ST SulTRAC

August 21, 2012

Mr. Howard Caine
Work Assignment Manager
Remedial Response Unit No.1
U.S. Environmental Protection Agency (EPA) Region 5
77 W. Jackson Blvd.
Chicago, IL 60604

Subject: **Final Sampling and Analysis Plan (SAP) for the**
Elm Street Groundwater Contamination Site, Terre Haute, Indiana
Remedial Action Contract (RAC) 2
Work Assignment No. 138-RICO-B5BF

Dear Mr. Caine:

SulTRAC is submitting an electronic copy of the revised sampling and analysis plan (SAP) for the above-referenced project. The revised SAP (dated August 15, 2012) consists of the field sampling plan (FSP) and the quality assurance project plan (QAPP). The sample management plan (SMP), the data management plan (DMP), and the health and safety plan (HASP), revised August 15, are also attached. The documents have been revised based upon EPA and IDEM's comments on the draft documents submitted in April 2012. Hard copies can be provided upon request.

The electronic files are attached and will also be transmitted via CD to your office and to IDEM.

If you have any questions regarding this submittal, please call me at (440) 781-7944.

Sincerely,

Brian Malone
SulTRAC Project Manager

Enclosure

cc: Parveen Vij, EPA Contracting Officer (letter only)
Mindy Gould, SulTRAC Program Manager (letter only)
Jessica Huxhold Fliss, IDEM
File

SAMPLING AND ANALYSIS PLAN

ELM STREET GROUNDWATER CONTAMINATION SITE

SulTRAC has prepared this Phase II sampling and analysis plan (SAP) for the Elm Street Groundwater Contamination Site (Elm Street site) in Terre Haute, Indiana, under the U.S. Environmental Protection Agency (EPA) Remedial Action Contract (RAC) II for Region 5, Contract No. EP-S5-06-02, Work Assignment (WA) No. 138-RICO-B5BF. A Remedial Investigation (RI)/Feasibility Study (FS) is being conducted in two phases at the Elm Street site. The Phase I RI was conducted from September 29 to November 3 of 2009, while the Phase II RI will be conducted in the Summer 2012. The RI/FS process includes collecting site data to characterize the nature and extent of contamination and evaluating human health and ecological risks that may be posed by site contamination. The SAP addendum consists of the field sampling plan addendum (Attachment A) and the quality assurance project plan (QAPP) addendum (Attachment B), which are among the site-specific plans to be prepared under the WA in accordance with Task 1 of the EPA statement of work (SOW).Quality assurance (QA) and quality control (QC) protocols associated with sampling and analysis are presented in the QAPP addendum. Also provided are the data management plan (DMP), the sample management plan (SMP), and the health and safety plan (HASP). The attached documents are the final versions and incorporate EPA and IDEM comments and revisions to the draft documents.

REMEDIAL ACTION CONTRACT 2
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND
NON-TIME CRITICAL REMOVAL ACTIVITIES
IN REGION 5

ATTACHMENT A

PHASE II FIELD SAMPLING PLAN
ELM STREET CONTAMINATION GROUNDWATER SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

Prepared for
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604

Date Submitted:	August 15, 2012
EPA Region:	5
Work Assignment No:	138-RICO-B5BF
Contract No:	EP-S5-06-02
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ACRONYMS AND ABBREVIATIONS

µm	Micrometer
amsl	Above mean sea level
ATSDR	Agency for Toxic Substances and Disease Registry
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	Below ground surface
°C	Degrees Celsius
CLP	Contract Laboratory Program
COC	Chain of custody
CRL	Central Regional Laboratory
DCA	Dichloroethane
DCE	Dichloroethene
DGPS	Differential global positioning system
DOT	Department of Transportation
DPT	Direct-push technology
EM	Electromagnetic
EPA	U.S. Environmental Protection Agency
ESI	Expanded site inspection
FS	Feasibility study
FSP	Field sampling plan
FTL	Field team leader
GIS	Geographic Information System
GPR	Ground penetrating radar
GPS	Global positioning system
HASP	Health and safety plan
HHRA	Human health risk assessment
IAWC	Indiana American Water Company
ID	Identification
IDW	Investigation-derived waste
IDEM	Indiana Department of Environmental Management

MCL	Maximum contaminant level
MHz	MilliHertz
MS	Matrix spike
MSD	Matrix spike duplicate
MTS	Machine Tool Service
NPL	National Priorities List
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PID	Photoionization detector
PPE	Personal protective equipment
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RAC	Remedial action contract
RSL	EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites
RI	Remedial investigation
RISC	Risk Integrated System of Closure
SAP	Sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SLERA	Screening-level ecological risk assessment
SMO	Sample Management Office
SOP	Standard operating procedure
SOW	Statement of work
SSI	Screening site inspection
SVOC	Semivolatile organic compound
TAL	Target analyte list
TCA	Trichloroethane
TCE	Trichloroethene
TOC	Top of casing
UST	Underground storage tanks
VOC	Volatile organic compound
WA	Work assignment

1.0 INTRODUCTION

SulTRAC has prepared this Phase II field sampling plan (FSP) as part of the sampling and analysis plan (SAP) for the Elm Street Groundwater Contamination Site (Elm Street site) in Terre Haute, Indiana, under the U.S. Environmental Protection Agency (EPA) Remedial Action Contract (RAC) II for Region 5, Contract No. EP-S5-06-02, Work Assignment (WA) No. 138-RICO-B5BF. A Remedial Investigation (RI)/Feasibility Study (FS) is being conducted in two phases at the Elm Street site. The Phase I RI was conducted from September 29 to November 3 of 2009, while the Phase II RI will likely begin in Spring 2012. The RI/FS process includes collecting site data to characterize the nature and extent of contamination and evaluating human health and ecological risks that may be posed by site contamination. The SAP addendum consists of this FSP addendum (Attachment A) and the quality assurance project plan (QAPP) addendum (Attachment B), which are among the site-specific plans to be prepared under the WA in accordance with Task 1 of the EPA statement of work (SOW) (EPA 2008). Quality assurance (QA) and quality control (QC) protocols associated with sampling and analysis are presented in the QAPP addendum.

This FSP addendum describes only the field activities to be conducted during the Phase II RI. In cases where additional sampling is to be conducted following the same procedures that were described in the Phase I FSP, this FSP addendum presents the number and locations of additional samples and refers to the Phase I FSP (SulTRAC 2009) that was approved by EPA on September 18, 2009 for sampling procedures. In cases where field sampling activities that differ from those conducted during the Phase I RI are to be conducted, this addendum describes the sampling approach and methods and relevant standard operating procedures (SOP) are provided, as needed.

Indiana American Water Company (IAWC) operates the city of Terre Haute municipal water system. Several municipal wells and a radial collector well are located adjacent to the site to the west. The municipal wells, which are installed in the deep portion of a surficial sand and gravel aquifer along the east bank of the Wabash River, have shown detectable levels of volatile organic compounds (VOC) including tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,2-dichloroethene (1,2-DCE) since 1988. Three potential source areas have been identified by the Indiana Department of Environmental Management (IDEM): I. Gurman (Gurman) property located at 800 North 3rd Street; the Ashland (formerly BiState Products) property located at 118 Elm Street; and the Machine Tool Service (MTS) property located at 117 Elm Street.

For purposes of the Phase I investigation, SulTRAC subdivided the MTS property into two potential source areas, including the MTS building and surrounding land (MTS property) and the former roundhouse and the former Sinclair Oil areas in the central and eastern part of the MTS property (former Sinclair/round house area). Therefore, the site was subdivided into the following four distinct investigation areas for the Phase I investigation: (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the former Sinclair/roundhouse area. The same four investigation areas are the focus of the Phase II RI.

SulTRAC will perform various field activities or combinations of activities for data acquisition to support the RI/FS. The primary goals of the Phase II investigation are to (1) investigate any data gaps identified from the Phase I investigation including soil, groundwater and soil gas, and, (2) delineate areas of soil contamination exceeding the Residential Soil, Industrial Soil and Protection of Groundwater generic values identified in the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSL) (3) further assess the potential vapor intrusion exposure pathway at the Riverside Apartment complex, Gurman processing area and MTS facility, (4) collect updated groundwater quality data, including additional information on background water quality, and (5) further investigate contaminant distribution in groundwater and aquifer characteristics. This FSP addendum addresses the following field investigations at the Elm Street site that will be performed as part of the Phase II activities:

Preliminary Phase II Activities—Completed January 2011

- Pre-intrusive Verification Sampling – Collecting groundwater samples for volatile organic compound (VOC) analysis from upgradient monitoring wells MW-7S, MW-7D, MW-14S, MW-14D, MW-15S, and MW-15D and on-site monitoring wells MW-8S, MW-8D, MW-10S, and MW-10D due to detections of VOCs in these wells

- Collecting soil gas samples for VOC analysis from soil gas wells SG001A, SG001B, SG002A, SG003A, SG003B, SG004A, SG004B,SG005A, SG005B,SG006A, and SG006B to further evaluate and verify VOCs detected at these locations

Phase II Activities

- Geological Investigation - SulTRAC will conduct geological investigations and collect surface and subsurface soil samples from a total of 46 soil borings drilled at the Ashland, Gurman, and MTS properties, the former Sinclair/roundhouse area, and two background locations east of US Highway 41. Grab groundwater samples will be collected from 14 of the investigative soil boring locations.

- Hydrogeologic Investigations — SulTRAC will install up to 7 monitoring wells, ranging in depth from about 50 to 150 feet. Three paired sets of new monitoring wells will be installed with one replacement well installed at MW-13D. Surface soil and subsurface soil samples will be collected from each location. Groundwater sampling of existing and newly installed monitoring wells will be conducted following well installation and development. In addition, four IAWC water supply wells will be sampled.

- Vertical Aquifer Sampling (VAS) – SulTRAC will advance a total of 9 soil borings, collect surface and subsurface soil samples and conduct vertical aquifer sampling. Monitoring wells MW-05, MW-03, MW-06 (NEW), MW-12, MW-01, MW-02, and MW-09 will be sampled in conjunction with the VAS program creating lines of VAS locations at three discreet areas of the site.

- Soil Gas Investigation — SulTRAC will conduct a soil gas investigation to assess the potential vapor intrusion exposure pathway near the Gurman building drum processing area, the MTS Machine building and three locations between the Riverside Apartment complex and utility corridors along Second Street. Nine new soil gas wells will be installed in paired sets with a shallow well and deep well at each location. Surface soil, subsurface soil and grab groundwater samples will be collected from each paired location. Soil gas sampling of existing and newly installed wells will be conducted following well installation and development.

- Aquifer Testing – SulTRAC will conduct a mechanical slug test on up to 11 wells to determine aquifer characteristics and variations site wide. SulTRAC will also monitor pumping effects of the IAWC wells and aquifer response from up to 4 monitoring wells on the east side of First Street. Transducers will be placed in monitoring wells to collect data while IAWC wells are activated in the normal cycling operation.

The groundwater samples from monitoring wells, surface water and soil samples will be analyzed through EPA's Contract Laboratory Program (CLP). The soil gas samples from existing wells will be analyzed through EPA's Central Regional Laboratory. Soil gas samples from new wells will be analyzed for rush turnaround by a subcontracted laboratory to provide data for decision making purposes. Groundwater samples from 14 grab groundwater locations and all vertical aquifer sampling locations will be analyzed by EPA's mobile laboratory, if available, or by a subcontracted laboratory for quick turnaround. Based upon the EPA's mobile laboratories availability and ability to handle the volume of samples collected, additional samples may require analysis by a subcontracted laboratory.

2.0 SITE DESCRIPTION AND HISTORY

The Elm Street site is located in Terre Haute, Indiana. Surrounding land includes an apartment complex and open/recreational land to the north, commercial and residential property to the east, commercial and industrial property to the south, and the IAWC and the Wabash River to the west. Therefore, the site is roughly bounded by Locust Street to the north, North 3rd Street (Highway 41) to the east, railroad tracks to the south, and the Wabash River to the west. The study area for the Elm Street site, located in Terre Haute, Vigo County, Indiana, encompasses 18.5 acres, including active facility buildings, abandoned buildings and related underground utilities, streets, railroad lines, and surrounding properties (Figures 1 and 2).

Surface and near-subsurface conditions of the site generally include silty fine sand with trace clay, fine to coarse gravel, and organic matter fill. Subsurface soils are predominantly very loose to dense silty fine to coarse sand with varied amounts of fine to coarse gravel to the water table, which exists approximately 50 feet below ground surface (bgs). Shale bedrock has been encountered below the site at approximately 130 to 150 feet bgs. The topography of the site is generally flat with a slight decline toward the Wabash River. The groundwater flow direction has been identified as trending from a northeast to southwest direction (IDEM 2002). This general flow pattern was confirmed during the Phase I sampling activities.

IAWC operates the city of Terre Haute municipal water system. Four municipal wells (IAWC 2, IAWC 3, IAWC 5, and IAWC 6) and a radial collector well are located adjacent to the site to the west; Figure 2 shows the location of the IAWC facility and the associated wells. Screen depths of nearby municipal wells include IAWC 2 at 96-118 feet bgs, IAWC 3 at 98-120 feet bgs, IAWC 5 at 104.5-124 feet bgs, and IAWC 6 at 89.5-99.5 feet bgs. The municipal wells, which are installed in the deep portion of a surficial sand and gravel aquifer along the east bank of the Wabash River, have shown detectable levels of VOCs including PCE, TCE, 1,1,1-TCA, and 1,2-DCE since 1988. The radial collector well is installed in alluvium about 1,200 feet west-northwest of the site (IDEM 2002).

IDEM has identified three potential source areas through the site assessment process. The potential sources areas include (1) the Gurman property located at 800 North 3rd Street, (2) the Ashland (formerly BiState Products) property located at 118 Elm Street, and (3) the MTS property located at 701 North 1st Street. A brief description and history of each of these areas (based on information provided by EPA and IDEM) is provided in Section 2.1.

According to the Terre Haute city Geographic Information System (GIS) portal, no storm water pipes, structures, encasements, or pump stations are located on any of the four investigation areas other than those identified on Figure 2. The features identified include: two storm water catchment basins east of the Gurman property, one near the foot of the U.S. Highway 41 overpass and one located in Locust Street, are connected and extend beneath the overpass, continuing east along Elm Street. According to the GIS data, no other storm water structures or related underground utilities are located on, or in right-of-ways between any of the three properties.

As previously noted, the site will be subdivided into four distinct investigation areas for the Phase II investigation, including (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the former Sinclair/roundhouse area. The properties will be assigned distinct identifiers to separate sampling locations by potential source area (see Figure 2).

2.1 SITE HISTORY

The Gurman facility has been in operation since 1922. The northern one-third of the property was residential prior to the early 1980s. From 1930 to 1980, Gurman primarily reconditioned and sold steel barrels. Since 1980, Gurman primarily sold paper and plastic containers and reconditioned customer-owned drums. It is believed that Gurman accepted drums with various types and likely small quantities of product or waste material. The standard practice for most of its operational history from the 1950s to the 1980s was to open the drums and dump their contents onto the ground surface, then rinse the remaining contents down the storm sewer in the process area before they were refurbished. During IDEM’s screening site inspection (SSI) in 1987, about 4,000 barrels were believed to be on site. About 1,000 barrels were believed to be on site during the 1999 expanded site inspection (ESI).

The Ashland facility (formerly BiState) served as a local supplier of Texaco products from the 1930s through the 1980s. Petroleum products were stored in bulk and distributed, and solvents were used for parts cleaning at local service stations. In 1980, MTS purchased the property and leased it to BiState, which operated the facility for satellite collection and storage of waste oils. In the late 1980s, the property was purchased by Consolidated Recycling for petroleum recycling. In the early 1990s, the property was transferred to Valvoline Oil Company (Valvoline). From 1990 through 1998, the property was owned and operated by First Recovery, a former division of Valvoline. In 1999, many Valvoline recycling facilities were transferred to Safety Kleen; however, Ashland, the current owner of Valvoline, stated that in 1999, Safety Kleen did not take possession of the property but removed some real property in early 2000. In addition, two underground storage tanks (UST) were removed near the warehouse area in 1986 and 1988, respectively (IDEM 2002). The used oil storage operations that followed may have accepted oils containing solvents; however, the presence of chlorinated VOCs in the raw municipal well water predates the oil recycling operations.

According to historical records, in 1911, MTS property housed the Terre Haute Oil Company. Multiple storage tanks, a coal shed, and empty barrels were reportedly present on the property. By 1950, the Terre Haute Oil Company was no longer present. MTS purchased the property in 1975; however, historical research indicates the buildings were used for machine tool and equipment repair since 1967. The MTS facility also stored petroleum products and solvents on the eastern portion of the property, which includes a remnant bulk oil containment with aboveground storage tanks (AST) and small warehouse building (IDEM 2002). Furthermore, a former locomotive repair and maintenance facility (roundhouse) existed on the central portion of the property. Although no evidence exists to substantiate the use of solvents during locomotive repair operations at the facility, the use of solvents is considered common practice during that period. In addition, a Sinclair Oil facility was on the eastern portion of the property.

IAWC, which operates the municipal water works in Terre Haute, began noticing chlorinated VOCs in samples from the deep wells in the early 1980s during required monitoring of its well field (IDEM 2002). The site discovery process for the Elm Street site began by IDEM in 1987 based on information submitted by IAWC. VOCs have not been detected in the radial collector well. Source areas for the Elm Street site are summarized in Table 1.

TABLE 1
POTENTIAL SOURCE AREAS IDENTIFIED AT THE ELM STREET SITE

Identified Area	Description
Gurman Property	Drum recycling facility with detected concentrations of VOCs.
Ashland Property	Bulk storage of waste oils in aboveground storage tanks, removed underground storage tanks, chemical drum storage, and storage and distribution of solvents. Detected concentrations of VOCs and petroleum hydrocarbons.
MTS Property	Machining operations and equipment repair facility on the western portion of the site.
Former Sinclair/Roundhouse Area	Historical bulk oil and solvent storage on the eastern portion of the property. Historical locomotive roundhouse for engine storage and repair on the central portion of the property.

Sources of metals on the Elm Street site could be attributed to multiple distinct operations site wide — specifically, remnant metals contamination in waste solvents in drums recycled at the Gurman property, locomotive repair operations at the former roundhouse, machining operations at the MTS property, and distribution along the Penn Central Railroad from hauling raw ores or scrap metals via open box train cars. Additionally, lead contamination from repair of locomotives is suspected in the area of the former roundhouse.

Pesticides and herbicides may be found at the Elm Street because the railroads commonly sprayed these types of products in the mid-1900s for vegetation control; the Penn Central railroad is located along the southern boundary of the study area, just south of the IAWC and MTS properties. Pesticides also may have been used for control measures during site operations.

Many documented potential organic contaminant sources led IDEM to suspect potential contamination by semivolatile organic compounds (SVOC) and VOCs at the Elm Street site. VOC and SVOC use have been pervasive at the Gurman, MTS, and Ashland properties and the former Sinclair/roundhouse area, as detailed in the following list of source candidates for potential soil and groundwater contamination:

- Gasoline or coal-powered locomotives used for moving cars along the southern boundary of the site.
- Locomotive repair at the roundhouse.
- Presence of numerous above ground storage tanks at the former Sinclair containment area and Ashland property.
- Underground storage tanks formerly located at the Ashland property.
- Machinery and engine oils used at the roundhouse.
- Coal burning at the roundhouse.
- The presence of carbon tetrachloride fire extinguishers.
- The presence of engine/machine shops.

Polychlorinated biphenyl (PCB) contamination may also be found in surface soils of the Elm Street site. PCBs were used in electrical transformers manufactured between 1929 and 1977. The removal and disposal of these transformers is not documented; thus, PCB soil contamination may be found in the vicinity of former transformer sites.

2.2 FORMER SITE INVESTIGATIONS

Site investigations prior to the Phase I RI completed in November 2009 are summarized in the Phase I FSP, Section 2.2 (SulTRAC 2009a). The Phase I RI included: a geophysical survey, a storm sewer investigation, drilling, installing and developing new monitoring wells, drilling, installing and developing soil gas wells, surface and subsurface soil sampling, grab groundwater sampling, groundwater sampling from monitoring wells, and soil gas sampling. An additional follow-up confirmation sampling of 11 soil gas wells and 10 groundwater monitoring wells was conducted in January 2011. A summary of the Phase I RI activities was presented in the Data Evaluation Summary Report (SulTRAC, 2012a). A summary of the analytical results from the Phase I RI is presented below.

SOIL SAMPLES

Surface soil samples were obtained from the 0 to 2 foot sample interval from each boring location. Analytical results for surface soil were compared to the Residential Soil, Industrial Soil and Protection of Groundwater generic values identified in the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites. Results for each analyte group are summarized below.

VOLATILE ORGANIC COMPOUNDS

A total of 71 field and 6 duplicate surface soil samples (0 to 2 feet bgs) were analyzed for VOCs.

- None of the results for VOCs exceeded the Industrial Soil RSLs. PCE exceeded the residential screening level at location SB-22.
- VOC results for surface soil were also compared to the Protection of Groundwater Soil Screening Levels (SSL's), the Risk Based and/or MCL based, which are indirect exposure values and much lower than the direct exposure Residential and Industrial RSLs. The VOC results that exceeded the Protection of Groundwater SSLs (risk based and/or MCL based) were: Methylene chloride, *trans*-1,2-DCE, Methyl tertiary butyl ether, 1,1-DCA , *cis*-1,2-DCE, Chloroform, 1,1,1-TCA, Benzene, Toluene, TCE, PCE, Ethylbenzene, 1,1,2,2-Tetrachloroethane, 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene (TCB), 1,2,3-Trichlorobenzene.

All subsurface soil samples collected from soil borings were analyzed for VOCs. A total of 143 field and 12 duplicate samples were analyzed for VOCs. Two subsurface depths were collected from each boring. One sample was collected from a 2-foot interval within the 2-10 foot depth range and one sample from a 2-foot interval within the 10-20 foot depth range.

- One sample, SB-44, exceeded the Residential or Industrial Soil RSLs for VOCs. 1,1,2-Trichloroethane exceeded residential screening levels, while 1,1,2,2-Tetrachloroethane exceeded industrial screening levels at this location. Location specific analytical results were presented in Section 5.1 of the DESR, Table A-1 and Figures B-4 through B-6.
- The following detected analytes exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) : Methylene Chloride , 1,1-DCA, 1,1-DCE, cis 1,2-Dichloroethene, Chloroform, Benzene, 1,4-Dichlorobenzene, Ethylbenzene, Toluene, 1,1,2-TCA, 1,1,2,2 – Tetrachloroethane, 1,2,4 – TCB, trans-1,3-Dichloropropene, 2-Hexanone, Dibromochloromethane , 1,2-

Dibromoethane, and 1,2,3 – TBC. In addition, concentrations of TCE exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) in 16% of the samples. Concentrations of PCE exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) in 56% of the samples. Location specific analytical results for all VOCs detected in subsurface soil are presented in Section 5.1 of the DESR and are depicted on Figures B-4 through B-6.

SEMIVOLATILE ORGANIC COMPOUNDS

All surface soil samples collected were analyzed for SVOCs. A total of 71 field and 6 duplicate surface samples (0 to 2 feet bgs) were analyzed for SVOCs. Of these results, only the concentrations of five analytes, all PAHs, exceeded the residential soil and/or industrial soil RSLs: benzo(a)anthracene (BA), benzo(a)pyrene (BPY), benzo(b)fluoranthene (BBF), benzo(k)fluoranthene (BKF), and indeno(1,2,3-cd)pyrene (IDP). Location specific analytical results for all SVOCs detected in surface soil are presented in Section 5.1 of the DESR in Table A-2 and are depicted on Figure B-7.

- Surface soil sample PAH concentrations that exceeded RSLs were detected at locations throughout the site. BA was detected at 34 locations at concentrations exceeding the residential soil RSL, and at one location (SB-32) exceeding the industrial RSL, with a maximum concentration of 2,200 µg/kg. BPY was detected at 29 locations exceeding the residential soil RSL, and at 29 locations exceeding the industrial RSL, with a maximum concentration of 1,700 µg/kg at location SB-032. BKF was detected at one location (SB-032) exceeding the residential soil RSL at a concentration of 1,500 µg/kg. BBF was detected at 36 locations exceeding the residential soil RSL, and at three locations exceeding the industrial soil RSL, with a maximum concentration of 3,400 µg/kg at location SB-032. IDP was detected at 23 locations exceeding the residential soil RSL, with a maximum concentration of 910 µg/kg at location SB-032. All analytical results for SVOCs in surface soil exceeding residential or industrial RSLs are included in Section 5.1 of the DESR and depicted on Figure B-7.

- Subsurface soil contamination of SVOCs exceeding RSLs is predominately PAH compounds and is evidenced at most sampling locations. Resulting concentrations of subsurface PAH exceeding RSLs were generally within the upper 10 feet of soil. The highest concentrations of PAHs occurred at locations SB-032 near the former location of railroad tracks on the Ashland property and near the MTS southeast portion of the MTS building where a set of railroad tracks was used to move railcars to the facility for maintenance. The sampling locations in the area of the Former Sinclair Containment also exhibited elevated concentrations of surface and subsurface PAH contamination suggesting a possible historic release from the containment area. Location specific analytical results are discussed in detail in section 5.1of the DESR and depicted on Figure B-8 of the report.

METALS

All surface soil and subsurface soil boring samples collected were analyzed for metals. Analytical results are discussed for each analyte below as exceedances of the Residential Soil and Industrial Soil RSLs.

- Arsenic was detected in concentrations exceeding the Industrial Soil RSL in every surface and subsurface sample collected. Lead was detected in varying concentrations in surface and subsurface samples at the site. One surface soil sample SB-22 exceeded the Residential Soil RSL with a concentration of 675 mg/kg. No other exceedances of lead were reported. Mercury was detected in varying concentrations in surface and subsurface samples at the site. One subsurface soil sample SB-44 at a depth of 18 feet bgs exceeded the Residential Soil RSL with a concentration of 8.6 mg/kg. No other exceedances for Mercury were reported. Location specific analytical results for metals were discussed in detail in section 5.1of the DESR and are presented in Table A-3 of the report.

POLYCHLORINATED BIPHENYLS

Select surface soil samples were collected and analyzed for PCBs based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate sample were collected and analyzed for PCBs. Location specific analytical results were provided in Tables A-4 and depicted on Figure B-9 of the DESR.

- Surface soil sample SB-17 exceeded the Residential Soil RSL for Arochlor 1254 with a concentration of 410 µg/kg. Surface soil sample SB-21 exceeded the Industrial Soil RSL for Arochlor 1254 with a concentration of 900 µg/kg. Surface soil sample SB-67 exceeded the Industrial Soil RSL for Arochlor 1260 with a concentration of 3,000 µg/kg. Location specific analytical results for PCBs were discussed in detail in section 5.1of the DESR and are presented in Table A-4 of the report.

PESTICIDES

Select surface soil samples were collected and analyzed for pesticides based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate surface samples collected were analyzed for Pesticides. Due to the nature of the Clor-N-Soil field test and possible chemical interferences, the same sample locations were selected for analysis of Pesticides that were analyzed for PCBs. A compound-specific discussion of exceedances is summarized below.

- One sample, SB-21, exceeded the Industrial RSL for Heptachlor (380 µg/kg) with a concentration of 3,500 µg/kg, Heptachlor Epoxide (190 µg/kg) with a concentration of 220 µg/kg, and gamma-Chlordane (6,500 µg/kg) with a concentration of 30,000 µg/kg. No other samples analyzed for Pesticides exceeded the Residential Soil or Industrial Soil RSL.

All analytical results were estimated (J qualifier) and most were marginally above the method quantitation limit with the exception of location SB-21. Location specific analytical results for Pesticides were discussed in detail in section 5.1of the DESR and are presented in Table A-5 of the report.

HERBICIDES

Select surface soil samples were collected and analyzed for Herbicides based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate surface samples collected were analyzed for Herbicides. Due to the nature of the Clor-N-Soil field test and possible chemical interferences, the same sample locations were selected for analysis of herbicides that were analyzed for PCBs.

- MCPA was detected in 45% of the samples exceeding the Industrial Soil RSL (310µg/kg) and 30% of the samples exceeding the Residential Soil RSL (31 µg/kg) with a maximum concentration of 3,200 µg/kg in SB-36. MCPP was detected in 55% of the samples above the Residential Soil RSL (61 µg/kg) and two samples (SB-38, 64) above the Industrial Soil RSL of 620 µg/kg. The maximum concentration was detected in sample SB-38 with a concentration of 1,900 µg/kg. Pentachlorophenol was detected in four samples (SB-36, 38, 16, 21) above the Residential Soil RSL of 3.0 µg/kg. Two samples, SB-17 and SB-70 exceeded the Industrial Soil RSL of 9.0 µg/kg with a maximum concentration of 63 µg/kg at location SB-70.

All analytical results were estimated (J qualifier) with the highest concentrations detected at locations SB-36, 38 on the Ashland property and SB-68, 70 on the Sinclair property. Most of the impacted areas are also identified with PCB contamination above the RSLs. Location specific analytical results for Herbicides were discussed in detail in section 5.1of the DESR and are presented in Table A-6 of the report.

GRAB GROUNDWATER

VOLATILE ORGANIC COMPOUNDS

Grab ground water samples were collected at all soil boring locations identified with “SB” with the exceptions of locations 030, 047, 057 and 073 where ground water samples could not be obtained. All grab groundwater samples collected were analyzed for VOCs. A total of 59 field and five duplicate surface samples were analyzed for VOCs.

Eight samples exceeded the MCL for PCE of 5 µg/L—at locations GB-031 (7.9 micrograms/liter [µg/L]), GB-036 (6.7 µg/L), GB-051 (7.3 µg/L), GB-070 (11 µg/L), GB-053 (14 µg/L), GB-017 (7.4 µg/L), GB-069 (6.1 µg/L), and GB-058 (8.2 µg/L).

No other exceedances of MCLs were reported for the other analytes tested. Analytical results are presented in Table A-7 of the DESR. Location specific analytical results for grab groundwater samples were discussed in detail in section 5.2 of the DESR, Table A-6 and depicted on Figures B-10 through B-13.

Concentrations of PCE and TCE were detected in shallow groundwater on the MTS property, the northeast corner of the former Sinclair property and the southeast corner of the Gurman property. Concentrations of PCE were also detected near the center of the Ashland property. Concentrations of TCA were detected in shallow groundwater south of the MTS building and the southeast corner of the former Sinclair property.

GROUNDWATER FROM MONITORING WELLS

A total of 27 field samples and three duplicate samples were collected from 14 well sets at the site. Paired wells of shallow (S) and deep (D) are at each location. MW-13D was collapsed approximately four feet bgs and was unable to be sampled. All shallow monitoring well samples collected were analyzed for VOCs, SVOCs, Metals, Pesticides and PCBs (deep monitoring well samples were analyzed for VOCs, and metals only). Location specific analytical results for groundwater samples from monitoring wells were discussed in detail in section 5.3 of the DESR, Table A-8 through A-12 and depicted on Figure B-14 and B-15.

VOLATILE ORGANIC COMPOUNDS

Analytical results were compared to EPA MCLs and IDEM RISC Default Closure Levels for Groundwater. Two results exceeded the MCL and RISC level for PCE of 5 µg/l. The sample collected from MW3S had a concentration of 6.8 µg/l. The sample collected from MW5S had a concentration of 5.5 µg/l. Analytical results for VOCs were presented in Table A-8 and depicted on Figure B-14 of the DESR.

Based on the results of the monitoring well sampling, low concentrations of VOCs were detected in numerous locations at the site.

SEMIVOLATILE ORGANIC COMPOUNDS

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for SVOCs. Samples for SVOC were only collected from the shallow monitoring wells in the network to determine if additional sampling for SVOC was warranted. Analytical results were compared to EPA MCLs and IDEM RISC levels for groundwater. None of the results were above laboratory reporting limits. Analytical results for SVOCs are presented in Table A-9 of the DESR.

METALS

A total of 27 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for unfiltered, total Metals. Exceedances of MCLs and RISC levels were reported for the analytes Arsenic, Beryllium, Cadmium, Chromium, Iron, Lead, Manganese and Thallium. A detailed discussion of exceedances of each analyte is presented below. Analytical results for Metals are presented in Table A-10 and depicted on Figure B-15 of the DESR.

Arsenic was detected above the MCL and RISC levels in MW-02D (16.8 µg/l), MW-08D (11.9 µg/l), MW-10D (19.8 µg/l) and MW-13S (72.4 µg/l). The MCL and RISC level for Arsenic is 10 µg/l.

Beryllium was detected above the MCL and RISC levels in MW-13S with a concentration of 5.8 µg/l. The MCL and RISC level for Beryllium is 4.0 µg/l.

Cadmium was detected above the MCL and RISC levels in MW-03S (45.1 µg/l) and MW-13S (16.2 µg/l). The MCL and RISC level for Cadmium is 5.0 µg/l.

Chromium was detected above the MCL and RISC levels in MW-13S with a concentration of 117 µg/l. The MCL and RISC level is 100 µg/l.

Iron was detected above the MCL in 55% of the samples collected. The maximum concentration was in MW-13S with a concentration of 146,000 µg/l. The MCL for Iron is 300 µg/l.

Manganese was detected above the MCL in 44% of the samples collected. The maximum concentration was in MW-13S with a concentration of 5,330 µg/l. The MCL for Manganese is 50 µg/l.

Thallium was detected in MW-13S at a concentration of 14.0 µg/l exceeding the MCL and RISC level of 2 µg/l. This result was an estimated result as it was below the laboratory reporting limit.

Based upon these results, metals were detected at elevated concentrations above the MCL and RISC level for numerous contaminants. The highest concentrations of metals detected were near the Ashland property and MW-13S.

POLYCHLORINATED BIPHENYLS

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for PCBs. Samples for PCBs were only collected from the shallow monitoring wells in the network to determine if additional sampling for PCBs was warranted. Analytical results were compared to EPA MCLs and IDEM RISC levels for groundwater. None of the results were above laboratory reporting limits.

PESTICIDES

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for Pesticides. Samples for Pesticides were only collected from the shallow monitoring wells in the network to determine if additional sampling was warranted. None of the analytical results were above laboratory reporting limits.

SURFACE WATER

One field and one duplicate surface water sample was collected and analyzed for VOCs, Metals, PCBs, Pesticides and Herbicides. The validated analytical results for the surface water samples were compared to EPA MCLs, IDEM RISC levels for groundwater and EPA Human Health criteria for Consumption of Water and Organisms. The analytical results for the surface water samples are presented in Table A-14 of the DESR. Four results were above analytical reporting limits and are discussed below. None of the results exceeded screening levels for any of the analytes tested. Analytical results for surface water samples were presented in detail in the DESR, Table A-14.

Volatile Organic Compounds: One analyte, 1,1 – Dichloroethene was detected above the laboratory reporting limit with a concentration of 0.76 µg/l. The MCL and IDEM RISC value is 7.0 µg/l.

Polychlorinated Biphenyls: No surfaced water sample results exceeded the SSL for PCBs.

Pesticides: No surfaced water sample results exceeded the MCL or IDEM RISC value for pesticides (Table A-14). Concentration for 2,4-D (0.13 µg/l), MCPA (0.10 µg/l), and MCPP (1.5 µg/l) were detected above laboratory reporting limits.

Herbicides: No surface water sample results exceeded the EPA MCL or IDEM RISC value for Herbicides.

SOIL GAS

Eleven field samples were collected from the soil gas wells surrounding the Riverside Apartment Complex during the RI in November, 2009. The eleven soil gas wells were also sampled during an additional sampling event in January, 2011. A sample could not be collected from location SG-002B (deep well) because the well had collapsed or become clogged with soil after installation. Soil gas results for the analytes 1,2-DCA, PCE, TCE, and vinyl chloride were compared to the IDEM RSGPALs, 20 and 30 year exposure duration for soil gas. Results for the remainder of the analytes that do not have established soil gas benchmark values were compared to RIAALs (10, 20 and 30 year exposure level for indoor air. Per IDEM guidance (IDEM 2006), RIAALs when compared to soil gas require use of an attenuation factor of 0.01 to derive the soil gas screening levels (SGSL). After applying the attenuation factor to the RIAAL to derive the SGSL, soil gas sample results were compared to the SGSLs to identify any exceedances. Screening level exceedances are discussed by analyte below. All wells identified below have the identifier A as the shallow well (approximately 5 feet bgs) and B as the deep well (within about 2 feet of the water table). Analytical results for soil gas samples are presented in Table A-15 of the DESR. Exceedances of RSGPALs and SGSLs are depicted in the DESR on Figure B-16.

PCE concentrations at SG-001A exceeded the IDEM RSGPAL, 30 year exposure level for the 2011 sampling event with a concentration of 47,400 pptv. The RSGPAL, 30 year exposure level for PCE is 47,000 pptv.

PCE concentrations at SG-001B exceeded the IDEM RSGPAL, 20 and 30 year exposure level for the 2009 sampling event with a concentration of 84,200 pptv. The RSGPAL, 20 and 30 year exposure level for PCE are (64, 000 and 47,000 pptv), respectively.

PCE concentrations at SG-003B exceeded the IDEM RSGPAL, 10, 20 and 30 year exposure level for the 2009 sampling event and exceeded the 20 and 30 year exposure level for the 2011 sampling event. PCE was detected at a concentration of 145,000 pptv in 2009. PCE was detected in the 2011 sample, and its duplicate at concentrations of 69,800 and 92,600 pptv respectively. The RSGPAL, 10, 20 and 30 year exposure level for PCE are (100,000, 64, 000 and 47,000 pptv), respectively.

PCE concentrations at SG-004B exceeded the IDEM RSGPAL, 20 and 30 year exposure level for the 2009 and 2011 sampling events. PCE was detected at a concentration of (120,000 and 59,600 pptv) respectively. The RSGPAL, 20 and 30 year exposure level for PCE are (64, 000 and 47,000 pptv), respectively.

Chloroform concentrations at locations SG-003B and SG-004B exceeded the IDEM SGSL, 30 year exposure level for the 2009 sampling event with concentrations of (18, 500 pptv) and (21,100 pptv) respectively. The SGSL, 30 year exposure level, for chloroform is 17,000 pptv.

Chloroform concentrations at location SG-005B exceeded the IDEM SGSL, 20 year exposure duration for both the 2009 and 2011 sampling events with concentrations of (29,100 pptv) and (30,100 pptv) respectively. The SGSL, 20 year exposure level, for chloroform is 23,000 pptv.

Based upon the results of the soil gas sampling, VOC concentrations are generally elevated in the southern and eastern wells. Moreover, VOC concentrations tend to be higher in the “B” series wells at greater depths near the water table. Only one exceedance of the RSGPAL, 20 year exposure level was observed in SG-001A, which is the shallow well, east of the Riverside Apartment complex.

The chemicals of interest potentially hazardous to human health and the environment at the Elm Street Site were identified based on these investigations and information obtained by SulTRAC. These chemicals of interest are shown in Tables 2 and 3.

TABLE 2
CHEMICALS DETECTED IN SOIL IN GREATEST CONCENTRATIONS

Facility	Year	Boring or Well Location	Sample Depth (feet)	Results (µg/kg)	
				Tetrachloroethene	Trichloroethene
Gurman	1999	B5	15	13	ND
	1999	B6	10	14	ND
	1999	B7	15	17	ND
	1999	B8	5	85	ND
	1999	B8	15	57	12
	1999	MW-8	15	53	ND
	2009	SB-14	2	1.5	61
	2009	SB-15	2	110	48
	2009	SB-15	4	27	6.6
	2009	SB-15	14	52	7.5
	2009	SB-17	2	4.3	13
	2009	SB-18	18	140	14
	2009	SB-19	20	230	ND
	2009	SB-21	10	42	19
	2009	SB-21	14	17	1.6
	2009	SB-22	2	810	1200
	2009	SB-22	10	13	6
Ashland	1999	B11	15	27	ND
	2009	SB-33	14	19	2.2
	2009	SB-35	2	13	17
	2009	SB-35	4	34	9.5
	2009	SB-36	2	13	2.0
	2009	SB-36	4	23	3.7
	2009	SB-36	12	28	1.2
	2009	SB-40	2	42	12
	2009	SB-40	6	15	2.9
	2009	SB-40	16	11	9.6
MTS	1999	B1-B4	NA	NA	NA

Notes:

µg/kg = micrograms per kilogram
NA = Analytical results for soil samples collected at MTS were unavailable
ND = Not detected

Sources: 2002 Indiana Department of Environmental Management ESI report
2011 Data Evaluation Summary Report: Phase I Remedial Investigation

TABLE 3
CHEMICALS DETECTED IN GROUNDWATER

Site Location	**Well ID**	**Year**	**Results (µg/L)**										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethene	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
Ashland	MW-1S	1999	6	1	2	5	--	--	--	--	--	--	--
		2000	2.3	2.1	2.5	8.7	--	--	--	--	--	--	--
		2005	--	--	--	4.3	--	--	--	--	2.4	--	--
		2009	--	--	--	1.9	--	--	--	--	1.3	--	--
	MW-1D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	--	--
		2009	--	--	--	--	--	--	--	--	--	--	--
	MW-2S	1999	2	3	4	7	2	--	--	--	--	--	--
		2000	0.9	2.1	1.4	7.6	26	11	--	--	--	--	--
		2005	--		1.4	6.1	--	--	--	--	1.2	7.1	--
		2009	--	--	1.8	4.9	--	--	--	--	0.81	--	--
	MW-2D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	0.5	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	12	--
		2009	--	--	--	--	--	--	--	--	--	0.62	--
	MW-3S	1999	2	2	2	7	2	--	--	--	--	--	--
		2000	0.6	4.1	5.9	7.2	11	5	--	--	--	--	--
		2005	--	--	0.71	3.8	0.54	--	--	--	2.1	1.8	1.4
		2009	--	0.97	1.2	6.8	--	--	--	--	0.81	--	--
	MW-3D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	--	--
		2009	--	--	--	--	--	--	--	--	--	--	--
North of Locust Street	MW-4S	1999	0.7	--	--	--	--	--	--	--	--	--	--
		2000	DRY										
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-4S_NEW	2009	--	--	--	--	--	--	--	--	--	--	--
	MW-4D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-4D_NEW	2009	--	--	--	--	--	--	--	--	--	--	--

TABLE 3 (Continued)
CHEMICALS DETECTED IN GROUNDWATER

Site Location	Well ID	Year	Results (µg/L)										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethene	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
Gurman	MW-5S	1999	3	0.7	0.8	14	--	--	--	--	--	--	--
		2000	1.3	1.6	2.2	5.3	--	--	--	--	--	--	--
		2005	--	--	--	5.9	--	--	--	--	2.9	--	--
		2009	--	--	--	5.5	--	--	--	--	0.85	0.56	--
	MW-5D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	--	--
North of Locust Street	MW-7S	1999	0.6	--	--	--	--	--	--	--	--	--	--
		2000	1.8	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-7S_NEW	2009	--	--	--	--	--	--	--	--	0.73	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-7D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-7D_NEW	2009	--	--	--	--	--	--	--	--	--	0.55	--
		2011	--	--	--	--	--	--	--	--	--	--	--
Gurman	MW-8S	1999	2	3	--	8	12	3	--	--	--	--	--
		2000	0.7	25	10	22	44	11	2.2	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	3.1	--	--	--	--	--	2.3	--
		2009	--	0.58	--	3.3	--	--	--	--	0.72	0.62	--
		2011	--	1.9	3.4	5.1	2.5	0.81	--	--	--	--	--
	Duplicate	2011	--	2.1	4.2	6.0	3.0	0.89	--	--	--	--	--
	MW-8D	1999	--	--	--	0.6	--	--	--	--	--	--	--
		2000	--	--	0.7	0.9	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	0.53	--
		2009	--	--	--	--	--	--	--	--	--	0.96	--
		2011	--	--	--	--	--	--	--	--	--	--	--
MTS	MW-9S	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	1.4	600	--	--	7.2	1.2	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	1.7	--	--	--	--	--
	MW-9D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	1	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	0.80	--

TABLE 3 (Continued)
CHEMICALS DETECTED IN GROUNDWATER

Site Location	Well ID	Year	Results (µg/L)										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethene	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
MTS	MW-10S	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	0.5	37	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	1.1	--	--	--	--	--	--	--	--	--
		2011	--	0.70	--	--	--	--	--	--	1.6	--	--
	MW-10D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-11S	2009	--	0.64	--	--	--	--	--	--	--	--	--
	MW-11D	2009	--	--	--	--	--	--	--	--	--	--	--
	MW-12S	1999	2	--	--	--	--	--	--	12	--	--	--
		2000	3.6	600	--	--	7.2	1.2	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	6.1	--	--	--	--	--	--	1.9	2.0	--
	MW-12D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	2.8	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009		--	--	--	--	--	--	--	--	1.2	--
North of Locust Street	MW-13S	1999	--	--	--	1	--	--	--	--	--	--	--
		2000	1.6	--	--	0.5	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	2.9	--	--
	MW-13D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-14S	2009	--	--	--	0.73	--	--	--	--	--	--	0.82
		2011	--	--	--	0.49	--	--	--	--	--	--	--
	MW-14D	2009	--	--	--	--	--	--	--	--	--	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-15S	2009	--	--	--	--	--	--	--	--	0.73	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-15D	2009	--	--	--	--	--	--	--	--	--	--	0.83
		2011	--	--	--	--	--	--	--	--	--	--	--

Notes:
µg/L = Micrograms per liter
-- = Not detected
NS = Not sampled
Sources: 2002 Indiana Department of Environmental Management ESI report; 2005 URS Corporation Limited Phase I/Phase II; 2009 SulTRAC Phase I Remedial Investigation; 2011 SulTRAC Phase I Remedial Investigation: Confirmation Sampling Event

3.0 PROJECT OBJECTIVE

This FSP describes the approach that will be used to conduct Phase II of the RI/FS at the Elm Street site. Phase I encompassed field and other activities to identify potential contamination source areas and begin defining the nature and extent of contamination. The Phase I investigation provided some of the data required to identify whether the identified properties are potential contamination source areas, whether potential additional contamination source areas exist upgradient of the Gurman property, the concentrations and depths of contamination in soil at the identified properties, the impact to shallow and deep groundwater beneath the site, whether vapor intrusion is potentially occurring at the Riverside apartment complex, and other potential soil gas receptors at the MTS and Gurman properties.

Based on the results of the Phase I investigation, data gaps were identified and presented in the Phase I DESR (SulTRAC 2012). Data gaps identified after the Phase I investigation include:

- Based upon the surface and subsurface soil investigation, the data does not indicate a large or concentrated source area of soil contamination, rather historic small areas of release potentially contributing to groundwater contamination. The area around the Gurman drum processing area exhibited the most frequent detected concentrations of VOCs in soil. However, none of the results exceeded the RSLs. The frequency of VOC detections and the limited access in and around the Gurman process area during the investigation warrant further investigation of surface and subsurface soils.

- Concentrations of VOCs in the subsurface soil at location SB-044 at a depth of 10 feet with no surface soil detections is an apparent anomaly. The geophysical survey results indicated a possible subsurface feature of interest in the area of SB-044 which warrants further surface and subsurface soil investigation.

- Subsurface soil contamination of SVOCs exceeding RSLs is predominately PAH compounds and is evidenced at most sampling locations. Resulting concentrations of subsurface PAHs exceeding RSLs were generally within the upper 10 feet of soil. Locations SB-019 (18 feet bgs), SB-022 (18 feet bgs), SB-065 (18 feet bgs), SB-064 (18 feet bgs), SB-061 (20 feet bgs) and SB-057 (18 feet bgs) were exceptions. The highest concentrations of PAHs occurred at locations SB-032 (4 feet bgs) near the former location of railroad tracks on the Ashland property and near the MTS southeast portion of the MTS building where a set of railroad tracks was used to move railcars to the facility for maintenance. The sampling locations in the area of the Former Sinclair Containment also exhibited elevated concentrations of surface and subsurface PAH contamination suggesting a possible historic release from the containment area. Based upon the spatial coverage of sampling and results, additional soil sampling and delineation is warranted in the area of the Former Sinclair above ground storage tank containment and the Ashland property in the area of SB-032. Due to the depth of exceedances at SB-065 (18-20 feet), a grab groundwater sample should be collected in the area of SB-065 to determine if groundwater has been impacted in this area.

- Additional soil sampling and analysis for metals will be conducted in the area of SB-022 and SB-044 to delineate the extent of contamination. Based on the Phase I results, additional soil sampling for delineation of metals is not warranted at the site. Adequate spatial coverage was obtained to assess the impacts of various operations at the site. Areas identified with elevated Arsenic concentration are impacted with other contaminants and results are from samples within the top two feet of soil. Additional background sampling is warranted in the Phase II investigation at off-site areas during monitoring well installation.

- Based upon the locations of the samples with analytical detections of PCBs and those that exceeded the RSLs, PCB contamination in the surface soil appears to be localized to the southeast corner of the Gurman property and northeast corner of the Former Sinclair Oil property. Additional limited surface soil investigation and delineation of near surface PCB contamination is warranted in the above mentioned areas. The positive detection at location SB-057 is considered an outlier and may be attributed to its proximity to overhead powerlines and associated transformers.

- Based upon analytical results for Pesticides, limited investigation in the Phase II RI is warranted. One sample, SB-021, exceeded the Industrial RSL for Heptachlor (380 µg/kg) with a concentration of 3,500 µg/kg, Heptachlor Epoxide (190 µg/kg) with a concentration of 220 µg/kg, and gamma-Chlordane (6,500 µg/kg) with a concentration of 30,000 µg/kg. No other samples analyzed for Pesticides exceeded the Residential Soil or Industrial Soil RSL. All analytical results were estimated (J qualifier) and most were marginally above the method quantitation limit with the exception of location SB-021. Based on these results, limited investigation and analysis for Pesticides in the area of SB-021 is warranted.

- All Herbicide analytical results were estimated (J qualifier) with the highest concentrations detected at locations SB-036 and SB-038 on the Ashland property and SB-068 and SB-070 on the Sinclair property. Based on these results, limited surface and subsurface soil investigation and delineation of near surface Herbicide contamination is warranted in the above mentioned areas. Most of the impacted areas are also identified with PCB contamination above the RSLs. Proposed sample locations for Phase II include both PCB and Herbicides analysis for surface and shallow subsurface soil.

- Based on the results of the monitoring well sampling, low concentrations of VOCs were detected in numerous locations at the site. Additional sampling and analysis of VOCs in existing monitoring wells is warranted. Installation of additional paired monitoring wells is warranted to address data gaps and bound the site from any potential off-site contributors of contamination.

- Based upon analytical results from the Phase I investigation, numerous metals were detected at elevated concentrations above the MCL and RISC level in monitoring wells at several locations. The highest concentrations of metals detected were near the Ashland property and MW-13S. Additional sampling of existing shallow and deep monitoring wells should include dissolved metals using field filter techniques in addition to total metals. Additional investigation of the deeper portion of the aquifer at location MW-13 is warranted. Any additional wells installed in the deeper portion of the aquifer should be sampled for dissolved metals in addition to total metals.

- Based upon the results of the soil gas sampling, VOC concentrations are generally elevated in the southern and eastern wells. Moreover, VOC concentrations tend to be higher in the “B” series wells at greater depths near the water table. Only one exceedance of the RSGPAL, 20 year exposure level was observed in SG-001A, which is the shallow well, east of the Riverside Apartment complex. Based upon the number of detections and relatively low concentrations of VOCs in groundwater, additional sampling and analysis of soil gas in the area of the Riverside

Apartment Complex is warranted to confirm the initial results. However, since the exceedances were in the deep series wells only (with the exception of PCE in the 2011 sample from SG-001A), sub-slab and indoor air sampling is not warranted at this time. Sampling will be conducted in a different season with warmer ambient temperatures to evaluate the potential for season variations which may exceed screening levels. Based upon the exceedance of PCE at location SG-001A, additional soil gas investigation with soil sampling and grab groundwater sampling is warranted east of the Riverside Apartment complex to determine if it is a result of soil contamination in the area or elevated groundwater concentrations contributing to soil gas which has a potential for migration. Soil and grab groundwater samples should be collected at the locations of existing soil gas wells with screening level exceedances. Additional soil gas investigation and grab groundwater sampling should be also conducted at the Gurman and MTS properties, based upon VOC concentrations detected in the surface and subsurface soil.

As a result of the identified data gaps, SulTRAC prepared a subsequent work plan for a Phase II investigation. The specific objectives of the Phase II investigation are as follows:

- Investigate any data gaps identified from the Phase I investigation including soil, groundwater and soil gas.
- Delineate areas of soil contamination exceeding the Residential Soil, Industrial Soil and Protection of Groundwater generic values identified in the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites
- Re-sample soil gas at existing well locations and collect additional soil and groundwater samples near existing locations.
- Further investigate soil, groundwater and soil gas east of the Riverside Apartment complex.
- Install soil gas wells and sample soil, groundwater and soil gas near the Gurman drum processing area and the MTS facility.
- Collect updated groundwater quality data, including additional information on background water quality
- Further investigate contaminant distribution in groundwater and aquifer characteristics by conducting VAS and a pneumatic draw-down test.
- Further investigate pumping effects of IAWC wells on potential contaminant migration in the aquifer by measuring pumping effects using transducers in monitoring wells east of the IAWC well field.

Data collected from the Phase II RI is expected to address Phase I data gaps and provide the required information to determine the nature and extent of contamination, complete necessary risk assessments to evaluate actual or potential risks posed by site contaminants and conduct a Feasibility Study to evaluate potential remedial alternatives to address site contamination.

4.0 FIELD SAMPLING ACTIVITY

Field sampling activities discussed in this section pertain to the Phase II RI. Figure 4 shows the locations of proposed Phase II sampling and investigation activities, and Table 4 lists all samples to be collected, the number of samples, and specific information on sample collection. A detailed discussion of sample collection procedures is presented in Section 5.0.

Before intrusive field work begins, utilities will be located and sampling locations may be modified based upon utilities in the area of investigation.

As discussed with the EPA and as outlined in the Elm Street Groundwater Contamination Site work plan (SulTRAC 2011), SulTRAC will conduct the following Phase II field sampling activities:

- Collecting surface and subsurface soil samples from 46 investigative soil borings not including, monitoring well locations, background locations, VAS locations or soil gas well locations.
- Collecting groundwater grab samples at the water table at 14 of the 46 investigative soil boring locations
- Collecting surface soil, subsurface soil and groundwater grab samples at 6 previously installed soil gas locations and 9 new soil gas locations.
- Conducting VAS with surface and subsurface soil sampling at 9 soil boring locations with concurrent groundwater sampling from 12 existing monitoring wells.
- Collecting soil gas samples from 15 locations (nested pairs)
- Installing up to 7 new monitoring wells with surface and subsurface soil samples.
- Collecting surface and subsurface soil samples from two additional background locations (4 depths per boring)
- Performing mechanical rising and falling head tests to estimate aquifer characteristics
- Performing a pumping test using IAWC wells and measuring drawdown in nearby monitoring wells
- Collecting groundwater samples from existing and new monitoring wells
- Collecting groundwater samples from four existing IAWC wells

Phase II sampling activities are discussed further in Sections 4.3 and 4.4, and summarized in Table 4. Field activities to support ecological and human health risk assessments are discussed in Sections 4.5 and 4.6, respectively.

TABLE 4
SUMMARY SAMPLE INFORMATION FOR ELM STREET GROUNDWATER SITE

Number of Sampling Locations	Matrix	Depth (feet bgs)
14 locations	Soil and Groundwater	Soil samples at 0-2 and from a 2-foot interval within the 2-10, 10-20, 20-40 zones; groundwater samples at just below the water table (about 35-45) at each location
31 locations	Soil	Soil samples at 0-2, and 2-4 feet bgs at each sample location.
2 locations	Soil	Soil samples at 0-2, and from a 2-foot interval within the 2-10 foot zone at each location.
29 locations	Soil, Groundwater, and Soil Gas	Soil samples at 0-2 and from a 2-foot interval within the 2-10, 10-20, 20-40 zones; groundwater samples at just below the water table (about 35-45) at each location (15 total). Soil gas samples from nested wells, shallow (5 or greater) and deep (>30) deep, 30 total.
9 locations	Soil and Groundwater Vertical Aquifer Profiling	Soil samples at 0-2 and from a 2-foot interval within the 2-10, 10-20, 20-40 zones; groundwater samples at just below the water table and every ten feet to the total depth of the borehole.
12 locations	Groundwater From Wells Concurrent With Vertical Aquifer Profiling	Groundwater samples from both shallow and deep wells at locations MW-01, MW-02, MW-03, MW-05, MW-09, and MW-12.
17 locations (Shallow wells)	Groundwater	40-55
17 locations (Deep wells)	Groundwater	125-140
4 locations (IAWC Wells)	Groundwater	89.5-124

4.1 PRIVATE WELL SURVEY AND EVALUATION

Based upon information obtained from the Health Consultation conducted by the Agency for Toxic Substances and Disease Registry (ATSDR), 20 groundwater supply wells are located within the five-year time-of-travel (TOT) boundary. During the Phase I RI, SulTRAC reviewed the consultation and diagrams provided by EPA and conducted a physical reconnaissance of the reported location of the wells. Since most of the well locations were estimated and access agreements had not been secured, the reconnaissance was limited to a “windshield” survey and foot reconnaissance of publicly accessible areas. At locations where the address could be verified and a resident or worker was present, a brief interview was conducted which included: the name and address of the occupant, confirming the current or previous existence of a groundwater well at the address, the use of the well and current operational status, approximate volume of water utilized per day, the number of lines branched off the main well and their uses, if a water softener or filter was attached to the well, if the well had undergone water quality sampling and if the results of the analyses were available. Of the 20 wells identified in the five-year TOT boundary, two wells were confirmed to be present and in operation, one well was confirmed to have existed but was not in use and four well locations were identified as not having groundwater wells, three locations were abandoned or unoccupied at the time of the reconnaissance and 1 location was identified as a bad address.

For the Phase II RI, additional reconnaissance will be performed to confirm presence or absence of listed residential wells in the 5-year TOT. A door to door reconnaissance with a questionnaire will be conducted to determine the presence or absence of a residential well, if present the current use, and if abandoned the date of abandonment and known prior use.

4.2 UTILITIES LOCATION

SulTRAC will contact the local utility companies and the City of Terre Haute to conduct an underground utility location to identify any buried underground utilities related to electrical supply, storm water conveyance systems, drinking water conveyance systems, sanitary sewer systems, natural gas conveyance systems, telephone lines and cable television lines. SulTRAC will provide oversight of the utilities location and document general locations using a global positioning system (GPS). All utilities identified will be marked in the field using pin flags or spray paint as appropriate. The GPS locations of all utilities will be stored in a centralized database for future reference and re-locating as needed for additional investigations.

4.3 SOURCE AREA SOIL INVESTIGATIONS

SulTRAC will conduct geological investigations and collect surface and subsurface soil samples. Surface and subsurface samples will be collected via soil borings (Section 4.3.1) in a biased approach.

In this FSP the term “soil boring” or “surface soil sample” includes man-made substrates that have been filled or dumped at the Elm Street site. Surface and subsurface soil samples collected at the site from soil borings and as grab samples are expected to include both native soil and fill material. All field notebook entries and geologic logs must include one of the substrate designations for each sampled horizon unless no man-made substrates are encountered; in that case, the specific soil type (for example, sand, clay, gravel, etc.) will be identified in both the geologic log.

4.3.1 Soil Borings

During the Phase II field investigation, SulTRAC will collect soil samples obtained at a total of 74 investigative borings. The primary purpose of this sampling is to delineate potential contamination source areas, obtain additional soil contamination data near previously installed and newly installed soil gas well locations, and to provide additional background data that can be used to compare with on-site soil sample results. The proposed boring locations are at or near areas of contamination identified in the Phase I investigation that require additional delineation or further investigation of surface and subsurface soil and groundwater. Proposed locations (see Figure 4, 4A) were selected to further delineate source areas of contamination at the site, to supplement data obtained through prior investigations, and to bound the site from potential off-site contributors of contamination.

Soil recovered during boring advancement will be screened in two foot increments using a portable PID. Samples selected for analysis will be biased within each interval based on the concentration of VOCs detected by the PID. The soil sample with the highest PID reading from each sample segment (0 to 2 ft bgs, 2 to 10 feet bgs, 10 to 20 feet bgs, and 20 to 40 feet bgs) will be selected for analysis. If no concentration of VOC is detected by the PID, the sample that exhibits visible evidence of contamination or the sample from the deepest portion of each interval (0 to 2 ft bgs, 2 to 10 feet bgs, 10 to 20 feet bgs, and 20-40 feet bgs) will be selected for analysis. Table 8 provides a detail of anticipated analysis for select sample locations. All samples will be submitted for VOC analysis.

TABLE 5
SOIL BORING LOCATIONS FOR IDENTIFIED AREAS

Location	Use and Environmental Concern	Number of Soil Borings/Depth (feet)	Number of Soil and Grab Groundwater Samples
Gurman Property	Operating drum recycling facility where drums have historically been rinsed and cleaned, spilling contents on the ground surface.	4/4 9/40* SG 3/40* VAS 3/140	75
Ashland Property	Petroleum bulk storage in ASTs and chemical bulk storage in drums. USTs removed from the property.	9/4 2/10 VAS 3/140	34
MTS Property	Machining operations on the western portion of the site.	4/4 2/40* SG 3/40* VAS 3/140	45
Former Sinclair/Roundhouse Area	A former railroad roundhouse located on the central portion of the property. Petroleum bulk storage in ASTs on the eastern portion of the property.	13/4 3/40* MW 2(nested)/140	49
Riverside Apartment Building	Apartment building north of Ashland property with soil gas wells. One boring will be advanced at each soil gas well location.	SG 9/40*	45
Background East of US Highway 41	Evaluate potential for upgradient sources of contamination contributing to GW contamination.	1/40* MW 1(nested)/140	9
Downgradient	Re-drill MW-13S which was removed during storm sewer construction.	MW 1/40 (MW-13SR)	4

Note:

***** Number of samples indicated consists of four soil samples and one groundwater sample per boring and does not include QA/QC samples for each subset. This table excludes groundwater samples from monitoring wells and groundwater samples during VAS.

Analytical methods at each sampling location are detailed in Table 8. All samples will be analyzed for VOC at each depth interval. Select samples will also be analyzed for SVOCs, metals, pesticides and herbicides, and PCBs. Samples will be analyzed for these analytical groups using appropriate EPA methods, as identified in Section 6.0 of this FSP. QC samples (field duplicate, matrix spike [MS], and matrix spike duplicate [MSD]) will be collected for soils as described in Section 11.0 of this FSP.

4.3.2 Soil Gas Sampling

SulTRAC drilled and installed 12 soil gas wells around the perimeter of the Riverside Apartment Complex in the Phase I investigation. Two soil gas implants were installed at the borehole at each sampling location. One implant was placed approximately two feet from the static water level, and the second implant was placed approximately five feet from the ground surface. Soil gas samples were collected during the Phase I investigation and a subsequent re-sampling event in January 2011. A sample could not be collected from location SG-002B (deep well) because the well had collapsed or become clogged with soil after installation.

Analytical results from the Phase I investigation indicated exceedances of screening levels for compound specific soil gas action levels in three of the deep soil gas wells surrounding the Riverside Apartment complex. None of the analytical results from shallow soil gas wells directly adjacent to the apartment complex exceeded screening levels. The shallow soil gas well SG-001A located approximately 50 feet east of the apartment complex had an analytical result exceeding the screening level for PCE one of the two times sampled. Existing soil gas wells will be re-sampled for VOCs during the spring sampling event to confirm analytical results and collect data during a different season to evaluate temporal variations in soil gas results. If it is determined in preliminary field activities that soil gas wells are clogged or cannot produce viable samples, new soil gas wells will be installed during the advancement of soil borings and grab groundwater sampling at existing locations SG-001 through SG-006.

In addition to re-sampling existing soil gas wells, SulTRAC will install nine additional paired sets of soil gas wells and collect samples from each location. Three paired soil gas wells will be installed between the utility corridor along 2nd street and the Riverside Apartment complex. Three paired soil gas wells each will be installed around the perimeter of the Gurman and MTS buildings in areas of elevated soil and groundwater VOC concentrations detected during the Phase I investigation. Paired soil gas probes will be installed in a similar manner to the Phase I investigation. One soil gas sample will be collected within 5 feet bgs at each gas probe location. An additional soil gas sample will be collected at a deeper depth, within approximately 5 feet of the groundwater table (approximately 35-40 feet bgs). All proposed sampling locations have been mapped (see Figure 4C). Soil and groundwater samples will be collected from each the soil borings prior to installation of the soil gas implants. The soil gas sampling procedures will be in accordance with the guidance provided in the IDEM Draft Vapor Intrusion Pilot Program (IDEM 2006).

4.4 GROUNDWATER

SulTRAC will conduct hydrogeologic investigations that will include installing and developing new monitoring wells, executing pneumatic slug tests, monitoring pumping effects of IAWC wells with transducers and collecting one round of samples at all monitoring wells and IAWC intake wells with surface elevation measurements.

Currently, 13 nested pairs of groundwater monitoring wells and one shallow monitoring well (MW-13) are located at the Elm Street site. SulTRAC will install up to three nested pairs of groundwater monitoring wells (see Figure 4D) and one replacement well (MW-13D) to provide background groundwater quality information, to evaluate the potential for upgradient sources potentially contributing to contamination from east of the Gurman property, and to continue characterization of groundwater at the site. Preliminary well locations were selected based upon data gaps from the Phase I RI, and to replace a previously installed well at location MW-13D which has been removed. The upgradient well location(s) was selected to bound the site from potential offsite sources and to provide background groundwater quality based on documented groundwater flow directions (see Figures 6 and 7 of DESR). In addition, grab groundwater samples will be collected at 29 soil boring locations, including the locations of 15 nested soil gas wells. Based upon data obtained during the VAS investigation, and additional grab groundwater samples, final locations of new monitoring wells may be altered.

SulTRAC will also collect groundwater samples from the following four active IAWC wells:
IAWC 2, IAWC 3, IAWC 5, and IAWC 6.

All newly installed wells at the Elm Street site will be located in the first water-bearing zone with the shallow wells screened at or just below the water table and the deep wells will be screened just above the shale bedrock formation. All monitoring wells will be installed to collect groundwater samples from the same water bearing zone as the current IAWC wells.

The locations of the new monitoring wells have been selected based on data gaps identified from previous investigations and the Phase I RI that indicate the upgradient eastern edge, the central portion of the site and the southern edge of the site have not been adequately assessed or additional delineation is required to adequately assess the groundwater contamination at the site. Potentiometric groundwater maps created by IDEM and confirmed with the Phase I RI data; indicate a general groundwater flow to the southwest. Final monitoring well locations and screen depths will be determined in the field. These planned depths can only be estimated, since previous investigations have indicated an elevation difference of as much as 10 feet for the shale bedrock surface.

Based on the data evaluation from previous site investigations (Giles Engineering 1990, IDEM 2002(a,b), IDEM 2005, URS Corporation 2005, SulTRAC Data Evaluation Summary Report 2011: Phase I investigation) and detailed in the work plan (SulTRAC 2011a), three shallow monitoring wells and four deep monitoring wells will be advanced. Shallow monitoring wells are expected to be screened between approximately 40 and 55 feet bgs in the first water-bearing zone. Deep monitoring wells will be advanced to bedrock and are expected to be screened between 120 and 140 feet bgs, just above the shale bedrock formation. All monitoring wells will be developed when installation is complete.

After wells are developed, one round of groundwater samples will be collected at all monitoring wells. Based upon data from the Phase I RI, and the time elapsed from the previous sampling event, analytical methods for the Phase II sampling have been modified. Specifically, sampling of shallow and deep wells will include analysis for non-filtered TAL metals (including mercury and cyanide) and filtered TAL metals at all monitoring well locations. All shallow and deep wells will be sampled for VOCs. Sampling of IAWC wells and grab groundwater samples from soil borings will include analysis for VOCs. Sampling of IAWC wells will include analysis for non-filtered TAL metals (including mercury and cyanide) and filtered TAL metals. QC samples (field duplicate, trip blank, MS, and MS/MSD) will be collected for groundwater as described in Section 11.0 of this FSP.

A mechanical rising and falling head test will be performed on at least 12 of the monitoring wells to assess aquifer parameters such as hydraulic conductivity and trasmissivity. The wells to be tested include two pairs in the eastern portion of the site (selected from well pairs MW-7, MW-14, and MW-15, and MW-16), two pairs in the central portion of the site (selected from , MW-4, MW-5, MW-6 and MW-12), and two pairs in the western portion of the site (selected from MW-1, MW-2, MW-9, and MW-13. Wells will be selected to represent horizontal and vertical heterogeneity within the aquifer.

In addition, a modified pump test will be conducted using IAWC wells to stress the aquifer with transducers placed in monitoring wells MW-01, MW-02 and MW-09 to measure pumping effects on the hydraulic conductivity and aquifer response at the site and to further analyze potential contaminant migration in groundwater. Tests will be conducted during normal cycling of the IAWC wells that are activated on an “on demand” basis. Test conditions will reflect the normal cycling that occurs when the IAWC well field wells are activated.

4.5 ECOLOGY AND BIOLOGY

Ecological risk assessment will rely on analytical results collected during the Phase I and Phase II sampling events. The first step in the ecological risk assessment process is to conduct a screening-level ecological risk assessment (SLERA). As part of that process, the available ecological habitats need to be identified and characterized. A SulTRAC biologist will visit the site and identify the areas likely to support ecological communities within the areas potential affected by releases from the site. The quality of the habitats will also be assessed. The biologist will contact the appropriate state agencies to determine if threatened and endangered species are present or suspected to be present at the site or areas adjacent to the site.

The SLERA will use soil, surface water , and groundwater data to assess the potential impacts on releases from the site to ecological receptors. These data will be compared with appropriate state and federal standards, criteria, and guidelines for the protection of ecological receptors.

4.6 HUMAN HEALTH

The human health risk assessment (HHRA) will rely on analytical results associated with Phase I and Phase II soil, groundwater, surface water, and soil gas samples, as well as historical groundwater and soil samples collected at the site. This section focuses on the samples of specific relevance to characterizing potential human health exposures both on and off site. These samples are associated with four investigations identified under Task 3 (Field Investigation/Data Acquisition) in the RI/FS work plan. Discussed below is the HHRA-related sampling conducted as part of each of these investigations: geological and storm sewer investigations; hydrogeologic investigations; surface water investigation; and soil gas investigation.

4.6.1 Geological Investigations

As discussed in Section 4.3.1, SulTRAC will collect surface and subsurface soil samples from the Gurman, Ashland, and MTS properties and the former Sinclair/roundhouse area; and off site for background (see Figure 4

The Phase II soil samples, along with Phase I results, will be used to characterize and evaluate potential human exposure through soil-related exposure pathways. More specifically, results for surface soil samples (0 to 2 feet bgs) will be used to characterize current exposures for all receptors other than construction/utility workers. Results for both surface and subsurface soil (2 to 10 feet bgs) samples will be used to characterize current and future exposure for construction/utility workers and future exposure for all other receptors, assuming subsurface soil is brought to the surface as the result of future construction or landscaping. The location and basis for the Phase II surface and subsurface samples has been discussed (see Section 4.3.1). (Note: historical soil samples collected at the site will be used to provide context for interpreting the RI investigation results, whereas the analytical results associated with the Phase I and Phase II RI will be used for risk assessment purposes.)

4.6.2 Hydrogeologic Investigations

As discussed in Section 4.4, groundwater samples will be collected from monitoring well clusters (one shallow well and one deep well) at a total of 17 on-site, off-site and upgradient locations.

These Phase II groundwater samples will provide the most current data and will be used to characterize and evaluate potential human exposure through direct groundwater-related exposure pathways. The location and basis for the Phase II groundwater samples were discussed in Section 4.4. (Note: analytical results associated with the Phase I RI, Phase II RI, Phase II VAS program will be used for risk assessment purposes.)

4.6.3 Soil Gas Investigation

Soil gas samples will be collected from a depth of approximately (and no less than) 5 feet bgs at five locations adjacent to (and on all four sides of) the Riverside Apartment building (located immediately north of the Ashland property), one location where a single-family residence was formerly situated (immediately east of the Riverside Apartment building), three locations between the Riverside Apartment Complex and buried underground utility corridors along Second Street, three locations adjacent to the MTS building in areas of highest VOC concentrations determined in the Phase I investigation, and three locations around Gurman drum processing building in areas of highest VOC concentrations determined in the Phase I investigation (see Figure 4C). The sampling locations were selected consistent with the recommendations presented in IDEM’s “Draft Vapor Intrusion Pilot Program Guidance” (IDEM 2006).

IDEM’s vapor intrusion guidance also recommends collection of a second soil gas sample at each location at a depth of several feet above the water table (IDEM 2006). Therefore, a second soil gas sample will be collected approximately 2 feet above the water table (35 to 40 feet bgs) at all soil gas well locations.

These soil gas samples (along with soil sample and grab groundwater sample results at each soil gas location) will be used to characterize and evaluate potential human health exposure through subsurface vapor transport-related (indoor air) exposure pathways.

4.6.4 Vertical Aquifer Sampling

The purpose of the VAS sample collection is to vertically delineate the aquifer for VOCs in order to eliminate the possibility of a discrete plume of contamination within the aquifer which was previously undetected at the screened groundwater sampling depth intervals. VAS sample locations have been selected to provide three distinct lines situated perpendicular to the groundwater flow path. The three lines of VAS locations are as follows: a North-South line on east side of First Street consisting of four VAS soil borings and also including samples from well pairs MW-01, MW-02, MW-09 to reduce the number of intervals sampled from the four borings, a North-South Line along Second street consisting of three VAS soil borings and including samples from well pairs MW-05, MW-03, MW-12 and proposed new monitoring well MW-06 to reduce the number of intervals sampled from the three borings, and a North-South line south of the Gurman property with two VAS soil borings including one location near SB-016 and the second in the center of Elm Street. See Figure 4B for VAS sampling locations.

5.0 FIELD SAMPLING PROCEDURES

This section describes only the field activities to be conducted during the Phase II RI. In cases where additional sampling is to be conducted following the same procedures that were described in the Phase I FSP, this FSP section presents the number and locations of additional samples and refers to the Phase I FSP (SulTRAC 2009a) that was approved by EPA on September 18, 2009 for sampling procedures. In cases where field sampling activities that differ from those conducted during the Phase I RI are to be conducted, this section describes the sampling approach and methods and relevant standard operating procedures (SOP) are provided, as needed. Where the FSP differs from the SOPs, the FSP's site-specific procedures will take precedence. Specifically, this section details the procedures and methods that will be used to collect soil, soil gas, and groundwater samples.

5.1 SOIL

The primary purpose of soil sampling is to identify potential contamination source areas, evaluate whether a soil vapor pathway is present, begin delineating the extent of soil contamination at the site, and attempt to determine if additional contamination source areas are contributing contamination at the site. The following subsections describe the sampling collection procedures and methods that will be used during the Phase II field investigation.

5.1.1 Soil Borings

During the Phase II field investigation, surface and subsurface soil samples will be collected from 29 borings with grab ground water samples and soil sampling at four depth intervals in the four source areas identified, 31 borings at two depth intervals to a maximum depth of four feet, and 2 borings at two depth intervals to a maximum depth of 10 feet. Totals for surface, subsurface and grab groundwater samples include locations of soil gas wells. Before sampling, public utility clearance to the site will be accomplished.

Shallow soil borings (either 4 feet or 10 feet in total depth) will be advanced using a Geoprobe. The shallow soil borings will be located as follows: (4) soil borings will be located on or in the general vicinity of the Gurman property, (11) soil borings will be located on the Ashland property, (13) soil borings will be located on the former Sinclair property; and (4) soil borings will be located on the MTS property.

The soil sampling depth intervals for 30 of the shallow soil borings will be from 0 to 2 feet bgs and from 2 to 4 feet bgs. The sample depth interval from 2 of the shallow soil borings will be from 0 to 2 feet bgs and from a 2-foot interval within the 2 to 10 feet bgs, zone. All proposed soil boring locations are identified on Figure 4.

Deep soil borings including grab groundwater samples will be advanced using sonic technology to collect soil samples at specific depths below ground surface. Surface soil and subsurface soil samples will be collected from the 29 borings in the potential source areas at four depth intervals per boring. The soil borings will then be advanced to the water table and grab groundwater samples will be collected. The deep soil borings will be located as follows: (9) soil borings will be located on or in the general vicinity of the Gurman property, (3) soil borings will be located west of the tank containment on the former Sinclair property; (2) soil borings will be located on the MTS property, (9) borings will be advanced at locations of existing and new soil gas wells in the vicinity of the Riverside Apartment building, (3) borings will be advanced at locations of new soil gas wells in the vicinity of the Gurman drum processing area, (3) borings will be advanced at locations of new soil gas wells in the vicinity of the MTS building, and (1) background location upgradient of MW-15 and MW-16, east of U.S. Highway 41. Soil boring locations are identified on Figure 4.

The soil sampling depth intervals for all deep soil borings will be from 0 to 2 feet bgs, and from a 2-foot interval within the 2 to 10 feet bgs, 10 to 20 feet bgs, and 20 to 40 feet bgs zones. All proposed soil boring locations are identified on Figure 4A.

Proposed soil boring locations and number of samples may be adjusted during the Phase II investigation based on utilities location, preliminary screening results, access agreements, and evidence collected from prior soil borings advanced during Phase I activities.

All soil borings will be logged and sampled following the same procedures specified in the Phase I Field Sampling Plan, Section 5.2.1 (SulTRAC 2009a).

5.2 SOIL GAS SAMPLING

Analytical results from the Phase I investigation indicated exceedances of screening levels for compound specific soil gas action levels and a potential for indoor air exposures resulting from contamination at the site. In addition to re-sampling existing soil gas wells, SulTRAC will install nine additional paired sets of soil gas wells. Three paired soil gas wells will be installed between the utility corridor along 2nd street and the Riverside Apartment complex. Three paired soil gas wells will be installed around the perimeter of the Gurman and MTS buildings in areas of elevated soil and groundwater VOC concentrations detected during the Phase I investigation. Paired soil gas probes will be installed in a similar manner to the Phase I investigation. One soil gas sample will be collected no less than 5 feet bgs at each gas probe location. An additional soil gas sample will be collected at a deeper depth, within approximately 2 feet of the groundwater table (approximately 35-40 feet bgs). Based upon the findings of a preliminary pressure test of soil gas wells SG-001B, SG-002B and SG-006B, replacement of the wells may be required to collect samples. New soil gas probes will be installed during the soil sampling and grab groundwater sampling at each location. All proposed sampling locations are shown on Figure 4C. The soil gas sampling procedures will be in accordance with the guidance provided in the IDEM draft vapor intrusion pilot program (IDEM 2006).

5.2.1 Soil Gas Vapor Installation

Based upon the soil gas analytical results from the Phase I investigation and subsequent sampling in January 2011, additional delineation and re-sampling of soil gas wells are warranted for the Phase II investigation. New soil gas wells will be installed around the Gurman drum processing area and the MTS building to further evaluate soil gas in areas of elevated soil and groundwater VOC concentrations determined in the Phase I investigation. In addition, replacement soil gas probes may be installed at locations SG-001B, SG-002B, and SG-006B. The utility locations will be marked before soil gas probes are installed.

SulTRAC will install a total of nine new nested soil gas probes permanently along with flush-mount vaults. Shallow probes and deep probes will be installed in the same borehole. Soil gas probes will be installed as close to the Gurman and MTS buildings as possible. The three additional soil gas wells will be installed as close to the utility corridors as possible but out of right of ways or traffic areas to prevent damage. Boreholes will be advanced to a depth of 50 feet, or when the groundwater table is encountered. Soil sampling and screening with grab groundwater samples will be obtained from each soil gas well location. Soil sampling, soil screening, and grab groundwater sampling will be conducted following the same protocol as described in the Phase I FSP section 5.2.1 and section 5.4.5. Soil gas well installation will be conducted following the same protocol as described in the Phase I FSP Section 5.3.1. (SulTRAC 2009a). The location of the existing soil gas wells are shown on Figure 2. Locations for proposed soil gas wells are shown on Figure 4C.

5.2.2 Probe Development

Soil gas probe development will follow the procedures specified in the Phase I FSP, Section 5.3. 2.

5.2.3 Sampling Procedure and Analysis

Sampling equipment should ideally have the smallest possible internal volume to reduce the need for purging and the risk of inducing air flow from outside. All connections or fittings in the sampling equipment will be tight to avoid leakage from the sample collection container.

SulTRAC will use small-volume Summa canisters (2.7 liter or 6 liter) for soil gas sample collection. A sampling rate of 100 to 200 milliliters per minute is recommended in the IDEM guidance (IDEM 2006). Ideally, vacuum during sampling should be less than or equal to 10 inches of water and should not exceed 50 inches (IDEM 2006). A very slow sample rate will be used if the soil is wet or fine-grained. SulTRAC will record sample collection rate and vacuum readings.

The following actions will be taken during air sampling:

- The canister pressure reading, ambient air temperature, and ambient air pressure will be measured, and record the readings in the field logbook before the sample is collected.
- The sampling port will be attached to the Summa canister using new tubing for each sample. Teflon or Tygon tubing, in lengths of 1 foot or less, will be used to connect the Summa canisters to the sampling ports using Swagelock fittings.
- The tubing will be flushed out by connecting it to the sampling port, opening the sampling port valve to allow air flow, and then connecting it, under system pressure, to the Summa canister. Opening the canister pressure valve will allow the evacuated canister to draw in soil gas until the canister reaches ambient pressure. When the sampling valve on the canister shows that ambient pressure has been reached, the sampling valve will be closed and the canister removed from the sampling line. Only individually certified Summa canisters will be used for sampling.
- The post-sampling pressure reading on the canister pressure valve will be measured and recorded.
- The canister and its corresponding field datasheet will be labeled with the sample number.
- The laboratory will report the vacuum for each canister as shipped and the vacuum will be field verified using the same gauge before each sample is collected. Canisters exhibiting vacuum changes will be removed from use.

A tee fitting with a two-way valve or laboratory provided manifold system will be connected to the sampling tubing and Summa canisters to collect duplicate samples. Two Summa canisters will be attached, one to each end of the tee fitting and tubing, or manifold system. Sample collection will proceed as described above. After the samples are collected, the samples will be labeled identically to provide a blind duplicate to the laboratory.

Leak testing will be conducted at a rate of 10 percent of the samples. Leak testing will be accomplished in one of two ways; a manifold pressure leak testing procedure, or a tracer gas introduction procedure.

The manifold pressure leak testing procedure utilizes a tee fitting attached to a stainless steel sample train, a purge canister for soil gas well purging and a series of gauges. The first gauge after the purge canister connection indicates the pressure/vacuum from the subsurface, followed by an inline flow restrictor, then a second gauge which indicates the vacuum of the sample canister and can be used to determine if the canister is filling at the appropriate rate. Leak testing is accomplished by connecting the entire manifold system including a sample canister and purge canister in the appropriate locations, and connecting the manifold to the sample port with tubing and Swagelock fittings. Once all the connections are completed and the sample canister remains sealed, the purge canister will be opened and quickly closed to apply vacuum to the system lines and fittings. If the vacuum is maintained as indicated by the gauges, the sample train is leak free. Required purging of the soil gas well followed by sampling can be accomplished without disconnecting any of the manifold components. Duplicate sampling can also be accomplished utilizing the manifold system by disconnecting the purge canister upon appropriate purge volume and connecting a second Summa canister in place of the purge canister.

Leak testing using tracer gas will be accomplished by placing a portable enclosure over the sampling probe, sample tubing, and Summa canister, and helium gas will be introduced into the enclosure. An aliquot of soil gas from the sample tubing line will be collected in an attached Tedlar bag (using a sampling pump or vacuum pump), and then vapors in the bag will be screened for helium using a hand-held detector. If no helium above 10% of the helium concentration introduced into the shroud is detected, it will be assumed that no leaks exist (i.e., no helium has entered the tubing through a poorly sealed probe, vacuum gauge, flow regulator, or tubing connectors), and sampling can proceed. The sampling line will be purged before leak testing and sample collection begins.

All new soil gas well samples will be submitted for analysis to a subcontracted laboratory for rapid turnaround of results. Results will be used to determine if additional investigation of the Gurman and MTS facilities is warranted during the same mobilization. Samples from existing soil gas wells will be analyzed through EPA’s CRL. The soil gas sample analysis will include the full list of analytes listed in EPA Method TO-15 (EPA 1999). Analysis of oxygen, carbon dioxide, methane and total petroleum hydrocarbons is not required (IDEM 2006). Results for all soil gas samples will be individually compared with the appropriate screening levels. Any contaminant exceeding the screening level may require further investigation such as sub-slab or indoor air sampling (IDEM 2006). The acceptable reporting limits depend on the exposure duration for chlorinated sites. Table 6 provides the residential screening levels for chlorinated compounds that would require prompt action. Table 7 provides the residential screening levels for chlorinated compounds and acceptable reporting limits.

TABLE 6
RESIDENTIAL SCREENING LEVELS FOR CHLORINATED COMPOUNDS – PROMPT ACTION LEVEL

Compound	Exposure Duration	1 year	5 years	10 years	20 years	30 years
	Units					
1,2 DCA	µg/m^3	510	240	160	100	74
	Ppbv	130	59	39	25	18
PCE	µg/m^3	3600	1000	680	430	320
	Ppbv	540	150	100	64	47
TCE	µg/m^3	2000	410	270	170	120
	Ppbv	380	75	49	31	23
VC	µg/m^3	3500	710	460	290	220
	Ppbv	1400	280	180	120	85

Notes:

µg/m^3	micrograms per cubic meter
ppbv	parts per billion by volume

TABLE 7
RESIDENTIAL SCREENING LEVELS FOR CHLORINATED COMPOUNDS – POTENTIAL SOIL GAS

Compound	Exposure Duration	1 year	5 years	10 years	20 years	30 years
	Units					
1,2 DCA	µg/m^3	74-510	74-240	74-160	74-100	74
	ppbv	18-130	18-59	18-39	18-25	18
PCE	µg/m^3	320-3600	320-1000	320-680	320-430	320
	ppbv	47-540	47-150	47-100	47-64	47
TCE	µg/m^3	120-2000	120-410	120-270	120-170	120
	ppbv	23-380	22-75	23-49	23-31	23
VC	µg/m^3	220-3500	220-710	220-460	220-290	220
	ppbv	85-1400	85-280	85-180	85-120	85

Notes:

µg/m^3	micrograms per cubic meter
ppbv	parts per billion by volume

5.3 GROUNDWATER

Groundwater samples will be collected from existing and newly installed wells at the Elm Street site and the IAWC wells. Grab groundwater samples will also be collected following the advancement of deep soil borings at 29 locations which includes existing and newly installed soil gas borings. The following subsections describe the procedures to augment the current monitoring well network, as well as sample collection procedures and methods that will be used during Phase II field investigation.

Currently, 13 nested pairs of groundwater monitoring wells and one shallow well (MW-13S) are located at the site. The shallow monitoring wells are installed with 10 foot screens extending to approximately 40 to 54 feet bgs. The deep monitoring wells are installed with 10 foot screens extending to approximately 127 to 137 feet bgs. SulTRAC will install an additional three nested pairs of monitoring wells and one replacement deep well at location MW-13D to delineate the extent of groundwater contamination. Each pair of nested monitoring wells will consist of one shallow well and one deep well. Shallow monitoring wells will be installed with 10 foot screens extending to approximately 40 to 55 feet bgs in the upper portion of the first water-bearing zone. Deep monitoring wells will be installed with 10 foot screens installed in the deeper portion of the first water-bearing zone between approximately 120 and 140 feet bgs, just above the shale bedrock formation (see Figure 4 for locations). Alterations to actual proposed monitoring well depths and locations may be identified by the field team leader (FTL) after actual water table depths are measured and depths where the bedrock surface is encountered. All proposed sample monitoring wells have been mapped (see Figure 4D).

5.3.1 Monitoring Well Installation

Monitoring wells will be installed using either hollow stem auger or rotosonic drilling methods. Monitoring well installation will follow the same protocol used in the Phase I RI referenced in the Phase I FSP, Section 5.4.1.

5.3.2 Well Development

Monitoring well development will follow the same protocol used in the Phase I RI referenced in the Phase I FSP, Section 5.4.2.

5.3.3 Groundwater Monitoring

One round of groundwater samples will be collected from all existing and newly installed groundwater monitoring wells and the IAWC wells for the Phase II investigation. Groundwater samples from all shallow and deep wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOC and CLP SOW ILM05.4 for Total and Dissolved TAL Metals (including cyanide and mercury). Phase II sampling will include both total and dissolved metals to provide additional dissolved metals data and to compare to the Phase I results given the significant time difference from the Phase I and Phase II sampling events. Laboratory analytical methods are detailed in Table 9. All sampling criteria and sample identifications are listed in Tables 4 and 10.

Groundwater sampling will be conducted following the protocols described in the Phase I FSP Section 5.4.3. Dissolved metals samples will be filtered in the field prior to containerization. Previous monitoring well sampling locations are shown on Figure 3. Proposed monitoring well sampling locations are shown on Figure 4.

5.3.4 Grab Groundwater Samples

A grab groundwater sample will be collected from 29 investigative borings when the boring is advanced below the water table. Grab groundwater samples will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs. Select samples may be submitted to the EPA mobile laboratory for quick turn analysis by EPA Method 8260B for VOCs. Laboratory analytical methods are detailed in Table 9. All sampling criteria and sample identifications are listed in Tables 4 and 10.

Grab groundwater sampling will be conducted following the protocol specified in the Phase I FSP Section 5.4.5. Proposed Phase II grab groundwater sampling locations are depicted on Figure 4A.

5.3.5 Vertical Aquifer Sampling

VAS will be performed at nine new sampling locations in conjunction with sampling seven existing monitoring wells. VAS samples will be collected in three distinct north-south lines across the site. A north-south line near the Gurman property will include two VAS locations, one near the center of the Gurman property east of location SB-16, and one directly south of the SB-16 location in the center of Elm Street. A second north-south line utilizing MW-05, MW-03, MW-06 with a VAS location north of MW-05 near the location of SB-025, a second VAS location in between MW-03S and MW-03D, and a third

VAS location located centrally (north-south/east-west) between SB-049 and SB-048 on the Sinclair and MTS properties. A third VAS line east of North 1st Street including MW-01, a VAS location between MW-01 and MW-02, a second VAS location between MW-02S and MW-02D, a third VAS location near SB-055, in line with the previous locations, and a fourth VAS location in between MW-09S and MW-09D. VAS sample locations are shown on Figure 4B.

Soil samples will be collected for all borings advanced for VAS at four intervals (0-2 feet, 2-10 feet, 10-20 feet, and 20-40 feet bgs). Sample collection methodology will be completed as described in Section 5.2.1. Soil samples will be will be submitted for VOC analysis to CLP.

Two methods may be used to collect groundwater samples during the VAS program: (1) the "push ahead" sampler or (2) isolation of the target zone using a packer. In either case, a sampling pump will be used to obtain the sample from the target zone. Note that the exact sampling system to be used will be selected based on discussions with the drilling subcontractor and compatibility with the drilling systems used. VAS will be conducted from the groundwater table to bedrock in 10-foot increments. The well will be initially purged using a submersible pump to remove the recorded volume of drilling water added to the borehole prior to sampling, plus three times the standing water in the borehole below the packer, or three times the volume of the water calculated within the screened push ahead sampler prior to the start of the low purge and sample. After the initial well purge, the VAS sample will be collected using low flow groundwater purging techniques with an electric submersible pump or a bladder pump. Low flow purging at the monitoring wells will be conducted using a maximum pumping rate of 500 mL/min. The pumps will be lowered slowly into the well, with their intake corresponding to the middle of the temporary well screen. During groundwater purging, field measurements for pH, specific conductivity, temperature, Eh (or ORP), dissolved oxygen (DO), and turbidity will be measured and recorded every five minutes. Purging will continue until three consecutive and consistent readings are obtained or a maximum of five well screen volumes are purged. Temperature, pH, DO, Eh, and turbidity readings will be considered consistent if all three values are within 10 percent of the average value, conductivity readings will be considered consistent if all three values are within 3 percent of the average value, and pH readings will be considered consistent if all three values are within ±0.1 pH unit of the average value. During the purging process, the depth to groundwater will be periodically measured to ensure minimal draw down during pumping (i.e. <0.3 feet). If excessive drawdown occurs, then the purge rate will be reduced by increments of 50 to 100 mL/min. until drawdown stabilizes. In the event that drawdown does not stabilize, then a sample will be collected after three well screen volumes have been purged. The boreholes will be sampled using bladder pumps or electric submersible pumps at a rate between 250 and

500 mL/min. to minimize volatilization of the volatile organic portion of the sample. Prior to use for purging and/or sampling, non-dedicated pumps to be utilized for sampling will be cleaned as specified by Section 7.0. Sampling will be conducted for analysis of VOCs immediately after the purging has been completed and placed on ice in a cooler. VAS advancement will continue throughout the depth of the borehole in ten foot intervals until bedrock is encountered at approximately 140 feet bgs. Up to 10 samples will be collected from VAS locations not advanced in between monitoring wells dependent upon the depth of the water table. Ten foot intervals will be sampled from the water table, anticipated at 33-38 feet bgs to a maximum anticipated depth of 127-133 feet bgs. It is anticipated that up to 8 VAS samples will be collected from VAS location located in between or next to monitoring wells. The existing screened depths of monitoring wells will be sampled concurrently with VAS advancement to provide data from depths corresponding to the screened monitoring well intervals.

Sample container, preservation, shipping, and packaging requirements will be in accordance with the appropriate methods listed in Table 10; and sufficient groundwater will be collected for chemical analysis. Quality control sample requirements are discussed in the QAPP. Duplicate samples will be collected concurrently with the original samples; therefore, sampling equipment will not be decontaminated before the collection of the duplicate sample. Field (rinsate) blanks will be collected using only analyte-free deionized water supplied by the laboratory. All sample containers will be precleaned in accordance with "Specifications and Guidance for Contaminant-free Sample Containers", EPA 540/R-93/051.

Samples collected from VAS locations will be analyzed by an EPA mobile laboratory (if available), or shipped overnight to a subcontracted laboratory for rapid turnaround. VAS samples will be analyzed be EPA Method 8260B for VOCs.

5.3.6 Aquifer Testing

Mechanical rising and falling head tests will be performed to assess aquifer parameters such as hydraulic conductivity. Rising and falling head slug test were performed during the Phase I investigation. However, due to the high transmissivity of the aquifer and evaluation of the falling and rising head slug test data, mechanical rising and falling head tests will be performed to provide better data. SulTRAC will perform mechanical rising and falling head tests on at least one-third of the monitoring wells to obtain representative site-wide hydraulic conductivity data. The 12 monitoring wells (MW-1, MW-2, MW-4, MW-5, MW-6, MW-7, MW-9, MW-12, MW-13, MW-14, MW-15, and MW-16) selected for the mechanical rising and falling head tests will be spatially representative of the aquifer both laterally and vertically. The rising and falling head testing will likely occur immediately following the Spring 2012 round of groundwater sampling.

It is also anticipated that mechanical rising and falling head tests will be duplicated at one shallow well and one deep well for quality control purposes. Any deviations from these procedures due to site-specific conditions will be documented in the field.

A well head assembly will be attached to each monitoring well to conduct the mechanical slug test. The well head assembly will have a quick release ball valve at the top of the unit that is the same diameter as the well or larger and is oriented in line with the well. A probe insertion port will allow effective air sealing around the transducer cable and not interfere with the ball valve operation. A manual air gauge or vacuum gauge will be used to measure the pressure or vacuum applied in the well head and is preferably graduated in inches or centimeters of water. To apply pressure to the water within the well, an oil-less compressor with air tight fittings will be used to connect to the well head assembly. To induce vacuum to the water within the well, a small vacuum blower with air tight fittings will be connected to the well head assembly.

To conduct the rising head test, the following procedures will be conducted. The depth to static water level (SWL) will be measured using a water level indicator to determine the distance from SWL to the top of screen. The amount of downward pressure imparted by air must not exceed this distance. The well head assembly will be attached to the monitoring well. The transducer and logging software will be programmed prior to inducing pressure on the well. The well will be pressurized to a pressure equivalent that is four to eight feet of water, but not to exceed the previously determined maximum. When the pressure gauge stabilizes, the aquifer is approaching equilibrium and the test can be initiated. A second water level indicator will be advanced to the depth of the pressurized water level. The pressurized water level will be recorded. The test will be initiated and after a few seconds, the ball valve will be opened to allow the air to escape from the well. The water level will be monitored with the water level indicator as it rises. The test will be complete when the water level has risen to approximately the original SWL. The final segment of the curve will be used to analyze the data and calculate the hydraulic conductivity of the aquifer in that location.

To conduct the falling head test, the following procedures will be conducted. The depth to static water level (SWL) will be measured using a water level indicator to determine the distance from SWL to the top of screen. The amount of vacuum induced must not exceed this distance. The well head assembly will be attached to the monitoring well. The transducer and logging software will be programmed prior to inducing vacuum on the well. Vacuum will be applied to the water in the well that is equivalent to four to eight feet of water, but not to exceed the previously determined maximum. When the vacuum gauge stabilizes, the aquifer is approaching equilibrium and the test can be initiated. A second water level indicator will be advanced to the depth of the raised water level under vacuum. The raised water level will be recorded. The test will be initiated and after a few seconds, the ball valve will be opened to allow the vacuum to escape from the well. The water level will be monitored with the water level indicator as it decreases. The test will be complete when the water level has dropped to approximately the original SWL. The final segment of the curve will be used to analyze the data and calculate the hydraulic conductivity of the aquifer in that location.

SulTRAC will use a pressure transducer and data logger to record pneumatic slug test data in the field. Data will be collected at a minimum of 0.5 second-intervals. It is expected that transducers such as an In-Situ Level TROLL 500® or Solinst Levelogger LT F30/M10® will be used. The actual transducers and data loggers to be used will be operated in accordance with the manufacturer’s operations manuals.

The transducer, water level meters, and transducer cable will be decontaminated between each use at each monitoring well. Decontamination procedures will consist of an Alconox soap wash followed by tap water and distilled water rinses. All decontamination fluids will be containerized and stored on site with other IDW.

Upon completion of the rising and falling head tests, SulTRAC will reduce and analyze the data to develop site-specific hydraulic conductivity estimates at each monitoring well tested. The response data will be imported into AQTESOLV® for hydraulic conductivity analysis using the Bower and Rice method for unconfined aquifers. If other analytical methods are deemed necessary, SulTRAC will notify EPA prior to data analysis.

5.4 ECOLOGY AND BIOLOGY

As part of the initial phase of the site investigation, no specific field sampling procedures associated with characterizing potential ecological exposures in the various habitats at the Elm Street site are required. As noted earlier, the initial ecological evaluation will focus on determining the presence of ecological habitat, the presence or absence of soil, surface water, or groundwater contamination at the site, and the maximum concentrations of the contaminants consistent with EPA’s guidance for conducting a SLERA (EPA 1992). As noted in Section 4.6, the SLERA will use soil, surface water, and groundwater data to assess the potential risks to ecological receptors. The procedures to collect these data have been described in previous sections.

TABLE 8
PHASE II SAMPLE SUMMARY

Type	Number of Sample Locations	Location	Depth	Analysis
Surface Soil and Shallow Subsurface	4	(3) SB-21, 1-SE of SB-017,	4	VOC, SVOC, PCB, Pesticides
Surface Soil and Shallow Subsurface	23	(2) Northwest and Northeast of SB-070, (3) SB-068, (3) SB-064, (3) North of CSX railroad east to west, (3) SB-056, (3) SB-036, (3) SB-038, (3) SB-039	4	VOC, SVOC, Herbicides, PCB (SB-70)
Surface Soil and Shallow Subsurface	4	(3) SB-067, (1) SB-016	4	VOC, SVOC, PCB, Pesticides, Herbicides
Surface and Shallow Subsurface Soil	2	(2) North and at SB-032.	10	VOC, SVOC
Surface, Subsurface and Grab Groundwater	9	(1) South of SB-018, (1) West of SB-015, (1) SB-016(re-drill), (1) Northwest of SB-21--data gap, (1) centered between SB-13, SB-14 and SB-22, (1) West of SB-016, (1) East of SB-022 between SB-021 and SB-022, (2) SB-017	40	Soil: VOC, SVOC, Metals only SB-22 and East of SB-22 GW:VOC
Surface, Subsurface and Grab Groundwater	5	(2) Northeast & Southeast SB-044, (3) SB-065	40	Soil: VOC, SVOC, HG (SB-44) GW:VOC, SVOC
Surface, Subsurface and Grab Groundwater	15	Existing soil gas wells SG-001-006 and new soil gas wells SG-007-015	40	Soil: VOC GW: VOC
Surface, Subsurface and VAS	14	(6) North-South Line along second street including MW-05*, MW-03*, MW-12* with three additional borings and proposed new monitoring well (see diagram). (6) North-South line on east side of 1st Street including: MW-01*, MW-02*, MW-09* and three additional boring locations. (2) North-South line, one location near SB-016 and second location south of Gurman property in center of Elm Street in line with SB-016	140	Surface and Subsurface Soil (VAS only): VOC GW:VOC
Soil Gas Wells Install (NEW)	9	Nested set: (3) Gurman Process Area, (3) MTS Machining Building, Re-drill SG-002B, (3) between utilities and Riverside apartment complex	Shallow (4) Deep (37)	Surface and Subsurface Soil: VOC Grab GW

TABLE 8 (continued)
PHASE II SAMPLE SUMMARY

Type	Number	Location	Depth	Analysis
Soil Gas Wells Sampling	30	All new and existing	Shallow and Deep	Soil Gas: VOC
MW Installation	7	MW-16S, MW-16D, MW-17S, MW-17D, MW-6S, MW-6D, MW-13D (re-drill).	40, 140	Surface Soil: VOC, SVOC, Metals Subsurface Soil: VOC, SVOC (40 feet)
MW Shallow Wells Sampling	17	All new and existing	Shallow	All: VOC, Metals (Total and Dissolved)
MW Deep Wells	17	All new and existing	Deep	All: VOC Total and Dissolved Metals

Notes:

*VAS at MW locations will be sampled within the screened interval of shallow and deep wells for GW only.

GW	Groundwater
MW	Monitoring Well
MTS	Machine Tool Service
PCB	Polychlorinated biphenyl
SB	Soil boring
SVOC	Semivolatile organic compound
SOW	Statement of work
VAS	Vertical Aquifer Sampling
VOC	Volatile organic compound
TAL	Target Analyte List

6.0 LABORATORY ANALYTICAL METHODS

Table 9 presents the laboratory methods that will be used to analyze the samples collected by SulTRAC. Field investigation samples will be analyzed by the CLP laboratory, the Central Regional Laboratory (CRL), the EPA mobile laboratory, or a subcontracted laboratory. Select soil and groundwater samples will be analyzed for VOCs be EPA's mobile laboratory or a subcontracted laboratory to provide rapid turnaround.

TABLE 9
ANALYTICAL METHODS SUMMARY

Parameter	Analytical Method
SOIL	
VOCs	CLP SOW SOM01.2/ Mobile: EPA Method 8260B
SVOCs	CLP SOW SOM01.2
PCBs	CLP SOW SOM01.2
Pesticides	CLP SOW SOM01.2
Herbicides	CLP SOW SOM01.2
TAL metals (including mercury and cyanide)	CLP SOW ILM05.4
SURFACE WATER	
VOCs	CLP SOW SOM01.2
Herbicides	CLP SOW SOM01.2—Requires Modified Analysis
Pesticides	CLP SOW SOM01.2
SOIL GAS	
VOCs	CRL -- TO-15, Sub: TO-15 low level
GROUNDWATER	
VOCs	CLP SOW SOM01.2, Sub/Mobile: EPA Method 8260B
SVOCs	CLP SOW SOM01.2
Total and Filtered TAL metals (except cyanide)	CLP SOW ILM05.4
Cyanide	CLP SOW ILM05.4

Notes:

CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
Mobile	EPA Mobile Laboratory
PCB	Polychlorinated biphenyl
Sub	Subcontracted laboratory
SVOC	Semivolatile organic compound
SOW	Statement of work
VOC	Volatile organic compound
TAL	Target Analyte List

7.0 DECONTAMINATION PROCEDURES

During sampling, SulTRAC will follow decontamination procedures for (1) soil and groundwater sampling and (2) soil gas sampling as outlined below.

All downhole drilling rods for advancement of soil borings and installation of monitoring wells will be steam cleaned before work begins and between sampling locations. To prevent cross contamination, measuring and sampling equipment will be decontaminated before sample collection begins and between each two consecutive sampling locations. The equipment will be decontaminated following the general practices in SOP 002. A portable steam cleaner and an on-site source of potable water will be used for decontamination. All water derived from decontamination will be collected and temporarily stored in Department of Transportation (DOT)-approved, 55-gallon drums on site for characterization. If stainless steel bowls and spoons will be used, they will be used for one discrete sample and will then require decontamination. In lieu of stainless steel sampling equipment, disposable sampling equipment may be used to collect individual samples only.

The direct push rig and equipment used for soil gas sampling will be steam cleaned before work begins and between sampling locations. To prevent cross contamination, measuring and sampling equipment will be decontaminated before sample collection begins and between each two consecutive sampling locations; disposable tubing will also be used for soil gas sampling. The equipment will be decontaminated following the general practices in SOP 002. A portable steam cleaner and an on-site source of potable water will be used for decontamination. All water derived from decontamination will be collected and temporarily stored in DOT-approved, 55-gallon drums on site for characterization. Disposable sampling equipment will be used to collect individual samples only. Except for the detergent that will be used for the initial cleaning, the solutions used to decontaminate the field equipment will not be reused.

To prevent cross contamination, all non-dedicated or non-disposable slug testing and groundwater sampling equipment will be decontaminated before sample collection begins and after sampling at each location. Per the “general sampling equipment decontamination” guidelines established in Section 2.5 of SOP 002, stainless steel sampling equipment will be decontaminated using a three-tier process including an Alconox or Liquinox wash, a potable water rinse, and a distilled water rinse. SulTRAC does not anticipate the need to use chemical solvents in decontaminating this type of equipment; however, solvents may be used as described in SOP 002 if field conditions indicate that gross contamination is present. All water derived from decontamination will be collected and temporarily stored in DOT-approved, 55-gallon drums or polyethylene tanks on site for characterization. In lieu of stainless steel sampling equipment, disposable sampling equipment may be used to collect individual samples and to minimize the need to decontaminate equipment and generate decontamination water.

The submersible pump used for groundwater sampling will be decontaminated by successive washes in, and circulation through, a three-tier decontamination process as described in Section 2.6.2 of SOP 002. This process will consist of three 5-gallon buckets containing solutions of (1) Alconox or Liquinox detergent and potable water, (2) potable water, and (3) distilled water. The pump will be placed in the first bucket, and water will be pumped until the detergent and potable water solution is drawn down to the maximum extent possible (approximately 2 to 3 gallons). Next, the pump will be placed in the second bucket, and potable water will be pumped through until the discharge water appears "visually clear" of detergent. Finally, the pump will be placed in the third bucket (distilled water), and at least 1 gallon will be circulated through the pump. All water derived from decontamination will be collected and temporarily stored in DOT-approved, 55-gallon drums or polyethylene tanks on site for characterization and subsequent disposal.

8.0 SAMPLE HANDLING PROCEDURES

SulTRAC will collect soil, soil gas, and groundwater; prepare the samples for shipment; complete all necessary documentation; and decontaminate non-disposable equipment. Sample containers, preservatives, holding times, identification, documentation, COC, packaging, and shipping are discussed in this section.

8.1 SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIMES

SulTRAC anticipates collecting soil, soil gas, and groundwater. Sample handling procedures are different for each type of chemical group, analysis, and matrix type. These details are summarized in Table 10

8.2 SAMPLE IDENTIFICATION

Samples will be identified by a unique sample identification number (see Table 11). The identifier will be composed of the following information:

- Matrix
- Sample location (for example, monitoring well identification number, MW-14)
- Area designation such as GUR-Gurman, ASH-Ashland, MTS-Machine Tool Service, SIN-former Sinclair/roundhouse area
- Sample date
- Sample type (field, field duplicate, or QA/QC)

TABLE 10
SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIMES

Matrix	Analyte	Sample Container	Preservation Requirements	Maximum Holding Time (preparation/analysis)[1]
Soil	VOCs	Three 40-mL glass containers with PTFE-lined septa and open open-top screw caps, pre-weighted and containing magnetic stir bars, and one container of sample filled with no headspace for determination of moisture content.	Iced 4 ºC ± 2 ºC	48 hours to preservation at laboratory/ 14 days for analysis following preservation
		At least three coring tools used as transport devices (such as, 5-gram samplers), and one container of sample filled with no head space for determination of moisture content.	Frozen -7 ºC to -15ºC	48 hours (frozen) to preservation at laboratory for analysis after preservation
Soil	SVOCs	Two 4- or one 8-ounce wide-mouth glass jars	Cool to 4±2°C Immediately after collection	14 days/40 days
Soil	PCBs	Two 4- or one 8-ounce wide-mouth glass jars	Cool to 4 ±2°C Immediately after collection	14 days/30 days
Soil	Pesticides and herbicides	Two 4- or one 8-ounce wide-mouth glass jars	Cool to 4±2°C Keep away from light	14 days/30 days
Soil	Metals (including Hg, CN))	Two 4- or one 8-ounce wide-mouth glass jars	Cool to 4°C ± 2°C immediately after collection	NA/6 months (Metals & Hg) 14 days/14 days (CN)
Soil Gas	VOCs	One Summa canister (2.7 Liter or 6 Liter)	The pressure should not vary more than ± 13.8 kPa (± 2 psig) from the initial pressure over the 24 hour period.	Up to 30 days
Water	VOCs	Three 40-mL glass vials with PTFE-lined septa and open-top screw caps	No headspace Cool to 4±2°C adjust pH to less than 2 with HCl	7 days/14 days

TABLE 10 (CONTINUED)
SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIMES

Matrix	Analyte	Sample Container	Preservation Requirements	Maximum Holding Time (preparation/analysis)[1]
Water	Total and Filtered TAL Metals (including mercury)	Four 1-liter HDPE bottle with polyethylene-lined caps Particulate metals sample: no filter needed Dissolved Metals: field filter required	HNO_3 to pH < 2 and cool to 4 ˚C (±2 ˚C) immediately after collection	NA
Water	Cyanide	One 1-liter HDPE bottle with polyethylene-lined caps	NaOH to pH>12 and cool to 4±2°C immediately after collection	NA/14 days

Notes:

µm	Micron
°C	Degrees Celsius
CLP	Contract Laboratory Program
CN	Cyanide
HCL	Hydrochloric acid
HDPE	High-density polyethylene
Hg	Mercury
HNO_3	Nitric acid
MCE	Mixed cellulose ester
mL	Milliliter
mm	Millimeter
NA	Not applicable
NaOH	Sodium hydroxide
NR	Not required
PCB	Polychlorinated biphenyl
PTFE	Polytetrafluoroethylene
SVOC	Semivolatile organic compound
TBD	To be determined
TCLP	Toxicity characteristic leaching procedure
VOC	Volatile organic compound

[1] Holding time is measured from time of sample collection to the time of sample extraction and analysis (EPA 2004).

Each sample will also be assigned an identifying number by Forms II lite. Forms II lite was developed to expedite sample documentation, track samples from the field to the laboratory, and reduce the most common documentation issues associated with sampling. The user will enter information on the site, project, sampling team, analysis, location, matrix, collection time and date, and sample and tag numbers before or during the sample event. SulTRAC will identify specific sample names after the start of the field campaign, but before intrusive field activities begin, because preliminary activities to be completed before the sampling event may alter sample locations.

8.3 SAMPLE LABELS

Scribe generates labels for each sample. A sample label will be affixed to all sample containers. The label will be completed with the following information:

- Project number
- CLP case number
- CLP sample number
- Sample station name (the sample identity [ID] discussed above)
- Sample collection date and time
- Preservative
- Sample collector’s initials
- Analysis
- Sample tag number.

After labeling, if required, each sample will be will be preserved as required (see Table 10).

Samples analyzed by EPA’s mobile laboratory or a subcontracted laboratory will be identified using the nomenclature described in Table 11. However, the CLP labeling requirements will not apply to these samples because these samples will not be analyzed through the EPA CLP. The label for these samples will be completed with the following information:

- Project number
- Sample collection date and time
- Preservative
- Sample collector’s initials
- Analysis.

TABLE 11
GENERALIZED SAMPLE IDENTIFICATION SCHEME

Matrix		Location Number	Area Designation	Depth in Feet	Date	Example Identification	Notes
Groundwater from Monitoring Wells	MW	01	NA	Shallow=S Deep=D	March 01, 2012 = 030112	MW-01S-030112	Wells will be sampled from the middle of the screened interval. Same sampled locations will have same sample location number with different designation and date in sample ID; MWS14-1009 sampled in October 2009
Groundwater from IAWC Wells	IAWC	001 (3 digits)	NA	NA	March 01, 2012 = 030112	IAWC-1-030112	Wells will be sampled from the middle of the screened interval.
Groundwater grab samples	GWG	013 (3 digits)	GUR-Gurman ASH-Ashland MTS-Machine Tool Services SIN- Sinclair/ roundhouse area	45 (depth at which ground water table is encountered)	March 01, 2012 = 030112	GWG-074-GUR-45-030112	All sample locations will have new sample ID, in numerical order corresponding with soil boring number. Grab groundwater samples will be obtained at the groundwater table at 11 investigative borings.
Vertical Aquifer Sampling	VAS	001 (3 digits)	GUR-Gurman ASH-Ashland MTS-Machine Tool Services SIN- Sinclair/ roundhouse area	XXX (3 digits, depth at which the sample is collected)	March 01, 2012 = 030112	VAS-085-GUR-045-030112	All sample locations will have new sample ID, in numerical order corresponding with soil boring number. VAP water sample depth will be identified by the depth at which the sample was collected.
Soil Boring	SB	013 (3 digits)	GUR-Gurman ASH-Ashland MTS-Machine Tool Services SIN- Sinclair/ roundhouse area	10	March 01, 2012 = 030112	SB074-GUR-10-030112	All sample locations will have new sample ID, in numerical order, beginning with 074. The depth listed is the bottom of the sample interval.

TABLE 11 (CONTINUED)
GENERALIZED SAMPLE IDENTIFICATION SCHEME

Matrix		Location Number	Area Designation	Depth in Feet	Date	Example Identification	Notes
Soil Gas	SG	003 (3 digits)	RAC-Riverside Apartment Complex	5	March 01, 2012 = 030112	SG003-RAC-02-030112	All sample locations will have new sample ID, in numerical order.

Notes:

CLP	Contract Laboratory Program
ID	Identification
MW	Monitoring well
NA	Not applicable
GWG	Groundwater grab
SB	Soil Boring
SG	Soil gas sample

8.4 SAMPLE DOCUMENTATION

Sample documentation will be conducted following the protocol specified in the Phase I FSP Section 8.4. (SulTRAC, 2009a).

8.5 SAMPLE CHAIN OF CUSTODY

SulTRAC will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis in accordance with the SulTRAC RAC II Contract Level QAPP. A sample will be considered in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Scribe generates and prints COC forms, called traffic reports, in Scribe (a laboratory copy and a region copy). The laboratory copy will be sealed inside the lid of the cooler. COC procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. One COC record will be generated for each cooler shipped. The COC record also will be used to document all samples collected and the analysis requested. The following information will be documented on the COC form:

- Project name and number (region copy only)
- CLP case number
- CLP sample numbers
- Sample tag numbers
- Sampling location (station identification)
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample ID number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used (if applicable)
- Sample designation (grab or composite)
- Special instructions (e.g., laboratory needs to sub-sample oversized material or perform additional homogenization)
- Signatures of all samplers
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Airbill number (if applicable)

- Project contact and phone number
- Custody seal number

For samples not analyzed through the EPA CLP, SulTRAC will use laboratory-provided COC forms. The same level of information as the Scribe-generated COC forms will be included with the exception of the CLP-specific information (CLP case number, CLP sample numbers, and sample tag numbers).

SulTRAC will follow the procedures in the EPA Region 5 CRL "Superfund Amendments and Reauthorization Act (SARA)/Superfund Sample Handling Manual" (EPA 1989) to complete the documentation listed above.

SulTRAC will appoint one of its field technical staff members to serve as the sample custodian. When all required documents have been completed, the sample custodian will sign and date the document and list the time of the sample collection. The custodian will also confirm that all descriptive information is complete on the COC forms, which will be included with each shipping container. Two custody seals total will be used: one with the custody seal placed across the latch of the container, and the other affixed on the opposite side of the container lid. The lid will be securely taped shut for shipment. The field sample custodian will send the original copies of the COC region copy to the project manager, who in turn will submit these forms to the Region 5 Sample Management Office (SMO), care of Warren Layne, within 5 working days. The sample custodian will also retain and scan all copies of all COCs (laboratory and region) for the project files.

8.6 SAMPLE PACKING AND SHIPPING

The following procedures will be implemented when soil and aqueous samples collected during this project are shipped:

- All samples jars will be individually wrapped with bubble wrap or other packing material and placed in their own individual Ziploc-type bags. The CLP ID tag for each sample will accompany the sample package.
- Ice will be double bagged in large Ziploc-type bags and placed at the bottom of the cooler. If the cooler has a drain, it will be taped shut both inside and outside of the cooler.
- The cooler will be lined with bubble wrap or other packing material, and all individually packaged samples will be placed into one large plastic bag and tied after all sample jars have been input. Sufficient packing material will be used to prevent sample containers from breaking during shipment.

- Additional ice, double bagged, will be added on top of the tied plastic bag full of samples. Enough ice will be added to maintain a sample temperature of 4 ± 2°C. SulTRAC will prepare, label, and place a temperature blank in each cooler.
- The laboratory should be notified if a sampler suspects that any sample contains anomalously high or low concentrations (handwrite this anomaly directly on the laboratory copy of the COC), or if there may be a sampled substance that would require laboratory personnel to take safety precautions.
- The COC specific to each cooler will be sealed inside a plastic bag and taped to the inside of the cooler lid. Ensure that the COC is signed by all samplers and the custody seal numbers are included on the COC. Include with the COC a return pre-paid air bill so the cooler may be returned to SulTRAC.
- The cooler will be closed and taped shut with strapping tape around both ends.
- Signed and dated custody seals will be placed on the front and side of each cooler. Wide clear tape will be placed over the seals to prevent accidental tearing.
- The air bill, if required, will be completed before the samples are relinquished to the carrier.
- The COC will be transported within the taped sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the COCs to document transfer of samples.
- The Superfund SMO (for CLP laboratory samples) and the project contact person (for subcontracted laboratory samples) will be notified if the laboratory should expect to receive samples on a Saturday. SulTRAC will call its CLP sample coordinator, who in turn will notify the SMO, for samples to be sent to a CLP laboratory.
- After packaging, the samples will be shipped to the CLP laboratory specified by the EPA Region 5 Regional Sample Control Coordinator.

The following procedures will be implemented when air samples collected during this project are shipped:

- All summa canisters will be placed in original packaging material with sample tag attached to the neck of the canister.
- If canisters are individually packaged, the sample ID will be marked on the exterior top of the box. If multiple boxes will be shipped, each box will be numbered and identified on the COC(s).
- COCs will be signed by the sampler, placed in zip-lock type bags in the shipping containers.
- Chain of custody seals will be placed on each shipping container and taped shut with packaging tape. All unsecured edges of shipping containers will be taped shut with packaging tape.
- The air bill, if required, will be completed before the samples are relinquished to the carrier.
- When the container is received at the analytical laboratory, laboratory personnel will open the cooler and sign the COCs to document transfer of samples.

All shipping containers will be labeled as required by the DOT.

9.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

Disposal of Investigation-Derived Waste will be handled in accordance the protocol specified in the Phase I FSP, Section 9.0.

10.0 HEALTH AND SAFETY PROCEDURES

All field activities will be conducted in accordance with SulTRAC Health and Safety Plan (HASP), which is among the site-specific plans to be prepared for the WA. The revised HASP for the Phase II RI will be completed and submitted to EPA for review before field activities begin. All SulTRAC field personnel and subcontractors will read and sign the HASP, indicating that they understand the plan and agree to operate in accordance with its requirements. Daily tailgate meetings will be conducted to review daily activities and task-specific hazards. All SulTRAC personnel and subcontractors must have 40-hour hazardous waste and emergency response training, and proof of certification must be filed with the signed HASP. A complete copy of the site-specific plans, including the updated Phase I HASP, will be maintained by the field sampling team at the site.

11.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

All QA activities will be conducted in accordance with the SAP. A copy of the SAP will be maintained by the field sampling team for immediate use in resolving any QA issues that might arise during field activities.

QC samples will be collected at the following frequencies:

- Field Duplicate: One per 10 environmental samples will be collected, with a minimum of one per sample matrix.
- Trip Blank Samples: One trip blank will be included in each cooler containing water samples for analysis of VOCs.
- MS/MSD Samples: One per 20 environmental samples per matrix will be collected.
- Rinsate Blank Samples: One per week of sampling to verify quality of decontamination procedures.

Field duplicate samples consist of two separate samples collected from the same sampling location and depth, using the same equipment and sampling procedures. A trip blank is a clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory, without having been exposed to sampling procedures (typically analyzed only for volatile compounds). This sample is not to be labeled or identified as a trip blank for the CLP laboratory. A rinsate blank sample is collected by collecting analyte free water which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. A rinsate blank sample will be collected weekly and analyzed by the CLP for VOCs, SVOCs, PCB, pesticides, herbicides, and metals. MS/MSD is an environmental sample divided into two separate aliquots, each of which is spiked with known concentrations of target aliquots. The two spiked aliquots, in addition to an unspiked sample aliquot, are analyzed separately and the results are compared to determine the effects of the matrix on the precision and accuracy of the analysis. For groundwater samples, the MS/MSD generally requires collecting triple sample volume (three sets of vials), while for solid matrices, the MS/MSD does not require extra volume collection. All samples should be identified as MS/MSD for the CLP laboratory.

12.0 REFERENCES

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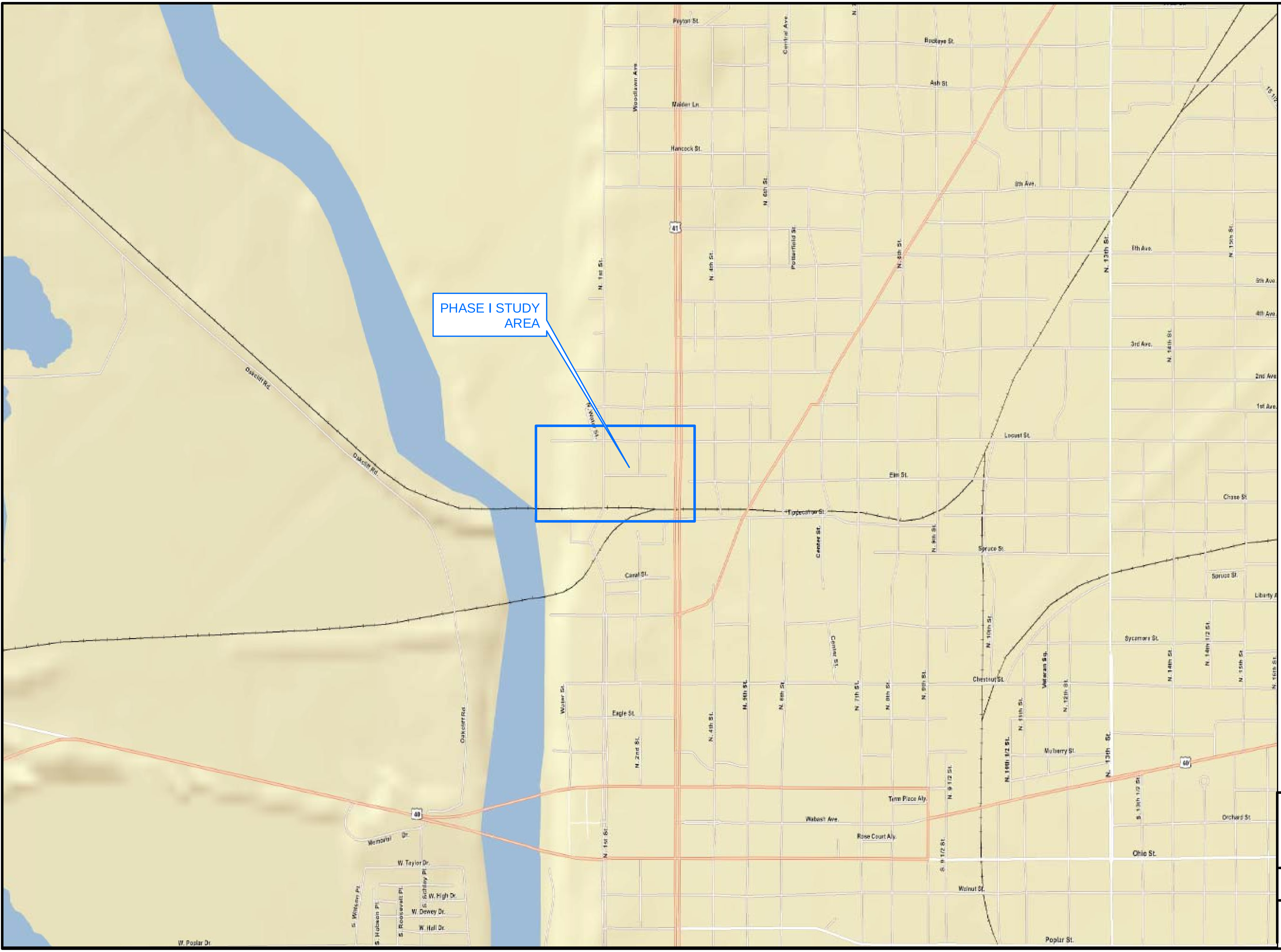
FIGURES

(Nine Sheets)



LEGEND

▭ Site Boundary

SOURCE: MODIFIED FROM INMAP, 2005.

0 500 1,000 Feet

PHASE I STUDY AREA
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, INDIANA

FIGURE 1
SITE LOCATION MAP

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2008-09-18 s:\cadd\gi\9021\0380102\mxd\figure 1 site location map.mxd TTEMI-NV joel.peters

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LEGEND

- ▭ Investigation Area
- ▲ IAWC Well
- ▭ Site Boundary
- ● Storm Sewer Manhole
- ⊕ Storm Sewer Grate

SOURCE: MODIFIED FROM BING WMS.

0 100 200 Feet

PHASE I STUDY AREA
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, INDIANA

FIGURE 2
SITE LAYOUT MAP

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IMAGE SOURCE: MODIFIED FROM BING WMS.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE I
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 3
PREVIOUS INVESTIGATIONS

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Legend

Phase II Proposed Sampling

⌖	Groundwater Monitoring Well Location
◉	Soil Boring Location
⊕	Grab Groundwater Boring Location
⬟	Soil Gas Location
■	Soil Boring VAS Location

Existing Sampling Locations

⌖	Groundwater Monitoring Well Location
◉	Phase I Soil Boring Location
⬟	Soil Gas Sample Location to be re-sampled
▲	IAWC Location to be re-sampled

0 60 120
Feet

SOURCE: MODIFIED FROM INMAP, 2005.
Bing Maps, Online Aerial Imagery

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4
SITE INVESTIGATION AND LAYOUT MAP
PROPOSED PHASE II SAMPLE LOCATIONS

ST SulTRAC

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Legend

Phase II Proposed Sampling

- ⊙ Soil Boring Location
- ⊕ Grab Groundwater Boring Location

SOURCE: MODIFIED FROM INMAP, 2005.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4A
PROPOSED PHASE II SOIL BORINGS AND
GRAB GROUNDWATER LOCATIONS

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N
W E
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Legend

Phase II Proposed Sampling

▪ Soil Boring VAS Location

Existing Sampling Locations

⊕ Groundwater Monitoring Well Location

0 125 250
Feet

SOURCE: MODIFIED FROM INMAP, 2005.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4B
VERTICAL AQUIFER SAMPLING LOCATIONS

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Legend

Phase II Proposed Sampling

⬟ Soil Gas Location

Existing Sampling Locations

⬟ Soil Gas Sample Location to be re-sampled

0 125 250
Feet

SOURCE: MODIFIED FROM INMAP, 2005.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4C
SOIL GAS SAMPLING LOCATIONS

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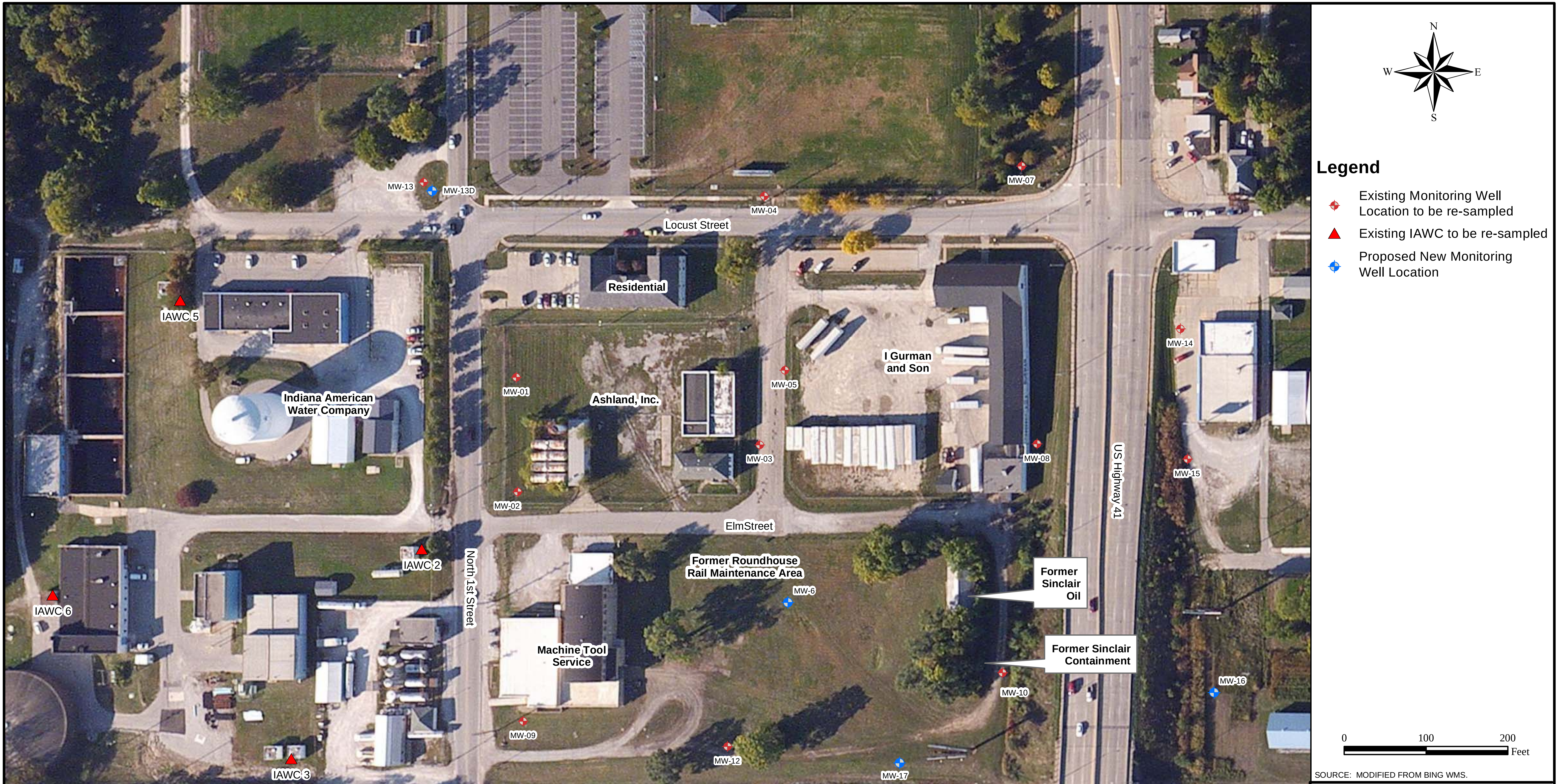

SOURCE: MODIFIED FROM BING WMS.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4D
MONITORING WELL AND IAWC WELL
SAMPLING LOCATIONS

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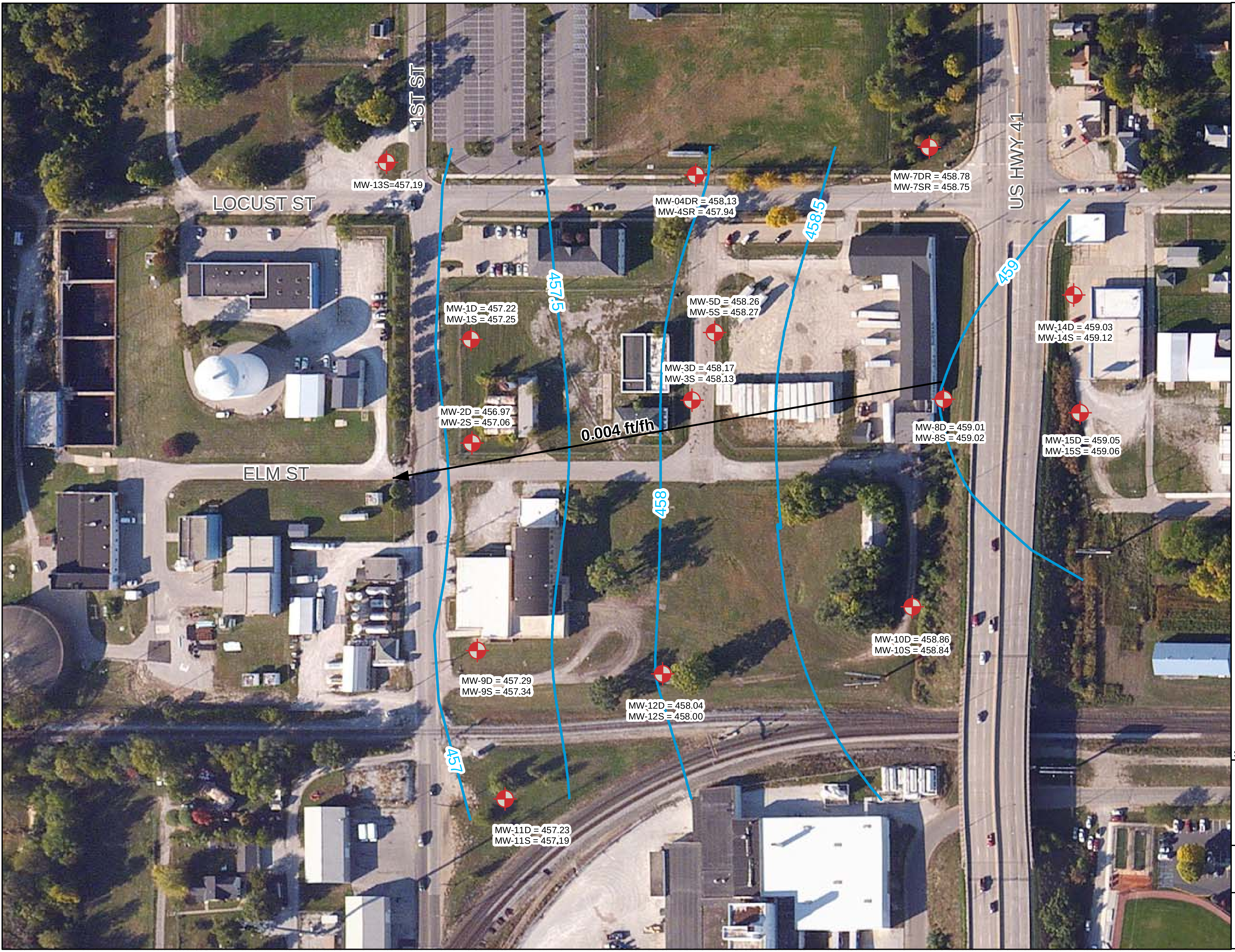

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LEGEND

Monitoring Well Location

Potentiometric Contour

(458.78) Groundwater Elevation

0 100 200
Feet

SOURCE: IMAGE MODIFIED FROM INMAP, 2005.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE I
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 5
POTENTIOMETRIC SURFACE MAP

SulTRAC

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STANDARD OPERATING PROCEDURES

SOP 002	General Equipment Decontamination
SOP 003	Organic Vapor Air Monitoring
SOP 005	Soil Sampling
SOP 010	Groundwater Sampling
SOP 014	Static Water Level, Total Well Depth, and Immiscible Layer Measurement
SOP 015	Groundwater Sample Collection Using Micropurge Technology
SOP 019	Packaging and Shipping Samples
SOP 020	Monitoring Well Installation
SOP 021	Monitoring Well Development
SOP 024	Recording of Notes in Field Notebook
SOP 061	Field Measurement of Groundwater Indicator Parameters
SOP 074	Soil Gas Sampling Methods

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

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1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap, obtained in powder detergent form and dissolved in water

Liquinox: Nonphosphate soap, obtained in liquid form for mixing with water

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992a. “Guide to Management of Investigation-Derived Wastes.” Office of Solid Waste and Emergency Response. Washington D.C. EPA 9345.3-03FS. January.

EPA. 1992b. “RCRA Ground-Water Monitoring: Draft Technical Guidance.” Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. “Sampling Equipment Decontamination.” Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). http://www.ert.org/mainContent.asp?section=Products&subsection=List

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Alconox or Liquinox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Isopropanol (pesticide grade)
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, general sampling equipment, and groundwater sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

4. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.

5. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.

6. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.

7. Remove disposable gloves and place them in plastic bag for disposal.

8. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at satellite locations within the site area in support of temporary work areas. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination activities should be considered contaminated and thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned and placed on polyethylene sheeting on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Remove loose soil using shovels, scrapers, wire brush, etc.
4. Steam clean or pressure wash to remove all visible dirt.
5. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
6. To the extent possible, allow components to air dry.
7. Wrap or cover equipment in clear plastic until it is time to be used.
8. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION

All soil sampling downhole equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Prior to sampling, scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long bristle brush and Liquinox or Alconox solution.
4. After sampling, steam clean the sampling equipment over the rinsate tub and allow to air dry.
5. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
6. Containerize all water and rinsate; disposable single-use sampling equipment should also be containerized.
7. Decontaminate all equipment placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel.
4. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with pesticide-grade isopropanol.
5. Rinse with deionized water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (isopropanol, methanol, or hexane) rinse, if applicable, or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (isopropanol, methanol, or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

2.6 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed for the decontamination of equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) pump tubing or bailers. Bailer and downhole pumps and tubing decontamination procedures are described in the following sections.

2.6.1 Bailers

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Evacuate any purge water in the bailer.
4. Scrub using soap and water and/or steam clean the outside of the bailer.
5. Insert the bailer into a clean container of soapy water. Thoroughly rinse the interior of the bailer with the soapy water. If possible, scrub the inside of the bailer with a scrub brush.
6. Remove the bailer from the container of soapy water.
7. Rinse the interior and exterior of the bailer using tap water.
8. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
9. Rinse the bailer interior and exterior with deionized water to rinse off the tap water and solvent residue, as applicable.
10. Drain residual deionized water to the extent possible.
11. Allow components to air dry.
12. Wrap the bailer in aluminum foil or a clean plastic bag for storage.
13. Containerize the decontamination wash waters for proper disposal.

2.6.2 Downhole Pumps and Tubing

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Evacuate any purge water in the pump and tubing.

4. Scrub using soap and water and/or steam clean the outside of the pump and, if applicable, the pump tubing.

5. Insert the pump and tubing into a clean container of soapy water. Pump/run a sufficient amount of soapy water to flush out any residual well water. After the pump and tubing are flushed, circulate soapy water through the pump and tubing to ensure that the internal components are thoroughly flushed.

6. Remove the pump and tubing from the container.

7. Rinse external pump components using tap water.

8. Insert the pump and tubing into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).

9. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse the pump and tubing with pesticide-grade isopropanol.

10. Rinse the pump and tubing with deionized water to flush out the tap water and solvent residue, as applicable.

11. Drain residual deionized water to the extent possible.

12. Allow components to air dry.

13. For submersible bladder pumps, disassemble the pump and wash the internal components with soap and water, rinse with tap water, isopropanol (if necessary), and deionized water, and allow to air dry.

14. Wrap pump and tubing in aluminum foil or a clean plastic bag for storage.

15. Containerize the decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) can include disposable single-use PPE and sampling equipment, soil cuttings, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination activities contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.

3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.

4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal following determination of the disposal method.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

ORGANIC VAPOR AIR MONITORING

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1.0 BACKGROUND

Exposure to airborne organic contaminants can present a significant threat to worker health and safety. Identifying and quantifying these contaminants through air monitoring is essential for reconnaissance activities. Reliable measurements of airborne organic contaminants are necessary for selecting or upgrading personal protective equipment (PPE), delineating areas where protection is needed, assessing the potential health effects of exposure, and determining the need for specific medical monitoring. Organic vapor air monitoring is also commonly used as a screening tool to identify relatively impacted environmental media and to provide a real-time basis for selecting samples for chemical analysis.

Various types of air monitoring instruments are available for measuring organic vapors. Common organic vapor monitoring instruments used by Tetra Tech include HNu® or Photovac 2020ComboPRO® photoionization detectors (PID), Foxboro® organic vapor analyzer (OVA) flame ionization detectors (FID), Photovac MicroFID, and MiniRae 2000 or 3000 PIDs. It should be noted that this standard operating procedure (SOP) discusses only some of the air monitoring instruments available to field personnel. The particular type of meter or monitoring system to be used should be identified in the project work plan or field sampling plan and selected on a site-specific basis depending on the data collection needs, the types of organic vapors to be monitored, and the sampling procedures to be used.

1.1 PURPOSE

This SOP establishes the general requirements and procedures for using various instruments to conduct organic vapor air monitoring in the field. It also discusses general factors to consider when conducting organic vapor air monitoring.

1.2 SCOPE

This SOP applies to general procedures for calibrating and operating organic vapor air monitoring instruments in the field. The project work plan or field sampling plan should identify the types of instruments to be used and the actual project-specific field parameters to be measured. The project-specific health and safety plan should identify chemical-specific action levels for health and safety purposes. For each type of air monitoring instrument, the manufacturer’s manual should be consulted for specific operating instructions.

1.3 DEFINITIONS

Flame ionization: A process by which a sample gas is ionized with a flame, allowing a count of carbon atoms to determine organic vapor concentration.

Flame ionization detector (FID): A portable instrument used to detect, measure, and provide a direct reading of organic vapor concentrations in a gas sample that is ionized with a flame.

Ionization potential: The amount of energy needed to strip an electron from the orbit of its resident molecule, expressed in electron volts.

Organic vapor: Airborne compounds composed of carbon, hydrogen, and other elements with chain or ring structures.

Organic vapor analyzer (OVA): A portable instrument used to detect, measure, and provide a direct reading of the concentration of a variety of trace organic gases in the atmosphere through flame ionization.

Photoionization: A process involving the absorption of ultraviolet light by a gaseous molecule, leading to ionization.

Photoionization detector (PID): A portable instrument used to detect, measure, and provide a direct reading of the concentrations of a variety of trace organic gases in the atmosphere through photoionization.

Breathing zone: The area where field workers would be inhaling potentially impacted air, generally from about 3 to 5 feet above the ground surface. The breathing zone will vary depending on the types of work activities being performed. Air monitoring is conducted in this zone to ensure that it is representative of the air being breathed by field team members.

Head space: The vapor mixture trapped above a solid or liquid in a sealed vessel.

1.4 REFERENCES

National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard, and U.S. Environmental Protection Agency (EPA). 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." U.S. Government Printing Office. Washington, DC.

1.5 REQUIREMENTS AND RESOURCES

The following items are typically required to monitor organic vapors in air using this SOP:

- Organic vapor air monitoring meter
- Manufacturer-supplied calibration gas
- Manufacturer-supplied calibration kits including tubing and regulators
- Resealable plastic bags for conducting soil head space measurements (if applicable)
- Sample jars for conducting water head space measurements (if applicable)
- Sharpie or similar type of permanent marker
- Container to collect soil or water used for head space measurements (if applicable)
- Logbook or field data sheets

2.0 APPLICATIONS, DETECTION METHODS, AND LIMITATIONS

All direct-reading instruments have inherent constraints in their ability to detect gaseous organic compounds. They usually detect and/or measure only specific classes of chemicals. Generally, they are not designed to measure and/or detect airborne concentrations below 1 part per million (ppm). Finally, many direct-reading instruments that have been designed to detect one particular substance also detect other substances, causing interference and possibly resulting in false readings. The following subsections discuss general application, detection methods, and limitations when using a PID and an OVA FID.

2.1 APPLICATION

The PID can be used to detect total concentrations of many organic and some inorganic gases and vapors. It can also be used in conjunction with other detection devices such as colorimetric indicator detector tubes to identify specific compounds (see SOP No. 065, Colorimetric Indicator Detectors [Dräeger Tubes]).

When set in the survey mode, the OVA FID can detect the total concentration of many organic gases and vapors. In the gas chromatography (GC) mode, the OVA FID can identify and measure the concentrations of specific compounds. In the survey mode, all organic compounds are ionized and detected at the same time. In the GC mode, volatile species are ionized and detected separately.

Each type of unit (PID or FID) has some limitations as to the detection of various categories of compounds or for specific organic compounds. Examples are described below in Section 2.2. The user manual for the specific instrument should be used to confirm its applicability for measurements of the organic vapors of concern at the site.

2.2 DETECTION METHODS

The PID ionizes molecules using ultraviolet (UV) radiation and can be used with a variety of electron voltage lamps best matched to the compound of concern at a site. The UV radiation strips electrons from the molecules, producing ions that produce a current proportional to the number of ions generated. The PID is more sensitive to aromatic and unsaturated compounds than the OVA FID. The PID is nonspecific for gas and vapor detection for organic and some inorganic compounds. The PID is also sensitive to 0.1 ppm of benzene. Sensitivity is related to the ionization potential of the compound being monitored. PIDs will only detect compounds that have ionization energies similar to the energy of the photons the detector uses. Gases with ionization potential values below the electron volt (eV) output of the lamp will be detected. The most common PID lamp used is the 10.6 eV lamp because it detects most volatile organic compounds; however, 9.5 eV and 11.7 eV lamps are also commonly available. It is recommended that the ionization potential of the chemicals of concern be known in order to select the most appropriate lamp for a specific project. Ionization potential information can be obtained from the vendor, in the manufacturer’s manual, or on line (for example, at http://www.detectorsbyaic.com/ion_potential.html).

Organic gases and vapors are flame-ionized in the OVA FID. The ions produce a current that is proportional to the number of carbon atoms present. The current is interpreted by a deflection on the instrument’s meter. In the survey mode, the OVA FID functions as a nonspecific total hydrocarbon analyzer. In the GC mode, the OVA FID can provide a tentative qualitative and quantitative identification of gases and vapors. The OVA FID is most sensitive to saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes), and aromatic hydrocarbons. The OVA FID is not suitable for inorganic gases such as chlorine, hydrogen cyanide, and ammonia. The OVA FID is also less sensitive to aromatics and unsaturated compounds than the PID. However, the OVA FID is less sensitive to high humidity than the PID. Gases and vapors that contain substituted function groups such as hydroxide (OH-) reduce the detector's sensitivity. Finally, if the operator monitors for a specific gas or vapor, the operator should use a calibration standard and GC column specific to that particular gas or vapor.

2.3 LIMITATIONS

The PID cannot be used to:

- Detect methane
- Detect a compound that has a higher energy level than the ionization potential of the PID light source
- Respond accurately to a mixture of gases or vapors
- Respond accurately in high humidity or very cold weather
- Respond accurately when interference from other sources is present

The OVA FID cannot be used to:

- Detect organic vapors at temperatures below 40 °F (4 °C)
- Identify specific organic vapors when operated in the survey mode; results must be reported relative to the calibration standard used (for example, as methane equivalents).
- Detect inorganic gases and vapors; the instrument also gives a lower response to oxygen-containing organic compounds (such as alcohols, ethers, and aldehydes) and nitrogen-containing organic compounds (such as amines, amides, and nitriles).

Detect high organic contaminant concentrations or detect contaminants in oxygen-deficient atmospheres; operation in these conditions requires system modification.

3.0 PROCEDURES

The procedures outlined in this SOP are general and typically apply to various types of monitoring instruments used to measure organic vapors in air. General procedures for testing and calibrating the instruments are presented first, followed by procedures for using the instruments and making field measurements, guidelines for recording information accurately, and a discussion of variables that may affect outdoor air monitoring. The particular monitoring instrument should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

3.1 TESTING AND CALIBRATION PROCEDURES

Each air monitoring instrument should be calibrated according to manufacturer's specifications. General procedures applicable to most equipment are as follows:

- Equipment should be thoroughly cleaned, and then calibrated and tested before the startup of sampling at each site.

- Equipment should be calibrated and tested using manufacturer-provided calibration gas and calibration connector kits.

- Batteries should be charged prior to startup of field work, and the battery charge level should be checked at the start of each day. The battery charge life will vary depending on the particular monitoring instrument to be used and the application.

- It is recommended that extra batteries be kept on hand when conducting field work.

- The PID can typically run continuously on a fully charged battery for at least 8 hours. The PID battery should be recharged for 14 hours.

- The OVA FID can typically run continuously on a fully charged battery for 8 hours alone or for 3 hours with a strip chart recorder. The OVA FID battery must be recharged every 8 hours or replaced, as needed.

- Calibration and testing of field equipment should be documented every time it is performed. Calibration and testing information should be recorded in field logbooks (or field data sheets, if applicable).

- If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.

3.2 FIELD MEASUREMENT PROCEDURES

Each air monitoring instrument should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of air monitoring to be conducted. Almost all PIDs and OVA FIDs have a recommended warm-up period (see the manufacturer's operations manual for the specific type of meter to be used). Similarly, many instruments are affected by moisture, humidity, and dust. The use of an external filter on the probe tip is recommended in these situations. Finally, many instruments include a data logging option that can be used, if desired. A general procedural summary for air monitoring associated with health and safety and field screening applications is presented below.

3.2.1 Health and Safety Monitoring

The site-specific health and safety plan will specify the types of contaminants of concern, health and safety related action levels, and the types of PPE necessary. The goal of air monitoring for health and safety purposes is to ensure that field work is conducted in accordance with the health and safety plan and to identify conditions where upgrading the level of PPE may be necessary. General procedures for conducting health and safety air monitoring for organic vapors are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment.
- Approach the sampling location from the upwind direction.
- Monitor organic vapors in the breathing zone (multiple levels of monitoring may be required depending on the work being performed).
- Monitor down-hole vapor concentrations, if drilling.
- Take readings at a frequency appropriate for the types of tasks being conducted, the types of organic vapors expected, and the levels of organic vapors being detected (monitor at a more frequent rate if organic vapors are detected and they are near the site-specific action levels specified in the health and safety plan).
- Record information in a field log book, on field data sheets, or on an air monitoring log sheet (record site name, date and time, sampling location, PID or FID readings, and pertinent weather information).
- Upgrade the level of PPE, implement engineering controls, or stop work if organic vapors are sustained in the breathing zone above action levels specified in the site-specific health and safety plan.

3.2.2 Field Screening

The site-specific work plan or field sampling plan will specify the media to be sampled, the sampling methods and procedures to be used, and field screening requirements. Typically, the goals of air monitoring for field screening purposes are to identify relatively higher organic vapor concentrations in soil, groundwater, or other media to select subsequent sampling locations, or to select environmental samples to send to a laboratory for chemical analysis. General procedures for conducting field screening air monitoring for organic vapors are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment.
- Work from the upwind direction, when possible.
- Directly screen soil cores or drill cuttings by running the tip of the meter along the soil surface while taking care not to get soil into the probe.
- Depending on sampling protocol, dig into or freshly “break” the soil and measure vapors at the newly exposed surface.
- When collecting soil samples for head space measurements, place soil in a resealable plastic bag, record the sampling location and depth on the bag with a Sharpie or other type of permanent marker, wait at least 5 minutes for vapors to accumulate (the bag may be placed in direct sunlight or in a warm area while waiting), shake the bag vigorously, and then insert the probe into the bag without placing the tip directly in the soil (while taking care not to let vapors escape).
- Directly screen purged well water (or surface water) by running the tip of the meter along the water surface while taking care not to get water into the probe.
- When collecting water samples for head space measurements, place water in a jar and tightly close the lid, record the sampling location and depth on the jar with a Sharpie or other type of permanent marker, wait at least 5 minutes for vapors to accumulate (the jar may be placed in direct sunlight or in a warm area while waiting), shake the jar vigorously, and then slightly open the lid and insert the probe into the jar without placing the tip directly in the water (while taking care not to let vapors escape).
- Record information in a field log book, on field data sheets, or on an air monitoring log sheet (record site name, date and time, sampling location, PID or FID readings, and pertinent weather information).

3.3 ACCURATE RECORDING AND INTERPRETATION

Direct-reading instruments must be operated and the data interpreted by individuals who understand the operating principles and limitations of the instruments. At hazardous waste sites, where unknown and multiple contaminants are frequently encountered, instrument readings should be interpreted conservatively.

The following guidelines promote accurate recording and interpretation:

- Calibrate instruments in accordance with the manufacturer's instructions before and after every use.
- Conduct additional monitoring at any location where a positive response occurs.
- Report a reading of zero as nondetectable (ND) rather than as "clean." Quantities of chemicals may be present but at concentrations that are not detectable by the instrument.
- Repeat the air monitoring survey using other detection devices.

3.4 VARIABLES AFFECTING OUTDOOR AIR MONITORING

Complex environments containing many substances, such as those associated with hazardous waste sites, pose significant challenges to accurately and safely assess airborne contaminants. Several independent and uncontrollable variables (most notably temperature and weather conditions) can affect airborne concentrations. These factors must be considered when conducting air monitoring and interpreting data. The following environmental variables must be considered:

- **Temperature:** An increase in temperature increases the vapor pressure of most chemicals.
- **Wind speed:** An increase in wind speed can affect vapor concentration near a free-standing liquid surface. Dust and particulate-bound contaminants are also affected.
- **Rainfall:** Water from rainfall can essentially cap or plug vapor emission routes from open or closed containers, saturated soil, or lagoons, thereby reducing airborne emissions of certain substances.
- **Moisture:** Dusts, including finely divided hazardous solids, are highly sensitive to moisture. Moisture can vary significantly with respect to location and time and can also affect the accuracy of many sampling results.

- **Background vapor emissions:** Vapor emission from other activities in the area of the field investigations can also impact readings. Operations such as vehicle maintenance or fueling facilities can affect readings associated with perimeter monitoring.

- **Work activities:** Work activities often require the mechanical disturbance of contaminated materials, which may change the concentration and composition of airborne contaminants and contribute to airborne emissions. Organic air emissions at a work site can also occur from operation of gasoline or diesel engines.

These conditions should be reported with organic vapor readings to provide a more accurate interpretation of monitoring results.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL SAMPLING

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1.0 BACKGROUND

Soil sampling is conducted for three main reasons: for laboratory chemical analysis, laboratory physical analysis, or visual classification and field screening. These three sampling objectives can be achieved separately or in combination with each other. Sampling locations are typically chosen to provide chemical, physical, or visual information in both the horizontal and vertical directions. A sampling and analysis plan is used to outline sampling methods and provide preliminary rationale for sampling locations. Sampling locations may be adjusted in the field based on the screening methods being used and the physical features of the area.

1.1 PURPOSE

Soil sampling is conducted to determine the chemical, physical, and visual characteristics of surface and subsurface soils.

1.2 SCOPE

This standard operating procedure (SOP) describes procedures for soil sampling in different areas using various implements. It includes procedures for test pit, surface soil, and subsurface soil sampling, and describes ten soil sampling devices.

1.3 DEFINITIONS

Hand auger: Instrument attached to the bottom of a length of pipe that has a crossarm or “T” handle at the top. The auger can be closed-spiral or open-spiral.

Bucket auger: A type of auger that consists of a cylindrical bucket 10 to 72 inches in diameter with teeth arranged at the bottom.

Core sampler: Thin-wall cylindrical metal tube with diameter of 0.5 to 3 inches, a tapered nosepiece, a “T” handle to facilitate sampler deployment and retrieval, and a check valve (flutter valve) in the headpiece.

EnCore^{TM} sampler: A disposable volumetric sampling device. It comes in sample sizes of 5 and 25 grams. It is a hermetically sealed, single-use soil sampler made from a high-tech, inert polymer. EnCore^{TM} samplers are used to collect soil samples with zero headspace, as required for volatile organic compound analysis. Each sample is collected using a reuseable "T" handle.

Spatulas or Spoons: Stainless steel or disposable instruments for collecting loose unconsolidated material.

Trier: Tube cut in half lengthwise with a sharpened tip that allows for collection of sticky solids or loosening of cohesive soils.

Trowel: Metal or disposable tool with a scooped blade 4 to 8 inches long and 2 to 3 inches wide with a handle.

Split-Spoon (or Split-Barrel) Sampler: Thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to drill rods.

Thin-Wall Tube Sampler: Steel tube (1 to 3 millimeters thick) with a tapered bottom edge for cutting. The upper end is fastened to a check valve that is attached to drill rods.

Volatile Organics Analysis (VOA) Plunger: Disposable, plastic, single-use soil sample collection device for volatile organic compound sample collection.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

Soil sampling requires the use of one or more of the following types of equipment:

- Spoons and spatulas
- Trowel
- Shovel or spade
- Trier
- Core sampler
- EnCore^{TM} sampler
- VOA Plunger
- Hand auger
- Bucket auger
- Split-spoon
- Thin-wall tube

In addition, the following equipment is also needed for various methods:

- Sample containers, labels, and chain-of-custody forms
- Logbook
- Tape for measuring recovery
- Soil classification information
- Wax or caps for sealing ends of thin-wall tube
- "T" Handles
- Plastic sheeting
- Decontamination equipment
- Drilling equipment
- Backhoe
- Health and safety equipment

2.0 SOIL SAMPLING PROCEDURES

This SOP presents procedures for conducting test pit, surface soil, and subsurface soil sampling. The site sampling plan will specify which of the following procedures will be used.

Soil samples for chemical analysis should be collected in the following order: (1) volatile organics, (2) semivolatile organics, and (3) metals. Once the chemical samples have been containerized, samples for physical analyses can be containerized. Typical physical analyses conducted include (1) grain size distribution, (2) moisture content, (3) saturated permeability, (4) unsaturated permeability, and (5) Atterberg limits. Additionally, visual descriptions of samples, using the Unified Soil Classification System (USCS), should be recorded. Field tests such as head space analyses can also be conducted.

Soil samples for chemical analyses can be collected either as grab samples or composite samples. A grab sample is collected from a discrete location or depth. A composite sample consists of soil combined from more than one discrete location. Typically, composite samples consist of soil obtained from several locations and homogenized in a stainless steel or Teflon® pan, tray, or baggie. Refer to the site-specific Quality Assurance Project Plan (QAPP) for methodology for composite sample collection. Samples for volatile organics analysis should not be composited.

All soil samples collected should be packaged and shipped to the laboratories in accordance with SOP 019. All nondedicated or nondisposable equipment used for soil sampling should be decontaminated between sampling locations in accordance with SOP 002.

2.1 SOIL SAMPLE COLLECTION PROCEDURES

Soil samples can be collected as discrete samples for volatile organic compound (VOC) analysis using specialized equipment for preservation in the laboratory or in the field. Soil samples collected for non-VOC analysis can be collected as either grab or composite samples using standard equipment.

2.1.1 Procedure for Preserving and Collecting Soil Samples for VOC analysis

Samples collected for VOC analysis using traditional methods, such as collection in a jar with no preservation, are shown to yield nonrepresentative samples due to loss of VOCs. To prevent such losses, preservation with methanol or sodium bisulfite may be used to minimize volatilization and biodegradation. This preservation may be performed in the laboratory or in the field, depending on the sample collection methodology used. The specific sampling methodology will be specified in the project-specific QAPP or work plan.

Soil samples to be preserved in the laboratory are collected using SW-846 Method 5035. For samples preserved in the field, laboratories may perform low-level analysis (sodium bisulfate preservation) or high- to medium-level analyses (methanol preservation), depending on the project-specific QAPP.

The following procedures outline the necessary steps for collecting soil samples to be preserved at the laboratory, and for collecting soil samples to be preserved in the field with methanol or sodium bisulfate.

2.1.1.1 Soil Samples to be Preserved at the Laboratory

Soil samples collected for VOC analysis that are to be preserved at the laboratory shall be obtained using a hand-operated, hermetically sealed sample vial such as an EnCore™ sampler. Each sample shall be obtained using a reusable sampling handle (“T” handle) that can be provided with the EnCore™ sampler when requested and purchased. Collect the soil sample in the following manner for each EnCore™ sampler.

The EnCore™ sampler is loaded into the “T” handle with the plunger fully depressed. Press the “T” handle into the soil to be sampled. The plunger will be forced upward as the cavity fills with soil. When the sampler is full, using the “T” handle, rotate the plunger and lock it into place. If the plunger does not lock, then it is not filled with soil. Soft soil may require several plunges or forcing soil against a hard surface such as a decontaminated sample trowel to ensure headspace has been eliminated. Remove soil from the outside of the sampler so a tight seal can be made between the sample cap and the O-ring. With soil slightly piled above the rim of the sampler, force the cap on until the catches hook the side of the sampler. Remove any surface soil from outside of the sampler and place in the foil bag provided with the sampler. Label the bag with sample location information. Typically, collect three EnCore™ samplers per sample location. Decontaminate the “T” handle between sample locations.

Using the EnCore™ sampler eliminates the need for field preservation and the shipping restrictions associated with preservatives. A complete set of instructions is included with each EnCore™ sampler.

After the EnCore™ samples are collected, they should be placed on ice immediately and delivered to the laboratory within 48 hours. The samples must be preserved by the laboratory within 48 hours of collection.

2.1.1.2 Soil Samples to be Preserved in the Field

Soil samples preserved in the field may be prepared for analysis using both the low-level (sodium bisulfate preservation) and high- to medium-level (methanol preservation) methods. If samples effervesce when placed in preservative, it is necessary to collect a sample unpreserved, in deionized water. In addition, an unpreserved sample for determination of moisture content must also be collected when collecting soil samples to be preserved in the field.

Methanol Preservation (High to Medium Level). Bottles may be pre-spiked with methanol in the laboratory or prepared in the field. Soil samples to be preserved in the field with methanol shall utilize 40- to 60-milliliter (mL) glass vials with septum-lined lids. Each sample bottle shall be filled with 25 mL of demonstrated analyte-free purge-and-trap grade 3 methanol. The preferred method for adding methanol to the sample bottle is by removing the lid and using a pipette or scaled syringe to add the methanol directly to the bottle.

Soil shall be collected with the use of a decontaminated (or disposable), small-diameter coring device such as a disposable VOA plunger. The outside diameter of the coring device must be smaller than the inside of the sample bottle neck. To collect the sample, pull the plunger back to the required location, insert it into the soil to be sampled, push the coring device into the soil, extrude the soil sample into the methanol-preserved sample bottle, and cap the bottle tightly. Swirl the sample (do not shake) in the methanol to break up the soil such that all of the soil is covered with methanol. Place the sample on ice immediately.

Sodium Bisulfate Preservation (Low Level). Bottles may be prepared in the laboratory or in the field with sodium bisulfate solution. Samples to be field-preserved using sodium bisulfate are collected using the same procedures described for methanol preservation.

2.1.2 Procedure for Collecting Soil Samples for Non-VOC Analyses

Samples collected for non-VOC analyses may be collected as either grab or composite samples as follows. Using a sampling device, transfer a portion of soil to be sampled to a stainless steel bowl, disposable inert plastic tray, or baggie. Remove roots, vegetation, sticks, and stones larger than the size of pea gravel. Thoroughly mix the soil to obtain as uniform a texture and color as practicable. Transfer the mixed soil to the appropriate sample containers and close the containers. Place the sample containers immediately on ice.

2.2 TEST PIT AND TRENCH SOIL SAMPLING

Test pit and trench soil sampling is conducted when a complete soil profile is required or as a means of locating visually detectable contamination. This type of sampling provides a detailed description of the soil profile and allows for multiple samples to be collected from specific soil horizons. Prior to conducting any test pit or trench excavation with a backhoe, the sampling team should ensure that the sampling area is clear of utility lines, subsurface pipes, and poles.

A test pit or trench is excavated by incrementally removing soil material with a backhoe bucket. The excavated soil is placed on plastic sheeting well away from the edge of the test pit. A test pit should not be excavated to depths greater than 4 feet unless its walls are properly sloped or stabilized. No personnel shall enter any test pit or trench excavation over 4 feet deep; such action would constitute confined space entry and must conform with Occupational Safety and Health Administration (OSHA) regulations at Title 29 of the *Code of Federal Regulations* § 1910.

Personnel entering the test pit may be exposed to toxic or explosive gases and oxygen deficient environments. Air monitoring is required before entering the test pit, and the use of appropriate respiratory gear and protective clothing is mandatory. At least two persons must be present at the test pit before sampling personnel may enter the excavation and begin soil sampling. Refer to project-specific Health and Safety Plans for required safety procedures for excavations.

Soil samples can also be obtained directly from the backhoe bucket or from the excavated material after it has been removed and deposited on plastic sheeting. The sampling personnel shall direct the backhoe excavator to obtain material from the selected depth and location within the excavation. The backhoe operator shall set the backhoe bucket on the ground in a designated location, at a sufficient distance from the excavation to allow the sampler safe access to the bucket. The backhoe operator shall disengage the controls and signal to the sampler that it is safe to approach the bucket. The soil sample shall then be collected from the center of the backhoe bucket to reduce the potential for cross-contamination of the sample.

Test pits are not practical for sampling at depths greater than 15 feet. If soil samples are required from depths greater than 15 feet, samples should be obtained using test borings instead of test pits. Test pits are also usually limited to a few feet below the water table. In some cases, a pumping system may be required to control the water level within the pits.

Access to open test pits should be restricted by the use of flagging, tape, or fencing. If a fence is used, it should be erected at least 6 feet from the perimeter of the test pit. The test pit should be backfilled as soon as possible after sampling is completed.

Various equipment may be used to collect soil samples from the walls or bottom of a test pit. A hand auger, bucket auger, or core sampler can be used to obtain samples from various depths. A trier, trowel, EnCore^{TM} sampler, VOA plunger, or spoon can be used to obtain samples from the walls or pit bottom surface.

2.3 SURFACE SOIL SAMPLING

The surface soil sampling equipment presented in this SOP is best suited for sampling to depths of 0 to 6 feet below ground surface (bgs). The sample depth, sample analyses, soil type, and soil moisture will also dictate the most suitable sampling equipment. Prior to sample collection, the sampling locations should be cleared of any surface debris such as twigs, rocks, and litter. The following table presents various surface soil sampling equipment and their effective depth ranges, operating means (manual or power), and sample types collected (disturbed or undisturbed).

Sampling Equipment	Effective Depth Range (feet bgs)	Operating Means	Sample Type
Hand Auger	0 to 6	Manual	Disturbed
Bucket Auger	0 to 4	Power	Disturbed
Core Sampler	0 to 4	Manual or Power	Undisturbed
EnCore^{TM} Sampler	Not Applicable	Manual	Disturbed
Spoon/Spatula	0 to 0.5	Manual	Disturbed
Trowel	0 to 1	Manual	Disturbed
VOA Plunger	Not Applicable	Manual	Disturbed

The procedures for using these various types of sampling equipment are discussed below.

2.3.1 Hand Auger

A hand auger equipped with extensions and a “T” handle is used to obtain samples from depths of up to 6 feet bgs. If necessary, a shovel may be used to excavate the topsoil to reach the desired subsoil level. If topsoil is removed, its thickness should be recorded. Samples obtained using a hand auger are disturbed in their collection; determining the exact depth at which samples are obtained is difficult.

The hand auger is screwed into the soil at an angle of 45 to 90 degrees from horizontal. When the entire auger blade has penetrated soil, the auger is removed from the soil by lifting it straight up without turning it, if possible. If the desired sampling depth has not been reached, the soil is removed from the auger and deposited onto plastic sheeting. This procedure is repeated until the desired depth is reached and the soil sample is obtained. The auger is then removed from the boring and the soil sample is collected directly from the auger into an appropriate sample container.

2.3.2 Bucket Auger

A bucket auger, equipped similarly as the hand auger, is used to obtain disturbed samples from depths of up to 4 feet bgs. A bucket auger should be used when sampling stony or dense soil that prohibits the use of a hand-operated core or screw auger. A bucket auger with closed blades is used in soil that cannot generally be penetrated or retrieved by a core sampler.

The bucket auger is rotated while downward pressure is exerted until the bucket is full. The bucket is then removed from the boring, the collected soil is placed on plastic sheeting, and this procedure is repeated until the appropriate depth is reached and a sample is obtained. The bucket is then removed from the boring and the soil sample is transferred from the bucket to an appropriate sample container.

2.3.3 Core Sampler

A hand-operated core sampler (Figure 1), similarly equipped as the hand auger, is used to obtain samples from depths of up to 4 feet bgs in uncompacted soil. The core sampler is capable of retrieving undisturbed soil samples and is appropriate when low concentrations of metals or organics are of concern. The core sampler should be constructed of stainless steel. A polypropylene core sampler is generally not suitable for sampling dense soils or sampling at greater depths.

The core sampler is pressed into the soil at an angle of 45 to 90 degrees from horizontal and is rotated when the desired depth is reached. The core is then removed, and the sample is placed into an appropriate sample container.

2.3.4 Shovel

A shovel may be used to obtain large quantities of soil that are not readily obtained with a trowel. A shovel is used when soil samples from depths of up to 6 feet bgs are to be collected by hand excavation; a tiling spade (sharpshooter) is recommended for excavation and sampling. A standard steel shovel may be used for excavation; either a stainless steel or polypropylene shovel may be used for sampling. Soil excavated from above the desired sampling depth should be stockpiled on plastic sheeting. Soil samples should be collected from the shovel and placed into the sample container using a stainless-steel scoop, plastic spoon, or other appropriate tool.

2.3.5 Trier

A trier (Figure 2) is used to sample soil from depths up to 1 foot bgs. A trier should be made of stainless steel or polypropylene. A chrome-plated steel trier may be suitable when samples are to be analyzed for organics and heavy metal content is not a concern.

Samples are obtained by inserting the trier into soil at an angle of up to 45 degrees from horizontal. The trier is rotated to cut a core and is then pulled from the soil being sampled. The sample is then transferred to an appropriate sample container.

2.3.6 Trowel

A trowel is used to obtain surface soil samples that do not require excavation beyond a depth of 1 foot. A trowel may also be used to collect soil subsamples from profiles exposed in test pits. Use of a trowel is practical when sample volumes of approximately 1 pint (0.5 liter) or less are to be obtained. Excess soil should be placed on plastic sheeting until sampling is completed. A trowel should be made of stainless steel or galvanized steel. It can be purchased from a hardware or garden store. Soil samples to be analyzed for organics should be collected using a stainless steel trowel. Samples may be placed directly from the trowel into sample containers.

2.4 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling is accomplished in conjunction with borehole drilling, for soil sampling from depths greater than approximately 6 feet bgs. Subsurface soil sampling is frequently coupled with exploratory boreholes or monitoring well installation.

Subsurface soil sampling may be conducted using a drilling rig, power auger, or direct-push technology (DPT). Selection of sampling equipment depends upon geologic conditions and the scope of the sampling program. Two types of samplers used with machine-driven augers—the split-spoon sampler and the thin-wall tube sampler—are discussed below. All sampling tools should be cleaned before and after each use in accordance with SOP No. 002 (General Equipment Decontamination). Both the split-spoon sampler and the thin-wall tube sampler can be used to collect undisturbed samples from unconsolidated soils. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.4.1 Split-Spoon Sampler

Split-spoon samplers are available in a variety of types and sizes. Site conditions and project needs, such as large sample volume for multiple analyses, determine the specific type of split-spoon sampler to be used. Figure 3 shows a generic split-spoon sampler.

The split-spoon sampler is advanced into the undisturbed soil beneath the bottom of the casing or borehole using a weighted hammer and a drill rod. The relationship between hammer weight, hammer drop, and number of blows required to advance the split-spoon sampler in 6-inch increments indicates the density or consistency of the subsurface soil. After the split-spoon sampler has been driven to its intended depth, it should be removed carefully to avoid loss of sample material. In noncohesive or saturated soil, a catcher or basket should be used to help retain the sample.

After the split-spoon sampler is removed from the casing, it is detached from the drill rod and opened. If VOA samples are to be collected, EnCore™ samplers or VOA plungers should be filled with soil taken directly from the split-spoon sampler. Samples for other specific chemical analyses should be taken as soon as the VOA sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample (except for the top several inches of possibly disturbed material) is retained for analysis or disposal.

2.4.2 Thin-Wall Tube Sampler

A thin-wall tube sampler, sometimes called the Shelby tube (Figure 4), is used to collect soil samples for geophysical analysis. Tube samplers are best suited for collecting cohesive soils such as clays and silts. The tube sampler may be pressed or driven into soil inside a hollow-stem auger flight, wash bore casing, or uncased borehole. The tube sampler is pressed into the soil, without rotation, to the desired depth or until refusal. If the tube cannot be advanced by pushing, it may be necessary to drive it into the soil without rotation using a hammer and drill rod. The tube sampler is then rotated to collect the sample from the soil and removed from the borehole.

After removal of the tube sampler from the drilling equipment, the tube sampler should be inspected for adequate sample recovery. The sampling procedure should be repeated until an adequate soil core is obtained (if sample material can be retained by the tube sampler). The soil core obtained should be documented in the logbook. Any disturbed soil is removed from each end of the tube sampler. If chemical analysis is required, VOA samples must be collected immediately after the tube sampler is withdrawn. EnCore^{TM} samplers or VOA plungers should be filled with soil taken directly from the tube sampler. Before use, and during storage and transport, the tube sampler should be capped with a nonreactive material. For physical sampling parameters, the tube is sealed using plastic caps. The top and bottom of the tube sampler should be labeled and the tube sampler should be stored accordingly.

2.4.3 Direct-Push Technology Sampler

Geoprobe systems utilize DPT. In many cases, DPT is less expensive and faster than collecting soil samples with a standard drilling rig. In addition, the use of DPT causes minimal disturbance to the ground surface and generates little to no soil cuttings. DPT uses acetate or clear polyvinyl chloride (PVC) sleeves for collecting soil samples. Use of the Geoprobe system is described in SOP No. 054.

Upon retrieval of the sampling rod from the ground, the sample sleeve is extruded from the sampling rod. The sleeve is sliced lengthwise twice, to open the sleeve. Soil samples can be collected directly from the opened sleeve. If VOA samples are to be collected, EnCore^{TM} samplers or VOA plungers should be filled with soil taken directly from the opened DPT sampler. Samples for other specific chemical analyses should be taken after the VOA sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample is retained for analysis or disposal.

FIGURE 1

HAND-OPERATED CORE SAMPLER

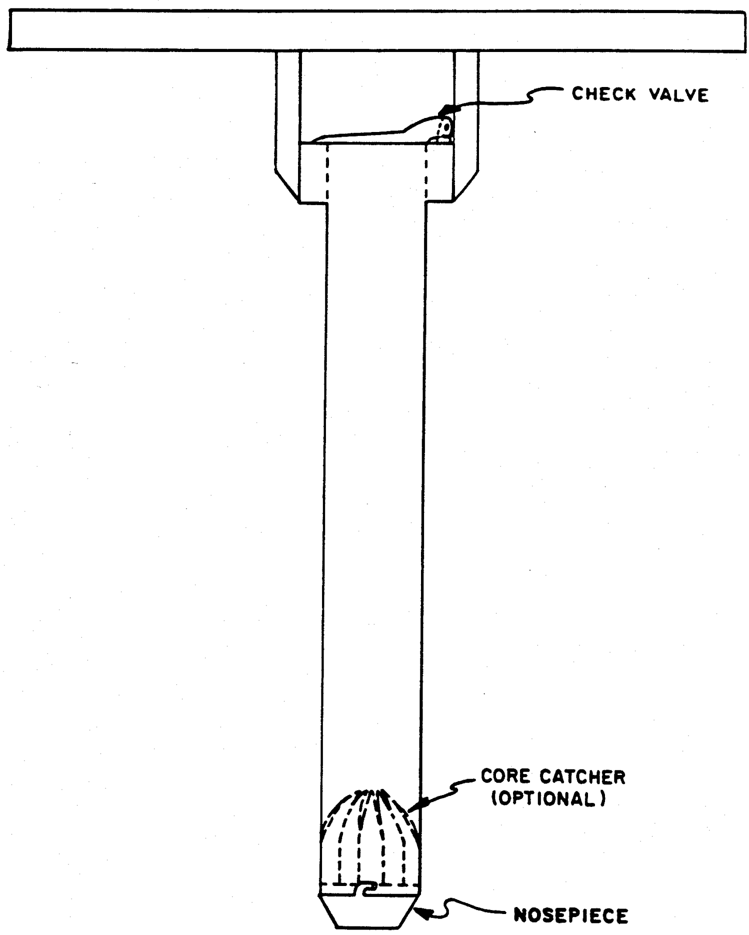


FIGURE 2

TRIER

TRIER

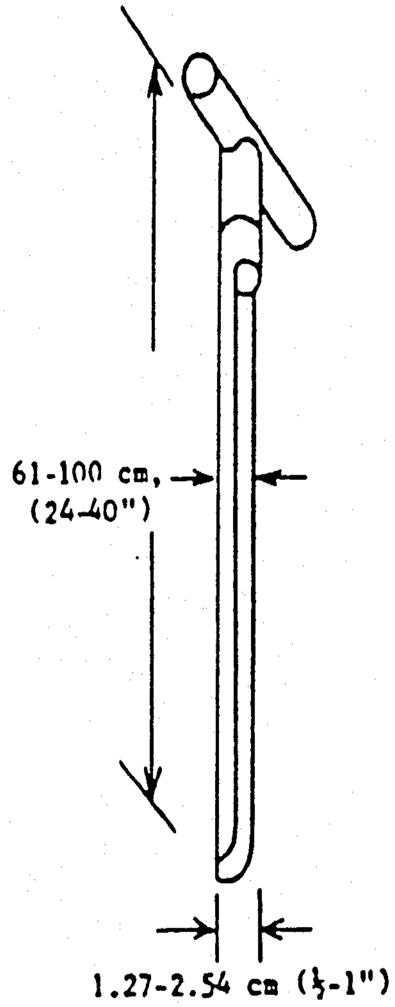


FIGURE 3

GENERIC SPLIT-SPOON SAMPLER

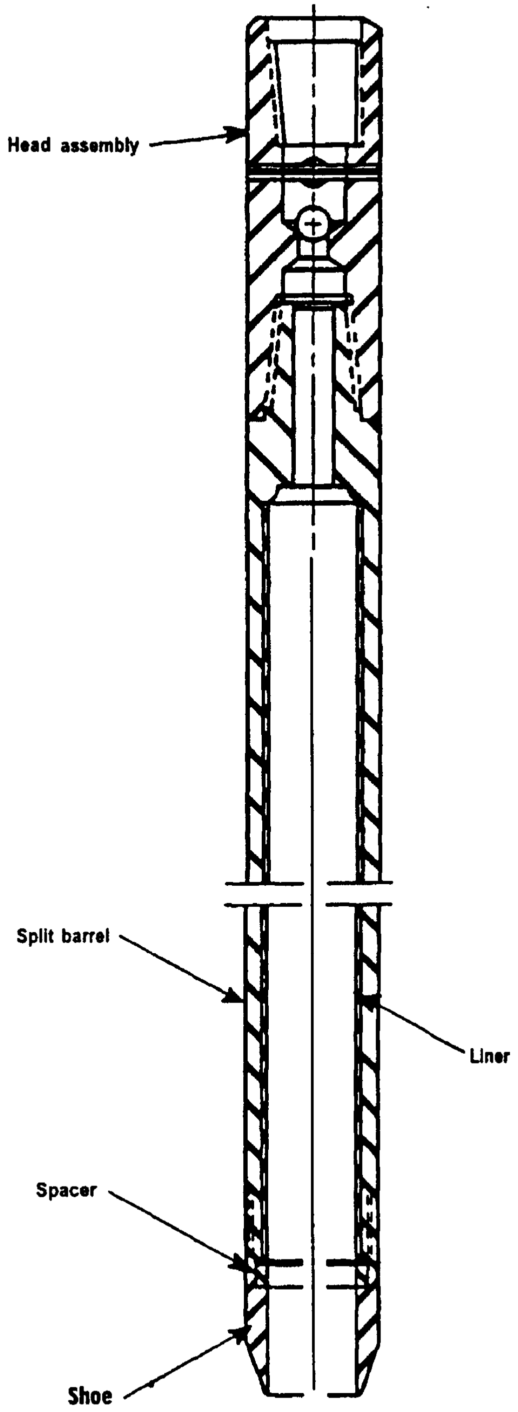
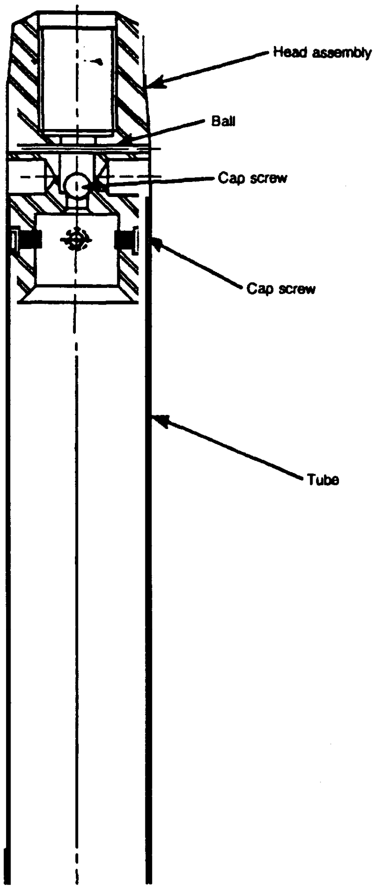


FIGURE 4

THIN-WALL TUBE SAMPLER



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

SOP NO. 010

REVISION NO. 4

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Quality Assurance Approved

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1.0 BACKGROUND

Groundwater sampling may be required for a variety of reasons, such as to examine potable or industrial water supplies, check for and track contaminant plume movement in the vicinity of a land disposal or spill site, conduct Resource Conservation and Recovery Act (RCRA) compliance monitoring, or examine a site where historical information is minimal or nonexistent, but where groundwater may be contaminated.

Groundwater is usually sampled through an in-place well, either temporarily or permanently installed. SOP No. 020 (Monitoring Well Installation) provides guidance for installing new monitoring wells. However, it can also be sampled anywhere groundwater is present, such as in a pit or a dug or drilled hole.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for determining the quality of groundwater entering, leaving, or affected by site activities through groundwater sampling. The samples are obtained by retrieving water from a well screened in the aquifer or aquifers underlying a site.

1.2 SCOPE

This SOP provides general guidance for groundwater sampling activities conducted in the field. SOP No. 015 (Groundwater Sample Collection Using Micropurge Technology) provides additional specific guidance for using low-flow methods to collect groundwater samples.

1.3 DEFINITIONS

Bailer: A cylindrical sampling device with valves on either end, used to extract water from a well. Bailers are usually constructed of an inert material such as stainless steel or polytetrafluoroethylene (Teflon). The bailer is lowered and raised by means of a cable that may be cleaned and reused, or by disposable rope.

Electrical Water Level Indicator: An electrical device that has a light or sound alarm connected to an open circuit, used to determine the depth to liquid. The circuit is closed when the probe intersects a conducting liquid. The wire used to raise and lower the probe is usually graduated.

Immiscible Phase: A liquid phase that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink, and light immiscible phases float on water.

Interface Probe: An electrical probe that determines the distance from the surface to air-water, air-immiscible, or immiscible-water interfaces.

Purge Volume: The volume of water that needs to be removed from the well prior to sampling to ensure that the sample collected is representative of the formation groundwater.

Riser Pipe: The length of well casing above the ground surface.

Total Well Depth: The distance from the reference measuring point (top of well casing or ground surface) to the bottom of the well.

Water Level: The level of water in a well, measured as depth to water or as elevation of water, relative to a reference mark or datum.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

There are various options available to obtain groundwater samples. The procedures are outlined in the following section. The equipment needed to accomplish these procedures includes the following:

- Organic vapor detector with a flame ionization detector (FID) or a photoionization detector (PID)
- Pipe wrench and/or other tools needed to open monitoring wells (socket wrench, mallet, etc.)
- Electrical water level indicator or interface probe
- Purging device (type needed depends on well depth, casing diameter, and type of sample desired; see sampling devices below)
- Graduated cylinder or bucket
- Sampling device (type needed depends upon depth to water and type of sample desired)
  - Teflon bailer
  - Stainless steel bailer
  - Teflon bladder pump
  - Stainless steel submersible (non-oil-bearing) pump
  - Existing dedicated equipment
  - Peristaltic pump
- Sample containers
- Wastewater containers

- Field logbook
- Stopwatch

Additional equipment is required to complete measurement of field parameters (for example, pH, specific conductance, and temperature) of the groundwater in the well. Refer to Tetra Tech SOP 061 (Field Measurement of Dissolved Oxygen, Oxidation-Reduction Potential, pH, Specific Conductance, Temperature, and Turbidity Using a Multi-Parameter Water Quality Meter) or individual field parameter SOPs as appropriate.

2.0 PROCEDURE

Prior to sampling, a site-specific sampling plan should be developed. The plan should take into consideration the site characteristics and should include:

- Specific, repeatable well measurement techniques and reference points for determining the depth to water and the depth to the bottom of the well
- Specific method of purging and selection of purging equipment
- Specific methods and equipment for measurements of field parameters
- Specific method of sample collection and the sampling equipment that will be used
- Specific parameters for which samples will be analyzed
- Order in which sample bottles will be filled, based on the analytical parameters

The following sections discuss procedures for approaching the well, establishing a sample preparation area, making preliminary well measurements, purging the well, and collecting samples.

2.1 APPROACHING THE WELL

In general, all wells should be assumed to pose a health and safety risk until field measurements indicate otherwise. Approach the well from the upwind side. Record well appearance and the general condition of the protective casing, surface seal, and surrounding area in the logbook.

Once at the well, the lead person should systematically use the organic vapor detector to survey the immediate area around the well (from the breathing zone to the top of the casing to the ground). If elevated FID and PID meter readings are encountered, retreat to a safe area and instruct the sampling team to either let vapors dissipate and approach the well again or put on the appropriate level of personal protective equipment (PPE), as specified in the site-specific health and safety plan. See SOP No. 003 (Organic Vapor Air Monitoring) for additional air monitoring guidance.

Some monitoring wells have the potential to contain pressurized headspace—for example, through the generation of gases from contaminated groundwater, due to biological processes, degradation of contaminants, or simply based on location such as near a landfill or in areas that intersect lithological abnormalities; or through intentional artificial means such as those associated with air sparging systems. Injection or extraction wells may be artificially pressurized and may remain so for several days after the system has been turned off. This presents a hazard to people opening these wells. Tetra Tech personnel shall employ the following practices to minimize these hazards:

- Wear safety glasses to protect the eyes. If site-specific observations and conditions indicate that the wells may be pressurized, wear a full-face shield over the safety eye protection.
- Do not place the face or any other part of the body over the well when opening because this may place you in a strike zone.
- Open the well cover at arm’s length, then step away and allow the well to off gas and stabilize.

Upon opening the well casing, the lead person should systematically survey inside the well casing, above the well casing in the breathing zone, and in the immediate area around the well. If elevated FID or PID meter readings in the breathing zone are encountered (see health and safety plan for action levels), retreat and put on appropriate PPE. It is important to remember that action levels are based on readings in the breathing zone, not within the well casing. Representative organic vapor detector readings should be recorded in the logbook. Also look out for insects or other animals that may nest in well openings, and refer to the health and safety plan for specific hazards.

2.2 ESTABLISHING A SAMPLE PREPARATION AREA

The sample preparation area is generally located upwind or to either side of the well. If elevated readings are encountered using an organic vapor detector, this area should be taped off and the sample preparation area should be located upwind of the well, where ambient conduction are measured.

2.3 MAKING PRELIMINARY WELL MEASUREMENTS

Several preliminary well measurements should be made prior to initiating sampling of the well. These include determining water level and total well depth measurements, determining the presence of immiscible phases, and calculating purge volumes. All preliminary measurements will be recorded in the logbook or the Groundwater Sampling Data Sheet (included as an exhibit to this SOP) as they are determined. SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) provides additional information concerning these preliminary measurements.

2.3.1 Water Level and Total Well Depth Measurements

Tetra Tech typically uses an electric water level indicator for water level and total well depth measurements. This device sounds an alarm or triggers a light when the measuring probe touches the water surface, thus closing an electrical circuit. The electric cable supporting the probe is usually graduated to 0.01 foot and can be read at the well site directly. The distance between the static water level and the marked or notched location at the top of the riser pipe is measured. The height of the riser pipe above ground surface, as obtained from well location survey data, is then subtracted from the total reading to give the depth to static water. To improve accuracy, three separate readings should be made, and the values averaged. This helps to eliminate any errors due to kinks or bends in the cables, which may change in length when the water level indicator is raised and lowered.

The total well depth can be measured by lowering the probe into the well until resistance is met, indicating that the probe has reached the bottom of the well. The total well depth is then read to the 0.01-foot fraction. The distance between the bottom of the well and the marked or notched location on the riser pipe is measured. The height of the riser pipe above the ground surface, as obtained from well survey data, is then subtracted from the total reading to give the depth to the bottom of the well. To improve accuracy, three separate readings should be made, and the readings averaged.

2.3.2 Determining if Immiscible Nonaqueous-Phases Liquids are Present

If immiscible, nonaqueous-phase liquid (NAPL) are present, the following measurement activities should be undertaken. Organic liquids are measured by lowering an interface probe slowly to the surface of the liquid in the well. When the audible alarm sounds, record the depth. If the alarm is continuous, a floating immiscible layer has been detected. To determine the thickness of this layer, continue lowering the probe slowly until the alarm changes to an oscillating signal. The oscillating signal indicates that the probe has detected an aqueous layer. Record this depth as the depth to water and determine the thickness and the volume of the immiscible layer.

Continue lowering the probe into the well to determine if dense immiscible phases (sinkers) are present. If the alarm signal changes from oscillating to a continuous sound, a heavier immiscible layer has been detected; record this depth.

Continue lowering the probe to the bottom of the well and record the total depth. Calculate and record the sinker phase volume and total water volume in the well (see equation in Section 2.3.3). If immiscible phases are present, immediately refer to Section 2.5.3 or 2.5.4 of this SOP for sample collection procedures.

2.3.3 Determination of Purging Volume

If the presence of immiscible phases does not need to be determined, determine the depth to water and the total depth of the well as described in Section 2.3.1. Once these measurements have been made and recorded, use Table 1 to calculate the total volume of water in the well. Multiply this volume by the purging factor to determine purging volume. The minimum purging factor is typically three casing volumes but may be superseded by site-specific program requirements, individual well yield characteristics, or stabilization of field parameters measured during purging. Field parameters (for example, pH, specific conductance, and temperature) should be measured prior to purging and after each well volume. All field parameter data should be recorded in the field logbook, Groundwater Sampling Data Sheet, or personal digital assistant (PDA). Refer to specific Tetra Tech SOP 061 as appropriate for more detailed procedures for determining these field parameters.

The volume of water in the well is based on the following formula:

$$V = \pi r^2 h \times 7.48$$

where

V = static volume of water in the well (gallons)

r = inside radius of the well (feet)

h = length of water in the well (total well depth minus depth to water) (feet)

7.48 = conversion factor (cubic feet to gallons)

Common well sizes and corresponding volumes are as follows:

- 1-inch well = h x 0.041 gal/ft
- 2-inch well = h x 0.163 gal/ft
- 3-inch well = h x 0.367 gal/ft
- 4-inch well = h x 0.652 gal/ft

2.4 PURGING THE WELL

Currently, Tetra Tech standards allow for six options for purging wells:

1. Teflon bailers
2. Stainless steel bailers
3. Teflon bladder pumps
4. Stainless steel submersible (non-oil-bearing) pumps
5. Existing dedicated equipment
6. Peristaltic pumps (these devices are for shallow wells only)

As previously stated, the minimum purging volume is typically three casing volumes. Exceptions to this standard may be made in the case of low-yield wells. When purging low-yield wells, purge the well until the water level is equal to the top of screen elevation (if possible). Samples should be collected no sooner than 2 hours after purging and when sufficient groundwater volume is available.

The well should be purged until measured field parameters have stabilized. If any field parameter has not stabilized, additional purging should be performed. To be considered stable, field parameters should change by no more than the stabilization criteria listed on Table 1 between each well volume purged. If the above conditions have not been met after a specified period of time, purging will be considered complete and sampling can begin. Refer to the field sampling plan or quality assurance project plan for specified time period. Record the final well stabilization parameters on the Groundwater Sampling Data Sheet, and indicate if the well purging was considered complete due to stabilized parameters or exceeding the specified period of time.

At no time should the purging rate be high enough to cause the groundwater to cascade back into the well, as this could result in excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured using several acceptable methods:

- When bailers are used, the actual volume of each bailer's contents can be measured using a calibrated bucket.
- If a pump is used for purging, the pump rate can be determined by using a bucket of known volume, stopwatch, and the duration of pumping time necessary to purge the known volume.

2.5 SAMPLE COLLECTION

This section first describes general groundwater sample collection procedures. This section also describes procedures for collecting groundwater samples for volatile organic analysis (VOA) and for collecting samples when light or heavy immiscible layers are present in a monitoring well. Samples of light and heavy immiscible layers should be collected before the well is purged. Site-specific sampling plans may indicate that, based on the presence of NAPL, no groundwater sample is to be collected.

2.5.1 General Groundwater Sampling Procedures

The technique used to withdraw a groundwater sample from a well should be selected based on the parameters for which the sample will be analyzed. To ensure that the groundwater samples are representative, it is important to avoid physically altering or chemically contaminating the sample during collection, withdrawal, or containerization. If the samples are to be analyzed for volatile organic compounds, it is critical that air does not become entrained in the water column.

Acceptable sampling devices for all parameters are double check valve stainless steel or Teflon bailers, bladder pumps, low-flow positive displacement pumps, or for shallow wells, peristaltic pumps. Additional measurements of field parameters should be performed at the time of sampling.

In some cases, it may become necessary to use dedicated equipment already in the well to collect samples. This is particularly true of high-volume, deep wells (>150 feet) where bladder pumps are ineffective and bailing is impractical. If existing equipment must be used, however, determine the make and model of the pump and obtain information on component construction materials from the manufacturer or facility representatives. If an existing pump is to be used for sampling, make sure the flow volume can be reduced so that a reliable VOA sample can be taken. Record the specific port, tap, or valve from which the sample is collected. If nondedicated sampling equipment is used, the least contaminated wells should be purged and sampled first and most contaminated wells should be purged and sampled last (if past sampling data are available to make this determination).

General sampling procedures are as follows:

- Clean sampling equipment should not be placed directly on the ground. Use a plastic drop cloth or feed line from clean reels. Never place contaminated lines back on reels.
- Check the operation of the bailer check valve assemblies to confirm free operation.
- If the bailer cable is to be decontaminated and reused, it must be made of Teflon-coated stainless steel.
- Lower sampling equipment slowly into the well to avoid degassing the water and damaging the equipment.
- Pump flow rates should be adjusted to eliminate intermittent or pulsed flow. The settings should be determined during the purging operations.

- A separate sample volume should be collected to measure necessary field parameters. Samples should be collected and containerized following procedures outlined in the project-specific field sampling plan (FSP), quality assurance project plan (QAPP), and in the order of the parameters' volatilization sensitivity. Table 2 lists the preferred collection order for common groundwater parameters.

Intermediate containers should never be used to prepare VOA samples and should be avoided for all parameters in general. All VOA containers should be filled at a single sampling point or from a single bailer volume. Also refer to site-specific sampling plan for other sample handling requirements that may be unique to a site or to specific chemical constituents.

2.5.2 Collection of Volatile Organics Samples

This section discusses in detail the collection of samples for VOA using either a bailer or bladder pump. Other pumps (such as positive displacement or peristaltic) can be used. The following factors are critical to the collection of representative samples for VOA: ensuring that no air has become entrained in the water column, achieving low pump flow rates (less than 100 milliliter [mL] per minute, if possible), avoiding flow surges, and adjusting sample preservatives if they are found to cause reactions with the sample.

2.5.2.1 Collection with Bailers

Samples for VOA should be collected from the first bailer removed from the well after purging is complete. The most effective means requires two people. One person should retrieve the bailer from the well and pour its contents into the appropriate number of 40-mL VOA vials held by the second person. Each vial should be capped and inverted to check if any air bubbles are present. If a bubble exists, unscrew the cap and add more water, or discard and repeat if vials are not pre-preserved. If bubbling persists in a vial containing acid preservative, the sample may need to be collected without the preservative and the laboratory notified to add preservative upon receipt. The sample should be transferred from the bailer to the sample container in a manner that will limit the amount of agitation in order to reduce the loss of volatile organics from the sample.

Always fill VOA vials from a single bailer volume. If the bailer is refilled, samples cannot be considered duplicates or splits.

2.5.2.2 Collection with a Bladder Pump (Well Wizard)

To successfully perform VOA sampling with a Well Wizard bladder pump, the following steps must be completed:

1. Following manufacturer's directions, activate the pump. Full water flow from the discharge tubing will begin after 5 to 15 pumping cycles. These initial pumping cycles are required to purge air from the pump and discharge tubing. The discharge and recharge settings must be manually set and adjusted to pump at optimum flow rates. To activate the bladder, it is best to set the initial cycle at long discharge and recharge rates.

2. Reduce water flow rate for VOA sample collection. To reduce the water flow rate, turn the throttle control valve (located on the left side of the Well Wizard pump control panel) counterclockwise.

3. Collect VOA sample from discharge tubing. VOA vials must be placed beneath the discharge tubing while avoiding direct contact between the vials and the tubing. Never place tubing past the mouth of the VOA vial. The pump throttle control must be turned as necessary to maintain a trickle of water in order to obtain a meniscus in the vial.

4. Continue with non-VOA sampling. Increase pump flow rate by turning the throttle control knob clockwise.

2.5.3 Sampling of Light Immiscible Floaters

The approach used when collecting a sample of a floating layer depends on the depth to the floating layer and the thickness of that layer. If the thickness of the floater is 2 feet or greater, a bottom-filling valve bailer should be used. Slowly lower the bailer until contact is made with the floater surface, and lower the bailer to a depth less than that of the floater-water interface depth as determined by preliminary measurements with the interface probe.

When the thickness of the floating layer is less than 2 feet and the depth to the surface of the floating layer is less than 15 feet, a peristaltic pump can be used to extract a sample.

When the thickness of the floating layer is less than 2 feet and the depth to the surface of the floating layer is beyond the effective "lift" of a peristaltic pump (greater than 25 feet), a bailer can be modified to allow filling from the top only (an acceptable alternative is to use a top- loading Teflon or stainless-steel bailer). Disassemble the bailer's bottom check valve and insert a piece of 2-inch-diameter Teflon sheet between the ball and ball seat. This will seal off the bottom valve. Remove the ball from the top check valve, thus allowing the sample to enter from the top. To overcome buoyancy when the bailer is lowered into the floater, place a length of 1-inch stainless steel pipe on the retrieval line above the bailer (this pipe may have to be notched to allow sample entry if the pipe remains within the top of the bailer). As an alternative, use a top-loading stainless-steel bailer. Lower the device, carefully measuring the depth to the surface of the floating layer, until the top of the bailer is level with the top of the floating layer. Lower the bailer an additional one-half thickness of the floating layer and collect the sample. This technique is the most effective method of collection if the floating layer is only a few inches thick.

2.5.4 Sampling of Heavy Immiscible Sinkers

The best method for collecting a sample of a sinker is the use of a double check valve bailer. The key to sample collection is controlled, slow lowering and raising of the bailer to and from the bottom of the well. Sample collection methods are equivalent to those described in Section 2.5.3 above.

TABLE 1

STABILIZATION CRITERIA FOR WATER QUALITY PARAMETERS

Parameter	**Stabilization Criterion**
pH	± 0.1 units
Specific Conductance	± 3 percent
Oxidation-Reduction Potential	± 10 millivolts
Turbidity	± 10 percent (when greater than 10 nephelometric turbidity units [NTU])
Dissolved Oxygen	± 0.3 milligrams per liter or ± 10 percent

TABLE 2

ORDER OF PREFERRED SAMPLE COLLECTION

1. VOA
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride
12. Nitrate and ammonia
13. Radionuclides

Tetra Tech EM Inc.

EXHIBIT: GROUNDWATER SAMPLING DATA SHEET

Page ____ of
Date ____

Well Name ____________________________
Project ________________________________
Project No. ____________________________
Well Location __________________________
Sample Date __________________________
Sampling Personnel ____________________
____
____
Sample ID ___________________________
Duplicate ID __________________________

Screen Interval ____________________________
Station Elevation ________ GND ____ TOC ______
Static Water Level (from TOC) _________________
Well Stick Up ___________________________
Static Elevation _________________________
Well Depth ___________ MEAS ____ RPTD _____
Feet of Water ___________________________
Gallons/Foot ____________________________
Casing Volume ___________________________

Immiscible Phases Present Yes No
Type _______________________________
Measured with _______________________
PID Readings (background) ______________
PID Reading (TOC) _____________________
Wells Installed by _____________________
Installation Date _______________________
Development Date(s) ____________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ____________________________ Spec. Conductance: Standard µmhos/c Reading µmhos/cm at ___°C

pH: pH 4.00 - _______ at _________ °C pH 7.00 - _______ at _________ °C pH 10.00 - ______ at _______ °C Slope ________________

Dissolved Oxygen: D.O. Meter ____ mg/L at _°C PID: Calibration Gas __________ PPM ______ Span ______ Reading ___

PURGING

Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (°C)	Specific Conduct. (µmhos/cm at °C)	Turbidity (NTU)	Cumulative Volume of Water Removed (Purged)		PID/OVA Reading		Depth to Water (ft)	Comments
								Gallons	Casing Vol.	Location	Value		

SAMPLE PARAMETERS

Condition of well: ____

Remarks: ____

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

STATIC WATER LEVEL, TOTAL WELL DEPTH, AND IMMISCIBLE LAYER MEASUREMENT

SOP NO. 014

REVISION NO. 1

Last Reviewed: July 2009

KRiesing

Quality Assurance Approved

July 2009

Date

Title: **Static Water Level, Total Well Depth, and Immiscible Layer Measurement**

Revision No. 1, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Measurement of static water level, total well depth, and any immiscible layers is necessary before a well can be sampled and groundwater flow direction can be determined. If an immiscible layer is present, its depth and thickness must be determined. In addition, the static water level and total depth of a monitoring well are often needed to determine a purging volume prior to sampling.

1.1 PURPOSE

This standard operating procedure (SOP) provides guidelines for field personnel measuring: (a) static water levels, (b) total water depths, and (c) immiscible layers in monitoring wells or piezometers.

1.2 SCOPE

This SOP describes the methodologies for measuring static water level, total well depth, and immiscible layer depth and thickness.

1.3 DEFINITIONS

Electrical Water Level Meter: An electrical probe used to determine the depth to fluid. The probe has a light or sound alarm connected to an open circuit. The circuit is closed and the alarm is activated when the probe contacts a conducting fluid such as water.

Immiscible Layer: A liquid phase that cannot be uniformly mixed or blended with water. Heavy immiscible phases or dense nonaqueous-phase liquids (DNAPL) sink in water; light immiscible phases or light nonaqueous-phase liquids (LNAPL) float on water.

Interface Probe: An electrical probe used to determine the presence and thicknesses of LNAPL or DNAPL in the water column of a monitoring well.

Ionization Detector: A photoionization detector (PID) or a flame ionization detector (FID) is used to measure the level of volatile organic compounds (VOC) in the gaseous phase. Ionization detectors are generally not compound-specific and thus measure only total volatile organic compounds. A PID generally cannot detect as complete a range of compounds as the FID. This difference is the result of the relative ionization energies of the two detectors. Most PIDs cannot detect methane, but FIDs can. The

Photovac and Minirae are examples of PIDs; the Foxboro organic vapor analyzer (OVA) is an example of an FID.

Static Water Level: The level of water in a monitoring well or piezometer left open and allowed to stabilize by equilibrating to existing atmospheric pressure prior to measuring. The static water level can be measured as the depth to water or as the elevation of water relative to a reference mark or datum.

Total Well Depth: The distance from the ground surface to the bottom of a monitoring well or piezometer

1.4 REFERENCES

Tetra Tech EM Inc. 2009. SOP No. 002, General Equipment Decontamination

U.S. Environmental Protection Agency (USEPA). 2007. “Groundwater Level and Well Depth Measurement.” Region 4, Field Branches Quality System and Technical Procedures. November 1. http://www.epa.gov/region4/sesd/fbqstp/Groundwater-Level-Measurement.pdf

U.S. EPA. 2000. “Manual Water Level Measurement.” Environmental Response Team. SOP #2043 (Rev. #0.0, 02/11/00). http://www.dem.ri.gov/pubs/sops/wmsr2043.pdf

1.5 REQUIREMENTS AND RESOURCES

The equipment required for measuring static water levels, total well depths, and immiscible layers is as follows:

- Electrical water level meter
- Interface probe
- PID or FID
- Decontamination supplies (wash and rinse solutions, buckets, paper towels, etc.)
- Keys or wrenches for well locks and well caps
- Light source such as a flashlight or mirror to inspect inside well vaults

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific health and safety plan
- Appropriate signage and traffic control to protect personnel during monitoring activities

2.0 PROCEDURES

This section provides general guidance followed by specific procedures for measurement of static water level, total well depth, and immiscible layer.

Procedures for measuring the depth to water and the depth to the bottom of a monitoring well should be identified in the planning stage of field work. Also at this stage, measuring devices should be chosen, and an individual should be assigned to take and record measurements.

All measurement instruments should be decontaminated before and after use and between measurement locations. Refer to SOP No. 002, General Equipment Decontamination. In addition, as a general rule wells with the lowest known contaminant concentrations should be measured first followed by progressively more contaminated wells. This technique helps avoid cross-contamination from a more contaminated water source to a less contaminated water source resulting in inaccurate or false sample analytic results.

Before initiating any measuring activities, the ambient air at a monitoring well head should be monitored for possible emissions of VOCs using a PID or an FID. The site-specific health and safety plan for on-site activities should provide action levels and the rationale for selection of the appropriate ionization detector.

The sampling team should wear appropriate respiratory protection equipment when necessary. The sampling team should approach wells from the upwind side and systematically survey the inside of the well casing, the area from the casing to the ground, the area from above the well casing to the breathing zone, and the area around the well for VOCs. VOC monitoring for comparison to action levels should occur in the breathing zone(s) rather than from within the well casing. If PID or FID readings of VOCs are above action levels, the sampling team should retreat to a safe area and determine if engineering controls, increased PPE, or both are necessary to reduce exposure to VOCs above action levels listed in the site-specific health and safety plan.

Sampling team should be careful when opening a well to check for insects or reptiles within the protective casing and use appropriate work gloves when reaching inside. The site-specific health and safety plan should be consulted for information on insects or reptiles that may be present in the project area.

2.1 STATIC WATER LEVEL MEASUREMENT

An electric water level meter is typically used to measure static water levels. The electrical probe of the meter is lowered into the monitoring well until the light or sound alarm is activated indicating the probe has touched the water surface. To ensure accuracy, the well or piezometer should be opened to allow groundwater in the well to equilibrate with atmospheric pressures before measuring depth to water. Ideally, static groundwater measurements will be collected prior to purging or sampling activities. The static water level is read directly from the graduated tape on the meter to the nearest 0.01-foot. Two to three measurements should be taken over several minutes to ensure water levels are not fluctuating. If water levels continue to fluctuate, the groundwater has not equilibrated or become static. Measurements should continue until static water levels readings are obtained before recording a final measurement. If the monitoring well top is not flush with the ground surface, the distance between the static water level and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth to static water below ground surface. Surveyed elevations should be used if available to establish the water level elevation. The well number, measurement date and time, and individual readings should be recorded in a field logbook.

2.2 TOTAL WELL DEPTH MEASUREMENT

Total well depth can also be measured using an electric water level meter. The electrical probe of the indicator is lowered into the monitoring well until resistance is met, indicating that the probe has reached the bottom of the well. During measurement, the probe should be positioned in the well so that resistance is met, but there is no slack in the measuring tape. The total well depth is read directly from the graduated tape on the indicator to the nearest 0.01-foot. Measurements become less accurate with increased depth as the length of measuring tape deployed increases and the distance under the water column increases making it more difficult to determine if the bottom of the well has reached. In this circumstance, a weighted water level meter or measuring tape may be necessary to allow the user to “feel” the bottom of the well. Care should be taken to ensure the use of only inert and chemical-free weighted devices such as stainless steel are used. If the monitoring well top is not flush with the ground surface, the distance between the bottom of the well and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth from ground surface to the bottom of the well. The well number, measurement date and time, and individual readings should be recorded in a field logbook.

2.3 IMMISCIBLE LAYER DETECTION AND MEASUREMENT

A LNAPL immiscible layer in a monitoring well can be detected by slowly lowering an interface probe to the surface of the water in the well. When the audible alarm sounds, the depth of the probe should be recorded. If the alarm is continuous, a light immiscible layer has been detected. To measure the thickness of this layer, the probe should then be slowly lowered until the alarm changes to an oscillating signal. The oscillating alarm indicates that the probe has reached a water layer. The probe depth at the time the alarm begins oscillating should be recorded as the depth to water. The thickness of the light immiscible layer should then be determined by subtracting the depth at which a continuous alarm occurred from the depth at which the alarm began to oscillate. The well number, measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

To determine whether a DNAPL immiscible layer is present, the interface probe is lowered into the monitoring well and allowed to slowly drop below the water causing an oscillating alarm. If the alarm changes from an oscillating to a continuous signal, a heavier immiscible layer has been detected, and the probe depth should be recorded at that point. Total well depth obtained in Section 2.2 should be used for calculating the thickness of the DNAPL layer within the well casing. The DNAPL layer is then calculated by subtracting the depth at which the alarm became continuous from the total well depth. This procedure provides an estimate of the thickness of the DNAPL layer in the monitoring well. The well number, measurement date and time, and individual readings for depth and thickness should be recorded in a field logbook.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLE COLLECTION USING LOW-FLOW SAMPLING METHODOLOGY

SOP NO. 015

REVISION NO. 1

Last Reviewed: April 2010

KRiesing	July 28, 2009
Quality Assurance Approved	Date

Title: **Groundwater Sample Collection Using Low-Flow Sampling Methodology**

Revision No. 1, July 2009
Last Reviewed: April 2010

1.0 BACKGROUND

Groundwater sample collection is an integral part of site characterization at many contaminant release investigation sites. Often, a requirement of groundwater contaminant investigation is to evaluate contaminant concentrations in the aquifer. Since data quality objectives of most investigations require a laboratory setting for chemical analysis, samples must be collected from the aquifer and submitted to a laboratory for analysis. Therefore, sample collection and handling must be conducted in a manner that minimizes alteration of chemical characteristics of the groundwater.

In the past, most sample collection techniques followed federal and state guidance that included removal of water in the casing of a monitoring well (purging), followed by sample collection. The water in the casing was removed so that groundwater from the formation could flow into the casing and be available for sample collection. Sample collection was commonly completed with a bailer, bladder pump, controlled flow impeller pump, or peristaltic pump. Samples were preserved during collection. Often, samples to be analyzed for metals were filtered through a 0.45-micron filter prior to preservation and placement into the sample container.

Research conducted by several investigators has demonstrated that movement of contaminants while sorbed onto colloid particles constitutes a significant component of contaminant transport. Colloid mobility in an aquifer is a complex, aquifer-specific transport issue, and its description is beyond the scope of this standard operating procedure (SOP). However, concentrations of suspended colloids have been measured during steady-state conditions and during purging activities. Investigation results indicate standard purging procedures may cause a significant increase in suspended colloids, which in turn may bias analytical results.

Low-flow sample collection, sometimes referred to as micropurge, low-stress, or minimal drawdown groundwater sample collection, is a groundwater sampling method that minimizes increased colloid mobilization by removing water from a well at the screened interval at a rate that preserves or minimally disrupts steady-state flow conditions in the aquifer. During low-flow sampling, groundwater is discharged from the aquifer at a rate that the aquifer will yield without creating a cone of depression around the sampled well (i.e., a rate of discharge less than or equal to the rate of recharge). Research indicates that colloid mobilization will not increase above steady-state conditions during low-flow discharge. Therefore, the sample collected by this method is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

The purpose of this SOP is to describe the procedures to be used to collect a groundwater sample from a well using low-flow sampling methodology. The following sections describe the equipment to be used and the methods to be followed to promote uniform sample collection techniques. Sampling is to be conducted by field personnel who are experienced in sample collection and handling for environmental investigations.

1.2 SCOPE

This SOP applies to groundwater sampling using low-flow sampling methodology. It is intended to be used as an alternate SOP to SOP No. 010 (Groundwater Sampling), which provides guidance for the general aspects of groundwater sampling. This SOP provides procedures to be used for various methods of low-flow sample collection. The specific type of sampling pump to be used should be specified in the project-specific work plan or field sampling plan.

1.3 DEFINITIONS

Colloid: Suspended particles that range in diameter from 5 nanometers to 0.2 micrometers.

Dissolved oxygen: The ratio of the concentration or mass of oxygen in water relative to the partial pressure of gaseous oxygen above the liquid, which is a function of temperature, pressure, and the concentration of other solutes.

Flow-through cell: A device connected to the discharge line of a groundwater purge pump that allows regular or continuous measurement of selected parameters of the water and minimizes contact between the water and air.

pH: The negative base-10 log of the hydrogen-ion activity in moles per liter.

Reduction and oxidation potential: A numerical index of the intensity of oxidizing or reducing conditions within a system, with the hydrogen-electrode potential serving as a reference point of zero volts.

Specific conductance: The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of aqueous solution at a specified temperature.

Turbidity: A measurement of the suspended particles in a liquid that have the ability to reflect or refract part of the visible portion of the light spectrum.

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA), Office of Research and Development. April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. Publication: EPA/540/S-95/504. http://www.epa.gov/ahaazvuc/download/issue/lwflw2a.pdf

EPA, Office of Solid Waste and Emergency Response. May 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. Publication: EPA542-S-02-001. http://www.epa.gov/tio/tsp/download/gw_sampling_guide.pdf

1.5 REQUIREMENTS AND RESOURCES

The following equipment is required to complete low-flow groundwater sample collection:

- Water level indicator
- Adjustable flow rate pump (bladder, piston, peristaltic, or impeller)
- Power source for the pump (such as a battery or generator, or compressed air source)
- Discharge flow controller
- Flow-through cell
- pH probe
- Dissolved oxygen (DO) probe
- Turbidity meter
- Oxidation and reduction (Redox or Eh) probe

- Specific conductance (SC) probe (optional)
- Temperature probe (optional)
- Meter to display data for the probes
- Calibration solutions for pH, SC, turbidity, and DO probes, as necessary
- Container of known volume for flow measurement or calibrated flow meter
- Data recording and management system

2.0 PROCEDURE

The following procedures and criteria are based on EPA guidance titled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (1996) and *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers* (2002). These references may be consulted for a more detailed description of low-flow sampling theory.

Low-flow groundwater sampling is most commonly accomplished with low discharge-rate pumps, such as bladder pumps, piston pumps, controlled velocity impeller pumps, or peristaltic pumps. Bailers and high-capacity submersible pumps are not considered acceptable low-flow sample collection devices. The purged water is monitored (in a flow-through cell or other constituent monitoring device) for chemical and optical parameters that indicate steady-state flow conditions between the sample extraction point and the aquifer. Samples are collected when steady-state conditions are indicated.

Groundwater discharge equipment may be permanently installed in the monitoring well as a dedicated system, or it can be installed in each well as needed. Most investigators agree that dedicated systems will provide the best opportunity for collecting samples most representative of steady-state aquifer conditions, but the scope and budget of a particular investigation will dictate equipment selection.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturers’ directions (see SOP No. 061 for more details regarding measurement of groundwater indicator parameters). Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen).

The SC meter and turbidity meter cannot be calibrated in the field; they are checked against a known standard. The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated in the field, but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mv) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25 °C). The Eh probe should be replaced if the reading is not within the manufacturer's specified range. All calibration data should be recorded on the Low-Flow Groundwater Sampling Data Sheet (example included as Figure 1), on a personal digital assistant (PDA), or in a logbook.

2.2 WELL PURGING

The well to be sampled should be opened, and groundwater in the well allowed to equilibrate to atmospheric pressure. Equilibration should be determined by measuring depth to water below the marked reference on the wellhead (typically the top of the well casing) over two or more 5-minute intervals. Equilibrium conditions exist when the measured depth to water varies by less than 0.01 foot over two consecutive readings. Total depth of well measurement should be made following sample collection, unless the datum is required to place nondedicated sample collection equipment. Depth to water and total well depth measurements should be made in accordance with procedures outlined in SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement).

If the well does not have a dedicated sample collection device, a new or previously decontaminated portable sample collection device should be placed within the well. If nondedicated sampling equipment is used, the least contaminated wells should be purged and sampled first and most contaminated wells should be purged and sampled last (if past sampling data are available to make this determination). The intake of the device should be positioned at the midpoint of the well screen interval. The device should be installed slowly to minimize turbulence within the water in the casing and minimize mixing of stagnant water above the screened interval with water in the screened interval. Following installation, the flow controller should be connected to the sample collection device, and the flow-through cell connected to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

If the well has a dedicated sample collection device, the controller for the sample collection device should be connected to the sample collection device. The flow meter and flow-through cell should be connected in line to the discharge tube, and the probes installed in the flow-through cell. Hook-up to the appropriate power source should be the last step prior to activating the pump to ensure all connections are completed prior to starting the pump.

The controller should be activated and groundwater extracted (purged) from the well. The purge rate should be monitored, and should not exceed the capacity of the well. The well capacity is defined as the maximum discharge rate that can be obtained with less than 0.1 meter (0.33 foot) drawdown. Typically, the discharge rate will be less than 0.5 liters per minute (L/min) (0.13 gallons per minute). The maximum purge rate should not exceed 1 L/min (0.25 gallons per minute), and should be adjusted to achieve minimal drawdown.

Water levels, effluent chemistry, and effluent flow rate should be continuously monitored while purging the well. Purging should continue until the measured chemical and optical parameters are stable. Stable parameters are defined as monitored chemistry values that do not fluctuate by more than the following ranges over three successive readings at 3- to 5-minute intervals:

- pH ±0.1 unit
- Temperature (while listed in EPA guidance, this parameter is described as the least important and not required to be stable if all other parameters have been met)
- SC ±3 percent
- Turbidity ±10 percent, when greater than 10 nephelometric turbidity units (NTU)
- DO ±10 percent or 0.3 milligrams per liter (mg/L)
- Eh ±10 mv

Purging will continue until these stabilization criteria have been met, excluding temperature, or three well casing volumes have been purged. If three casing volumes of water have been purged and the stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began after three well casing volumes were purged.

The volume of water in the well is based on the following formula:

$$V = \pi r^2 h \times 7.48$$

where

V = static volume of water in the well (gallons)

r = inside radius of the well (feet)

h = length of water in the well (total well depth minus depth to water) (feet)

7.48 = conversion factor (cubic feet to gallons)

Common well diameter sizes and corresponding volumes are listed below.

- 1-inch well = h x 0.041 gal/ft
- 2-inch well = h x 0.163 gal/ft
- 3-inch well = h x 0.367 gal/ft
- 4-inch well = h x 0.652 gal/ft

For wells with water table screen intervals: If a stabilized drawdown in the well cannot be maintained within 0.33 feet or the water level is approaching the bottom of the screened interval, reduce the flow rate, or turn the pump off for 15 minutes, and allow for recovery. The well should not be pumped dry. Resume pumping at a lower flow rate; if the water draws down to the bottom of the screened interval again, turn pump off and allow for recovery. If sufficient yield cannot be obtained, consider an alternative sampling method.

For wells with submerged or targeted screen intervals: If a stabilized drawdown in the well cannot be maintained within 0.33 feet or the water level is approaching the top of the screened interval, reduce the flow rate, or turn the pump off for 15 minutes, and allow for recovery. The well should not be pumped dry. Resume pumping at a lower flow rate; if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If sufficient yield cannot be obtained, consider either further drawdown or an alternative sampling method.

If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or groundwater sampling log. Slow-recovering wells should be identified and purged at the beginning of the workday to maximize field work efficiency. If possible, samples should be collected from these wells within the same workday and no later than 24 hours after the end of purging.

The final pH, SC, Eh, turbidity, and DO values should be recorded. All data should be recorded on the Low-Flow Groundwater Sampling Data Sheet (Figure 1), a PDA, or in a logbook.

2.3 SAMPLE COLLECTION

Following purging, the flow-through cell shall be disconnected, and groundwater samples should be collected directly from the discharge line. Discharge rates should be adjusted so that groundwater is dispensed into the sample container with minimal aeration of the sample. Samples collected for volatile organic compound analysis should be dispensed into the sample container at a flow rate equal to or less than 100 milliliters per minute. Samples should be preserved and handled as described in the investigation field sampling plan or quality assurance project plan. Depending on the project-specific types of analyses required, the preferred order of sample collection is as follows:

1. Volatile organic compounds (VOC)
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride

12. Nitrate and ammonia
13. Radionuclides

See SOP No. 010 (Groundwater Sampling) for more information on groundwater sample collection.

FIGURE 1 - LOW-FLOW GROUNDWATER SAMPLING DATA SHEET

Date/Time of Sample Collection: ___________/___________Project Site/Subsite: _______________
Sample ID: ____
Field ID: _______________________ Point Name: ________________
Depth to Well Bottom: ______________ ft. below top of casing (PVC cap)
Depth to Water Level: ______________ ft. below PVC cap
Depth to Water Level: ______________ ft. below PVC cap prior to sampling
Method of Purging: Bladder Pump ____ Submersible Pump ____
Peristaltic Pump ____
Minimum Purge Volume: 2-inch well ____Liters / 4-inch well ____Liters
Control Box Settings: Box # ______ Refill _______ Discharge _______
Throttle ________ psi
Total Purged: ___________ Liters (Purge Rate goal = 0.5 Liters/Min.)
Actual Purge Rate: ____________ Liters/Min.

Purge Calculations

PHYSIO-CHEMICAL PARAMETERS DURING PURGING

Measure in order listed**	Initial Reading									Stabiliz-ation Criteria	Final
Time											
pH										+/-0.1	
Temperature (°C)										NC*	
Specific Conductance (µmhos/cm)										+/-3%	
Turbidity (NTU)										+/-10%	
Dissolved Oxygen (mg/L)										+/-10% or +/-0.3	
ORP (mV)										+/-10	
Each Volume Purged (L)											
Total Liters Purged											

*NC = No Criteria. **Stabilization criteria listed should be used unless project-specific plans specify alternate stabilization criteria.

Duplicate Sample Collected? No Yes (Sample ID of Duplicate) ______________________________
MS/MSD Sample Collected? No Yes ____
Sample Remarks (odors, colors, sediment): ____
Comments: ____
Sample(s) Collected By: ____
Pump System Purge Volume Calc: Length of tubing X 9.6 (ml/ft) + 130 (bladder volume) = Total required purge (liters) before collection of parameters

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 6

December 2008

KRiesing

Quality Assurance Approved

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Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by four primary agencies that have regulatory or advisory guidelines: (1) the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR, *Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180); (2) the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR); (3) International Civil Aviation Organization (ICAO), which provides technical instructions for safe transportation of hazardous materials (dangerous goods) by air; and (4) United Nations (UN) “Recommendations of the Committee of Experts on Transport of Dangerous Goods.”

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, the HMR, ICAO, and UN. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 SCOPE

This SOP applies to sample classification, packaging, and shipping.

1.3 DEFINITIONS

Custody seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2008).

Environmental samples: Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMR are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGR are regulations that govern the international transport of dangerous goods by air. The DGR are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 2008). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 REFERENCES

U.S. Department of Transportation (DOT). 2007. Code of Federal Regulations, Title 49, Parts 171 through 180, especially Parts 171 (general), 172 (table, emergency response, and so on), and 173 (for shippers). Available from http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1. Updated annually, late in the year or early in the following year.

DOT. 2008. “Hazardous Materials Table”. (49 CFR 172.101 Table) Available on-line from http://phmsa.dot.gov/hazmat/library. Updated irregularly.

DOT. 2008. “Emergency Response Guidebook”. Available on-line at http://phmsa.dot.gov/hazmat/library/erg. Updated annually.

Federal Express. 2008. “Dangerous Goods Shipping”. Available on-line from http://www.fedex.com/us/services/options/dangerousgoods/index.html. Note especially “Declaration Forms”, which can be filled out on-line or downloaded for future use, and “Resources”, which includes the “Dangerous Goods Job Aid” on how to fill out the form, mark the package, and so on, the “Shipping Checklists” and the 1-800 numbers for assistance.

International Air Transport Association (IATA). 2008. “Dangerous Goods Regulations. 2009”. For sale at http://www.iata.org/ps/publications/dgr.htm. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency. 2007. “Contract Laboratory Program Guidance for Field Samplers”. EPA 540-R-07-06. Available on-line at http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf. July.

The following additional in-house resources are also available:

Email: Contact either the TtEMI Health & Safety Director and the Regional Safety Officers at EMI.HASPApprovers or your Office Health and Safety Representative (all are included at EMI.HealthSafety).

On-line: TtEMI Intranet Page “Dangerous Goods Shipping” at http://home.ttemi.com/C14/Dangerous%20Goods%20Shipping/default.aspx. Includes the “Dangerous Goods Shipping Manual”, various “Emergency Response Guide” excerpts, and other information, updated regularly.

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other non-combustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Appropriate shipping containers as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and hazardous samples.

2.1 SAMPLE CLASSIFICATION

Prior to sample shipment, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. If the hazardous sample is to be shipped by air, then the DGR should be followed. Any airline, including FedEx, belonging to IATA must follow the DGR. As a result, FedEx **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in “Section 2 - Limitations” of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 - Explosives

Division 1.1 -	Articles and substances having a mass explosion hazard
Division 1.2 -	Articles and substances having a projection hazard but not a mass explosion hazard
Division 1.3 -	Articles and substances having a fire hazard, a minor blast hazard and/or a minor projection hazard but not a mass explosion hazard
Division 1.4 -	Articles and substances presenting no significant hazard
Division 1.5 -	Very sensitive substances mass explosion hazard
Division 1.6 -	Extremely insensitive articles which do not have a mass explosion hazard

Class 2 - Gases

Division 2.1 - Flammable gas
Division 2.2 - Non-flammable, non-toxic gas
Division 2.3 - Toxic gas

Class 3 - Flammable Liquids

Class 4 - Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which, in Contact with Water, Emit Flammable Gases

Division 4.1 - Flammable solids
Division 4.2 - Substances liable to spontaneous combustion
Division 4.3 - Substances, which, in contact with water, emit flammable gases

Class 5 - Oxidizing Substances and Organic Peroxides

Division 5.1 - Oxidizers
Division 5.2 - Organic peroxides

Class 6 - Toxic and Infectious Substances

Division 6.1 - Toxic substances
Division 6.2 - Infectious substances

Class 7 - Radioactive Materials

Class 8 - Corrosives

Class 9 - Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger.

Class 1, explosives, includes any chemical compound, mixture, or device that by itself is capable of chemical chain reaction sufficient to produce a substantial, instantaneous release of gas, heat, and/or pressure. Tetra Tech does not ship substances that fall under this class.

Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a flammable gas because it may contain a high percentage of methane.

Class 3, flammable liquids, are based on the boiling point and flash point of a substance. DOT defines flammable liquids as substances with a flash point less than 140 °F. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits.

Class 4 are flammable solids; substances liable to spontaneous combustion; and substances which, in contact with water, emit flammable gasses. Tetra Tech does not ship substances that fall under this class.

Class 5, oxidizers and organic peroxides, include substances that readily yields oxygen, which may result in the ignition of combustible materials. Organic peroxide is combustible and reacts as an oxidizer in contact with other combustible materials. By itself, an organic peroxide can be flammable or explosive. Tetra Tech does not ship substances that fall under this class.

Division 6, toxic and infectious substances, is based on oral toxicity (LD_{50} [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD_{50} values), and inhalation toxicity (LC_{50} [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Tetra Tech does not ship substances that fall under this class.

Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [:Ci/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR.

Class 8, corrosives, are based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered Class 8 substances and should be packaged as nonhazardous samples.

Class 9, miscellaneous dangerous goods, are substances that present a danger but are not covered by any other hazard class. Examples of Class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, that is not specified in the DGR. “ORM-D material” refers to a material such as a consumer commodity that, although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a Class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. FedEx will not accept a shipment of hazardous waste.

2.2 PACKAGING NONHAZARDOUS SAMPLES

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner. Note that these are general instructions; samplers should be aware of any client-specific requirements concerning the placement of custody seals or other packaging provisions.

1. Place the sample in a resealable plastic bag.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler (bottom and sides) with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.

4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.

5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.

6. Tape any instructions for returning the cooler to the inside of the lid.

7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.

8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.

9. Place address labels on the outside top of the cooler.

10. Ship samples overnight by a commercial carrier such as FedEx.

2.3 PACKAGING HAZARDOUS SAMPLES

The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR referrals. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be “flammable liquid, n.o.s.” The abbreviation “n.o.s.” stands for “not otherwise specified” and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters “RQ” must appear in front of the proper shipping name.

2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one

package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A “Y” in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.

3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these are UN specification packages that have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages is listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.

4. Place each sample jar in a separate resealable plastic bag. Some UN specification packagings contain the sample jar and plastic bag to be used when shipping the sample.

5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.

6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.

7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packagings must be marked with proper shipping name; identification number; and name, address, and phone numbers of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words “limited quantity” or “LTD. QTY.” must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the “Cargo Aircraft Only” label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.

8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement "INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS" must be marked on the overpack.

9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES

A "Shippers Declaration for Dangerous Goods" and "Air Waybill" must be completed for each shipment of hazardous samples. Four copies of the Shipper's Declaration are required and it must be typed. FedEx supplies a Dangerous Goods Airbill to its customers; the airbill combines both the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure 2. A shipper's declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ___ of ___
- Shipper's reference number (project number)
- Deletion of either "Passenger and Cargo Aircraft" or "Cargo Aircraft Only," whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either "Non-Radioactive" or "Radioactive," which ever does not apply
- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words "limited quantity" or "LTD. QTY." if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation "USG-14" when a technical name is required after the proper shipping name but not entered because it is unknown.

- Signature for the certification statement

- Name and title of signatory

- Place and date of signing certification

- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good

- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for "Flammable liquids, n.o.s." as an example.

Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, ____ x ____ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.

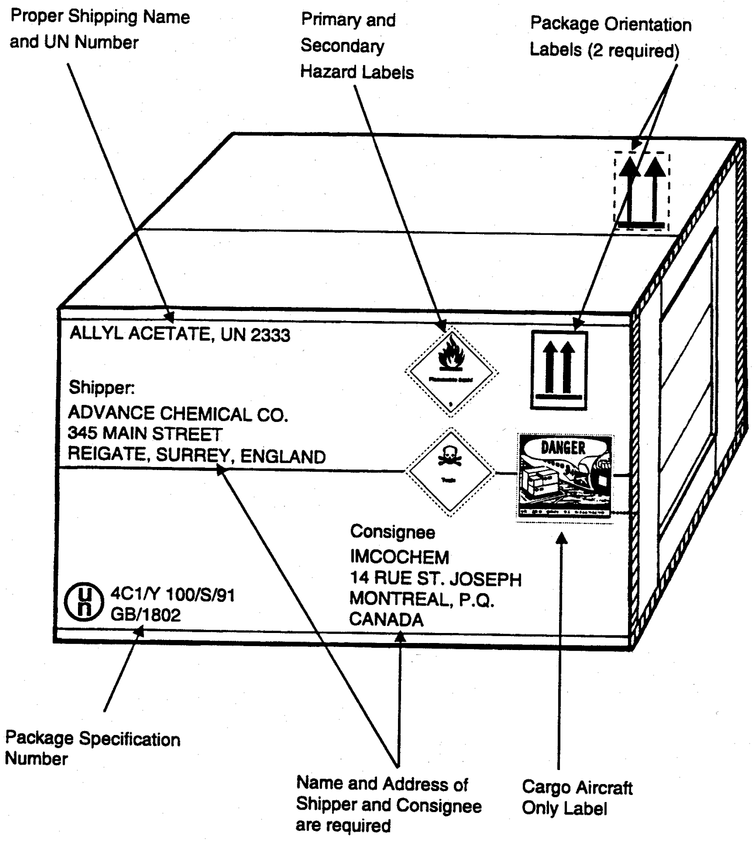
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.

- Improper, misspelled, or missing information on the shipper’s declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact FedEx with questions about dangerous goods shipments by calling 1-800-463-3339 and asking for a dangerous goods expert.

Also contact Tetra Tech health and safety representatives using the website identified on Page 3 of this SOP.

FIGURE 1
EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE



Source: International Air Transport Association (IATA). 1997.

FIGURE 2

EXAMPLE OF A DANGEROUS GOODS AIRBILL

Filling Out the FedEx Dangerous Goods Airbill

- The Dangerous Goods Airbill has two sections
    - The top section of the page is the airbill portion.
    - The bottom section is the Shipper's Declaration for Dangerous Goods.
- The sender *must complete* the following fields on the pre-printed airbill:
    - Section 1: Date
    - Section 1: Sender's Name
    - Section 7: Total Packages
    - Section 7: Total Weight
- Declaration for Dangerous Goods:
    - Under the section labeled "Proper Shipping Name" fill in the infectious substance (i.e., HIV, HCV, etc.) in the parentheses.
    - Under the "Quantity and Type of Packing" section, fill in the amount of specimen in the box (in mls).
    - List an emergency telephone number in the space provided at the bottom of the airbill.
    - Sign and date the airbill in the bottom right corner.

IMPORTANT: You must follow explicitly all packaging and labeling instructions for shipping infectious substances. Correct spelling and legibility are important. Otherwise, your package will be delayed or may be rejected by FedEx.

FedEx Dangerous Goods Airbill

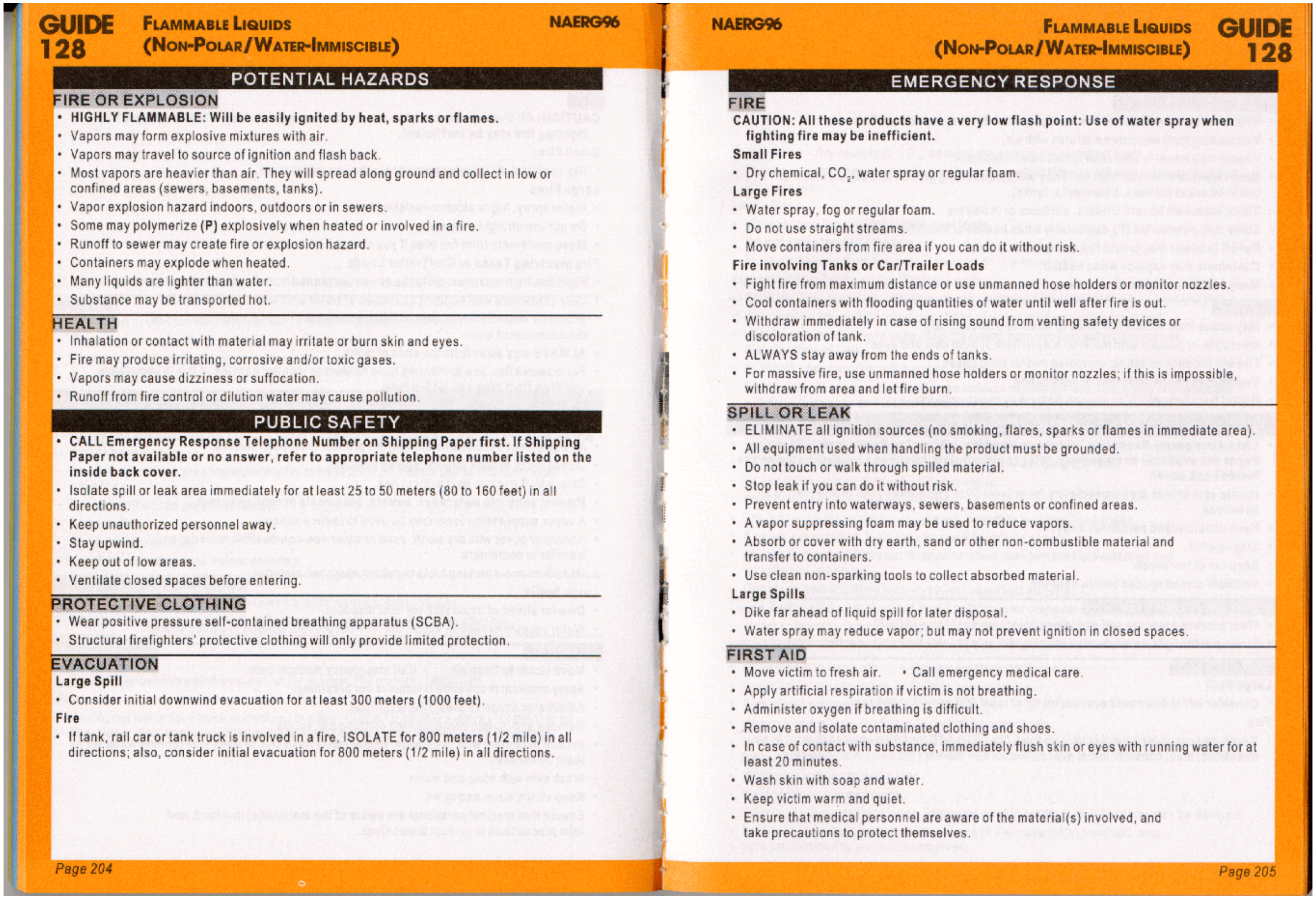
Sender's Copy

The World On Time.

807286707376 0204

FOR SHIPMENTS WITHIN USA, AK, AND HI ONLY

FIGURE 3
NAERG EMERGENCY RESPONSE INFORMATION FOR FLAMMABLE LIQUIDS, N.O.S.



GUIDE 128 **FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)** NAERG96

POTENTIAL HAZARDS

FIRE OR EXPLOSION

- **HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.**
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Some may polymerize (P) explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.

HEALTH

- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY

- **CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- Isolate spill or leak area immediately for at least 25 to 50 meters (80 to 160 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

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NAERG96 **FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)** **GUIDE 128**

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

Small Fires

- Dry chemical, CO_2, water spray or regular foam.

Large Fires

- Water spray, fog or regular foam.
- Do not use straight streams.
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from the ends of tanks.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean non-sparking tools to collect absorbed material.

Large Spills

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

- Move victim to fresh air. • Call emergency medical care.
- Apply artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- Keep victim warm and quiet.
- Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

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Source: DOT and others. 1996.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL INSTALLATION

SOP NO. 020

REVISION NO. 4

Last Reviewed: April 2009

KRiesing
Quality Assurance Approved

May 21, 2009
Date

1.0 BACKGROUND

Groundwater monitoring wells are designed and installed for a variety of reasons, including (1) detecting the presence or absence of contaminants, over both the short and the long term, (2) collecting groundwater samples representative of in situ aquifer chemical characteristics, (3) conducting aquifer testing, and (4) measuring water levels for determining groundwater potentiometric head and groundwater flow direction.

This standard operating procedure (SOP) focuses on common methods and minimum standards for oversight and documentation of monitoring well installation for Tetra Tech EM Inc. (Tetra Tech) projects. Detailed specifications for well design and installation may vary in response to site-specific conditions; however, some elements of well installation are common to most situations. Well installation conducted according to this SOP will have complete and approved construction specifications, usually in a work plan or site-specific field sampling plan. In most cases, Tetra Tech will provide oversight and documentation of the well installation process conducted by a drilling subcontractor. This SOP is based on widely recognized methods described by the U.S. Environmental Protection Agency (EPA) and American Society for Testing and Materials (ASTM). In addition, monitoring wells should be designed and installed in a manner consistent with all local and state regulations. Detailed specifications for well installation should be identified within a site-specific work plan, sampling plan, or quality assurance project plan (QAPP).

An experienced and knowledgeable person (preferably a hydrogeologist) will need to locate the well and supervise its installation so that the samples ultimately collected will be representative of the groundwater. Personnel installing wells should work under the supervision of a registered professional, and the requirements of the state where the work is being performed should be followed as to the specific requirements for the registered professional and his or her level of involvement and oversight.

The following types of monitoring well materials, installation procedures, and record-keeping requirements are included in this SOP:

Monitoring well materials

- Casing materials
- Well screen materials
- Filter pack materials
- Annular sealant (bentonite pellets or chips)
- Grouting materials
- Surface completion and protective casing materials

- Concrete surface pad and bumper posts
- Uncontaminated water

Monitoring well installation procedures

- Well screen and riser placement
- Filter pack placement
- Temporary casing retrieval
- Annular seal placement
- Grouting
- Surface completion and protective casing (aboveground and flush-mount)
- Concrete surface pad and bumper posts
- Permanent and multiple casing well installation

Record-keeping procedures

- Surveying
- Permits
- Well construction and borehole logging
- Monitoring well identification

Well installation methods will depend to some extent on the borehole drilling method. Specific boring or drilling protocols are detailed in other SOPs. The boring method, in turn, will depend on site-specific geology, hydrogeology, and project requirements. Drilling methods commonly used for well installation include hollow-stem augering, cable tool, mud-rotary, air rotary, air casing hammer, sonic, and rock coring.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well installation and associated documentation. The performance objectives for monitoring well installation are as follows:

- Ensure that the monitoring well will provide water samples representative of in situ aquifer conditions.
- Ensure that the monitoring well construction will last for the duration of the project.
- Ensure that the monitoring well will not serve as a conduit for vertical migration of contaminants, particularly vertical migration between discrete aquifers.
- Ensure that the well construction details are documented in a standardized format.

1.2 SCOPE

This SOP applies to the oversight and documentation of monitoring well installation. Although some of the procedures may apply to the installation of water supply wells, this SOP is not intended to cover the design and construction of such wells. The SOP identifies several well drilling methods related to monitoring well installation, but the scope of this SOP does not include drilling methods.

Other relevant SOPs include SOP 002 for decontamination of drilling and well installation equipment, SOP 026 for borehole logging, SOP 005 for soil sampling, SOP 021 for monitoring well development, SOPs 010 and 015 for groundwater sampling from monitoring wells, and SOP 014 for measuring static water levels within monitoring wells.

1.3 DEFINITIONS

Annulus: The space between the monitoring well casing or conductor casing and the wall of the well boring.

Bentonite seal: A colloidal clay seal separating the sand pack from the annular grout seal.

Centralizer: A stainless steel or plastic spacer that keeps the well screen and casing centered in the borehole.

Filter pack: Clean sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) bentonite and water, (2) cement, bentonite, and water, or (3) cement and water placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Tremie pipe: A rigid pipe used to place the well filter pack, bentonite seal, or grout seal. The tremie pipe is lowered to the bottom of the well or area to be filled and pulled up ahead of the material being placed.

Well casing: A solid piece of pipe, typically polyvinyl chloride (PVC) or stainless steel, used to keep a well open in either unconsolidated material or unstable rock.

Well screen: A PVC or stainless steel pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

1.4 REFERENCES

American Society for Testing and Materials. 2004. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-04. West Conshohocken, Pennsylvania.

California Department of Toxic Substances Control. 1995. Monitoring Well Design and Construction for Hydrogeologic Characterization. Guidance for Groundwater Investigations. July.

Driscoll, F.G. 1986. *Groundwater and Wells (Second Edition).* Johnson Division, UOP, Inc. St. Paul, Minnesota.

U.S. Environmental Protection Agency (EPA). 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. Office of Research and Development, Environmental Monitoring Systems Laboratory. Washington, DC. EPA/600-4-89/034. March. http://www.epa.gov/swerust1/cat/wwelldct.pdf

EPA. 1992. RCRA Ground Water Monitoring Technical Enforcement Guidance Document. Office of Solid Waste and Emergency Response. Washington, DC. OSWER-9950-1. November.

EPA. 1994. Monitor Well Installation. Environmental Response Team SOP #2048 (Rev. #0.0, 03/18/96). http://www.ert.org

1.5 REQUIREMENTS AND RESOURCES

To conduct oversight and document the installation of a monitoring well, the person at the drill site should be a geoscientist or engineer who has relevant professional training and experience. The site geoscientist is responsible for oversight and documentation of all well installation activities. The site geoscientist shall understand the project objectives and regularly communicate from the field with the project manager or technical project team members. The site geoscientist shall verify that all permits are obtained, and that the well locations are cleared for overhead and underground utilities or other obstructions.

Well installation requires a completed boring with stable or supported walls. The type of drilling rig needed to complete the boring and the well construction materials required for monitoring well installation will depend on the drilling method used, the geologic formations present, and chemicals of concern in groundwater. The rig and support equipment used to drill the borehole is usually used to install the well.

Under most conditions, the following items are also required for the proper installation of monitoring wells:

- Tremie pipe and funnel
- Bentonite pellets or chips
- Grouting supplies
- Casing materials
- Well screen materials
- Filter pack materials
- Surface completion materials (protective casing, lockable and watertight well cover, padlock)
- Electronic water level sounding device for water level measurement
- Measuring tape with weight for measuring the depth of the well and determining the placement of filter pack materials
- Decontamination equipment and supplies
- Site-specific work plan, field sampling plan, health and safety plan, and QAPP
- Monitoring Well Completion Record (see Figure 1 for example)

2.0 MONITORING WELL INSTALLATION PROCEDURES

For reference, this section presents standard procedures for monitoring well installation and is divided into three subsections. Section 2.1 addresses monitoring well construction materials, while Section 2.2 describes typical monitoring well installation procedures. Section 2.3 addresses record-keeping requirements associated with monitoring well installation. Monitoring well design and installation procedures described in work plans, sampling plans, and QAPPs should be fully consistent with the procedures outlined in this SOP as well as any applicable local and state regulations and guidelines.

2.1 MONITORING WELL CONSTRUCTION MATERIALS

Monitoring well construction materials should be specified in the site-specific work plan as well as in the statement of work for any subcontractors assisting in the well installation. The riser, well screen, and filter pack and annular sealant placement equipment should be certified as clean by the manufacturer and delivered to and maintained in clean condition at the site. Where this is not possible, all materials or tools should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002). Samples of the filter pack, annular seal, and mixed grout should be retained as a quality control measure until at least one round of groundwater sampling and analysis is completed.

This section generally discusses material specifications for the following well construction components:

- Casing and well screen
- Filter pack
- Annular sealant (bentonite pellets or chips)
- Grout
- Tremie pipes
- Surface completion components (protective casing, lockable and watertight cap, and padlock)
- Concrete surface pad
- Uncontaminated water

Figures 2A and 2B shows the construction details of a typical monitoring well, with above grade or flush mounted surface completion, respectively.

2.1.1 Casing Materials

The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. The ends of each casing section should be either flush-threaded or beveled for welding. Schedule 40 or Schedule 80 PVC casing is typically used for monitoring well installation. Either type of casing is appropriate for monitoring wells with depths less than 100 feet below ground surface (bgs). If the well is deeper than 100 feet bgs, Schedule 80 PVC should be used.

Stainless steel used for well casing is typically Type 304 and is of 11-gauge thickness.

2.1.2 Well Screen Materials

Well screens should be new, machine-slotted or continuous wrapped wire-wound, and composed of materials best suited for the monitoring environment based on site characterization findings. Well screens are generally constructed of the same materials used for well casing (PVC or stainless steel). The screen should be plugged at the bottom with the same material as the well screen. Alternatively, a short (1- to 2-foot) section of casing material with a bottom (sump) should be attached below the screen. This assembly must be able to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored.

The minimum internal diameter of the well screen should be chosen based on the particular application. A minimum inside diameter of 2 inches is usually needed to allow for the introduction and withdrawal of sampling devices. Typical monitoring well screen diameters are 2 inches and 4 inches.

The slot size of the well screen should be determined relative to (1) the grain size of particles in the aquifer to be monitored and (2) the gradation of the filter pack material. This determination is often made in the field based on the grain size and distribution of borehole material encountered.

2.1.3 Filter Pack Materials

The primary filter pack consists of a granular material of known chemistry and selected grain size and gradation. The filter pack is installed in the annulus between the well screen and the borehole wall. The grain size and gradation of the filter pack are selected to stabilize the hydrologic unit adjacent to the screen and to prevent formation material from entering the well during groundwater sampling. The procedure for determining the grain size and gradation of the filter pack is to be presented in each site-specific field sampling plan or work plan. After development, a properly filtered monitoring well is relatively free of turbidity.

A secondary filter pack is a layer of material placed in the annulus directly above the primary filter pack and separates the filter pack from the annular sealant. The secondary filter pack should be uniformly graded fine sand, with 100 percent by weight passing through a No. 30 U.S. Standard sieve, and less than 2 percent by weight passing through a No. 200 U.S. Standard sieve.

2.1.4 Annular Sealant (Bentonite Pellets or Chips)

The materials used to seal the annulus may be prepared as a slurry or used as dry pellets, granules, or chips. Sealants should be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

Bentonite (sodium montmorillonite) is the most commonly used annular sealant and is furnished in sacks or buckets in powder, granular, pelletized, or chip form. Bentonite should be obtained from a commercial source and should be free of impurities that may adversely impact the water quality in the well. Pellets are compressed bentonite powder in roughly spherical or disk shapes. Chips are large, coarse, irregularly shaped units of bentonite. The diameter of the pellets or chips should be less than one-fifth the width of the annular space into which they will be placed in order to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 inch in diameter. Bentonite slurry is prepared by mixing powdered or granular bentonite with water from a source of known chemistry.

2.1.5 Grouting Materials

The grout backfill that is placed above the bentonite annular seal is ordinarily liquid slurry consisting of either (1) a bentonite (powder, granules, or both) base and water, (2) a bentonite and Portland cement base and water, or (3) a Portland cement base and water. Often, bentonite-based grouts are used when flexibility is desired during the life of the well installation (for example, to accommodate freeze-thaw cycles). Cement- or bentonite-based grouts are often used when cracks in the surrounding geologic material must be filled or when adherence to rock units or a rigid setting is desired.

Each type of grout mixture has slightly different characteristics that may be appropriate under various physical and chemical conditions. However, quick-setting cements containing additives are not recommended for use in monitoring well installation because additives may leach from the cement and influence the chemistry of water samples collected from the well.

2.1.6 Tremie Pipe

A tremie pipe is used to place the filter pack, annular sealant, and grouting materials into the borehole. The tremie pipe should be rigid, have a minimum internal diameter of 1.0 inch, and be made of PVC or steel. The length of the tremie pipe should be sufficient to extend to the full depth of the monitoring well.

2.1.7 Surface Completion and Protective Casing Materials

Protective casings that extend above the ground surface should be made of aluminum, steel, stainless steel, cast iron, or a structural plastic. The protective casing should have a lid with a locking device to prevent vandalism. Sufficient clearance, usually 6 inches, should be maintained between the top of the riser and the top of the protective casing. A watertight well cap should be placed on the top of the riser to seal the well from surface water infiltration in the event of a flood. A weep hole should be drilled in the casing a minimum of 6 inches above the ground surface to enable water to drain out of the annular space.

Flush-mounted monitoring wells (wells that do not extend above ground surface) require a watertight protective cover of sufficient strength to withstand heavy traffic. The well riser should be fitted with a locking watertight cap.

2.1.8 Concrete Surface Pad and Bumper Posts

A concrete surface pad should be installed around each well when the outer protective casing is installed. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout), typically to a depth of 1 to 3 feet bgs (depending on state, federal, and local regulations). The protective casing is then installed into the concrete. As a general guideline, if the protective casing is 4 inches in diameter, the concrete pad should be 3 feet square and 4 inches thick. If the well casing is 8 inches in diameter, the pad should be 4 feet square and 6 inches thick. Round concrete pads are also acceptable.

The finished pad should be sloped so that drainage flows away from the protective casing and off the pad. The finished pad should extend at least 1 inch above grade, with the edge tapered to match the existing grade.

If the monitoring well is located in a high-traffic area and finished at surface grade, a traffic-bearing, flush-mounted cover should be used whenever possible. For wells finished with protective casing above grade, a minimum of three bumper posts (bollard) should be installed around the pad to protect the well. The bumper posts, consisting of steel pipes 3 to 4 inches in diameter and at least 5 feet long, should be installed in a radial pattern around the protective casing, beyond the edges of the cement pad. The base of the bumper posts should be installed 2 feet bgs in a concrete footing; the tops of the posts should be capped or filled with concrete. Bumper posts are not required for flush-mounted monitoring wells.

2.1.9 Uncontaminated Water

Water used in the drilling process, to prepare grout mixtures and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry or municipal tap water. The water should not contain constituents that could compromise the integrity of the monitoring well installation.

2.2 MONITORING WELL INSTALLATION PROCEDURES

This section describes the procedures used to install a single-cased monitoring well, with either temporary casing or hollow-stem augers to support the walls of the boring in unconsolidated formations. The procedures are described in the order in which they are conducted, and include (1) placement of well screen and riser pipe, (2) placement of filter pack, (3) progressive retrieval of temporary casing, (4) placement of annular seal, (5) grouting, (6) surface completion and installation of protective casing, and (7) installation of concrete pad and bumper posts.

The additional steps necessary to install a well with permanent or multiple casing strings are described at the end of this section.

2.2.1 Well Screen and Riser Placement

Screen length, depth, and monitoring well diameter will depend on site-specific considerations such as intended well use, contaminants of concern, and hydrogeology. Some specific considerations include the following:

1. Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.
2. Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.
3. Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.
4. Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.
5. Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.
6. The screened interval should not extend across an aquiclude or aquitard.
7. If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.
8. If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.
9. If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen slot size and well pack material are determined based on the specifications described in the work plan. The well-screen slot size can only be selected after the filter pack grain size is specified. In monitoring wells, the well screen should retain 90 to 100 percent of the filter pack sands. Cumulative weight percent vs. grain size in thousandths of an inch (standard size for screen slots) of the selected filter sand is used to select the appropriate screen size.

Next, the screen and riser are assembled from the bottom up as it is lowered down the hole. The following procedures should be followed:

1. Measure the total depth of the boring using a weighted tape.
2. Determine the length of screen and casing materials required to construct the well.
3. Assemble the well parts from the bottom up, starting with the well sump or cap, well screen, and then the riser pipe. Progressively lower the assembled length of pipe.
4. The length of the assembled pipe should not extend above the top of the drill rig or be longer than the lateral extent of fall protection surrounding the drill rig as a safety precaution.

The well sump or cap, well screen, and riser should be certified clean by the manufacturer or should be decontaminated before assembly and installation. Flush joints should be tightened, and welds should be watertight and of good quality. The riser should extend above grade and be capped temporarily to prevent entrance of foreign materials during the remaining well completion procedures.

When the well screen and riser assembly is lowered to the predetermined level, it may float and require a method to hold it in place. For borings drilled using cable tool or air-rotary drilling methods, centralizers should be attached to the riser at intervals of between 20 and 40 feet.

2.2.2 Filter Pack Placement

The filter pack is placed after the well screen and riser assembly has been lowered into the borehole. The steps below should be followed:

1. Determine the volume of the annular space in the filter pack interval. The filter pack should extend from the bottom of the borehole to at least 2 feet above the top of the well screen to allow for compaction during well development.
2. Assemble the required material (sand pack and tremie pipe).
3. Lower a clean or decontaminated tremie pipe down the annulus to within 1 foot of the base of the hole.

4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.
5. Check the depth of sand in the hole using a weighted tape.
6. Pull the drill casing up ahead of the sand to keep the sand from bridging.
7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

If bridging of the filter pack occurs, break out the bridge prior to adding additional filter pack material. For wells less than 30 feet deep installed inside hollow-stem augers, the sand may be poured in 1-foot lifts without a tremie pipe.

Sufficient measurements of the depth to the filter pack material and the depth of the bottom of the temporary casing should be made to ensure that the casing bottom is always above the filter pack. The filter pack should extend 2 feet above the well screen (or more if required by state or local regulations). However, the filter pack should not extend across separate hydrogeologic units. The final depth interval, volume, and type of filter pack should be recorded on the Monitoring Well Completion Record (Figure 1).

A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. A measured volume of secondary filter material should be added to extend 1 to 2 feet above the primary filter pack. As with the primary filter pack, the secondary filter pack must not extend into an overlying hydrologic unit. An on-site geoscientist should evaluate the need for a secondary filter pack by considering the gradation of the primary filter pack, the hydraulic head difference between adjacent units, and the potential for grout intrusion into the primary filter pack.

The secondary filter material is poured into the annular space through tremie pipe as described above. Water from a source of known chemistry may be added to help place the filter pack into its proper location. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the secondary filter pack as work progresses. The amount and type of secondary filter pack used should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.3 Temporary Casing Retrieval

The temporary casing or hollow-stem auger should be withdrawn in increments. Care should be taken to minimize lifting the well screen and riser assembly during withdrawal of the temporary casing or auger.

It may be necessary to place the top head of the rig on the riser to hold it down. To limit borehole collapse in formations consisting of unconsolidated materials, the temporary casing or hollow-stem auger is usually withdrawn until the lowest point of the casing or auger is at least 2 feet, but no more than 5 feet, above the filter pack. When the geologic formation consists of consolidated materials, the lowest point of the casing or auger should be at least 5 feet, but no more than 10 feet, above the filter pack. In highly unstable formations, withdrawal intervals may be much less. After each increment, the depth to the primary filter pack should be measured to check that the borehole has not collapsed or that bridging has not occurred. Should collapse occur, re-drilling of the borehole to remove collapsed material will be necessary.

2.2.4 Annular Seal Placement

A bentonite pellet, chip, or slurry seal should be placed between the borehole and the riser on top of the primary or secondary filter pack. This seal retards the movement of grout into the filter pack. The thickness of the bentonite seal will depend on state and local regulations, but the seal should generally be between 3 and 5 feet thick.

The bentonite seal should be installed using a tremie pipe, lowered to the top of the filter pack and slowly raised as the bentonite pellets or slurry fill the space. Care must be taken so that bentonite pellets or chips do not bridge in the augers or tremie pipe. The depth of the seal should be checked with a weighted tape or the tremie pipe.

If a bentonite pellet or chip seal is installed above the water level, water from a known source should be added to allow proper hydration of the bentonite. Sufficient time should be allowed for the bentonite seal to hydrate. The volume and thickness of the bentonite seal should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.5 Grouting

Grouting procedures vary with the type of well design. The volume of grout needed to backfill the remaining annular space should be calculated and recorded on the Monitoring Well Completion Record (Figure 1). The use of alternate grout materials, including grouts containing gravel, may be necessary to control zones of high grout loss. Bentonite grouts should not be used in arid regions because of their propensity to desiccate. Typical grout mixtures include the following:

- **Bentonite grout:** about 1 to 1.25 pounds of bentonite mixed with 1 gallon of water.

- **Cement-bentonite grout:** about 5 pounds of bentonite and one 94-pound bag of cement mixed with 7 to 8 gallons of water.
- **Cement grout:** one 94-pound bag of cement mixed with 6 to 7 gallons of water.

The grout should be installed by gravity feed or pumping through a tremie pipe. The grout should be mixed in batches in accordance with the appropriate requirements and then pumped into the annular space until full-strength grout flows out at the ground surface without evidence of drill cuttings or fluid. The tremie pipe should then be removed to allow the grout to cure.

The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. For bentonite grouts, curing times are typically around 24 hours; curing times for cement grouts are typically 48 to 72 hours. However, the curing time required will vary with grout content and climatic conditions. The curing time should be documented in the Monitoring Well Completion Record (Figure 1).

2.2.6 Surface Completion and Protective Casing

Aboveground completion of the monitoring well should begin once the grout has set (no sooner than 24 hours after the grout was placed). The protective casing is lowered over the riser and set into the cured grout. The protective casing should extend below the ground surface to a depth below the frost line (typically 3 to 5 feet, depending on local conditions). The protective casing is then cemented in place. A minimum of 6 inches of clearance should be maintained between the top of the riser and the protective casing. A 0.5-inch diameter drainage or weep hole should be drilled in the protective casing approximately 6 inches above the ground surface to enable water to drain out of the annular space between the casing and riser. A watertight cap should be placed on top of the riser to seal the well from surface water infiltration in the event of a flood. A lock should be placed on the protective casing to prevent vandalism.

For flush-mounted monitoring wells, the well cover should be raised above grade approximately 1 inch, and the surrounding concrete pad sloped so that water drains away from the cover. The flush-mount completion should be installed in accordance with applicable state and local regulations. Figures 2A and 2B show above grade and flush mounted completion details.

2.2.7 Permanent and Multiple Casing Well Installation

When wells are installed through multiple saturated zones, special well construction methods should be used to assure well integrity and limit the potential for cross-contamination between geologic zones.

Generally, these types of wells are necessary if relatively impermeable layers separate hydraulic units. Two procedures that may be used are described below.

In the first procedure, the borehole is advanced to the base of the first saturated zone. Conductor casing is then anchored in the underlying impermeable layer (aquitard) by advancing the casing at least 1 foot into the aquitard and grouting the annular space between the conductor casing and borehole from the bottom of the casing to the surface. After the grout has cured, a smaller diameter borehole is drilled through the conductor casing. This procedure is repeated until the zone of interest is reached. After the zone is reached, a conventional well screen and riser are set. A typical well constructed in this manner is shown on Figure 3.

A second acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. However, this method is not acceptable when the driven casing may structurally damage a competent aquitard or aquiclude and result in cross-contamination of the two saturated layers. This method should also be avoided when highly contaminated groundwater or nonaqueous-phase contamination may be dragged down into underlying uncontaminated hydrologic units.

2.3 RECORD -KEEPING PROCEDURES

Record-keeping procedures associated with monitoring well installation are described in the following sections. These include procedures for surveying, obtaining permits, completing well construction records, and identifying monitoring wells. Upon completion of the well installation the paperwork must be checked for completeness and technical accuracy by another qualified person as soon as practical.

2.3.1 Surveying

Although not a part of this SOP, the latitude, longitude, and elevation at the top of the riser should be determined for each monitoring well. A permanent notch or black mark should be made on the north side of the riser. The top of the riser and ground surface elevations should be surveyed to the nearest one-hundredth of a foot.

2.3.2 Permits and Well Construction Records

Local and state regulations should be reviewed prior to monitoring well installation, and any required well permits should be in-hand before the driller is scheduled.

Monitoring well installation activities should be documented in both the field logbook and on the Monitoring Well Completion Record (Figure 1). Additionally, boring logs should be completed (SOP 026) and, if necessary, filed with the appropriate regulatory agency within the appropriate time frame.

2.3.3 Monitoring Well Identification

Each monitoring well should have an individual well identification number or name as specified in the field work plan. The well identification may be stamped in the metal surface upon completion or permanently marked by using another method. Current state and local regulations should be checked for identification requirements (such as township, range, section, or other identifiers in the well name).

FIGURE 1
MONITORING WELL COMPLETION RECORD

DRILLING INFORMATION

RIG TYPE ____________________________

DRILLING BEGAN:

DATE ____________ TIME __________

BORING DIAMETER (in) _____________

BORING DEPTH (ft) __________________

WELL INSTALLATION BEGAN:

DATE ____________TIME __________

WELL DEPTH (ft) ___________________

ANNULAR SEAL

PORTLAND CEMENT (lbs) ______________

BENTONITE (lbs) _______________________

WATER (gal) ____________________________

FROM (ft) ____________TO (ft) _____________

BENTONITE SEAL

TYPE ______________________________

BENTONITE (lbs) ___________________

WATER (gal) _______________________

FROM (ft) __________TO (ft) ___________

FINE SAND

SAND SIZE _______________________

SAND (lbs) _______________________

FROM (ft) __________TO (ft) ___________

FILTER PACK

SAND SIZE ________________________

SAND (lbs) _________________________

FROM (ft) __________TO (ft) __________

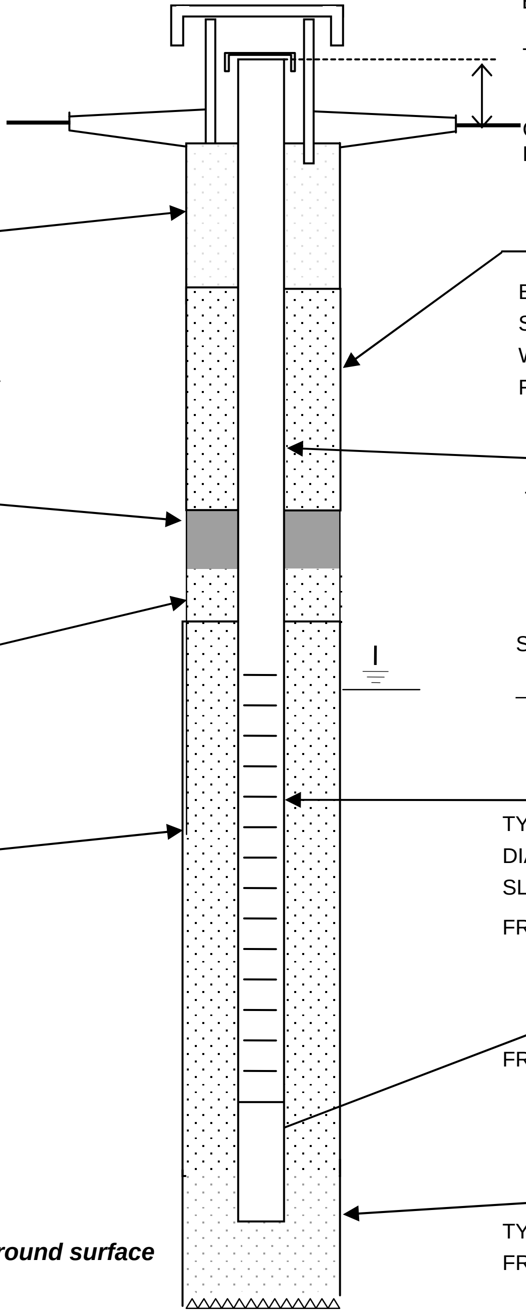
CENTRALIZERS

INTERVALS _________________________

____

SURFACE COMPLETION

ABOVE GROUND W/ CRASH POSTS



MONITORING WELL

MONITORING WELL ID _____________

PROJECT __________________________

SITE _______________________________

BOREHOLE ID ______________________

TOP OF CASING (ft)

GROUND SURFACE ELEVATION (ft)

BENTONITE/SAND SLURRY

BENTONITE (lbs) ___________________

SAND (lbs) __________________________

WATER (gal) ________________________

FROM (ft) ___________TO (ft) ____________

CASING

TYPE _________________________________

DIAMETER (in) _______________

STATIC WATER LEVEL (ft)

____

WELL SCREEN

TYPE ____________________________

DIAMETER (in) ____________________

SLOT SIZE (in) ______________________

FROM (ft) ___________TO (ft) ____________

SUMP

FROM (ft) ___________TO (ft) ____________

BOREHOLE BACKFILL

TYPE _______________________________

FROM (ft) ___________TO (ft) ____________

All measurements are in feet below ground surface except for well casing stickup

Notes____

____

____

FIGURE 2A

MONITORING WELL TYPICAL CONSTRUCTION DETAILS – ABOVE GRADE COMPLETION

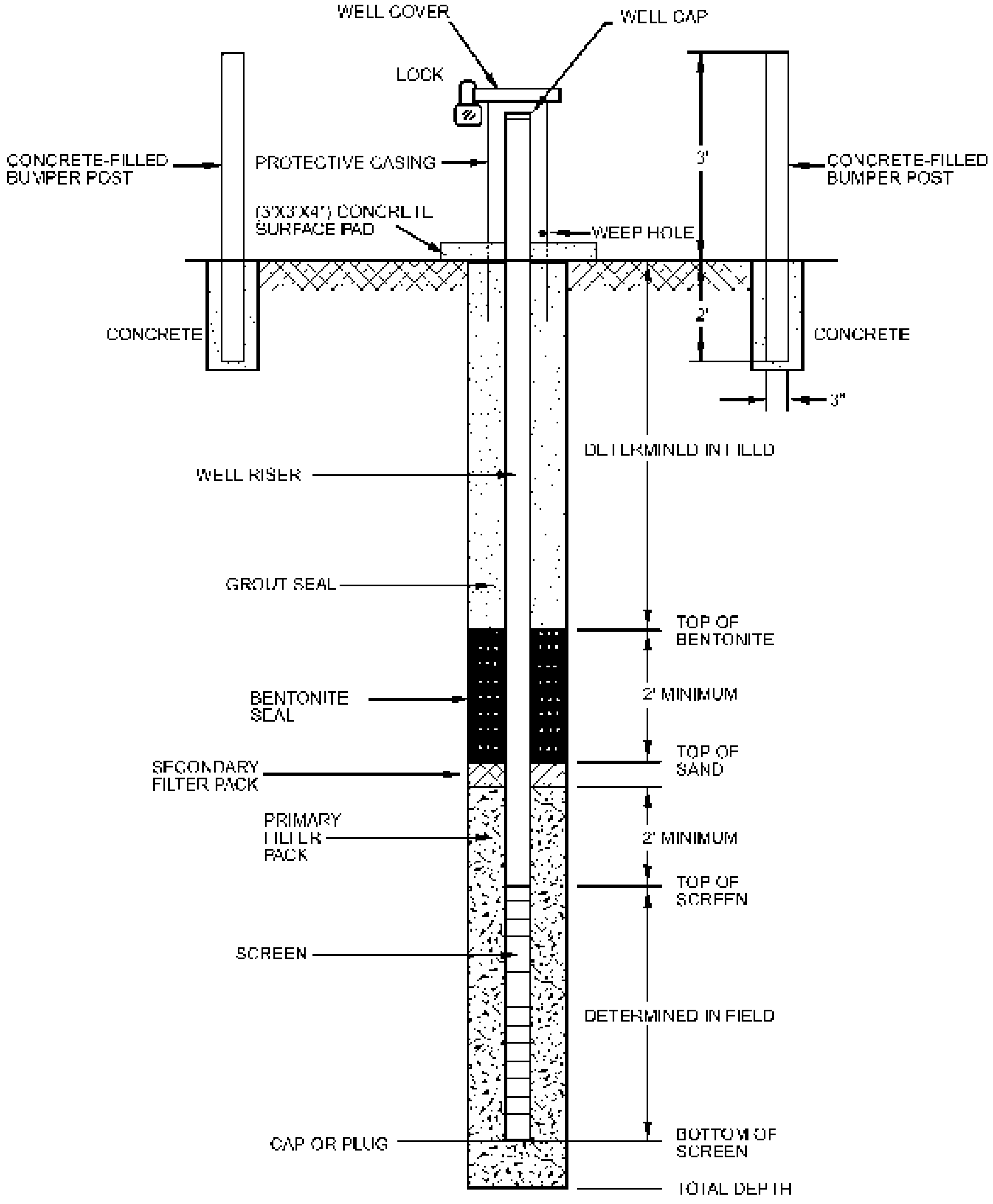


FIGURE 2B

MONITORING WELL TYPICAL CONSTRUCTION DETAILS – FLUSH MOUNTED COMPLETION

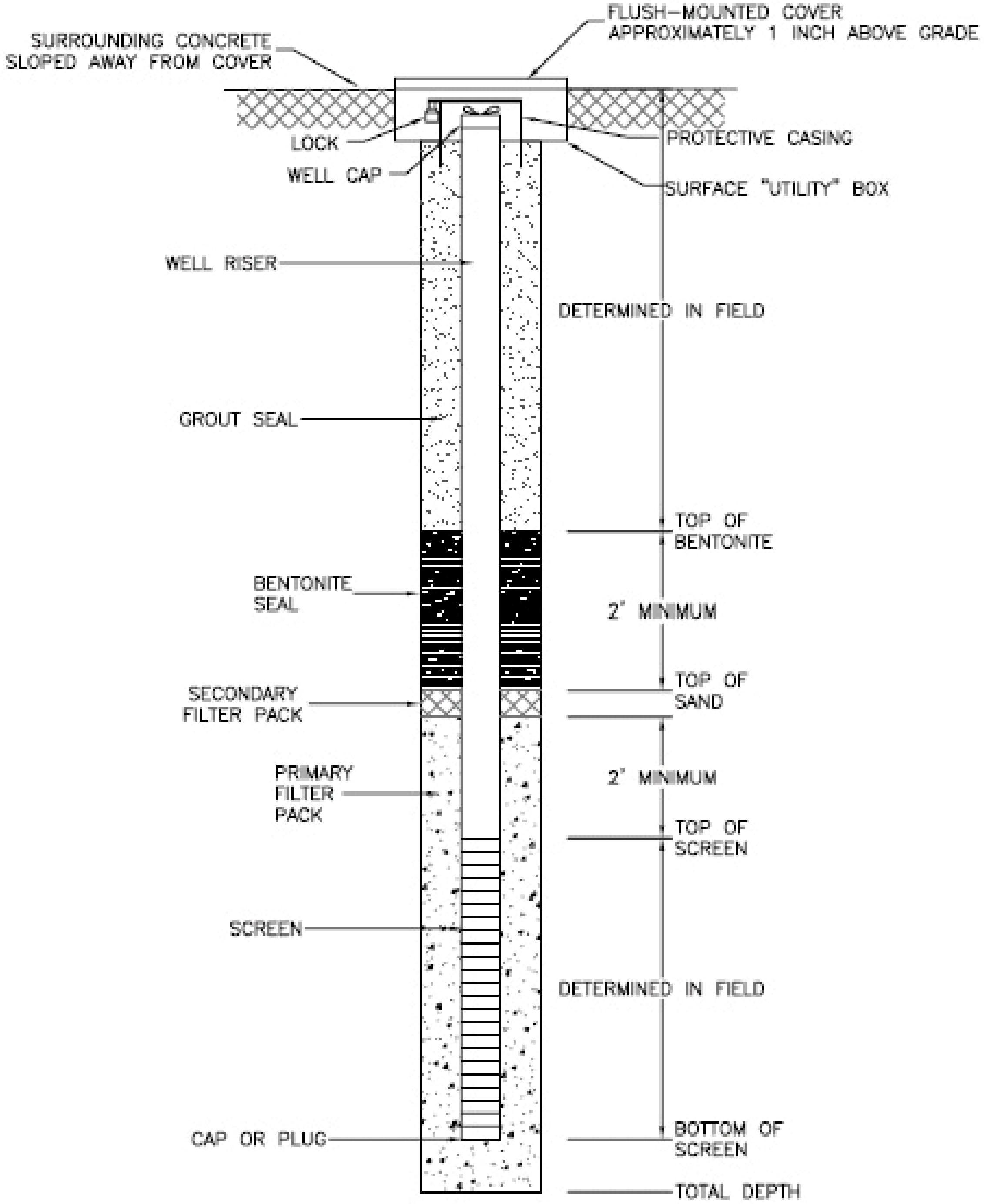
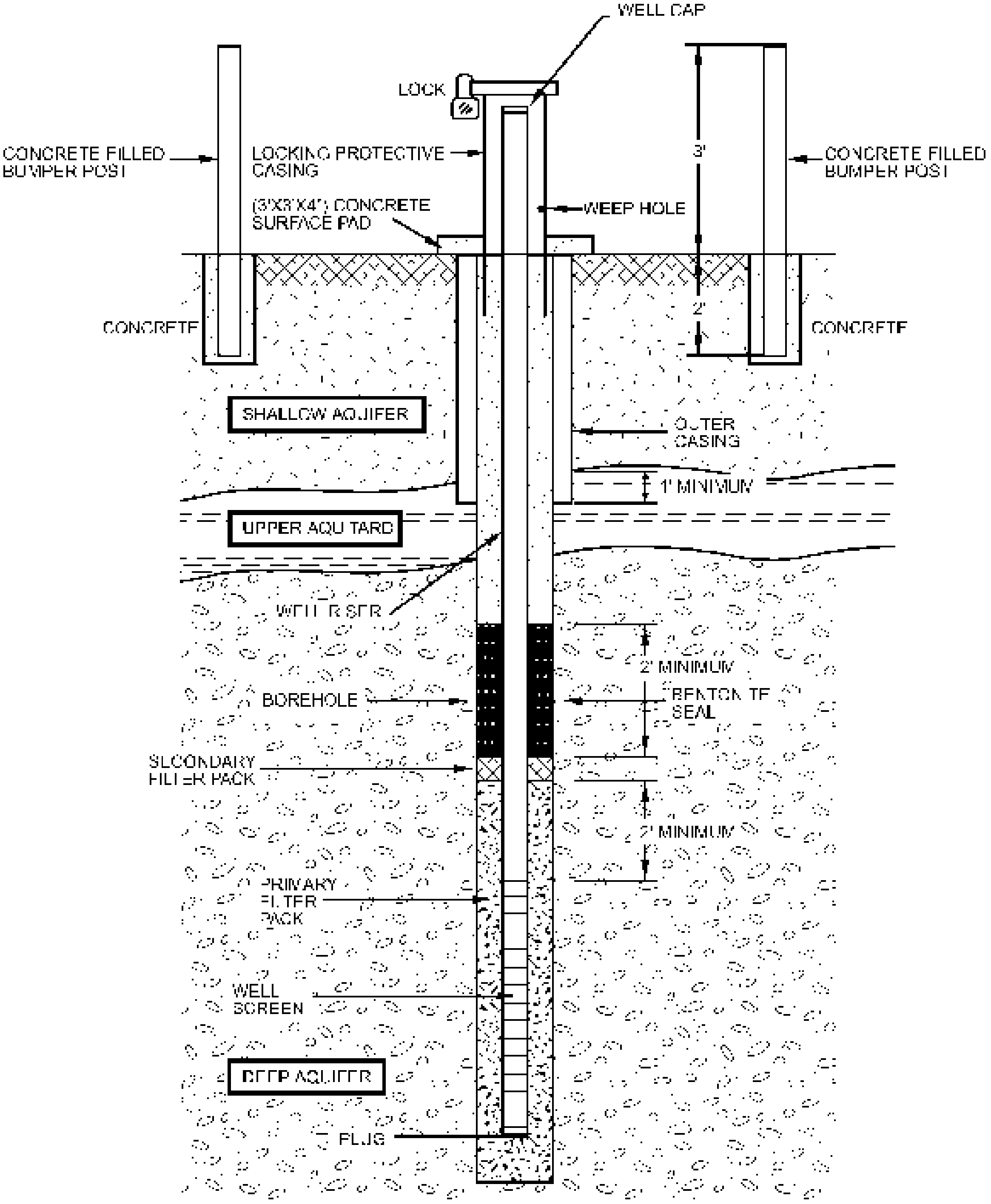


FIGURE 3

MULTIPLE CASING WELL CONSTRUCTION DIAGRAM



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 021

REVISION NO. 4

Last Reviewed: June 2009

	06-19-09
Quality Assurance Approved	Date

Title: **Monitoring Well Development**

Revision No. 4, June 2009
Last Reviewed: June 2009

1.0 BACKGROUND

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. This impairment is typically a result of disturbance of soil grains (smearing) or the invasion of drilling fluids or solids into the aquifer during the drilling process. The impact to the hydrologic unit surrounding the borehole must be remediated so that the well hydraulics and samples collected from the monitoring well are representative of the aquifer.

Well development should be conducted as an integral step of monitoring well installation to remove the finer-grained material, typically clay and silt, from the geologic formation near the well screen and filter pack. Monitoring well installation is discussed in standard operating procedure (SOP) No. 020. The fine-grained particles may interfere with water quality analyses and alter the hydraulic characteristics of the filter pack and the hydraulic unit adjacent to the well screen. Well development improves the hydraulic connection between water in the well and water in the formation. The most common well development methods are mechanical surging, overpumping, air-lift pumping, backwashing, surge bailing, and well jetting; these methods can be used individually or in combination to achieve the most effective well development.

The health and safety plan for the site should be followed to avoid exposure to chemicals of concern. Water, sediment, and other waste removed from a monitoring well should be disposed of in accordance with applicable federal, state, and local requirements.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well development. Well development improves the hydraulic characteristics of the filter pack and borehole wall by performing the following functions:

- Reducing the compaction and the intermixing of grain sizes produced during drilling by removing fine material from the pore spaces.
- Removing the filter cake or drilling fluid film that coats the borehole as well as much or all of the drilling fluid and natural formation solids that have invaded the formation.
- Creating a graded zone of sediment around the screen, thereby stabilizing the formation so that the well can yield sediment-free water.

1.2 SCOPE

In most cases, well development is conducted by a drilling contractor with oversight and documentation by Tetra Tech. This SOP applies to the development of newly installed monitoring wells. The SOP identifies the most commonly used well development methods. Selection of a particular method or combination will depend on site conditions, equipment limitations, and other factors. The method selected and the rationale for selection should be described in the site-specific sampling plan or work plan. All modifications to proposed well development methods should be documented in a field logbook and/or Well Completion Record.

1.3 DEFINITIONS

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and capable of storing and transmitting water.

Aquitard: A geologic formation, group of formations, or part of a formation through which virtually no water moves.

Bailer: A cylindrical sampling device with valves on either end, used to extract water from a well or borehole.

Bentonite seal: A colloidal (extremely fine particle that will not settle out of solution) clay seal separating the sand pack from the surface seal.

Drilling fluid: A fluid (liquid or gas) that may be used in drilling operations to remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) cement and water or (2) cement, bentonite, and water that is placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Hydraulic conductivity: A measure of the ease with which water moves through a geologic formation. Hydraulic conductivity, K, is typically measured in units of distance per time in the direction of groundwater flow.

Hydrologic units: Geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units.

Oil air filter: A filter or series of filters placed in the airflow line from an air compressor to reduce the oil content of the air.

Oil trap: A device used to remove oil from the compressed air discharged from an air compressor.

pH: The negative base-10 log of the hydrogen-ion activity in moles per liter.

Riser: The pipe extending from the well screen to or above the ground surface.

Specific conductance: A measure of the ability of the water to conduct an electric current. Specific conductance is related to the total concentration of ionizable solids in the water and is inversely proportional to electrical resistance.

Static water level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumping.

Surging: An uneven flow and strong momentum given to a fluid, as water in a tank, resulting in a rapid, temporary rise in pressure.

Transmissivity: The volume of water transmitted per unit width of an aquifer over the entire thickness of the aquifer flow, under a unit hydraulic gradient.

Turbidity: Muddy looking water created by having sediment or foreign particles stirred up or suspended.

Well screen: A cylindrical pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

1.4 REFERENCES

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EPA. 1994. Well Development. Environmental Response Team SOP #2044 (Rev. #0.0, 10/03/94). On-Line Address: http://www.ert.org

1.5 REQUIREMENTS AND RESOURCES

To conduct oversight of and document monitoring well development, the person at the drill site should be a geoscientist who has relevant professional training and experience. The site geoscientist is responsible for oversight and documentation of all well development activities. The site geoscientist shall understand the project objectives and regularly communicate from the field with the project manager or technical project team members.

The type of equipment used for well development will depend on the well development method. Well development methods and the equipment required are discussed in Section 2.1 of this SOP. In general, monitoring wells should be developed shortly after they are installed but no sooner than 24 to 48 hours after the placement of the grout seal, depending on the grout cure rate and well development method to be used. Most drilling or well development rigs have pumps, air compressors, bailers, surge blocks, and other equipment that can be used to develop a monitoring well.

All downhole equipment should be properly decontaminated before and after each well is developed. See SOP No. 002 (General Equipment Decontamination) for details.

2.0 WELL DEVELOPMENT PROCEDURES

This section describes common well development methods, factors to be considered in selecting a well development method, procedures for initiating well development, well development duration, and calculations typically made during well development. In addition to this, procedures described in any work plans for well development should be fully consistent with local and state regulations and guidelines.

2.1 WELL DEVELOPMENT METHODS

Well development methods vary with the physical characterization of hydrologic units in which the monitoring well is screened, and the drilling method used. The most common methods include mechanical surging, overpumping, air-lift pumping, backwashing, surge bailing, and well jetting. These methods may be effective alone or may need to be combined (for example, overpumping combined with backwashing). Factors such as well design and hydrogeologic conditions will determine which well development method will be most practical and cost effective. Commonly used well development methods are described in Sections 2.1.1 through 2.1.6.

The use of chemicals for monitoring well development should be avoided as much as possible. Introduction of chemicals may significantly alter groundwater chemistry in and around the well.

2.1.1 Mechanical Surging

The mechanical surging method forces water to flow in and out of the well screen by operating a plunger (or surge block) in the casing, similar to a piston in a cylinder. A typical surge block is shown on Figure 1. For shallow wells with limited bentonite or grout seal heights, care should be taken to avoid damaging the seal by surging. The surge block should fit snugly in the well casing to increase the surging action. The surge block is attached to a drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the down stroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing water and fine sediments to flow back into the well from the aquifer. Down strokes and recovery strokes are usually 3 to 5 feet in length.

The surge block should be lowered into the water column above the well screen. The water column will effectively transmit the action of the block to the filter pack and hydrologic unit adjacent to the well screen. Development should begin above the screen and move progressively downward to prevent the surge block from becoming sand locked in the well. The initial surging action should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. As water begins to move easily both in and out of the screen, the surge block is usually lowered in increments to a level just above the screen. As the block is lowered, the force of the surging movement should be increased. In wells equipped with long screens, it may be more effective to operate the surge block in the screen to concentrate its action at various levels.

A pump or bailer should be used periodically to remove dislodged sediment that may have accumulated at the bottom of the well during the surging process. The pump or bailer should be moved up and down at the bottom of the well to suspend and collect as much sediment as possible.

The accumulation of material developed from a specific screen interval can be measured by sounding the total depth of the well before and after surging. Continue surging until little or no sand accumulates.

2.1.2 Overpumping

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations and is usually conducted in conjunction with mechanical surging or backwashing. Overpumping is commonly implemented using a downhole submersible pump lowered to the bottom of the well. In cases were the water table is less than 25 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump at the ground surface. The intake pipe is lowered into the water column at a depth sufficient to ensure that the water in the well is not drawn down to the pump intake level. The inflow of water at the well screen is not dependent on the location of the pump intake as long as it remains submerged.

Overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well, opening clogged screen slots, and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen because of the flow rate and direction created by overpumping may be overcome by using mechanical surging or backwashing in conjunction with this method.

2.1.3 Air Lift Pumping

Air lift pumping uses a two-pipe system consisting of an air injection pipe and a discharge pipe. In this well development method, an air lift pump is operated by cycling the air pressure on and off for short periods of time. This operation provides a surging action that can dislodge fine-grained particles in the vicinity of the well screen. Subsequently applying a steady, low pressure removes the fines drawn into the well by the surging action.

The bottom of the air lift should be at least 10 feet above the top of the well screen. Air is injected through an inner pipe at sufficient pressure to bubble out directly into the surrounding discharge pipe. The bubbles formed by the injected air cause the column of water in the discharge pipe to be lifted upward and allow water from the aquifer to flow into the well. This arrangement prevents injected air from entering the well screen. Pumping air through the well screen and into the filter pack and adjacent hydrologic unit should be avoided because it can cause air entrainment, inhibiting future sampling efforts and possibly altering groundwater chemistry.

The air injected into the well should be filtered using an oil-air filter and oil trap to remove any compressor lubricant entrained in the air. Air pressures required for this well development method are relatively low; an air pressure of 14.8 pounds per square inch should move a 30-foot column of water. For small-diameter, shallow wells where the amount of development water is likely to be limited, tanks of inert gas (such as nitrogen) can be used as an alternative to compressed air.

2.1.4 Backwashing

Effective development procedures should cause flow reversals through the screen openings that will agitate the sediment, remove the finer fraction, and then rearrange the remaining formation particles. Backwashing overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the submersible pump and out through the well screen. The backflow portion of the backwashing cycle breaks down bridging, and the inflow then moves the fine material toward the screen and into the well.

Some wells respond satisfactorily to backwashing techniques, but the surging effect is not vigorous enough to obtain maximum results in many cases.

A variation of backwashing may be effective in low-permeability formations. After the filter pack is installed around the monitoring well screen, clean water is circulated down the well casing, out through the well screen and filter pack, and up through the open borehole before the grout or bentonite seal is placed in the annulus. Flow rates should be controlled to prevent floating the filter pack. Because of the low hydraulic conductivity of the formation, negligible amounts of water will infiltrate into the formation. Immediately after this procedure, the bentonite seal should be installed, and the nonformation water should be pumped out of the well and filter pack.

2.1.5 Surge Bailing

Surge bailing can be an effective well development method in relatively clean, permeable formations where water flows freely into the borehole. A bailer made of stainless steel or polyvinyl chloride and slightly smaller than the well casing diameter is allowed to fall freely through the borehole until it strikes the groundwater surface. The contact of the bailer produces a downward force and causes water to flow outward through the well screen, breaking up bridging that has developed around the screen. As the bailer fills and is rapidly withdrawn from the well, the drawdown created causes fine particles to flow through the well screen and into the well. Subsequent bailing can remove these particles from the well. Lowering the bailer to the bottom of the well and using rapid short strokes to agitate and suspend solids that have settled to the well bottom can enhance removal of sand and fine particles. Bailing should continue until the water is free of suspended particles.

2.1.6 Well Jetting

Well jetting can be used to develop monitoring wells in both unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in a very small increments to be sure that all portions of the screen are exposed to the jetting action.

Jetting is relatively ineffective on the fine screens typically used in monitoring wells (slot sizes from 0.01 to 0.02 inch). In addition, jetting requires the introduction of external water into the well and surrounding formation. This water should be obtained from a source of known chemistry. Water introduced for development should be completely removed from the aquifer immediately after development.

The use of compressed air as a jetting agent should not be employed for development of monitoring wells. Compressed air could entrain air in the formation, introduce oil into the formation, and damage the well screen.

2.2 FACTORS TO CONSIDER WHEN SELECTING A WELL DEVELOPMENT METHOD

It is important to check federal, state, and local regulatory requirements for monitoring well development requirements. This SOP may be changed to accommodate applicable regulations, site conditions, or equipment limitations where applicable.

The type of geologic material, the design, completion of the well, and the type of drilling method used are all factors to be considered during the development of a monitoring well.

Monitoring well development should usually be started slowly and gently and then performed with increasing vigor as the well is developed. Most well development methods require the application of sufficient energy to disturb the filter pack, thereby freeing fine particles and allowing them to be drawn into the well. The coarser particles then settle around and stabilize the screen.

Development of wells completed in fine sand and silt strata should involve methods that are relatively gentle so that strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the formation. In addition, development methods should be carefully selected based upon the potential contaminants present, the quantity of wastewater generated, and requirements for containerization or treatment of wastewater.

For small diameter and small volume wells, a development bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small diameter wells.

Any time an air compressor is used for well development, it should be equipped with an oil-air filter or oil trap to minimize the introduction of oil into the screened area. The presence of oil could affect the organic constituent concentrations of the water samples collected from the well.

The presence of light nonaqueous-phase liquids (LNAPL) can impact monitoring well development. Water jetting or vacuum-enhanced well development may assist in breaking down the smear zone in the LNAPL. Normal development procedures are conducted in the water-saturated zone and do not affect the LNAPL zone.

2.3 INITIATING WELL DEVELOPMENT

Newly completed monitoring wells should be developed as soon as practical, but no sooner than 24 to 48 hours after grouting is completed if rigorous well development methods are used. Development may be initiated shortly after well installation if the development method does not interfere with the grout seal. State and local regulations should be checked for guidance. The following general well development steps can be used with any of the methods described in Section 2.1.

1. Assemble the necessary equipment on a plastic sheet around the well. This may include a water level meter (or oil-water interface probe if LNAPL or dense nonaqueous-phase liquids [DNAPL] are present); personal protective equipment; pH, conductivity, temperature, and turbidity meters; air monitoring equipment; Well Development Data Sheets (see Figure 2); a watch; and a field logbook.

2. Open the well and take air monitoring readings at the top of the well casing and in the breathing zone. See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

3. Measure the depth to water and the total depth of the monitoring well. See SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) for additional guidance.

4. Measure the initial pH, temperature, turbidity, and specific conductance of the groundwater from the first groundwater that comes out of the well. Note the time, initial color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. See SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), 013 (Field Measurement of Specific Conductance), and 088 (Field Measurement of Water Turbidity) for additional guidance.

5. Develop the well using one or more of the methods described in Section 2.1 until the well is free of sediments and the groundwater turbidity has reached acceptable levels. Record the development method and other pertinent information on a Well Development Data Sheet (see Figure 2) or in a field logbook.

6. Containerize any groundwater produced during well development if groundwater contamination is suspected. The containerized water should be sampled and analyzed to determine an appropriate disposal method.

7. Do not add water to assist in well development unless the water is from a source of known chemical quality and the addition has been approved by the project manager. If water is added, five times the amount of water introduced should be removed during development.

8. Continue to develop the well, repeating the water quality measurements for each borehole volume. Development should remove a minimum of 3 well volumes and continue if necessary until water quality parameters are stable to within 10 percent. Development should also continue until all the water added during development (if any) is removed or the water has a turbidity of less than 50 nephelometric turbidity units. This level may only be attainable after allowing the well to settle and testing at low flow sampling rates.

9. At the completion of well development, measure the final pH, temperature, turbidity, and specific conductance of the groundwater. Note the color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. In addition to the final water quality parameters, the following data should be noted on the Well Development Data Sheet: well identification, date(s) of well installation, date(s) and time of well development, static water level before and after development, quantity of water removed and time of removal, type and capacity of pump or bailer used, and well development technique.

All contaminated water produced during development should be containerized in drums or storage vessels properly labeled with the date collected, generating address, well identification, and consultant contact number.

2.4 DURATION OF WELL DEVELOPMENT

Well development should continue until representative water is free of drilling fluids, cuttings, or other materials introduced during well construction. When pH, temperature, turbidity, and specific conductance readings stabilize and the water is visually clear of suspended solids, the water is representative of formation water. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment-free sample in a matter of minutes, whereas bailing the well may require several hours of continuous effort to obtain a clear sample.

An on-site project geoscientist should make the final decision as to whether well development is complete. This decision should be documented on a Well Development Data Sheet (see Figure 2) or in a field logbook. Upon completion of the well development, the data sheet must be checked for completeness and technical accuracy by another qualified person as soon as practical.

2.5 CALCULATIONS

It is necessary to calculate the volume of water in the well. Monitoring well diameters are typically 2, 3, 4, or 6 inches. The height of the water column (in feet) in the well can be multiplied by the following conversion factors to calculate the volume of water in the well casing.

Well Diameter (inches)	Volume (gal/foot)
2	0.1631

3	0.3670
4	0.6524
6	1.4680

3.0 POTENTIAL PROBLEMS

The following potential problems can occur during development of monitoring wells:

- In some wells the pH, temperature, and specific conductance may stabilize, but the water remains turbid. When this occurs, the well may still contain construction materials (such as drilling mud in the form of a mud cake) and formation soils that have not been washed out of the borehole. Excessive or thick drilling mud cannot 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 well development. If the well is completed in a silty zone, it may be necessary to sample with low flow methods or filtering. If, after several attempts, all parameters have stabilized except turbidity, the well may be considered developed with the exception noted in the field log and/or Well Completion Report.

- Mechanical surging and well jetting disturb the formation and filter pack more than other well development methods. In formations with high clay and silt contents, surging and jetting can cause the well screen to become clogged with fines. If an excessive amount of fines is produced, sand locking of the surge block may result. Well development with these methods should be initiated gently to minimize disturbance of the filter pack and to prevent damage to the well screen.

- Effective overpumping may involve the discharge of large amounts of groundwater. This method is not recommended when groundwater extracted during well development is contaminated with hazardous constituents. If the hazardous constituents are organic compounds, this problem can be partially overcome by passing the groundwater through an activated carbon filter.

- When a well is developed by mechanical surging or bailing, rapid withdrawal of the surge block or bailer can result in a large external pressure outside of the well. If the withdrawal is too rapid and this pressure is too great, the well casing or screen can collapse.

- A major disadvantage of well jetting is that an external supply of water is needed. The water added during well jetting may alter the hydrochemistry of the aquifer; therefore, the water added in this development procedure should be obtained from a source of known chemistry. In addition, the amount of water added during well development and the amount lost to the formation should be recorded.

- The use of air in well development can chemically alter the groundwater, either directly through chemical reaction or indirectly as a result of impurities introduced through the air stream. In addition, air entrainment within the formation can interfere with the flow of groundwater into the monitoring well. Consequently, air should not be injected in the immediate vicinity of the well screen.

FIGURE 1

SCHEMATIC DRAWING OF A SURGE BLOCK

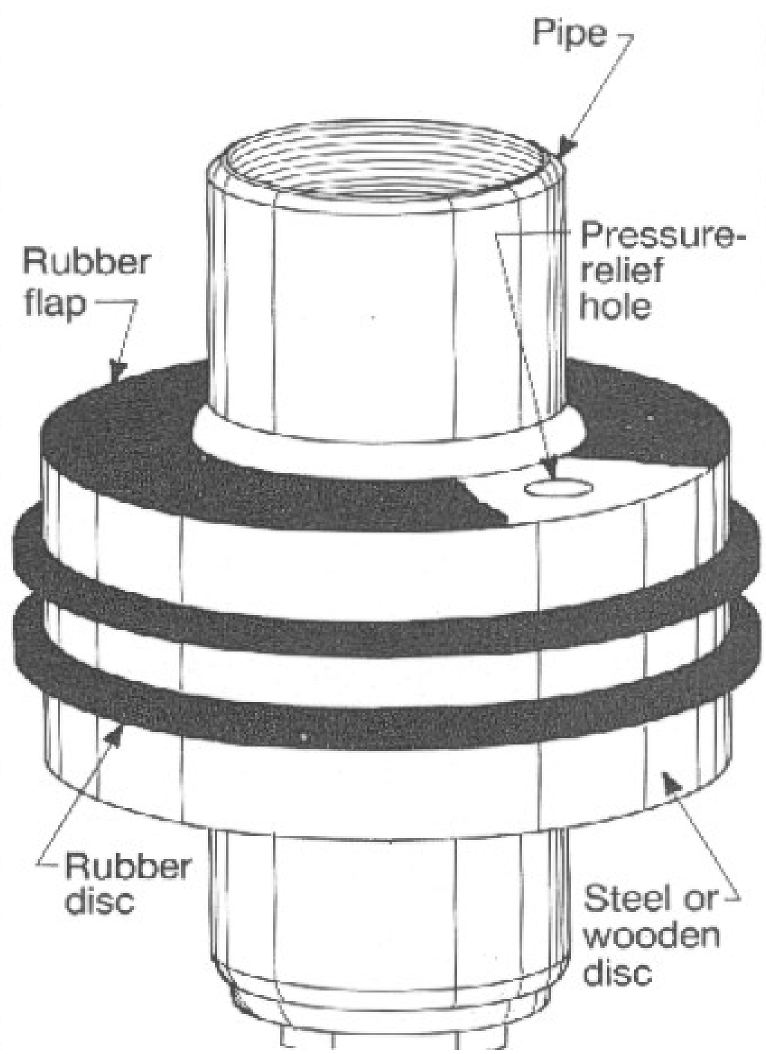

FIGURE 2

WELL DEVELOPMENT DATA SHEET

BORING NO. ___________WELL NO. ___________ Sheet ___ of ___

Project ____
Project No. ____
Date(s) of Installation ________________________
Date(s) of Development ______________________________
Personnel/Company ______________________________
____
Type of Rig Used __________________________________

Casing Diameter/Type ____________________
Borehole Diameter ____________________
Screened Interval(s) ________________________
Total Length of Well Casing____________________
Measured Total Depth (TOC) Initial ____________
Final ____________
Initial Depth to Water
(TOC) ____________________ Date ____ Time ____
Stabilized Depth to Water
(TOC) ____________________ Date ____ Time ____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

____ Jetting (Airlift) ________________________________
____ Surge Block ________________________________
____ Bailing ________________________________
____ Pumping ________________________________
____ Other ________________________________

FLUIDS ADDED

Lost Drilling Fluid:____________________ Gallons
Lost Purge Water: ____________________ Gallons
Water During Installation:______________ Gallons
Total Fluids Added: __________________ Gallons
Source of Added Water: ____________________________
Ground Water Quality Parameters of
Added Water Measured: Y N
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ____________________

PURGE VOLUME CALCULATION

Casing Volume: ____________ Ft. of water
x ____________________ Gallons/Foot
= ____________________ Gallons / Single Casing Volume
Sand Pack Volume: ________ Ft. of Saturated Sand Pack
x ____________________Gallons/Foot (borehole diameter)
= ____________________ Gallons (in borehole)
\- ____________________ Gallons of Casing Volume
= ____________________ x 0.3 (Assume porosity = 30%)
= ____________________ Gallons Within Sand Pack
Single Purge Volume: ________________ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)

Minimum Purge Volume: ______________ Gallons
Actual Purge Volume: ________________ Gallons
Volume Measured by: ________________________
Rate of Development ________ Gallons/Minute (Hour,Day)
Pumping Rate/Depth ________________ @ ______ Ft. (Below Grade.)

Immiscible Phases Present: Y N Thickness ________

INSTRUMENT CALIBRATION

pH Meter: __________________________________
pH 4.0 = __________ @ _____ °C
pH 7.0 = __________ @ _____ °C
pH 10.0 = _________ @ _____ °C
Dissolved Oxygen Meter: ______________________________

Spec. Conductance Meter:____
Standard _________ µmhos/cm@ 25°C
Reading __________________ µmhos/cm @ _____ °C
Turbidity Meter: ____
Other: ____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity or D.O.	Clarity, Odor, PID Readings, Other:

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING OF NOTES IN FIELD LOGBOOK

SOP NO. 024

REVISION NO. 1
May 18, 1993

Last Reviewed: December 2008

KRiesing
Quality Assurance Approved

December 5, 2008
Date

1.0 BACKGROUND

The field logbook should contain detailed records of all the field activities, interviews of people, and observations of conditions at a site. Entries should be described in as much detail as possible so that personnel can accurately reconstruct, after the fact, activities and events during their performance of field assignments. Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed; and they must reflect the importance of the field events.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidance to ensure that logbook documentation for any field activity is correct, complete, and adequate. Logbooks are used for identifying, locating, labeling, and tracking samples. A logbook should document any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel. They also serve as documentation of any photographs taken during the course of the project. In addition, the data recorded in the logbook may assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining good quality control. Quality control is enhanced by proper documentation of all observations, activities, and decisions.

1.2 SCOPE

This SOP establishes the general requirements and procedures for recording notes in the field logbook.

1.3 DEFINITIONS

None

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, N.Y.

1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Field logbooks
- Ballpoint pens with permanent ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers; they should have preprinted lines and wide columns. They should be approximately 7 1/2 by 4 1/2 inches or 8 1/2 by 11 inches in size. Loose-leaf sheets are not acceptable for field notes. If notes are written on loose paper, they must be transcribed as soon as possible into a regular field logbook by the same person who recorded the notes.

Logbooks can be obtained from an individual’s office supply room or directly from outside suppliers. Logbooks must meet the requirements specified in this SOP and should include preprinted pages that are consecutively numbered. If the numbers must be written by hand, the numbers should be circled so that they are not confused with data.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites, designate a separate logbook for each subsite. For special tasks, such as periodic well water-level measurements, data from multiple subsites may be entered into one logbook that contains only one type of information.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages can be removed from the logbook for any purpose.

- All field activities, meetings, photographs, and names of personnel must be recorded in the site logbook.
- Each logbook pertaining to a site or subsite should be assigned a serial number based on the date the logbook is issued to the project manager. The first issued logbook should be assigned number 1, the next issued logbook assigned number 2, and so on. The project manager is to maintain a record of all logbooks issued under the project.
- All information must be entered with a ballpoint pen with waterproof ink. Do not use pens with “wet ink,” because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective.
- Begin a new page for each day’s notes.
- Write notes on every line of the logbook. If a subject changes and an additional blank space is necessary to make the new subject title stand out, skip one line before beginning the new subject. Do not skip any pages or parts of pages unless a day’s activity ends in the middle of a page.
- Draw a diagonal line on any blank spaces of four lines or more to prevent unauthorized entries.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent with other field logbooks. Guidelines for the cover, spine, and internal pagination are discussed below.

2.2.1 FORMAT OF FIELD LOGBOOK COVER AND SPINE

Write the following information in clear capital letters on the front cover of each logbook using a Sharpie® or similar type permanent ink marker:

- Logbook identification number
- The serial number of the logbook (assigned by the project manager)
- Name of the site, city, and state
- Name of subsite if applicable
- Type of activity

- Beginning and ending dates of activities entered into the logbook
- “Tetra Tech EM Inc.” City and State
- “REWARD IF FOUND”

Some of the information listed above, such as the list of activities and ending dates, should be entered after the entire logbook has been filled or after decision that the remaining blank pages in the logbook will not be filled.

The spine of the logbook should contain an abbreviated version of the information on the cover: for example, “1, Col. Ave., Hastings, 5/88 - 8/88.”

2.2.2 First Page of the Field Logbook

Spaces are usually provided on the inside front cover (or the opening page in some logbooks), for the company name (“Tetra Tech EM Inc.”), address, contact name, and telephone number. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page.

2.3 ENTERING INFORMATION IN THE LOGBOOK

Enter the following information at the beginning of each day or whenever warranted during the course of a day:

- Date
- Starting time
- Specific location
- General weather conditions and approximate temperature
- Names of personnel present at the site. Note the affiliation(s) and designation(s) of all personnel
- Equipment calibration and equipment models used.
- Changes in instructions or activities at the site
- Levels of personal protective clothing and equipment

- A general title of the first task undertaken (for example, well installation at MW-11, decon at borehole BH-11, groundwater sampling at MW-11)
- Approximate scale for all diagrams. If this can't be done, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections. Label features on each diagram.
- Corrections, if necessary, necessarily including a single line through the entry being corrected. Initial and date any corrections made in the logbook.
- After last entry on each page, initials of the person recording notes. No information is to be entered in the area following these initials.
- At the end of the day, signature of the person recording notes and date at the bottom of the last page. Indicate the end of the work day by writing "Left site at (time)." A diagonal line must be drawn across any remaining blank space at the bottom of this last page.

The following information should be recorded in the logbook after taking a photograph:

- Time, date, location, direction, and, if appropriate, weather conditions
- Description of the subject photographed and the reason for taking the picture
- Sequential number of the photograph and the film roll number or disposable camera used (if applicable)
- Name of the photographer.

The following information should be entered into the logbook when collecting samples:

- Location description
- Name(s) of sampler(s)
- Collection time
- Designation of sample as a grab or composite sample
- Type of sample (water, sediment, soil gas, etc.)
- On-site measurement data (pH, temperature, specific conductivity)
- Field observations (odors, colors, weather, etc.)
- Preliminary sample description
- Type of preservative used
- Instrument readings.

If pre-printed field data forms are available (forms such as the micropurge field data collection form), data should be entered on these pre-printed forms rather than into field logbooks. Note in the logbook that the field data are recorded on separate forms.

2.4 PRECAUTIONS

Custody of field logbooks must be maintained at all times. Field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession. Logbooks are official project documents and must be treated as such.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF GROUNDWATER INDICATOR PARAMETERS

SOP NO. 061

REVISION NO. 2

Last Reviewed: July 2009

RRiesing

Quality Assurance Approved

July 2009

Date

1.0 BACKGROUND

Various water quality monitoring systems can be used for determining groundwater indicator parameters in the field. Commonly measured field indicator parameters include pH, specific conductance, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity. Groundwater field measurements are typically collected in conjunction with groundwater sampling or monitoring well development (see SOPs 010, 015, and 021).

Various types of water quality systems exist including down-hole systems and flow through cells. Tetra Tech used several common water quality meters including various types of In-Situ, YSI, Hydac, and Horiba meters (see Figure 1 at the end of this SOP). The sampling team should select the type of meter or monitoring system based on site-specific conditions including data collection needs, the types of wells being sampled, and the sampling procedures used. Multiple parameter systems should be used when multiple field parameters are to be measured.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the general requirements and procedures for using various water quality monitoring systems for determining groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field.

1.2 SCOPE

This SOP applies to general procedures for calibrating and operating water quality monitoring systems in the field. The project work plan or field sampling plan should identify the types of systems to be used and the actual project-specific field parameters to be measured. For each type of water quality system, the manufacturer’s manual should be consulted for specific operating instructions.

1.3 DEFINITIONS

Single Parameter System: A meter or monitoring system consisting of a single probe designed to measure a single indicator parameter.

Multiple Parameter System: A meter or monitoring system consisting of multiple probes capable of measuring multiple indicator parameters.

Open Container Measurements: Field measurements performed in an open container such as a cup, a jar, or a bucket where an air/water interface exists.

Flow-Through Chamber or Cell: A plastic cell or chamber connected to the sample pump discharge tubing so that a continuous flow of water passes across the probes. Additional tubing is used to route water from the flow-through cell to a waste container or final discharge point.

Down-Hole Monitoring System: A meter or monitoring system where probes are submerged by inserting them into the well. The probes are attached to the meter (located at the well head or ground surface) by one or more cables.

pH: A measure of the acidity or alkalinity of a solution. The pH scale ranges from 0 to 14 with strongly acidic solutions at the low end, strongly basic solutions at the high end, and “pure” or neutral water at 7. Field measurements of pH are recorded in standard units.

Specific Conductance: The ability of a solution to conduct electricity; a measure of the solution’s ionic activity and content. The higher the concentration of ionic (dissolved) constituents, the higher the conductivity. Conductivity of the same water changes substantially with temperature. Specific conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity. Conductivity is measured by placing two electrodes (with opposite electrical charge) in the water. For a known electrical current, the voltage drop across the electrodes reveals the solution’s resistance. Since the resistance of aqueous solution changes with temperature (resistance drops with increasing temperature), the resistance is corrected to the resistance of the solution at 25 ºC. Field measurements are recorded in units of microsiemens per centimeters (µS/cm).

Temperature: The degree of hotness or coldness of the solution being measured. Field measurements are typically recorded in degrees Celsius (°C).

ORP: ORP, or redox potential, is the tendency of a chemical species to acquire electrons and be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or lose electrons when new chemical species are introduced. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (to be reduced by oxidizing the new species) and a solution with a lower (more negative) reduction potential will have a tendency to lose electrons to the new species (to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the pH of an aqueous solution, the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor. It does not characterize the capacity of the system for oxidation or reduction, in much the same way that pH does not characterize the buffering capacity. Field measurements are typically recorded in millivolts (mV).

DO: Dissolved oxygen (or oxygen saturation) is a relative measure of the amount of oxygen dissolved or carried in a given medium. In aquatic environments, dissolved oxygen is a relative measure of the amount of oxygen (O_2) dissolved in the water. Field measurements are typically recorded in milligrams per liter (mg/L).

Turbidity: Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids). Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand, very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid. Field measurements are typically recorded in Nephelometric Turbidity Units (NTU).

1.4 REFERENCE

Essential Handbook of Ground-Water Sampling by Gillian Nielsen, 2007.

Tetra Tech EM Inc. July 2009. SOPs 010, 015, and 021

1.5 REQUIREMENTS AND RESOURCES

The following items are typically required to measure groundwater pH, specific conductance, temperature, ORP, DO, and turbidity using this SOP:

- Single or multiple parameter water quality measuring system
- Specific conductance calibration solutions
- Buffer solutions of pH 4, 7, and 10 for pH calibration
- Distilled or deionized water
- Rinse bottle
- 50-milliliter (mL) sample cups or beakers
- Sample tubing and connectors (specific to each type of system)
- Waste container to collect purge water
- Logbook or field data sheets

2.0 PROCEDURES

The procedures outlined in this SOP are general and may apply to various types of water quality monitoring systems to measure groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field. General procedures for testing and calibrating the monitoring systems are presented first, followed by procedures for using the instruments and making field measurements. Each particular monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer’s instruction manual.

2.1 TESTING AND CALIBRATION PROCEDURES

Each field meter or monitoring system should be calibrated according to manufacturer's specifications. In general, equipment should be thoroughly cleaned then calibrated and tested before the start-up of sampling at each site. Equipment should be calibrated and tested using manufacturer provided solutions and standards. Care should be taken to rinse the probes between testing and calibration to prevent cross contaminating solutions. Solutions should be poured from the manufacturer's container into another container to prevent compromising the entire solution provided by the manufacturer. Calibration and testing of field equipment should be documented each time it is performed in field logbooks (or field data sheets, if applicable). If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.

2.2 FIELD MEASUREMENT PROCEDURES

Each field meter or monitoring system should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring system being used (open container systems, flow-through cell systems, or down-hole systems) and the types of field parameters being measured. In addition, most systems include a data logging option. A description of open container, flow-through cell, and down-hole measurement processes are discussed below, followed by a general procedural summary and a summary of common errors associated with field measurements of indicator parameters.

2.2.1 Open Container Measurements

Open container measurements consist of collecting groundwater and placing it in a cup or container for field measurements using a hand held system. This method of field measurements is commonly used when bailing wells, but can also be used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan. To make open container field measurements, samplers collect groundwater from the well and place in a cup or container large enough to adequately submerge the probe or probes, as specified in the manufacturer's operations manual. For open containers, measurements should be taken in the following order: temperature, specific conductance, pH, and turbidity. Open container systems are not recommended for low-flow sampling as flow-through systems are more appropriate. The probes and cup or container should be thoroughly rinsed after each field measurement and between sampling locations.

2.2.2 Flow-Through Cell Measurements

Flow-through cell systems consist of measuring groundwater parameters as a continuous flow of water passes across the probes through a cell or chamber, and is primarily used when pumping wells and using low-flow sampling procedures. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer’s specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The flow-through cell or chamber is placed “in line” between the discharge tubing of the pump and the container used to collect purged water. The outlet from the pump must be connected to the sample chamber input. The sample chamber outlet must then be connected or routed to a waste container (or to another designated discharge point). Tubing, fittings, and adaptors are generally required and may be provided by the manufacturer. Pump discharge tubing and chamber inlets and outlets are typically 1/2 or 3/8 inch diameter.

After the cell or chamber is connected to the pump discharge tubing and waste collection container, the sensors should be inserted into the sensor mounting plate in their respective ports. Any unused sensor ports must have plugs installed to close off the sample chamber. The probe cables are then connected to the meter following manufacturer’s specifications.

With the system connected, the sampler should turn on the pump according to the manufacturer’s instructions and then turn on the water quality monitor. Before recording any values, the sample chamber should be full, all air should be voided, and all of the displayed values should be stable. The probes and sample chamber should be thoroughly rinsed between sampling locations.

2.2.3 Down-Hole Measurements

Down-hole measurement systems consist of inserting the probes (or a multi-parameter sensor housing) inside a well to obtain field measurements, and is primarily used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer’s specifications.

Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The probes or sensor are attached to a hand held meter or control unit by a cable and lowered inside the well to be sampled. Limiting factors when using down-hole systems include probe or sensor diameters and available cable lengths. The probes should be thoroughly decontaminated between sampling locations...

2.2.4 General Procedures for Field Measurements of Indicator Parameters

The following section discusses general procedures that typically apply to making field measurements of indicator parameters using various types of field instruments. Each particular type of meter or monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer’s instruction manual.

1. Inspect the instrument and batteries prior to the field effort.
2. Check the integrity of the buffer solutions used for field calibration since frequent replacement is necessary as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at proper levels and no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended) following manufacturer's instructions and record data in field logbook or on field data sheets.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to several minutes. If the parameter values continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be occurring in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize should be clearly noted in the logbook or field data sheet. For DO, provide for sufficient flow past the membrane by gently stirring the sample. Probes without stirrers placed in wells (down-hole measurements) may be gently moved up and down to achieve the required mixing.
6. Read and record the value of each parameter being measured making sure units of measure are clearly recorded.
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in accordance with manufacturer’s instructions

2.2.5 Common Errors or Problems Associated With Field Measurements

The project work plan or field sampling plan should clearly identify the types of parameters to be measured, the measurement frequency, and "stabilization" requirements. It is essential to ensure that the type of monitoring system selected is compatible with the monitoring well sampling or development methods to be utilized. Some common errors to avoid are identified below:

- No, or incorrect equipment calibration
- Incorrect or expired calibration standards
- Poor equipment maintenance
- Inadequate training or unfamiliarity with equipment
- No record of units of measure and "+" or "-" values for ORP
- Too much time taken to measure temperature sensitive parameters
- DO and ORP measured in closed systems (flow-through cell or down-hole) instead of closed cell systems

FIGURE 1

THE HORIBA U-10 WATER QUALITY MONITORING SYSTEM
THE IN-SITU TROLL 9500 LOW-FLOW SYSTEM
THE YSI HAND HELD 556 METER

Horiba U-10

In-Situ Troll

YSI 556

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL GAS SAMPLING METHODS

SOP NO. 074

REVISION NO. 2

Last Reviewed: July 2009

KRiesing

Quality Assurance Approved

July 28, 2009

Date

Title: **Soil Gas Sampling Methods**

Revision No. 2, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Soil gas samples can be collected using several methods. This standard operating procedure (SOP) presents sample collection procedures for collecting soil gas samples in plastic Tedlar® bags, syringes, stainless-steel Summa canisters, and sorbent tubes. Procedures for collection with glass bulbs are not included in this SOP. Tedlar® bags are best suited for on-site or near-site chemical analysis, syringes are best suited for on-site chemical analysis, and Summa canisters and sorbent tubes are best suited for shipping samples to a full-service laboratory.

1.1 PURPOSE

The purpose of this SOP is to provide guidance for the use of Tedlar® bags, syringes, Summa canisters, and sorbent tubes for soil gas sample collection.

1.2 SCOPE

This SOP applies to all personnel collecting soil gas samples in Tedlar® bags, syringes, Summa canisters, or sorbent tubes. The site-specific work plan and sampling plan should be followed during soil gas sampling activities.

1.3 DEFINITIONS

Soil gas: The gases or atmosphere filling the void spaces in soils and unconsolidated sediments. These gases may all be of natural origin, but manmade contaminants or byproducts may be present in detectable quantities.

1.4 REFERENCES

Department of Toxic Substances Control (DTSC). 2003. “Advisory – Active Soil Gas Investigations.” January 28. Available Online at: <http://www.dtsc.ca.gov/LawsRegsPolicies/Policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf>

U.S. Environmental Protection Agency (EPA). 1990. “General Precautions in the Use of Canister Sampling for Measuring VOCs in Ambient Air.” Office of Solid Waste Emergency Response (OSWER). Bulletin Board.

EPA. 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Second Edition.* Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC. 625/R-96/010b. January.

1.5 REQUIREMENTS AND RESOURCES

When using the Tedlar® bag collection method, the following items are needed:

- A sampling port and attached sampling line, ready for sampling.
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 liters per minute (L/min) to allow purging of the sample point prior to collecting a soil gas sample.
- Sampling lines (dedicated, 0.375-inch outer diameter Tygon® tubing or equivalent such as Teflon®) to connect all field equipment.
- Y-branched plastic (Teflon®-lined if available) sampling hose for duplicate collection.
- 500-cubic-centimeter (cc) Tedlar® bags, with metal fittings.
- Vacuum chamber.
- Leak check compound.

When using syringes to collect soil gas, the following items are needed:

- A supply of clean graduated syringes.
- Plastic 3-way valve.
- Aluminum foil.
- Leak check compound.

When using Summa canisters to collect soil gas, the following items are needed:

- A supply of clean, evacuated Summa canisters with a pressure gauge to verify internal pressure and flow controller (integrated flow controller pressure gauge may be used).
- A vacuum pump (SKC universal flow pump or equivalent) to allow purging of the sample point prior to collection of soil gas samples.

- Tygon® or equivalent tubing of appropriate size for connecting the sampling port to pump (during gas point purging) and the sampling port to stainless steel canister (during sample collection).
- Swagelok "T" for duplicate collection.
- Leak check compound.

When using sorbent tubes to collect soil gas, the following items are needed:

- A supply of sorbent tubes with the appropriate media.
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 L/min to allow purging of the sample point prior to collection of samples, with a low-flow adapter for sample collection (10 to 200 milliliters per minute [mL/min]), or two separate pumps.
- Tygon® or equivalent tubing of appropriate size for connecting the sorbent tube and pump and union fittings.
- Cooler with ice.
- Leak check compound.

2.0 PROCEDURES

This section describes selection of soil gas sampling locations and general preparation of the sampling system to be used. This section also provides detailed procedures for collecting samples using Tedlar® bags, syringes, Summa canisters, and sorbent tubes. Finally, this section discusses additional considerations that affect soil gas sampling—including duplicate and equipment blank sample collection, decontamination, and sample transfer—and summarizes the advantages and disadvantages of each sampling method.

2.1 SAMPLING LOCATION SELECTION

Sampling locations should be selected and prepared for sampling as described in a site-specific quality assurance project plan and field sampling plan. Soil gas samples may be collected from depths as shallow as 3 feet or as great as 50 feet below ground surface (bgs), depending on the objectives of the project, soil type encountered, and the type of drilling equipment used. The horizontal spacing of soil gas sampling points (grid size) may be only a few feet or more than 500 feet. Again, this is a function of project-specific objectives and site conditions.

2.2 SAMPLING SYSTEM PREPARATION

Sample probe assemblies generally consist of three types:

- A hand-driven (hand auger) probe, typically good for shallow, temporary applications.
- A hydraulic-driven (direct-push) probe, good for shallow to moderately deep temporary and permanent applications.
- A drill rig-driven (hollow-stem auger) probe, typically good for deep, permanent applications including nested, multi-depth probe constructions.

The probes may be assembled in series to reach the desired sampling depth. The probes will be driven to or emplaced at the desired sample collection depth, and then fitted with the Tygon® or equivalent sampling tube. During probe emplacement, subsurface conditions are disturbed. To allow for subsurface conditions to equilibrate, the following equilibration times are recommended:

- 30 minutes for probes installed by hand auger method.
- 20 minutes for probes installed by direct-push method where the drive rod remains in the ground.
- 30 minutes for probes installed by direct-push method where the drive rod does not remain in the ground.
- 48 hours for probes installed by hollow-stem auger drilling method.

Once fitted with the sampling tube, the ambient air within the sampling system is purged. Usually, three to five system volumes are purged prior to sample collection. If the sampling system purge volume cannot be measured, then a standard purge time of 3 to 5 minutes should be used. A flame ionization detector (FID) or photoionization detector (PID) may be used to purge ambient air while also providing a qualitative means to indicate when purging is complete, i.e., when volatile organic compounds (VOC) are detected.

After the system is purged of ambient air but before the pump is turned off, approximately 2 inches of the sampling line closest to the entrance port of the pump should be folded over itself, and the tubing should be clamped to keep ambient air from reentering the system. After the purged system is sealed to ambient air, the pump should be turned off. Sample collection can now proceed using a Tedlar® bag, a syringe, a Summa canister, or a sorbent tube.

2.3 SAMPLE COLLECTION USING TEDLAR® BAGS

Soil gas can be collected for chemical analysis in a 500-cc Tedlar® sampling bag. This is accomplished by using a pump to induce a vacuum on the exterior of the bag. This will cause the Tedlar® bag to be inflated with soil gas. The following procedures should be used:

1. Connect the free end of the Tygon® or equivalent tubing (previously inserted through the top of the vacuum chamber) to the Tedlar® sampling bag. Open the valve on the sampling bag and place the bag into the body of the vacuum chamber.
2. Place the top on the vacuum chamber.
3. Connect the free end of the evacuation tube to the pump.
4. Turn on the pump. This will create a vacuum in the chamber, and the Tedlar® bag should fill at a rate of approximately 2 liters per minute. The rate at which the Tedlar® sampling bag fills will depend on the porosity and permeability of the soil.
5. The minimum amount of soil gas needed for analysis is approximately 0.25 liters.
6. If less than 0.25 liters is collected after 4 minutes of sampling, raise the soil gas probe 0.5 feet (if possible, i.e., when using a temporary probe). Continue to evacuate the vacuum chamber for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted should be accurately recorded in a field logbook.
7. Remove the top of the vacuum chamber after the soil gas sample is collected in the Tedlar® bag.
8. Close the valve on the Tedlar® sampling bag, clamp the Tygon® tubing, and remove the Tedlar® sampling bag.
9. Turn off the pump.
10. Follow the leak check procedures described in Section 2.8.
11. Label the Tedlar® bag and its corresponding field data sheet (Figure 1) with the sample number.
12. Fill out the rest of the field data sheet. An alternative documentation procedure is to enter the requisite information in the field logbook.
13. Ship samples to the laboratory for analysis. Tedlar® samples do not need to be chilled after collection or during transportation.

2.4 SAMPLE COLLECTION USING SYRINGES

Soil gas also can be collected for chemical analysis in a syringe for on-site analysis. The system is purged and the sample is collected using the following procedures:

1. Connect the syringe to the probe tubing using a 3-way valve.
2. If the syringe is connected directly to the probe implant or tip (shallow applications only), no purging is required.
3. Open the valve and collect the sample by pulling on the syringe piston to extract the desired volume. Close the valve, then remove and cap the syringe.
4. Follow the leak check procedures described in Section 2.8.
5. Document the sample collection in a field logbook.
6. Analyze samples immediately (maximum holding time is 30 minutes); samples do not need to be chilled prior to analysis.

2.5 SAMPLE COLLECTION USING SUMMA CANISTERS

Soil gas also can be collected for chemical analysis in a stainless steel, evacuated canister, or Summa canister. Often, these expensive canisters are used to collect duplicate samples for off-site analysis from locations where field screening analysis using Tedlar® bags or syringes is in use.

When this method is used, the canister sampling train is connected directly to the purged Tygon® or equivalent sampling tube. To prevent ambient air from entering the canister during sample collection, all connections must be airtight. To collect soil gas samples using this method, the following procedures are used:

1. Confirm the valve is closed and remove the brass cap. Attach the pressure gauge and flow controller (integrated system) to the canister. Attach the soil probe to the sample train with Tygon® or equivalent tubing.
2. Open the canister valve, which will allow the evacuated canister to draw in soil gas, and immediately record the canister pressure reading and time.
3. Monitor sampling progress periodically. When target sample collection time has been reached, close the canister valve.

4. Record the time and post-sampling pressure reading on the canister pressure valve. Do not let the vacuum be reduced to zero pressure as this will compromise the analytic results.

5. Remove the canister from the sample train and replace the brass cap.

6. Follow the leak check procedures described in Section 2.8.

7. Label the canister and its corresponding field data sheet with the sample number.

8. Fill out the rest of the field data sheet and chain of custody. An alternative documentation procedure is to enter the requisite information in a field logbook.

9. Ship samples to the laboratory for analysis. Summa samples do not need to be chilled after collection or during transportation.

2.6 SAMPLE COLLECTION USING SORBENT TUBES

Sorbent tubes are provided by the laboratory, and selection of the sorbent tube media is dependent on the compounds to be reported. The pump should be calibrated before sample collection begins, and flow rates should be recorded. To collect soil gas samples using this method, the following procedure is used:

1. Connect the sampling inlet end of the sorbent tube to the soil gas probe with a union fitting.

2. Connect the other end of the sorbent tube to the pump using Tygon® or equivalent tubing.

3. Start the pump and record the start time. After the desired duration, stop the pump and record the end time.

4. Remove the sorbent tube from the probe and pump, and replace the end plugs on both ends of the tube.

5. Follow the leak check procedures described in Section 2.8.

6. Record the sample number, tube number, sample flow rate, collection date and time on the field data sheet and chain of custody. An alternative documentation procedure is to enter the requisite information in a field logbook.

7. Due to the sampling medium, samples must be stored and transported in a cooler with ice packs to the laboratory.

2.7 DUPLICATE AND EQUIPMENT BLANK COLLECTION

Duplicate soil gas samples will be collected at each site as required in the site-specific quality assurance project plan and field sampling plan. Generally, one duplicate sample will be collected for every ten samples collected. Each duplicate is collected in conjunction with a corresponding environmental sample.

To collect duplicate samples in Tedlar® bags, a Y-branched sampling hose will be connected to the vacuum chamber or pump. Two Tedlar® bags are then attached, one to each end of the Y-branched hose. Syringe duplicate sampling is performed by collecting and analyzing a subsequent sample. To collect duplicate samples in canisters, a Swagelok "T" will be connected to two canisters. Purging and sample collection will proceed as described above. After collection, one sample will be labeled as the environmental sample and one as the duplicate.

Equipment blanks also will be collected at each site as required in the site-specific quality assurance project plan and field sampling plan. Generally, one blank will be collected for every ten samples collected. Blanks will be collected by running ambient air through the sampling system immediately after it has been decontaminated, and by collecting the ambient air in a Tedlar® bag, Summa canister, or sorbent tube using the same procedures used to collect environmental samples. Blank sample collection is conducted upwind of any observed interference, and the location of the sampling should be recorded in a field logbook. Equipment blanks are collected to ensure that field equipment decontamination procedures are adequate.

2.8 LEAK CHECK PROCEDURES

Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate the actual site concentrations, or may contaminate the sample with external contaminants. Leak tests should be conducted to determine whether leakage is occurring. Leak detection is performed using the following procedures:

1. Leak tests should be conducted at every soil gas probe.
2. Tracer compounds such as isopropanol, butane, helium, or 1,1-difluoroethane may be used as leak check compounds. These compounds may be contained in common products such as Dust-Off and rubbing alcohol. Be sure the tracer compound used does not contain chemicals or impurities that may be present as a site contaminant.

3. Place tracer compounds around the soil gas well at the ground surface and at all connections in the aboveground sampling system train. Tracer compound is emplaced by wetting or spraying a paper towel or rag and wrapping around the area of the connation where leaks could occur.
4. Collect samples as describe in previous sections and use analytical results to determine if the tracer compound has leaked into the sample.

2.9 DECONTAMINATION

Sampling probes should be decontaminated before the first sample is collected and between sampling points. Probes that are grossly contaminated should be decontaminated using a high-pressure steam cleaner. Probes that are not grossly contaminated can be decontaminated by brushing off loose soil particles, then heating the probes until they are warm to the touch to drive off any volatile contaminants. Heating times of 7 to 10 minutes are generally sufficient for this purpose. This brushing and heating method greatly reduces the generation of decontamination fluids.

Syringes must be decontaminated between each use. Sampling syringes must be disassembled and baked at 240 °C for a minimum of 15 minutes or at 120 °C for a minimum of 30 minutes, or must be replaced. All canisters must be properly decontaminated by the laboratory as specified by appropriate EPA methods.

If Y-branched tubing or any other sampling equipment is to be reused, it must also be decontaminated between sampling locations.

2.10 SAMPLE TRANSFER

After collection, each sample container will be transported to the designated laboratory for analysis. In many cases, samples will be analyzed on site in a mobile laboratory.

2.11 ADVANTAGES AND DISADVANTAGES OF EACH SAMPLING METHOD

Tedlar® bags are relatively inexpensive to use but can only be used once and then must be disposed of. If the soil formation being sampled has a low porosity and permeability, such as clay or silty clay, it may not be possible to inflate the Tedlar® bag with soil gas. Some regulatory agencies do not recommend use of Tedlar® bags to collect soil gas for VOCs analysis. Due to short holding times, Tedlar® bags should typically only be used for on-site or near-site analysis.

Syringes must be decontaminated between each use, and periodic equipment blanks must be analyzed to verify that the decontamination procedures used are effective. Syringes can only be used for on-site analysis.

Summa canisters are expensive and, therefore, are not cost effective when conducting on-site analysis. Samples collected in canisters and sorbent tubes are shipped off site for analysis, with the advantage of excellent assurance of sample integrity. Sorbent tubes should be kept cold.

3.0 CAUTIONS

Both Tedlar® bags and syringes are transparent to light, and many volatile compounds are subject to degradation in sunlight. Because of this, samples in Tedlar® bags should be stored in a dark place, such as a cooler, and analyzed as quickly as possible. Syringes should be covered and wrapped in aluminum foil after collection to minimize exposure to sunlight. In general, samples collected in Tedlar® bags should be analyzed within 24 hours after collection, at a maximum. Syringe samples should be analyzed immediately. This will ensure sample integrity and minimize contaminant loss by degradation processes or absorption onto surfaces. Soil gas samples should not be subjected to changes in ambient pressure. Samples to be analyzed off site should not be shipped by air. If condensation is observed in the sample container, the sample should be discarded and a new sample collected.

FIGURE 1

EXAMPLE
FIELD DATA SHEET
FOR SOIL GAS SAMPLING METHODS

Date: ___________________________________ Site/Facility Name: ________________________

Time: ___________________________________ Project No.: ______________________________

Sample Container:

Tedlar® Bag: _______ Syringe: ________ Summa canister: _______ Sorbent Tube: ______

Sampling location and depth: ____

Description of location: ____

____

Sample location purged: Yes _______________ FID or PID (circle one) Reading: __________________

Sample relinquished by: __________________________ Date/Time: _________________

Sample received by: ______________________________ Date/Time: _________________

Attach field copy of sample label or write in sample number:

Notes:____

____

____

____

____

____

REMEDIAL ACTION CONTRACT 2 FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME-CRITICAL REMOVAL ACTIVITIES IN REGION 5

ATTACHMENT B

ADDENDUM
PHASE II QUALITY ASSURANCE PROJECT PLAN
ELM STREET GROUNDWATER CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

Prepared for
U.S. Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604

Date Submitted:	August 15, 2012
EPA Region:	5
Work Assignment No:	138-RICO-B5BF
Contract No:	EP-S5-06-02
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CHAIN OF CUSTODY

ACRONYMS AND ABBREVIATIONS

%D	Percent difference
%R	Percent recovery
µg/L	Micrograms per liter
µm	Micrometer
AES	Atomic emission spectroscopy
ASTM	American Society for Testing and Materials
bgs	Below ground surface
CA	Corrective action
CADRE	Computer-aided data review and evaluation
CAS	Chemical Abstract Services
cc	Cubic centimeter
CCV	Continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration factor
CLP	Contract Laboratory Program
CMS	Carbon molecular sieve
CRL	Central regional laboratory
CRQL	Contract-required quantitation limit
DCA	Dichloroethane
DCE	Dichloroethene
DESR	Data Evaluation Summary Report
DQI	Data quality indicator
EPA	United States Environmental Protection Agency
ESI	Expanded site inspection
FS	Feasibility study
FSP	Field sampling plan
GC	Gas chromatography
HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
HCl	Hydrochloric acid
HNO_3	Nitric acid
IAWC	Indiana American Water Company
ICP	Inductively coupled plasma
ID	Identification

ACRONYMS AND ABBREVIATIONS (CONTINUED

IDEM	Indiana Department of Environmental Management
L/min	Liters per minute
LEGS	Laboratory for Environmental and Geological Studies
LIMS	Laboratory information management system
MCL	Maximum contaminant level
mg/kg	Milligrams per kilogram
mL	Milliliter
mm	Millimeter
MS	Matrix spike
MSD	Matrix spike duplicate
MTS	Machine Tool Service
NA	Not applicable
NaOH	Sodium hydroxide
NC	No criteria
NFG	National Functional Guidelines
NPL	National Priorities List
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PID	Photoionization detector
ppm	Parts per million
pptv	Parts per trillion by volume
PQO	Project quality objective
PRG	Preliminary remediation goal
PTFE	Polytetrafluoroethylene
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QL	Quantitation limit
RAC	Remedial Action Contract
RI	Remedial investigation
RISC	Risk Integrated System of Closure
RPD	Relative percent difference
RRF	Relative response factor
RSCC	Regional Sample Control Coordinator
RSD	Relative standard deviation

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SAP	Sampling and analysis plan
SOP	Standard operating procedure
SOW	Statement of work
SI	Site investigation
SSI	Screening site inspection
SVOC	Semivolatile organic compound
TAL	Target Analyte List
TBD	To be determined
TCA	Trichloroethane
TCE	Trichloroethene
UFP	Uniform Federal Policy for Implementing Environmental Quality Systems
URS	URS Corporation
UST	Underground storage tank
VOC	Volatile organic compound
WA	Work assignment
WAM	Work assignment manager

1.0 INTRODUCTION

SulTRAC has prepared this quality assurance project plan (QAPP) as part of the sampling and analysis plan (SAP) for the Elm Street Groundwater Contamination Site (Elm Street site) in Terre Haute, Indiana, under the United States Environmental Protection Agency (EPA) Remedial Action Contract (RAC) II for Region 5, Contract No. EP-S5-06-02, Work Assignment (WA) No. 138-RICO-B5BF. A Remedial Investigation (RI)/Feasibility Study (FS) will be conducted in two phases at the Elm Street site. Phase I was completed in November 2009, while Phase II will likely begin in the Summer 2012. The RI/FS process includes collecting site data to characterize the nature and extent of contamination, evaluating human health and ecological risks that site contamination may pose, and identifying potential remedies to consider for remediation of the site. This QAPP is specific to Phase II activities and presents information which differs from the Phase I QAPP exclusively. The SAP consists of the field sampling plan (FSP) (Attachment A) and the QAPP (Attachment B), which are among the site-specific plans to be prepared under the WA in accordance with Task 1 of the EPA statement of work (SOW) (EPA 2012).

This Amended QAPP describes quality assurance (QA) and the quality control (QC) protocols and objectives, methods, and procedures to be performed by SulTRAC during the Phase II field investigation of the RI/FS at the Elm Street site. The scope of the QAPP, as outlined in the work plan, has been developed to perform various field activities or combination of activities in order to acquire data for the RI/FS. The primary goals of the Phase II investigation are to (1) investigate any data gaps identified from the Phase I investigation including soil, groundwater and soil gas; (2) delineate areas of soil contamination exceeding the Residential Soil, Industrial Soil, and Protection of Groundwater generic values identified in the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites; (3) assess the potential vapor intrusion exposure pathway at the Riverside Apartment complex, Gurman processing area, and MTS facility; (4) collect updated groundwater quality data, including additional information on background water quality; and (5) further investigate contaminant distribution in groundwater and aquifer characteristics.

This Amended QAPP discusses only the Phase II field sampling activities. Section 2.0 of this QAPP describes the site and its history, and Section 3.0 specifies the QAPP procedures. The QAPP worksheets appear after Section 3.0. References used to prepare this QAPP are listed after the worksheets, and tables and figures appear after the list of references.

2.0 SITE DESCRIPTION AND HISTORY

The Elm Street site is located in Terre Haute, Indiana. Surrounding land includes an apartment complex and open/recreational land to the north, commercial and residential property to the east, commercial and industrial property to the south, and the IAWC and the Wabash River to the west. Therefore, the site is roughly bounded by Locust Street to the north, North 3rd Street (Highway 41) to the east, railroad tracks to the south, and the Wabash River to the west. The study area for the Elm Street site, located in Terre Haute, Vigo County, Indiana, encompasses 18.5 acres, including active facility buildings, abandoned buildings and related underground utilities, streets, railroad lines, and surrounding properties (Figures 1 and 2).

Surface and near-subsurface conditions of the site generally include silty fine sand with trace clay, fine to coarse gravel, and organic matter fill. Subsurface soils are predominantly very loose to dense silty fine to coarse sand with varied amounts of fine to coarse gravel to the water table, which exists approximately 50 feet below ground surface (bgs). Shale bedrock has been encountered below the site at approximately 130 to 150 feet bgs. The topography of the site is generally flat with a slight decline toward the Wabash River. Subsurface groundwater gradient has been identified as trending from a northeast to southwest direction (IDEM 2002).

Indiana American Water Company (IAWC) operates the city of Terre Haute municipal water system. Four municipal wells (IAWC 2, IAWC 3, IAWC 5, and IAWC 6) and a radial collector well are located adjacent to the site to the west; Figure 2 shows the location of the IAWC facility and the associated wells. Screen depths of nearby municipal wells include IAWC 2 at 96-118 feet bgs, IAWC 3 at 98-120 feet bgs, IAWC 5 at 104.5-124 feet bgs, and IAWC 6 at 89.5-99.5 feet bgs. The municipal wells, which are installed in the deep portion of a surficial sand and gravel aquifer along the east bank of the Wabash River, have shown detectable levels of VOCs including PCE, TCE, 1,1,1-TCA, and 1,2-DCE since 1988. The radial collector well is installed in alluvium about 1,200 feet west-northwest of the site (IDEM 2002a).

IDEM has identified three potential source areas through the site assessment process. The potential sources areas include (1) the Gurman property located at 800 North 3rd Street, (2) the Ashland (formerly BiState Products) property located at 118 Elm Street, and (3) the MTS property located at 701 North 1st Street. A brief description and history of each of these areas (based on information provided by EPA and IDEM) is provided in Section 2.1.

According to the Terre Haute city Geographic Information System (GIS) portal, no storm water pipes, structures, encasements, or pump stations are located on any of the four investigation areas other than those identified on Figure 2. The features identified include: two storm water catchment basins east of the Gurman property, one near the foot of the U.S. Highway 41 overpass and one located in Locust Street, are connected and extend beneath the overpass, continuing east along Elm Street. According to the GIS data, no other storm water structures or related underground utilities are located on, or in right-of-ways between any of the three properties.

The site will be subdivided into four distinct investigation areas for the Phase II investigation, including (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the former Sinclair/roundhouse area. The properties will be assigned distinct identifiers to separate sampling locations by potential source area (see Figure 2).

2.1 SITE HISTORY

The Gurman facility has been in operation since 1922. The northern one-third of the property was residential prior to the early 1980s. From 1930 to 1980, Gurman primarily reconditioned and sold steel barrels. Since 1980, Gurman primarily sold paper and plastic containers and reconditioned customer-owned drums. It is believed that Gurman accepted drums with various types and likely small quantities of product or waste material. The standard practice for most of its operational history from the 1950s to the 1980s was to open the drums and dump their contents onto the ground surface, then rinse the remaining contents down the storm sewer in the process area before they were refurbished. During IDEM’s screening site inspection (SSI) in 1987, about 4,000 barrels were believed to be on site. About 1,000 barrels were believed to be on site during the 1999 expanded site inspection (ESI).

The Ashland facility (formerly BiState) served as a local supplier of Texaco products from the 1930s through the 1980s. Petroleum products were stored in bulk and distributed, and solvents were used for parts cleaning at local service stations. In 1980, MTS purchased the property and leased it to BiState, which operated the facility for satellite collection and storage of waste oils. In the late 1980s, the property was purchased by Consolidated Recycling for petroleum recycling. In the early 1990s, the property was transferred to Valvoline Oil Company (Valvoline). From 1990 through 1998, the property was owned and operated by First Recovery, a former division of Valvoline. In 1999, many Valvoline recycling facilities were transferred to Safety Kleen; however, Ashland, the current owner of Valvoline, stated that in 1999, Safety Kleen did not take possession of the property but removed some real property in early 2000. In addition, two underground storage tanks (UST) were removed near the warehouse area in 1986 and 1988, respectively (IDEM 2002a and b). The used oil storage operations that followed may have accepted oils containing solvents; however, the presence of chlorinated VOCs in the raw municipal well water predates the oil recycling operations.

According to historical records, in 1911, MTS property housed the Terre Haute Oil Company. Multiple storage tanks, a coal shed, and empty barrels were reportedly present on the property. By 1950, the Terre Haute Oil Company was no longer present. MTS purchased the property in 1975; however, historical research indicates the buildings were used for machine tool and equipment repair since 1967. The MTS facility also stored petroleum products and solvents on the eastern portion of the property, which includes a remnant bulk oil containment with aboveground storage tanks (AST) and small warehouse building (IDEM 2002a and b). Furthermore, a former locomotive repair and maintenance facility (roundhouse) existed on the central portion of the property. Although no evidence exists to substantiate the use of solvents during locomotive repair operations at the facility, the use of solvents is considered common practice during that period. In addition, a Sinclair Oil facility was on the eastern portion of the property.

IAWC, which operates the municipal water works in Terre Haute, began noticing chlorinated VOCs in samples from the deep wells in the early 1980s during required monitoring of its well field (IDEM 2002a and b). The site discovery process for the Elm Street site began by IDEM in 1987 based on information submitted by IAWC. VOCs have not been detected in the radial collector well. Sources areas for the Elm Street site are summarized in Table 1.

TABLE 1
POTENTIAL SOURCE AREAS IDENTIFIED AT THE ELM STREET SITE

Identified Area	Description
Gurman Property	Drum recycling facility with detected concentrations of VOCs.
Ashland Inc. Property	Bulk storage of waste oils in aboveground storage tanks, removed underground storage tanks, chemical drum storage, and storage and distribution of solvents. Detected concentrations of VOCs and petroleum hydrocarbons.
MTS Property	Machining operations and equipment repair facility on the western portion of the site.
Former Sinclair/Roundhouse Area	Historical bulk oil and solvent storage on the eastern portion of the property. Historical locomotive roundhouse for engine storage and repair on the central portion of the property.

Sources of metals on the Elm Street site could be attributed to multiple distinct operations site wide — specifically, remnant metals contamination in waste solvents in drums recycled at the Gurman property, locomotive repair operations at the former roundhouse, machining operations at the MTS property, and distribution along the Penn Central Railroad from hauling raw ores or scrap metals via open box train cars. Additionally, lead contamination from repair of locomotives is suspected in the area of the former roundhouse.

Pesticides and herbicides may be found at the Elm Street because the railroads commonly sprayed these types of products in the mid-1900s for vegetation control; the Penn Central railroad is located along the southern boundary of the study area, just south of the IAWC and MTS properties. Pesticides also may have been used for control measures during site operations.

Many documented potential organic contaminant sources led IDEM to suspect potential contamination by semivolatile organic compounds (SVOC) and VOCs at the Elm Street site. VOC and SVOC uses have been pervasive at the Gurman, MTS, and Ashland properties and the former Sinclair/roundhouse area, as detailed in the following list of source candidates for potential soil and groundwater contamination:

- Gasoline or coal-powered locomotives used for moving cars along the southern boundary of the site.
- Locomotive repair at the roundhouse.
- Presence of numerous above ground storage tanks at the former Sinclair containment area and Ashland property.
- Underground storage tanks formerly located at the Ashland property.
- Machinery and engine oils used at the roundhouse.
- Coal burning at the roundhouse.
- The presence of carbon tetrachloride fire extinguishers.
- The presence of engine/machine shops.

Polychlorinated biphenyl (PCB) contamination may also be found in surface soils of the Elm Street site. PCBs were used in electrical transformers manufactured between 1929 and 1977. The removal and disposal of these transformers is not documented; thus, PCB soil contamination may be found in the vicinity of former transformer sites.

2.2 PREVIOUS SITE INVESTIGATIONS

Site investigations prior to the Phase I RI completed in November 2009 are summarized in the Phase I FSP, Section 2.2 (SulTRAC 2009). The Phase I RI included: a geophysical survey, a storm sewer investigation, drilling, installing and developing new monitoring wells, drilling, installing and developing soil gas wells, surface and subsurface soil sampling, grab groundwater sampling, groundwater sampling from monitoring wells, and soil gas sampling. A summary of the Phase I RI activities was presented in the Data Evaluation Summary Report (SulTRAC, 2012b). A summary of the analytical results from the Phase I RI is presented below.

SOIL SAMPLES

Surface soil samples were obtained from the 0 to 2 foot sample interval from each boring location. Analytical results for surface soil were compared to the Residential Soil, Industrial Soil and Protection of Groundwater generic values identified in the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites. Results for each analyte group are summarized below.

Volatile Organic Compounds

A total of 71 field and 6 duplicate surface samples (0 to 2 feet bgs) were analyzed for VOCs. None of the results for VOCs exceeded the Industrial Soil RSLs. Tetrachloroethene exceeded the residential screening level at location SB-22.

VOC results for surface soil were also compared to the Protection of Groundwater Soil Screening Levels (SSLs), Risk Based and/or MCL based, which are indirect exposure values and much lower than the direct exposure Residential and Industrial RSLs. The VOC results that exceeded the Protection of Groundwater SSLs (risk based and/or MCL based) were: Methylene chloride, *trans*-1,2-DCE, Methyl tertiary butyl ether, 1,1-DCA ,*cis*-1,2-DCE, Chloroform, 1,1,1-TCA, Benzene, Toluene, TCE, PCE, Ethylbenzene, 1,1,2,2-Tetrachloroethane, 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene (TCB), 1,2,3-Trichlorobenzene.

All subsurface soil samples collected from soil borings were analyzed for VOCs. A total of 143 field and 12 duplicate samples were analyzed for VOCs. Two subsurface depths were collected from each boring. One sample was collected from within the 2-10 foot depth range and one sample from within the 10-20 foot depth range. One sample, SB-44, exceeded the Residential or Industrial Soil RSLs for VOCs. 1,1,2-Trichloroethane exceeded residential screening levels, while 1,1,2,2-Tetrachloroethane exceeded industrial screening levels at this location. Location specific analytical results were presented in Section 5.1 of the Data Evaluation Summary Report (DESR), Table A-1 and Figures B-4 through B-6.

The following detected analytes exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) : Methylene Chloride , 1,1-DCA, 1,1-DCE, cis 1,2-Dichloroethene, Chloroform, Benzene, 1,4-Dichlorobenzene, Ethylbenzene, Toluene, 1,1,2-TCA, 1,1,2,2 – Tetrachloroethane, 1,2,4 – TCB, trans-1,3-Dichloropropene, 2-Hexanone, Dibromochloromethane , 1,2-Dibromoethane, and 1,2,3 – TCB. In addition, concentrations of Trichloroethene exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) in 16% of the samples. Concentrations of Tetrachloroethene exceeded the Protection of Groundwater SSL (Risk Based and/or MCL based) in 56% of the samples. Location specific analytical results for all VOCs detected in subsurface soil are presented in Section 5.1 of the DESR and are depicted on Figures B-4 through B-6.

Semivolatile Organic Compounds

All surface soil samples collected were analyzed for SVOCs. A total of 71 field and 6 duplicate surface samples (0 to 2 feet bgs) were analyzed for SVOCs. Of these results, only the concentrations of five analytes, all PAHs, exceeded the residential soil and/or industrial soil RSLs: benzo(a)anthracene (BA), benzo(a)pyrene (BPY), benzo(b)fluoranthene (BBF), benzo(k)fluoranthene (BKF), and indeno(1,2,3-cd)pyrene (IDP). Location specific analytical results for all SVOCs detected in surface soil are presented in Section 5.1 of the DESR in Table A-2 and are depicted on Figure B-7.

Surface soil sample PAH concentrations that exceeded RSLs were detected at locations throughout the site. BA was detected at 34 locations at concentrations exceeding the residential soil RSL, and at one location (SB-32) exceeding the industrial RSL, with a maximum concentration of 2,200 µg/kg. BPY was detected at 29 locations exceeding the residential soil RSL, and at 29 locations exceeding the industrial RSL, with a maximum concentration of 1,700 µg/kg at location SB-032. BKF was detected at one location (SB-032) exceeding the residential soil RSL at a concentration of 1,500 µg/kg. BBF was detected at 36 locations exceeding the residential soil RSL, and at three locations exceeding the industrial soil RSL, with a maximum concentration of 3,400 µg/kg at location SB-032. IDP was detected at 23 locations exceeding the residential soil RSL, with a maximum concentration of 910 µg/kg at location SB-032. All analytical results for SVOCs in surface soil exceeding residential or industrial RSLs are included in Section 5.1 of the DESR and depicted on Figure B-7.

Subsurface soil contamination of SVOCs exceeding RSLs is predominately PAH compounds and is evidenced at most sampling locations. Resulting concentrations of subsurface PAHs exceeding RSLs were generally within the upper 10 feet of soil. The highest concentrations of PAHs occurred at locations SB-032 near the former location of railroad tracks on the Ashland property and near the southeast portion of the MTS building where a set of railroad tracks was used to move railcars to the facility for maintenance. The sampling locations in the area of the Former Sinclair Containment also exhibited elevated concentrations of surface and subsurface PAH contamination suggesting a possible historic release from the containment area. Location specific analytical results are discussed in detail in Section 5.1of the DESR and depicted on Figure B-8 of the report.

Metals

All surface soil and subsurface soil boring samples collected were analyzed for metals. Analytical results are discussed for each analyte below as exceedances of the Residential Soil and Industrial Soil RSLs. Arsenic was detected in concentrations exceeding the Industrial Soil RSL in every surface and subsurface sample collected. Lead was detected in varying concentrations in surface and subsurface samples at the site. One surface soil sample SB-22 exceeded the Residential Soil RSL with a concentration of 675 mg/kg. No other exceedances of lead were reported. Mercury was detected in varying concentrations in surface and subsurface samples at the site. One surface soil sample SB-44 at a depth of 18 feet bgs exceeded the Residential Soil RSL with a concentration of 8.6 mg/kg. No other exceedances for Mercury were reported. Location specific analytical results for metals were discussed in detail in Section 5.1of the DESR and are presented in Table A-3 of the report.

Polychlorinated Biphenyls

Select surface soil samples were collected and analyzed for PCBs based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate sample were collected and analyzed for PCBs. Location specific analytical results were provided in Table A-4 and depicted on Figure B-9 of the DESR. Surface soil sample SB-17 exceeded the Residential Soil RSL for Aroclor 1254 with a concentration of 410 µg/kg. Surface soil sample SB-21 exceeded the Industrial Soil RSL for Aroclor 1254 with a concentration of 900 µg/kg. Surface soil sample SB-67 exceeded the Industrial Soil RSL for Aroclor 1260 with a concentration of 3,000 µg/kg. Location specific analytical results for PCBs were discussed in detail in Section 5.1of the DESR and are presented in Table A-4 of the report.

Pesticides

Select surface soil samples were collected and analyzed for pesticides based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate surface samples collected were analyzed for Pesticides. Due to the nature of the Clor-N-Soil field test and possible chemical interferences, the same sample locations were selected for analysis of Pesticides that were analyzed for PCBs. Compound specific discussion of exceedances are summarized below.

One sample, SB-21, exceeded the Industrial RSL for Heptachlor (380 µg/kg) with a concentration of 3,500 µg/kg, Heptachlor Epoxide (190 µg/kg) with a concentration of 220 µg/kg, and gamma-Chlordane (6,500 µg/kg) with a concentration of 30,000 µg/kg. No other samples analyzed for Pesticides exceeded the Residential Soil or Industrial Soil RSL.

All analytical results were estimated (J qualifier) and most were marginally above the method quantitation limit with the exception of location SB-21. Location specific analytical results for Pesticides were discussed in detail in Section 5.1of the DESR and are presented in Table A-5 of the report.

Herbicides

Select surface soil samples were collected and analyzed for Herbicides based upon field testing results. A portion of all surface soil samples were field tested using a Clor-N-Soil ® test kit. Based upon a positive result (greater than 5 parts per million) and considering spatial coverage of the site, samples were submitted for laboratory analysis. A total of 20 field samples and 1 duplicate surface samples collected were analyzed for Herbicides. Due to the nature of the Clor-N-Soil field test and possible chemical interferences, the same sample locations were selected for analysis of herbicides that were analyzed for PCBs.

MCPA was detected in 45% of the samples exceeding the Industrial Soil RSL (310µg/kg) and 30% of the samples exceeding the Residential Soil RSL (31 µg/kg) with a maximum concentration of 3,200 µg/kg in SB-36. MCPP was detected in 55% of the samples above the Residential Soil RSL (61 µg/kg) and two samples (SB-38, 64) above the Industrial Soil RSL of 620 µg/kg. The maximum concentration was detected in sample SB-38 with a concentration of 1,900 µg/kg. Pentachlorophenol was detected in four samples (SB-36, 38, 16, 21) above the Residential Soil RSL of 3.0 µg/kg. Two samples, SB-17 and SB-

70 exceeded the Industrial Soil RSL of 9.0 µg/kg with a maximum concentration of 63 µg/kg at location SB-70.

All analytical results were estimated (J qualifier) with the highest concentrations detected at locations SB-36, 38 on the Ashland property and SB-68, 70 on the Sinclair property. Most of the impacted areas are also identified with PCB contamination above the RSLs. Location specific analytical results for Herbicides were discussed in detail in Section 5.1of the DESR and are presented in Table A-6 of the report.

GRAB GROUNDWATER

Volatile Organic Compounds

Grab ground water samples were collected at all soil boring locations identified with "SB" with the exceptions of locations 030, 047, 057 and 073 where ground water samples could not be obtained. All grab groundwater samples collected were analyzed for VOCs. A total of 59 field and five duplicate surface samples were analyzed for VOCs. Eight samples exceeded the MCL for PCE of 5 µg/L—at locations GB-031 (7.9 micrograms/liter [µg/L]), GB-036 (6.7 µg/L), GB-051 (7.3 µg/L), GB-070 (11 µg/L), GB-053 (14 µg/L), GB-017 (7.4 µg/L), GB-069 (6.1 µg/L), and GB-058 (8.2 µg/L). No other exceedances of MCLs were reported for the other analytes tested. Analytical results are presented in Table A-7 of the DESR. Location specific analytical results for grab groundwater samples were discussed in detail in Section 5.2 of the DESR, Table A-6 and depicted on Figure B-10 through B-13.

Elevated concentrations of PCE and TCE were detected in shallow groundwater on the MTS property, the northeast corner of the former Sinclair property and the southeast corner of the Gurman property. Elevated concentrations of PCE were also detected near the center of the Ashland property. Elevated concentrations of TCA were detected in shallow groundwater south of the MTS building and the southeast corner of the former Sinclair property.

GROUNDWATER FROM MONITORING WELLS

A total of 27 field samples and three duplicate samples were collected from 14 well sets at the site. Paired wells of shallow (S) and deep (D) are at each location. MW-13D was collapsed approximately four feet bgs and was unable to be sampled. All shallow monitoring well samples collected were analyzed for VOCs, SVOCs, Metals, Pesticides and PCBs (deep monitoring well samples were analyzed for VOCs, and metals only). Location specific analytical results for groundwater samples from monitoring wells were discussed in detail in Section 5.3 of the DESR, Tables A-8 through A-12, and depicted on Figures B-14 and B-15.

Volatile Organic Compounds

Analytical results were compared to EPA MCLs and IDEM RISC Default Closure Levels for Groundwater. Two results exceeded the MCL and RISC level for PCE of 5 µg/l. The sample collected from MW3S had a concentration of 6.8 µg/l. The sample collected from MW5S had a concentration of 5.5 µg/l. Analytical results for VOCs were presented in Table A-8 and depicted on Figure B-14 of the DESR.

Based on the results of the monitoring well sampling, low concentrations of VOCs were detected in numerous locations at the site.

Semivolatile Organic Compounds

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for SVOCs. Samples for SVOC were only collected from the shallow monitoring wells in the network to determine if additional sampling for SVOC was warranted. Analytical results were compared to EPA MCLs and IDEM RISC levels for groundwater. None of the results were above laboratory reporting limits. Analytical results for SVOCs are presented in Table A-9 of the DESR.

Based upon these results, no additional sampling of monitoring wells for SVOCs is warranted.

Metals

A total of 27 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for Metals. Exceedances of MCLs and RISC levels were reported for the analytes Arsenic, Berylium, Cadmium, Chromium, Iron, Lead, Manganese, and Thallium. A discussion of exceedances of each analyte is presented below. Analytical results for Metals are presented in Table A-10 and depicted on Figure B-15 of the DESR.

Arsenic was detected above the MCL and RISC levels in MW-02D (16.8 µg/l), MW-08D (11.9 µg/l), MW-10D (19.8 µg/l) and MW-13S (72.4 µg/l). The MCL and RISC level for Arsenic is 10 µg/l.

Berylium was detected above the MCL and RISC levels in MW-13S with a concentration of 5.8 µg/l. The MCL and RISC level for Berylium is 4.0 µg/l.

Cadmium was detected above the MCL and RISC levels in MW-03S (45.1 µg/l) and MW-13S (16.2 µg/l). The MCL and RISC level for Cadmium is 5.0 µg/l.

Chromium was detected above the MCL and RISC levels in MW-13S with a concentration of 117 µg/l. The MCL and RISC level is 100 µg/l.

Iron was detected above the secondary MCL in 55% of the samples collected. The maximum concentration was in MW-13S with a concentration of 146,000 µg/l. The MCL for Iron is 300 µg/l.

Manganese was detected above the secondary MCL in 44% of the samples collected. The maximum concentration was in MW-13S with a concentration of 5,330 µg/l. The MCL for Manganese is 50 µg/l.

Thallium was detected in MW-13S at a concentration of 14.0 µg/l exceeding the MCL and RISC level of 2 µg/l. This result was an estimated concentration as it was below the laboratory reporting limit.

Based upon these results, metals were detected at elevated concentrations above the MCL and RISC level for numerous contaminants. The highest concentrations of metals detected were near the Ashland property and MW-13S.

Polychlorinated Biphenyls

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for PCBs. Samples for PCBs were only collected from the shallow monitoring wells in the network to determine if additional sampling for PCBs was warranted. Analytical results were compared to EPA MCLs and IDEM RISC levels for groundwater. None of the results were above laboratory reporting limits.

Pesticides

A total of 14 field samples and two duplicate samples were obtained from the monitoring wells and analyzed for Pesticides. Samples for Pesticides were only collected from the shallow monitoring wells in the network to determine if additional sampling was warranted. None of the analytical results were above laboratory reporting limits.

SURFACE WATER

One field and one duplicate surface water sample was collected and analyzed for VOCs, Metals, PCBs, Pesticides and Herbicides. The validated analytical results for the surface water samples were compared to EPA MCLs, IDEM RISC levels for groundwater and EPA Human Health criteria for Consumption of Water and Organism. Four results were above analytical reporting limits and are discussed below. None of the results exceeded the screening level for any of the analytes tested. Analytical results for surface water samples were presented in detail in the DESR, Table A-14.

Volatile Organic Compounds: One analyte, 1,1 – Dichloroethene was detected above the laboratory reporting limit with a concentration of 0.76 µg/l. The MCL and IDEM RISC value is 7.0 µg/l.

Polychlorinated Biphenyls: No surface water sample results exceeded the screening levels for PCBs.

Pesticides: No surfaced water sample results exceeded the MCL or IDEM RISC value for pesticides (Table A-14). Three pesticides, 2,4-D (0.13 µg/l), MCPA (0.10 µg/l), and MCPP (1.5 µg/l), were detected at concentrations above laboratory reporting limits.

Herbicides: No surface water sample results exceeded the EPA MCL or IDEM RISC value for Herbicides.

Based on these results, additional surface water sampling is not warranted. Analytical results were below EPA MCL and IDEM RISC values and most were below laboratory reporting limits.

SOIL GAS

Eleven field samples were collected from the soil gas wells surrounding the Riverside Apartment Complex during the RI in November, 2009. The eleven soil gas wells were also sampled during an additional sampling event in January, 2011. A sample could not be collected from location SG-002B (deep well) because the well had collapsed or become clogged with soil after installation. Soil gas results for the analytes 1,2-DCA, PCE, TCE, and vinyl chloride were compared to the IDEM RSGPALs, 20 and 30 year exposure duration for soil gas. Results for the remainder of the analytes that do not have established soil gas benchmark values were compared to RIAALs (10, 20 and 30 year exposure level for indoor air. Per IDEM guidance (IDEM 2006), RIAALs when compared to soil gas require use of an attenuation factor of 0.01 to derive the soil gas screening levels (SGSL). After applying the attenuation factor to the RIAAL to derive the SGSL, soil gas sample results were compared to the SGSLs to identify any exceedances. Screening level exceedances are discussed by analyte below. All wells identified below have the identifier A as the shallow well (approximately 5 feet bgs) and B as the deep well (within about 2 feet of the water table). Analytical results for soil gas samples are presented in Table A-15 of the DESR. Exceedances of RSGPALs and SGSLs are depicted in the DESR on Figure B-16.

PCE concentrations at SG-001A exceeded the IDEM RSGPAL, 30 year exposure level for the 2011 sampling event with a concentration of 47,400 parts per trillion by volume (pptv). The RSGPAL, 30 year exposure level for PCE is 47,000 pptv.

PCE concentrations at SG-001B exceeded the IDEM RSGPAL, 20 and 30 year exposure level for the 2009 sampling event with a concentration of 84,200 pptv. The RSGPAL, 20 and 30 year exposure levels for PCE are (64, 000 and 47,000 pptv), respectively.

PCE concentrations at SG-003B exceeded the IDEM RSGPAL, 10, 20 and 30 year exposure level for the 2009 sampling event and exceeded the 20 and 30 year exposure level for the 2011 sampling event. PCE was detected at a concentration of 145,000 pptv in 2009. PCE was detected in the 2011 sample, and its duplicate at concentrations of 69,800 and 92,600 pptv respectively. The RSGPAL, 10, 20 and 30 year exposure levels for PCE are (100,000, 64, 000 and 47,000 pptv), respectively.

PCE concentrations at SG-004B exceeded the IDEM RSGPAL, 20 and 30 year exposure level for the 2009 and 2011 sampling events. PCE was detected at concentrations of 120,000 and 59,600 pptvrespectively. The RSGPAL, 20 and 30 year exposure levels for PCE are (64, 000 and 47,000 pptv), respectively.

Chloroform concentrations at locations SG-003B and SG-004B exceeded the IDEM SGSL, 30 year exposure level for the 2009 sampling event with concentrations of (18, 500 pptv) and (21,100 pptv) respectively. The SGSL, 30 year exposure level, for chloroform is 17,000 pptv.

Chloroform concentrations at location SG-005B exceeded the IDEM SGSL, 20 year exposure duration for both the 2009 and 2011 sampling events with concentrations of (29,100 pptv) and (30,100 pptv) respectively. The SGSL, 20 year exposure level, for chloroform is 23,000 pptv.

Based upon the results of the soil gas sampling, VOC concentrations are generally elevated in the southern and eastern wells. Moreover, VOC concentrations tend to be higher in the “B” series wells at greater depths near the water table.   Only one exceedance of the RSGPAL, 20 year exposure level was observed in SG-001A, which is the shallow well, east of the Riverside Apartment complex.

The chemicals of interest potentially hazardous to human health and the environment at the Elm Street Site were identified based on these investigations and information obtained by SulTRAC. These chemicals of interest are shown in Tables 2 and 3.

TABLE 2
CHEMICALS DETECTED IN SOIL IN GREATEST CONCENTRATIONS

Facility	Year	Boring or Well Location	Sample Depth (feet)	Results (µg/kg)	
				Tetrachloroethene	Trichloroethene
Gurman	1999	B5	15	13	ND
	1999	B6	10	14	ND
	1999	B7	15	17	ND
	1999	B8	5	85	ND
	1999	B8	15	57	12
	1999	MW-8	15	53	ND
	2009	SB-14	2	1.5	61
	2009	SB-15	2	110	48
	2009	SB-15	4	27	6.6
	2009	SB-15	14	52	7.5
	2009	SB-17	2	4.3	13
	2009	SB-18	18	140	14
	2009	SB-19	20	230	ND
	2009	SB-21	10	42	19
	2009	SB-21	14	17	1.6
	2009	SB-22	2	810	1200
	2009	SB-22	10	13	6
Ashland	1999	B11	15	27	ND
	2009	SB-33	14	19	2.2
	2009	SB-35	2	13	17
	2009	SB-35	4	34	9.5
	2009	SB-36	2	13	2.0
	2009	SB-36	4	23	3.7
	2009	SB-36	12	28	1.2
	2009	SB-40	2	42	12
	2009	SB-40	6	15	2.9
	2009	SB-40	16	11	9.6
MTS	1999	B1-B4	NA	NA	NA

Notes:

µg/kg = micrograms per kilogram
NA = Analytical results for soil samples collected at MTS were unavailable
ND = Not detected

Sources: 2002 Indiana Department of Environmental Management ESI report
2011 Data Evaluation Summary Report: Phase I Remedial Investigation

TABLE 3
CHEMICALS DETECTED IN GROUNDWATER

Site Location	Well ID	Year	Results (µg/L)										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethne	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
Ashland	MW-1S	1999	6	1	2	5	--	--	--	--	--	--	--
		2000	2.3	2.1	2.5	8.7	--	--	--	--	--	--	--
		2005	--	--	--	4.3	--	--	--	--	2.4	--	--
		2009	--	--	--	1.9	--	--	--	--	1.3	--	--
	MW-1D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	--	--
		2009	--	--	--	--	--	--	--	--	--	--	--
	MW-2S	1999	2	3	4	7	2	--	--	--	--	--	--
		2000	0.9	2.1	1.4	7.6	26	11	--	--	--	--	--
		2005	--		1.4	6.1	--	--	--	--	1.2	7.1	--
		2009	--	--	1.8	4.9	--	--	--	--	.81	--	--
	MW-2D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	0.5	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	12	--
		2009	--	--	--	--	--	--	--	--	--	.62	--
	MW-3S	1999	2	2	2	7	2	--	--	--	--	--	--
		2000	0.6	4.1	5.9	7.2	11	5	--	--	--	--	--
		2005	--	--	0.71	3.8	0.54	--	--	--	2.1	1.8	1.4
		2009	--	.97	1.2	6.8	--	--	--	--	.81	--	--
	MW-3D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	--	--	--	--	--	--	--	--	--	--	--
		2009	--	--	--	--	--	--	--	--	--	--	--
North of Locust Street	MW-4S	1999	0.7	--	--	--	--	--	--	--	--	--	--
		2000	DRY										
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-4S_NEW	2009	--	--	--	--	--	--	--	--	--	--	--
	MW-4D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-4D_NEW	2009	--	--	--	--	--	--	--	--	--	--	--

TABLE 3 (Continued)
CHEMICALS DETECTED IN GROUNDWATER

Site Location	**Well ID**	**Year**	**Results (µg/L)**										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethne	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
Gurman	MW-5S	1999	3	0.7	0.8	14	--	--	--	--	--	--	--
		2000	1.3	1.6	2.2	5.3	--	--	--	--	--	--	--
		2005	--	--	--	5.9	--	--	--	--	2.9	--	--
		2009	--	--	--	5.5	--	--	--	--	.85	.56	--
	MW-5D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	--	--
North of Locust Street	MW-7S	1999	0.6	--	--	--	--	--	--	--	--	--	--
		2000	1.8	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-7S_NEW	2009	--	--	--	--	--	--	--	--	.73	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-7D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-7D_NEW	2009	--	--	--	--	--	--	--	--	--	.55	--
		2011	--	--	--	--	--	--	--	--	--	--	--
Gurman	MW-8S	1999	2	3	--	8	12	3	--	--	--	--	--
		2000	0.7	25	10	22	44	11	2.2	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	3.1	--	--	--	--	--	2.3	--
		2009	--	.58	--	3.3	--	--	--	--	.72	.62	--
		2011	--	1.9	3.4	5.1	2.5	.81	--	--	--	--	--
	Duplicate	2011	--	2.1	4.2	6.0	3.0	.89	--	--	--	--	--
	MW-8D	1999	--	--	--	0.6	--	--	--	--	--	--	--
		2000	--	--	0.7	0.9	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	.53	--
		2009	--	--	--	--	--	--	--	--	--	.96	--
		2011	--	--	--	--	--	--	--	--	--	--	--
MTS	MW-9S	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	1.4	600	--	--	7.2	1.2	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	1.7	--	--	--	--	--
	MW-9D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	1	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	.80	--

TABLE 3 (Continued)
CHEMICALS DETECTED IN GROUNDWATER

Site Location	**Well ID**	**Year**	**Results (µg/L)**										
			Carbon tetrachloride	1,1,1Ttrichloroethane	Trichloroethene	Tetrachloroethne	cis-1,2-Dichloroethane	1,1-Dichloroethane	1,1,2-Trichloroethane	2-bBtanone	Chloroform	Toluene	1,1-Dichloroethene (total)
MTS	MW-10S	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	0.5	37	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	1.1	--	--	--	--	--	--	--	--	--
		2011	--	.70	--	--	--	--	--	--	1.6	--	--
	MW-10D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	--	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-11S	2009	--	.64	--	--	--	--	--	--	--	--	--
	MW-11D	2009	--	--	--	--	--	--	--	--	--	--	--
	MW-12S	1999	2	--	--	--	--	--	--	12	--	--	--
		2000	3.6	600	--	--	7.2	1.2	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	6.1	--	--	--	--	--	--	1.9	2.0	--
	MW-12D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	2.8	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009		--	--	--	--	--	--	--	--	1.2	--
North of Locust Street	MW-13S	1999	--	--	--	1	--	--	--	--	--	--	--
		2000	1.6	--	--	0.5	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	--	--	--	--	--	--	--	--	2.9	--	--
	MW-13D	1999	--	--	--	--	--	--	--	--	--	--	--
		2000	--	--	--	--	--	--	--	--	--	--	--
		2005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		2009	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-14S	2009	--	--	--	.73	--	--	--	--	--	--	.82
		2011	--	--	--	.49	--	--	--	--	--	--	--
	MW-14D	2009	--	--	--	--	--	--	--	--	--	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-15S	2009	--	--	--	--	--	--	--	--	.73	--	--
		2011	--	--	--	--	--	--	--	--	--	--	--
	MW-15D	2009	--	--	--	--	--	--	--	--	--	--	.83
		2011	--	--	--	--	--	--	--	--	--	--	--

Notes:
µg/L = Micrograms per liter
-- = Not detected
NS = Not sampled
Sources: 2002 Indiana Department of Environmental Management ESI report; 2005 URS Corporation Limited Phase I/Phase II; 2009 SulTRAC Phase I Remedial Investigation; 2011 SulTRAC Phase I Remedial Investigation: Confirmation Sampling Event

3.0 QUALITY ASSURANCE PROJECT PLAN PROCEDURES

This QAPP presents procedures that will be used to ensure the quality of data generated for the Elm Street RI/FS. The QAPP provides a framework for how environmental data will be collected to achieve specific project objectives, and describes procedures that will be implemented to obtain data of known and adequate quality. This QAPP was prepared in accordance with the EPA's "Uniform Federal Policy for Implementing Environmental Quality Systems" (UFP) (EPA 2005a).

Phase II activities for the Elm Street RI/FS are anticipated to begin in Summer 2012. Investigations will focus on the following potential source areas identified: the Gurman, Ashland and MTS properties and the Former Sinclair/Roundhouse Area.

Before intrusive field work begins, utilities will be located and sampling locations modified based upon utilities in the area of investigation.

As discussed with the EPA and as outlined in the Elm Street Groundwater Contamination Site work plan (SulTRAC 2012a), SulTRAC will conduct the following Phase II field sampling activities:

- Collect surface and subsurface soil samples from 71 soil borings
- Collect groundwater grab samples at the water table at 29 soil boring locations
- Conduct vertical aquifer sampling at 9 locations
- Collect soil gas samples from 15 locations
- Install up to 7 new monitoring wells
- Collect soil samples from two additional background locations (4 depths)
- Perform mechanical rising and falling head tests to estimate aquifer characteristics
- Perform a pumping test with IAWC wells to determine the influence on the hydraulic conductivity of the aquifer
- Collect groundwater samples from existing and new monitoring wells
- Collect groundwater samples from four existing IAWC wells

Phase II sampling activities are discussed in the FSP Sections 4.3 through 4.6, and summarized in Table 4. Field activities to support ecological and human health risk assessments are discussed in the FSP Sections 4.5 and 4.6, respectively. Analytical methods for the various sample locations are detailed below in Table 5.

TABLE 4
PHASE II SAMPLE SUMMARY

Type	Number of Sample Locations	Location	Depth (bgs)	Analysis
Surface Soil and Shallow Subsurface	4	(3) SB-21, 1-SE of SB-017,	4	VOC, SVOC, PCB, Pesticides
Surface Soil and Shallow Subsurface	23	(2) Northwest and Northeast of SB-070, (3) SB-068, (3) SB-064, (3) North of CSX railroad east to west, (3) SB-056, (3) SB-036, (3) SB-038, (3) SB-039	4	VOC, SVOC, Herbicides, PCB (SB-70)
Surface Soil and Shallow Subsurface	4	(3) SB-067, (1) SB-016	4	VOC, SVOC, PCB, Pesticides, Herbicides
Surface and Shallow Subsurface Soil	2	(2) North and at SB-032.	10	VOC, SVOC
Surface, Subsurface Soil and Grab Groundwater	9	(1) South of SB-018, (1) West of SB-015, (1) SB-016(re-drill), (1) Northwest of SB-21--data gap, (1) centered between SB-13, SB-14 and SB-22, (1) West of SB-016, (1) East of SB-022 between SB-021 and SB-022, (2) SB-017	40	Soil: VOC, SVOC, Metals only SB-22 and East of SB-22 GW:VOC
Surface, Subsurface Soil and Grab Groundwater	5	(2) Northeast & Southeast SB-044, (3) SB-065	40	Soil: VOC, SVOC, HG (SB-44) GW:VOC, SVOC
Surface, Subsurface Soil and Grab Groundwater	15	Existing soil gas wells SG-001-006 and new soil gas wells SG-007-015	40	Soil: VOC GW: VOC
Surface, Subsurface Soil and VAS	14	(6) North-South Line along second street including MW-05*, MW-03*, MW-12* with three additional borings and proposed new monitoring well (see diagram). (6) North-South line on east side of 1st Street including: MW-01*, MW-02*, MW-09* and three additional boring locations. (2) North-South line, one location near SB-016 and second location south of Gurman property in center of Elm Street in line with SB-016	140	Surface and Subsurface Soil (VAS only): VOC GW:VOC
Soil Gas Wells Install (NEW)	9	Nested set: (3) Gurman Process Area, (3) MTS Machining Building, Re-drill SG-002B, (3) between utilities and Riverside apartment complex	Shallow (4) Deep (37)	Surface and Subsurface Soil: VOC Grab GW: VOC

TABLE 4 (continued)
PHASE II SAMPLE SUMMARY

Type	Number	Location	Depth	Analysis
Soil Gas Wells Sampling	30	All new and existing	Shallow and Deep	Soil Gas: VOC
MW Installation	7	MW-16S, MW-16D, MW-17S, MW-17D, MW-6S, MW-6D, MW-13D (re-drill).	40, 140	Surface Soil: VOC, SVOC, Metals Subsurface Soil: VOC, SVOC (40 feet)
MW Shallow Wells Sampling	17	All new and existing	Shallow	All: VOC, Metals (Total and Dissolved)
MW Deep Wells	17	All new and existing	Deep	All: VOC, Total and Dissolved Metals

Notes:

*VAS at MW locations will be sampled within the screened interval of shallow and deep wells for GW only.

GW	Groundwater
MW	Monitoring Well
MTS	Machine Tool Service
PCB	Polychlorinated biphenyl
SB	Soil boring
SVOC	Semivolatile organic compound
SOW	Statement of work
VAS	Vertical Aquifer Sampling
VOC	Volatile organic compound
TAL	Target Analyte List

TABLE 5
ANALYTICAL METHODS SUMMARY

Parameter	Analytical Method
SOIL	
VOCs	CLP SOW SOM01.2/ Mobile: EPA Method 8260B
SVOCs	CLP SOW SOM01.2
PCBs	CLP SOW SOM01.2
Pesticides	CLP SOW SOM01.2
Herbicides	CLP SOW SOM01.2
TAL metals (including mercury and cyanide)	CLP SOW ISM01.3
SOIL GAS	
VOCs	CRL -- TO-15, Sub: TO-15
GROUNDWATER	
VOCs	CLP SOW SOM01.2, Sub/Mobile: EPA Method 8260B
SVOCs	CLP SOW SOM01.2
Total and Filtered TAL metals (including cyanide)	CLP SOW ISM01.3

Notes:

CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
Mobile	EPA Mobile Laboratory
PCB	Polychlorinated biphenyl
Sub	Subcontracted laboratory
SVOC	Semivolatile organic compound
SOW	Statement of work
VOC	Volatile organic compound
TAL	Target Analyte List

Soil samples will be submitted to the EPA mobile laboratory or designated EPA CLP laboratory for analysis. Analysis include: VOCs by EPA CLP SOM01.2 and SW-846 Method 8260B, SVOCs by CLP SOM01.2, PCBs by CLP SOM01.2, Pesticides by CLP SOM01.2, Herbicides by CLP SOM01.2, and TAL Metals (including mercury and cyanide) by CLP ISM01.3. Analyses are location specific and are detailed in Table 4.

All new soil gas well samples will be submitted for analysis to a subcontracted laboratory for rapid turnaround of results. Results will be used to determine if additional investigation of the Gurman and MTS facilities is warranted during the same mobilization. Samples from existing soil gas wells will be analyzed through EPA's CRL. Soil gas samples will be analyzed for VOCs by EPA Method TO-15 (EPA 1999).

Groundwater samples from all shallow wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs, and SOW ISM01.3 for Total and Dissolved TAL Metals (including cyanide and mercury). Groundwater samples from deep wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs and

CLP SOW ISM01.3 for Total and Dissolved TAL Metals (including cyanide and mercury). Groundwater samples from the IAWC wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs.

Grab groundwater samples will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs. Select samples may be submitted to the EPA mobile laboratory for quick turn analysis by EPA Method 8260 B for VOCs.

Samples collected from VAS locations will be analyzed by an EPA mobile laboratory (if available), or shipped overnight to a subcontracted laboratory for rapid turnaround. VAS samples will be analyzed be EPA Method 8260B for VOCs.

At completion of sampling activities at each location, a GPS survey will be completed identifying all sampling locations and recording location-specific sampling information for storage in a comprehensive database. The results of the sampling activities will be evaluated to further characterize contamination sources and to delineate the extent of contamination at the Elm Street site.

QAPP WORKSHEET #1
TITLE AND APPROVAL PAGE

Quality Assurance Project Plan for Remedial Investigation/Feasibility Study, Elm Street Site, Terre Haute, Vigo County, Indiana
Document Title

SulTRAC
Lead Organization

Brian Malone, SulTRAC
Preparer's Name and Organizational Affiliation

8221 Rosewood Avenue, Cleveland OH 44105; (440) 781-7944; brian.malone@tetratech.com
Preparer's Address, Telephone Number, and E-mail Address

April 27, 2012
Preparation Date (Day/Month/Year)

	E sig and date
Brian Malone SulTRAC Project Manager	Signature/Date
	E sig and date
John Dirgo SulTRAC QA Officer	Signature/Date

Approval Signatures:

	Signature/Date
	Howard Caine, Work Assignment Manager
	Printed Name/Title
Approval Authority Other Approval Signatures:	
	Signature/Date
	Warren Lane/QAPP Reviewer
	Printed Name/Title

QAPP WORKSHEET #2
QAPP IDENTIFYING INFORMATION

1. Identify guidance used to prepare QAPP:

"Uniform Federal Policy for Implementing Environmental Quality Systems" (UFP) (EPA 2005a) and "EPA Guidance for Quality Assurance Project Plans" (EPA 2002)

2. Identify regulatory program:

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. Identify approval entity: EPA Region 5

4. Indicate whether the QAPP is a generic or project-specific QAPP: Project-specific

5. List dates of scoping sessions that were held: July 1, 2008, July 15, 2010, May 12, 2011, June 1, 2011

6. List dates and titles of QAPP documents written for previous work site, if applicable: Attachment B, Phase I Quality Assurance Project Plan, July 2009.

7. List organizational partners (stakeholders) and connection with lead organization:

EPA Region 5, SulTRAC, Indiana Department of Environmental Management (IDEM)

8. List data users: EPA Region 5, SulTRAC, IDEM

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below: Not applicable

Identify where each required QAPP element is located in the QAPP (provide section, worksheet, table, or figure number) or other project planning documents (provide complete document title, date, section number, page numbers, and location of the information in the document). Circle QAPP elements and required information that are not applicable to the project. Provide an explanation in the QAPP.

QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet # or Crosswalk to Related Documents
Project Management and Objectives		
2.1 - Title and Approval Page	Title and Approval Page	1
2.2 - Document Format and Table of Contents	Table of Contents	
2.2.1 Document Control Format	QAPP Identifying Information	2
2.2.2 Document Control Numbering System		
2.2.3 Table of Contents		
2.2.4 QAPP Identifying Information		
2.3 - Distribution List and Project Personnel Sign-Off Sheet		
2.3.1 Distribution List	Distribution List	3
2.3.2 Project Personnel Sign-Off Sheet	Project Personnel Sign-Off Sheet	4
2.4 - Project Organization		
2.4.1 Project Organization Chart	Project Organization Chart	5
2.4.2 Communication Pathways	Communication Pathways	6
2.4.3 Personnel Responsibilities and Qualifications	Personnel Responsibilities and Qualifications	7
2.4.4 Special Training Requirements and Certification	Special Training Requirements and Certification	8
2.5 - Project Planning/Problem Definition		
2.5.1 Project Planning (Scoping)	Project Planning Session Documentation (including Data Needs tables)	9
	Project Scoping Session Participants Sheet	
2.5.2 Problem Definition, Site History, and Background	Problem Definition, Site History, and Background	10
	Site Maps (historical and present)	Figures

QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet # or Crosswalk to Related Documents
2.6 - Project Quality Objectives (PQO) and Measurement Performance Criteria		
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2.6.2 Measurement Performance Criteria	Measurement Performance Criteria Table	12
2.7 - Secondary Data Evaluation	Sources of Secondary Data and Information	13
	Secondary Data Criteria and Limitations Table	
2.8 - Project Overview and Schedule		
2.8.1 Project Overview	Summary of Project Tasks	14
	Reference Limits and Evaluation Table	15
2.8.2 Project Schedule	Project Schedule/Timeline Table	16
Measurement/Data Acquisition		
3.1 - Sampling Tasks		
3.1.1 Sampling Process Design and Rationale	Sampling Design and Rationale	17
	Sampling Location Map	18, Figure 4
	Sampling Locations and Methods/Standard Operating Procedures (SOP) Requirements Table	
3.1.2 Sampling Procedures and Requirements		
3.1.2.1 Sampling Collection Procedures	Field Quality Control Sample Summary Table	20
	Sampling SOPs	21
	Project Sampling SOP References Table	21
3.1.2.2 Sample Containers, Volume, and Preservation	Analytical Methods/SOP Requirements Table	19, 23
3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures	Analytical Methods, Containers, Preservatives, and Holding Times Table	19

QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet # or Crosswalk to Related Documents
3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures	Field Equipment, Calibration, Maintenance, Testing, and Inspection Procedures Table	22
3.1.2.5 Supply Inspection and Acceptance Procedures		
3.1.2.6 Field Documentation Procedures		
3.2 - Analytical Tasks		
3.2.1 Analytical SOPs	Analytical SOPs	23
	Analytical SOP References Table	
3.2.2 Analytical Instrument Calibration Procedures	Analytical Instrument Calibration Table	24
3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	25
3.2.4 Analytical Supply Inspection and Acceptance Procedures		
3.3 - Sample Collection Documentation, Handling, Tracking, and Custody Procedures	Sample Collection Documentation Handling, Tracking, and Custody SOPs	26
3.3.1 Sample Collection Documentation	Sample Container Identification	26, 27
3.3.2 Sample Handling and Tracking System	Sample Handling Flow Diagram	
3.3.3 Sample Custody	Example Chain-of-Custody Form and Seal	
3.4 - Quality Control (QC) Samples		
3.4.1 Sampling QC Samples	QC Samples Table	28
3.4.2 Analytical QC Samples		
3.5 - Data Management Tasks		
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QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

Required QAPP Element(s) and Corresponding QAPP Section(s)	**Required Information**	**QAPP Worksheet # or Crosswalk to Related Documents**
3.5.2 Data Package Deliverables	Analytical Services Table	30
3.5.3 Data Reporting Formats		23 (specified by analytical method) Data Management Plan
3.5.4 Data Handling and Management	Data Management SOPs	
3.5.5 Data Tracking and Control		
Assessment/Oversight		
4.1 - Assessments and Response Actions	Assessments and Response Actions	
4.1.1 Planned Assessments	Planned Project Assessments Table	31
	Audit Checklists	
4.1.2 Assessment Findings and Corrective Action (CA) Responses	Assessment Findings and CA Responses Table	32
4.2 - QA Management Reports	QA Management Reports Table	33
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Data Review		
5.1 - Overview	Not applicable (NA)	NA
5.2 - Data Review Steps		
5.2.1 Step I: Verification	Verification (Step I) Process Table	34
5.2.2 Step II: Validation		
5.2.2.1 Step IIa Validation Activities	Validation (Steps IIa and IIb) Process Table	35
5.2.2.2 Step IIb Validation Activities	Validation (Steps IIa and IIb) Summary Table	36

QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet # or Crosswalk to Related Documents
5.2.3 Step III: Usability Assessment		
5.2.3.1 Data Limitations and Actions from Usability Assessment	Usability Assessment	37
5.2.3.2 Activities		
5.3 - Streamlining Data Review	NA	NA
5.3.1 Data Review Steps to be Streamlined		
5.3.2 Criteria for Streamlining Data Review		
5.3.3 Amounts and Types of Data Appropriate for Streamlining		

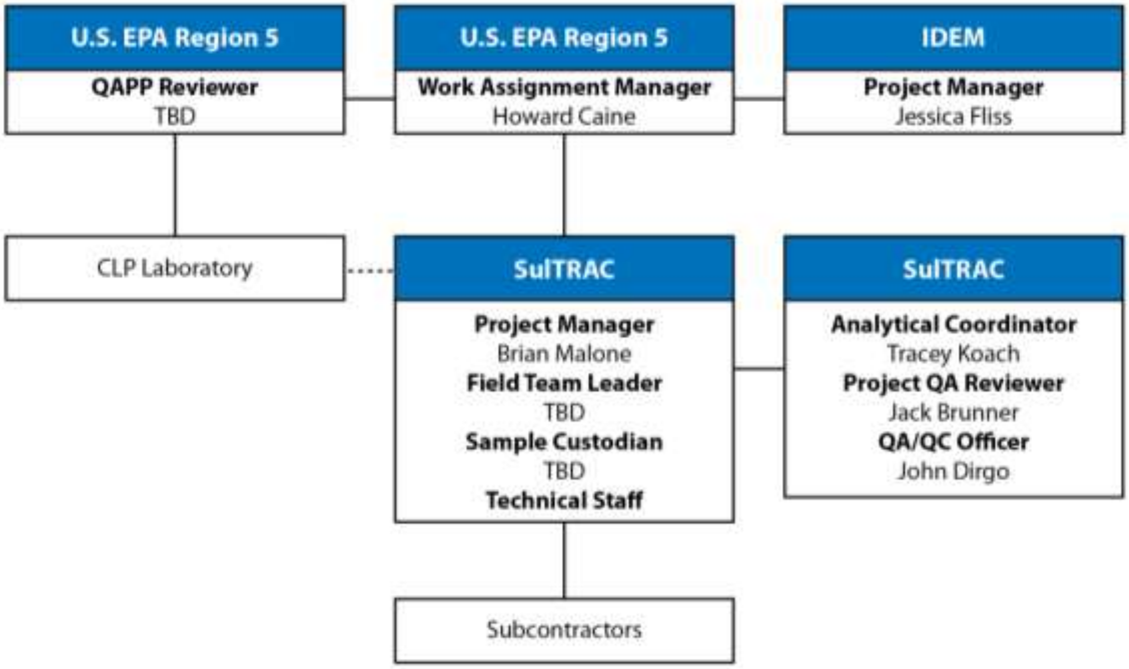
QAPP WORKSHEET #3
DISTRIBUTION LIST

QAPP Recipient	Title	Organization	Telephone Number	E-mail Address
Howard Caine	Work Assignment Manager (WAM)	EPA Region 5	(312) 353-9685	Caine.howard@epa.gov
TBD - EPA	QAPP Reviewer	EPA Region 5	(312) 886-7336	TBD@epa.gov
Jessica Fliss	Project Manager	IDEM	(317) 233-2823	JFLISS@idem.IN.gov
Brian Malone	Project Manager	SulTRAC	(440) 781-7944	Brian.malone@tetratech.com
TBD—SulTRAC	Field Team Leader	SulTRAC	TBD	TBD
TBD- SulTRAC	Project Scientist and Sample Custodian	SulTRAC	TBD	TBD
Jack Brunner	Project QA Reviewer	SulTRAC	(312) 201-7788	jack.brunner@tetratech.com
John Dirgo	QA/QC Officer	SulTRAC	(312) 201-7765	john.dirgo@tetratech.com
Tracey Koach	Analytical Coordinator	SulTRAC	(312) 443-0550, ext. 12	TKoach@onesullivan.com
David Homer	Ecological Risk Assessor	SulTRAC	(816) 412-1762	david.homer@tetratech.com
Eric Morton	Human Health Risk Assessor	SulTRAC	(312) 201-7797	eric.morton@tetratech.com

QAPP WORKSHEET #4
PROJECT PERSONNEL SIGN-OFF SHEET

Project Personnel	Organization	Title	Telephone No.	Signature	Date QAPP Read
Brian Malone	SulTRAC	Project Manager	(440) 781-7944		
Tracey Koach	SulTRAC	Analytical Coordinator	(312) 443-0550, ext. 11		
Jack Brunner	SulTRAC	Project QA Reviewer	(312) 201-7788		
John Dirgo	SulTRAC	QA/QC Officer	(312) 201-7765		
Varied	SulTRAC	Project Scientist and Sample Custodian	TBD		
Varied	SulTRAC	Field Team Leader	TBD		
Daniel Harrison	WDC Exploration	Field Operations Supervisor	317-872-1203		
Travis Roberts	Roberts Drilling	Project Manager	618-476-7334		
Surveyor Subcontractor	TBD	TBD	TBD	TBD	TBD

QAPP WORKSHEET #5
PROJECT ORGANIZATION CHART



Notes

CLP: Contract laboratory program
EPA: Environmental Protection Agency
FS: Feasibility study
IDEM: Indiana Department of Environmental Management
QA: Quality assurance
QAPP: Quality assurance project plan
RI: Remedial investigation

PROJECT TEAM ORGANIZATIONAL CHART
RI/FS ELM STREET
GROUNDWATER CONTAMINATION SITE

ST SulTRAC

QAPP WORKSHEET #6
COMMUNICATION PATHWAYS

Communication Drivers	Responsible Entity	Name	Telephone No.	Procedure (Timing, Pathways, etc.)
Point of contact with EPA WAM	Project Manager	Brian Malone	(440) 781-7944	Brian Malone will forward all materials and information about the project to Howard Caine.
Manage all project phases	Project Manager	Brian Malone	(440) 781-7944	Communicate information to project team (including subcontractors) on a timely basis. Notify EPA WAM by telephone or e-mail of any significant issues. Direct field team and facilitate communication with analytical coordinator. Delivery all Contract Laboratory Program (CLP) data packages to project QA reviewer for final review of validation.
Daily field progress report	Field Team Leader	TBD		Conduct specific field investigation tasks, direct field activities of subcontractors, and provide daily communication with project manager and sample custodian.
Manage Field Sample Organization and Delivery to CLP	Sample Custodian	TBD		Ensure field staff is collecting samples in proper containers, observing holding times, and properly packaging and preparing samples for shipment. Coordinate daily with analytical coordinator concerning sample quantities and delivery locations and dates. Communicate daily with field staff and project manager regarding any issues and developments.
Point of contact with EPA Region 5 Regional Sample Control Coordinator (RSCC)	Analytical Coordinator	Tracey Koach	(312) 443-0550, ext. 11	Contact the RSCC before each sampling event to schedule CLP laboratory services. Notify sample custodian and project manager of any CLP issues or developments. Track all CLP data deliveries. Notify project manager and forward data to him.
Release of Analytical Data	SulTRAC Project QA Reviewer	Jack Brunner	(312) 201-7788	No analytical data can be released until validation is completed and the QA reviewer has reviewed and approved the release.
Report of laboratory data quality issues	Laboratory QA Officer	TBD	TBD	All QA/QC issues with project field samples will be reported by the laboratory QA officer to the RSCC.

QAPP WORKSHEET #7
PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

Name	Title	Organization/ Affiliation	Responsibilities	Education and Experience Qualifications
Brian Malone*	Project Manager	SulTRAC	Manages project; coordinates between lead agency and subcontractor; coordinates CLP data deliverables from analytical coordinator to project QA reviewer; manages field staff	B.S. Environmental and Hazardous Materials Management, 9 years of experience
TBD*	Field Team Leader	SulTRAC	Supervises field sampling and coordinates all field activities; daily reporting to project manager while conducting field activities	
TBD*	Project Scientist Sample Custodian	SulTRAC	Prepares QAPP; implements field plan; verifies sample processing, packaging, and shipping	
Jack Bruner	Project QA Reviewer	SulTRAC	QA/QC oversight	B.S. Biology and M.S. Environmental Science, 20 years of experience
John Dirgo	QA/QC Officer	SulTRAC	QA/QC oversight	B.S. Biology; M.S. and Sc.D. Environmental Health Sciences; 31 years of experience
Tracey Koach*	Analytical Coordinator	SulTRAC	Coordinates sample scheduling; verifies sample chain of custody; reviews computer-aided data review and evaluation (CADRE) results and data from subcontracted laboratories; notifies sample custodian and project manager of any issues or developments	B.S. Environmental Studies, 20 years of experience
TBD	Technical Staff	SulTRAC	Implements field plan	TBD
Daniel Harrison/Travis Roberts	Drillers/Geoprobers	WDC Exploration/Roberts Drilling	Provides subsurface drilling and sampling	TBD
TBD	Surveyors	TBD Subcontractor	Provides survey of monitoring wells locations at the site	TBD
Terrence Hamill	Geophysical Company	Geosearches Inc.	Provides geophysical survey of the study area.	TBD

QAPP WORKSHEET #8
SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates[1]
Field Staff	40-hour and 8-hour refresher - OSHA	Various	Various	SulTRAC	SulTRAC	Corporate human resources office
Subcontractors	40-hour OSHA HAZWOPER training	TBD	TBD	Drillers/Geophysical/Geoprobers	TBD	As noted in subcontract agreement – corporate human resources office

Notes:

HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
OSHA	Occupational Safety and Health Administration

QAPP WORKSHEET #9
PROJECT SCOPING SESSION PARTICIPANTS SHEET

Project Name	Phase II RI/FS for Elm Street Groundwater Contamination Site	Site Name	Elm Street Site
Projected Date(s) of Sampling	May 2012 through June 2012	Site Location	Terre Haute, Vigo County, Indiana
Project Manager	Brian Malone		
Date of Session	May 12, 2011		
Scoping Session Purpose:	Define scope of project		

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
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Comments/Decisions: Based upon findings of the Phase I RI, SulTRAC discussed the data gaps and areas of the site where Phase I data indicated exceedances of appropriate comparison criteria. Phase II investigation activities will focus on eliminating data gaps, further delineating the extent of contamination, bounding the site to eliminate the potential for offsite contaminant migration, conduct vertical aquifer profiling and additional aquifer testing to characterize groundwater contamination and movement, and further evaluate the potential for soil gas exposure at residential and commercial facilities at the site. WA No. 138-RICO-B5BF will cover the Phase II field investigation of the RI/FS at the Elm Street Site and preparation of the RI/FS report. Based on the WA duration, the Phase II activities are anticipated to be completed in the Summer of 2012. The Phase II field investigation will include Tasks 1 through 15 of the SOW for the WA. At the completion of the Phase II RI, SulTRAC will prepare the RI/FS report.

QAPP WORKSHEET #10
PROBLEM DEFINITION

The problem to be addressed by the project: Concentrations of chlorinated volatile organic compounds (VOC) were detected in drinking water supply wells by the Indiana American Water Company (IAWC) in the early 1980s. The Indiana Department of Environmental Management (IDEM) began the site discovery process for the Elm Street site in 1987. Site investigations completed by IDEM in 1988, 1999, and 2000 included surface and near subsurface sampling, shallow and deep monitoring well installations, and groundwater sampling at the I. Gurman, Ashland, and MTS facilities. Analytical results of the investigations indicated that some of the contaminants detected in the municipal wells at IAWC were also detected in surface soil, shallow subsurface soil, subsurface soil, and groundwater at each of the three facilities. As a result of the contaminants detected in the 2000 Expanded Site Inspection (ESI) conducted by IDEM, the I. Gurman site scored 50 on the Hazard Ranking System package because of a maximum score on the groundwater migration pathway.

In 1990, an independent geotechnical exploration and preliminary petroleum hydrocarbon study was conducted on behalf of Valvoline by Giles Engineering Associates Inc., (Giles), at the Ashland facility. Findings included slight to moderate petroleum odors detected in soil samples recovered during drilling, and low concentrations of VOCs detected in the field using a photoionization detector (PID). Two soil samples (one from 7 to 8.5 feet below ground surface [bgs] at boring B1, and one from 29.5 to 31 feet bgs at boring B4) were submitted for laboratory analysis for benzene, toluene, xylenes, and total petroleum hydrocarbons. Soil boring logs and a location map were included in the report dated February 15, 1990; however, laboratory analytical data for the two soil samples were not attached.

From 2003 to 2006, EPA issued a series of Special Notice letters to Ashland, Gurman, and MTS requesting information regarding their operations. Various correspondences were submitted to EPA by each of the parties in response to the information requests.

In September 2005, URS Corporation (URS), on behalf of Ashland, conducted a modified Phase I/ Phase II investigation at 118 Elm Street. As part of the investigation, URS installed four temporary shallow groundwater monitoring points (SB-1, SB-2, SB-4 and SB-5) and collected groundwater samples from each point, as well as from eight monitoring wells (MW-1S, MW-1D, MW-2S, MW-2D, MW-3S, MW-3D, MW-5S, and MW-5D) installed by IDEM during the ESI. Tetrachloroethene (PCE) was detected above its maximum contaminant level (MCL) at two existing shallow monitoring wells (MW-1S and MW-2S) and at two of the temporary monitoring points (SB-2 and SB-5) on the Ashland property. PCE was also detected above its MCL at an existing shallow monitoring well (SB-5S) located east (upgradient) near the western edge of the Gurman property.

QAPP WORKSHEET #10 (CONTINUED)
PROBLEM DEFINITION

In addition, soil samples were collected at each of the four shallow points as they were being advanced. One soil sample was collected at each location just above the water table, and one boring (SB-5) had an additional soil sample collected at a depth of about 15 feet bgs. No chlorinated organic compounds were found in any soil samples. Several non-chlorinated organic compounds (including acetone, toluene, cyclohexane, and methyl cyclohexane) were detected at concentrations less than their respective Risk Integrated System of Closure (RISC) default closure levels for residential exposure at borings SB-2 (near the southeast corner of the office building) and SB-5 (near the location of the former UST).

On September 9, 2006, EPA proposed the site for inclusion on the National Priorities List (NPL). All three parties (Gurman, Ashland, MTS) declined to participate in an Administrative Settlement and Order on Consent for remedial investigation/feasibility study (RI/FS) proposed by EPA. Thus, in June 2008, EPA issued the fund-lead Remedial Investigation (RI)/Feasibility Study (FS) Work Assignment (WA) to SulTRAC.

The Phase I RI completed in the Fall of 2009 confirmed surface, and subsurface soil contamination by VOCs, SVOCs, PCBs, Pesticides, Herbicides and Metals exceeding comparison criteria screening levels. Groundwater contamination exceeding comparison criteria screening levels was identified for VOCs and metals. The Phase II RI activities for the project intend to investigate any data gaps remaining from previous investigations, delineate areas of the site with Phase I results exceeding comparison criteria, conduct additional soil gas investigations at the Gurman and MTS facilities to evaluate vapor intrusion potential, collect additional groundwater quality data, and collect necessary data to complete the RI/FS report.

The environmental questions being asked: Are existing source areas contributing to contamination at the Elm Street groundwater site, and what is the nature and extent of contamination?

Observations from any site reconnaissance reports: During the 1999 and 2000 IDEM site investigations, IDEM collected soil and groundwater samples from the Gurman, Ashland, and MTS properties. During the time of the investigations, approximately 1,000 metal and plastic drums were located on the Gurman property.

A synopsis of secondary data or information from site reports: See Worksheet #13

The possible classes of contaminants and the affected matrices: All soil samples will be analyzed for VOCs; select locations will also be sampled for SVOC, metals, herbicides, PCBs, and pesticides. Grab groundwater samples from 27 select soil borings will be analyzed for VOC; five grab groundwater samples will also be analyzed for SVOC. Monitoring well samples will be analyzed for VOC and will also be analyzed for non-filtered and filtered TAL metals (including mercury and cyanide). Soil gas samples will be analyzed for VOCs by an EPA Central Regional Laboratory (CRL) or subcontract laboratory for rapid turnaround results for decision making purposes.

Groundwater samples from shallow wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs, and CLP SOW ISM01.3 for Dissolved and Total TAL Metals (including cyanide and mercury). Groundwater samples from deep wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW.

QAPP WORKSHEET #10 (CONTINUED)
PROBLEM DEFINITION

SOM01.2 for VOCs and CLP SOW ISM01.3 for Dissolved and Total TAL Metals (including cyanide and mercury). Groundwater samples from the IAWC wells will be submitted to the designated EPA CLP laboratory for analysis by EPA Methods CLP SOW SOM01.2 for VOCs

Project decision conditions (“If…, then…” statements): If the Phase II activities indicate that contamination at the Elm Street site poses an unacceptable risk to human health and/or the environment, then an interim remedial action will be implemented.

QAPP WORKSHEET #11
PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

Who will use the data: EPA Region 5 and SulTRAC will use the data.

What will the data be used for? The data from the Phase II field investigation will be used to characterize potential contamination sources, as well as determine the nature of the contamination at the Elm Street site. Data from both the Phase I and Phase II field investigations will be used to conduct a risk assessment for the entire Elm Street Site and to evaluate remedial alternatives as part of the FS.

What type of data are needed (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)? Soil, soil gas, and groundwater samples will be collected from the Elm Street site. Soil samples will be collected from borings, and soil gas samples will be collected from subsurface soil gas collection points. Groundwater samples will be collected from groundwater monitoring wells, IAWC supply wells, and selected soil borings.

All soil samples will be analyzed for VOCs; select locations will also be sampled for SVOC, metals, herbicides, PCBs, and pesticides. Grab groundwater samples from 27 select soil borings will be analyzed for VOC; five grab groundwater samples will also be analyzed for SVOC. Monitoring well samples will be analyzed for VOC and non-filtered and filtered TAL metals (including mercury and cyanide). Soil gas samples will be analyzed for VOCs identified in EPA Method TO-15 by the EPA Region 5 Central Regional Laboratory (CRL) or by a subcontracted laboratory.

How "good" do the data need to be in order to support the environmental decision? Ultimately, the data from SulTRAC's collected samples of soil, water, and soil gas need to allow full assessment of the nature and extent of contamination in the soil and water. The data also need to be validated and used to support a risk assessment and evaluation of remedial alternatives.

How much data are needed (number of samples for each analytical group, matrix, and concentration)? SulTRAC will conduct Phase II field activities including collecting the following samples: surface soil, subsurface soil, and groundwater samples from 35 borings (including nine soil borings for VAS); surface soil and subsurface soil samples from 33 locations; 30 soil gas samples from 30 locations (nine new soil gas wells and 12 existing wells); and groundwater samples from 27 existing and nine new monitoring wells, and four IAWC supply wells. SulTRAC will also conduct a mechanical rising and falling head tests on a minimum 12 wells to determine aquifer characteristics.

In addition, QC samples will be collected and analyzed, including duplicates, matrix spikes (MS), matrix spike duplicates (MSD), and trip blanks. Trip blanks will be collected and analyzed for VOC samples only.

QAPP WORKSHEET #11 (CONTINUED)
PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

Where, when, and how should the data be collected/generated? Phase II sampling activities will take place during summer 2012 at the Elm Street site. SulTRAC will collect surface and subsurface soil samples from 46 investigative soil borings not including monitoring well locations, background locations, VAS locations or soil gas well locations. SulTRAC will collect grab groundwater samples at the water table at 14 of the 46 investigative soil boring locations. SulTRAC will collect surface, subsurface soil and grab groundwater samples at 6 previously installed soil gas locations and 9 new soil gas locations. SulTRAC will conduct VAS with surface and subsurface soil sampling at 9 soil boring locations with concurrent groundwater sampling from 12 existing monitoring wells. SulTRAC will collect soil gas samples from 15 locations (nested pairs). SulTRAC will install up to 7 new monitoring wells with surface and subsurface soil samples. SulTRAC will collect surface and subsurface soil samples from two additional background locations (4 depths per boring). SulTRAC will collect groundwater samples from existing and new monitoring wells. SulTRAC will collect groundwater samples from four existing IAWC wells. SulTRAC will perform mechanical rising and falling head tests to estimate aquifer characteristics, and perform a pumping test using IAWC wells and measuring drawdown in nearby monitoring wells.

Twenty-seven of the soil borings will be advanced to the water table (approximately 35-45 feet bgs); soil samples will be collected at 0-2 and from a 2-foot interval within the 2-10, 10-20, and 20-40 zones. A grab groundwater sample will be collected at just below the water table in the borings. Thirty-two shallow borings will be advanced to a depth of four feet, with samples collected at the 0-2 and 2-4 feet bgs intervals. Two additional soil borings will be advanced to ten feet with samples collected at 0-2 and from a 2-foot interval within the 2-10 foot zone. A total of nine soil borings will be taken to bedrock for the vertical aquifer sampling. Soil samples will be taken at 0-2 feet bgs and from a 2-foot interval with the 2-10, 10-20, and 20-40 feet bgs zones, and groundwater will be taken at the water table and every ten feet down to bedrock. Nine new soil gas wells will be installed in paired sets with a shallow well and a deep well at each location. Thirty samples will be collected from existing soil gas wells and the new wells located near the Gurman building drum processing area, the MTS Machine building and three locations between the Riverside Apartment complex and utility corridors along Second Street. Soil gas samples will be collected at about five feet bgs (shallow) and 35-40 feet bgs (deep). Soil gas samples will be collected from all locations after installation and development of sub-slab soil gas probes. A mechanical rising and falling head test on a minimum 12 wells will be conducted in order to determine aquifer characteristics and variations site wide.

The shallow soil borings (either four or ten feet in total depth) will be advanced using a Geoprobe. The deeper soil borings, seven new monitoring wells, and soil gas wells will be drilled using rotosonic techniques. All intrusive work will be performed by subcontractors with a SulTRAC geologist present. All groundwater samples collected from the soil borings will be sampled using micropurging techniques. The monitoring wells will be sampled using micropurging techniques after completion of development of the new monitoring wells. The depth of the static water level and total depth of the well will be measured with a water level indicator prior to sampling. Water quality parameters will be recorded prior to sample collection.

SulTRAC anticipates hiring subcontractors to perform the monitoring well and soil gas monitoring point installation, direct-push technology soil sampling, rotosonic advancement and soil collection, site surveying, site security, and site trailer mobilization.

QAPP WORKSHEET #11 (CONTINUED)
PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

Who will collect and generate the data? SulTRAC will collect the samples discussed herein. Soil and groundwater samples will be analyzed by a laboratory from the EPA Contract Laboratory Program (CLP). Select grab groundwater and VAS samples will be analyzed by the EPA mobile laboratory, if available, or a subcontracted laboratory for rapid turnaround and decision making purposes. Soil gas samples will be analyzed for the full suite of analytes provided in EPA Method TO-15 by the EPA Region 5 CRL or a subcontracted laboratory.

How will the data be reported? Data will be reported by the CLP, CRL, EPA mobile laboratory, and subcontracted laboratories using standard data reporting techniques. Data will be reported using Scribe software.

How will the data be archived? Electronic and hard copies of CLP and CRL analytical data will be archived by the individual laboratory. Electronic and hard copies of subcontracted laboratory data will be archived by the SulTRAC analytical coordinator. Field data (notebooks, sampling sheets, etc.) will be maintained at SulTRAC's Chicago office. SulTRAC will also provide 10-year data storage.

QAPP WORKSHEET #12
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP and 8260 VOCs
Concentration Level	Low concentration

Sampling Procedure[3]	**Analytical Method SOP[4]**	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-1	Precision	RPD ≤ 70%	Field duplicate	S & A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	VOC < QL	Trip blank	S & A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	VOC < QL	Rinsate blank	S & A
S-2, S-3	A-1	Accuracy/Bias	1,1-Dichloroethene: 59-172 %R TCE: 62-137 %R Benzene: 66-142 %R Toluene: 59-139 %R Chlorobenzene: 60-133 %R	MS/MSD	S & A
S-2, S-3	A-1	Precision	1,1-Dichloroethene: 22% RPD TCE: 24% RPD Benzene: 21% RPD Toluene: 21% RPD Chlorobenzene: 21% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP VOCs
Concentration Level	Low concentration

Sampling Procedure[3]	**Analytical Method SOP[4]**	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-1	Accuracy	Vinyl chloride-d_3: 68-122 %R Chloroethane-d_5: 61-130 %R 1,1-Dichloroethene-d_2: 45-132 %R 2-Butanone-d_5: 20-182 %R Chloroform-d: 72-123 %R 1,2-Dichloroethane-d_4: 79-122 %R Benzene-d_6: 80-121 %R 1,2-Dichloropropane-d_6: 74-124 %R Toluene-d_8: 78-121 %R 1,1,2,2-Tetrachloroethane-d_2: 56-161 %R Trans-1,3-Dichloropropene-d_4: 72-130 %R 2-Hexanone-d_5: 17-184 %R 1,4-Dioxane-d_8: 50-150 %R 1,2-Dichlorobnzene-d_4: 70-131 %R	Deuterated monitoring Compounds[7]	A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	VOC < QL	Method blank	A
S-2, S-3	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP SVOCs
Concentration Level	Low concentration

Sampling Procedure[3]	**Analytical Method SOP[4]**	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-1	Precision	RPD ≤ 70%	Field duplicate	S & A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	SVOC < QL	Rinsate blank	S & A
S-2, S-3	A-1	Accuracy/Bias	Phenol: 26-90 %R 2-Chlorophenol: 25-102 %R N-Nitroso-di-n-propylamine: 41-126 %R 4-Chloro-3-methylphenol: 26-103 %R Acenaphthene: 31-137 %R 4-Nitrophenol: 11-114 %R 2,4-Dinitrotoluene: 28-89 %R Pentachlorophenol: 17-109 %R Pyrene: 35-142 %R	MS/MSD	S & A
S-2, S-3	A-1	Precision	Phenol: 35% RPD 2-Chlorophenol: 50% RPD N-Nitroso-di-n-propylamine: 38% RPD 4-Chloro-3-methylphenol: 33% RPD Acenaphthene: 19% RPD 4-Nitrophenol: 50% RPD 2,4-Dinitrotoluene: 47% RPD Pentachlorophenol: 47% RPD Pyrene: 36% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP SVOCs
Concentration Level	Low concentration

Sampling Procedure[3]	Analytical Method SOP[4]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
S-2, S-3	A-1	Accuracy	Phenol-d_5: 17-103 %R Bis(2-Chloroethyl)ether-d_8: 12-98 %R 2-Chlorophenol-d_4: 13-101 %R 4-Methylphenol-d_8: 8-100 %R Nitrobenzene-d_5: 16-103 %R 2-Nitrophenol-d_4: 16-104 %R 2,4-Dichlorophenol-d_3: 23-104 %R 4-Chloroaniline-d_4: 1-145 %R Dimethylphthalate-d_6: 43-111 %R Acenaphthylene-d_8: 20-97 %R 4-Nitrophenol-d_4: 16-166 %R Fluorene-d_{10}: 40-108 %R 4,6-Dinitro-2-methylphenol-d_2: 1-121 %R Anthracene-d_{10}: 22-98 %R Pyrene-d_{10}: 51-120 %R Benzo(a)pyrene-d_{12}: 43-111 %R	Deuterated monitoring compounds	A
S-2, S-3	A-1	Accuracy/Bias-Contamination	SVOC < QL	Method blank	A
S-2, S-3	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S&A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP PCBs
Concentration Level	NA[5]

Sampling Procedure[3]	**Analytical Method SOP[4]**	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-1	Precision	RPD ≤ 70%	Field duplicate	S & A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	PCB < QL	Rinsate blank	S & A
S-2, S-3	A-1	Accuracy/Bias	Aroclor-1016: 29-135 %R Aroclor-1260: 29-135 %R	MS/MSD	S & A
S-2, S-3	A-1	Precision	Aroclor-1016: 15% RPD Aroclor-1260: 20% RPD	MS/MSD	S & A
S-2, S-3	A-1	Accuracy	Decachlorobiphenyl: 30-150 %R, Tetrachloro-m-xylene: 30-150 %R	Surrogate spike	A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	PCB < QL	Method blank	A
S-2, S-3	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP Pesticides
Concentration Level	NA[5]

Sampling Procedure[3]	Analytical Method SOP[4]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
S-2, S-3	A-1	Precision	RPD ≤ 70%	Field duplicate	S & A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	Pesticides < QL	Rinsate blank	S & A
S-2, S-3	A-1	Accuracy/Bias	Gamma-BHC: 46-127 %R Heptachlor: 35-130 %R Aldrin: 34-132 %R Dieldrin : 31-134 %R Endrin : 42-139 %R 4,4’-DDT : 23-134 %R	MS/MSD	S & A
S-2, S-3	A-1	Precision	Gamma-BHC: 50% RPD Heptachlor: 31% RPD Aldrin: 43% RPD Dieldrin: 38% RPD Endrin: 45% RPD 4,4’-DDT: 50% RPD	MS/MSD	S & A
S-2, S-3	A-1	Accuracy	Tetrachloro-m-xylene: 30-150 %R Decachlorobiphenyl: 30-150 %R	Surrogate spike	A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	Pesticide < QL	Method blank	A
S-2, S-3	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	CLP Metals and Cyanide
Concentration Level	ICP-AES

Sampling Procedure[3]	**Analytical Method SOP[4]**	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-2	Precision	RPD ≤ 70%	Field duplicate	S & A
S-2, S-3	A-2	Accuracy/ Bias-Contamination	Metal, cyanide < QL	Rinsate blank	S & A
S-2, S-3	A-2	Accuracy/Bias	All metals and cyanide: 75-125 %R	MS	A
S-2, S-3	A-2	Precision	All metals and cyanide: < 20% RPD	Laboratory duplicate	A
S-2, S-3	A-2	Sensitivity/Contamination	Metals and cyanide <QL	Method blank	A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil[1]
Analytical Group[2]	SAS Herbicides
Concentration Level	NA[5]

Sampling Procedure[3]	**Analytical Method SOP**[4]	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-2, S-3	A-1	Precision	RPD ≤ 50%	Field duplicate	S & A
S-2, S-3	A-1	Accuracy/Bias-Contamination	Herbicide < QL	Rinsate blank	S & A
S-2, S-3	A-1	Accuracy/Bias	2,4,5-T: 60-140 %R[6] Dalapon: 60-140 %R[6] Dicamba: 60-140 %R[6] Pentachlorophenol : 60-140 %R[6]	MS/MSD	S & A
S-2, S-3	A-1	Precision	2,4,5-T: 40% RPD[6] Dalapon: 40% RPD[6] Dicamba: 40% RPD[6] Pentachlorophenol: 40% RPD[6]	MS/MSD	S & A
S-2, S-3	A-1	Accuracy	2,4-Dichlorophenylacetic acid: 30-150 %R[6]	Surrogate spike	A
S-2, S-3	A-1	Accuracy/ Bias-Contamination	Herbicide < QL	Method blank	A
S-2, S-3	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

Notes:

DQI	Data quality indicator
QL	Quantitation limit
%R	Percent recovery
RPD	Relative percent difference

[1] Soils include native and fill material.

[2] If information varies within an analytical group, separate by individual analyte.

[3] Reference number from QAPP Worksheet #21

[4] Reference number from QAPP Worksheet #23

[5] Not applicable, only one concentration level is listed for the analytical method selected

[6] If the laboratory has established its own statistically based QC limits, they will supersede those listed here.

[7] If a non-CLP laboratory (EPA mobile laboratory or subcontractor laboratory) is performing soil VOC analyses by EPA SW-846 Method 8260, they should use the surrogates and quality control limits specified in that method in lieu of the deuterated monitoring compounds specified here and in the CLP SOW.

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Water
Analytical Group[1]	CLP and 8260 VOCs
Concentration Level	Low and trace concentration

Sampling Procedure[2]	**Analytical Method SOP**[3]	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-6	A-1	Precision	RPD ≤ 50%	Field duplicate	S & A
S-6	A-1	Accuracy/ Bias-Contamination	VOC < QL	Trip blank	S & A
S-6	A-1	Accuracy/ Bias-Contamination	VOC < QL	Rinsate blank	S & A
S-6	A-1	Accuracy/Bias	1,1-Dichloroethene: 61-145 %R TCE: 71-120 %R Benzene: 76-127 %R Toluene: 76-125 %R Chlorobenzene: 75-130 %R	MS/MSD[4]	S & A
S-6	A-1	Precision	1,1-Dichloroethene: 14% RPD TCE: 14% RPD Benzene: 11% RPD Toluene: 13% RPD Chlorobenzene: 13% RPD	MS/MSD[4]	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Water
Analytical Group[1]	CLP and 8260 VOCs
Concentration Level	Low and trace concentration

Sampling Procedure[2]	**Analytical Method SOP**[3]	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-6	A-1	Accuracy	Vinyl chloride-d_3: 65-131 %R Chloroethane-d_5: 71-131 %R 1,1-Dichloroethene-d_2: 55-104 %R 2-Butanone-d_5: 49-155 %R Chloroform-d: 78-121 %R 1,2-Dichloroethane-d_4: 78-129 %R Benzene-d_6: 77-124 %R 1,2-Dichloropropane-d_6 : 79-124 %R Toluene-d_8 : 77-121 %R 1,1,2,2-Tetrachloroethane-d_2: 73-125 %R Trans-1,3-Dichloropropene-d_4: 73-121 %R 2-Hexanone-d_5: 28-135 %R 1,4-Dioxane-d_8: 50-150 %R 1,2-Dichlorobnzene-d_4: 80-131 %R	Deuterated monitoring Compounds [4,5]	A
S-6	A-1	Accuracy/ Bias-Contamination	VOC < QL	Method blank	A
S-6	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Water
Analytical Group[1]	CLP SVOCs
Concentration Level	Low concentration

Sampling Procedure[2]	Analytical Method SOP[3]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
S-6	A-1	Precision	RPD ≤ 50%	Field duplicate	S & A
S-6	A-1	Accuracy/ Bias-Contamination	SVOC < QL	Rinsate blank	S & A
S-6	A-1	Accuracy/Bias	Phenol: 12-110 %R 2-Chlorophenol: 27-123 %R N-Nitroso-di-n-propylamine: 41-116 %R 4-Chloro-3-methylphenol: 23-97 %R Acenaphthene: 46-118 %R 4-Nitrophenol: 10-80 %R 2,4-Dinitrotoluene: 24-96 %R Pentachlorophenol: 9-103 %R Pyrene: 26-127 %R	MS/MSD	S & A
S-6	A-1	Precision	Phenol: 42% RPD 2-Chlorophenol: 40% RPD N-Nitroso-di-n-propylamine: 38% RPD 4-Chloro-3-methylphenol: 42% RPD Acenaphthene: 31% RPD 4-Nitrophenol: 50% RPD 2,4-Dinitrotoluene: 38% RPD Pentachlorophenol: 50% RPD Pyrene: 31% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Water
Analytical Group[1]	CLP SVOCs
Concentration Level	Low concentration

Sampling Procedure[2]	Analytical Method SOP[3]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
S-6	A-1	Accuracy	Phenol-d_5: 39-106 %R Bis(2-Chloroethyl)ether-d_8: 40-105 %R 2-Chlorophenol-d_4: 41-106 %R 4-Methylphenol-d_8: 25-111 %R Nitrobenzene-d_5: 43-108 %R 2-Nitrophenol-d_4: 40-108 %R 2,4-Dichlorophenol-d_3: 37-105 %R 4-Chloroaniline-d_4: 1-145 %R Dimethylphthalate-d_6: 47-114 %R Acenaphthylene-d_8: 41-107 %R 4-Nitrophenol-d_4: 33-116 %R Fluorene-d_{10}: 42-111 %R 4,6-Dinitro-2-methylphenol-d_2: 22-104 %R Anthracene-d_{10}: 44-110 %R Pyrene-d_{10}: 52-119 %R Benzo(a)pyrene-d_{12}: 32-121 %R	Deuterated monitoring compounds	A
S-6	A-1	Accuracy/Bias-Contamination	SVOC < QL	Method blank	A
S-6	A-1	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S&A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Water
Analytical Group[1]	CLP Metals and cyanide
Concentration Level	ICP-AES

Sampling Procedure[2]	**Analytical Method SOP**[3]	**DQIs**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
S-6	A-2	Precision	RPD ≤ 50%	Field duplicate	S & A
S-6	A-2	Accuracy/Bias-Contamination	Metals and cyanide < QL	Rinsate blank	S & A
S-6	A-2	Accuracy	All metals and cyanide: 75-125 %R	MS	A
S-6	A-2	Precision	All metals and cyanide: < 20% RPD	Laboratory duplicate	A
S-6	A-2	Sensitivity/Contamination	Metals and cyanide < QL	Method blank	A

Notes:

DQI	Data quality indicator
QL	Quantitation limit
%R	Percent recovery
RPD	Relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21
[3] Reference number from QAPP Worksheet #23
[4] If the laboratory has established its own statistically based QC limits, they will supersede those listed here.
[5] If a non-CLP laboratory (EPA mobile laboratory or subcontractor laboratory) is performing soil VOC analyses by EPA SW-846 Method 8260, they should use the surrogates and quality control limits specified in that method in lieu of the deuterated monitoring compounds specified here and in the CLP SOW.

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA TABLE

Matrix	Soil Gas
Analytical Group[1]	CRL VOCs
Concentration Level	NA[4]

Sampling Procedure[2]	Analytical Method SOP[3]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
S-1	A-3	Precision	RPD ≤ 50%	Field duplicate	S & A
S-1	A-3	Accuracy	Bromochloromethane, 60-140 %R Chlorobenzene-d5, 60-140 %R 1,4-Difluorobenzene, 60-140 %R	Internal standards	A
S-1	A-3	Accuracy	70-130 %R	Laboratory control sample	A
S-1	A-3	Accuracy/ Bias-Contamination	VOC < QL	Method blank	A
S-1	A-3	Precision	RPD <30%	Laboratory Duplicate	A
S-1	A-3	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

Notes:

DQI	Data quality indicator
QL	Quantitation limit
%R	Percent recovery
RPD	Relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21
[3] Reference number from QAPP Worksheet #23
[4] Not applicable, only one concentration level is listed for the analytical method selected

QAPP WORKSHEET #13
SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Source (Originating Org, Data Types, data Generation/Collection Dates)	How data will be used	Limitation on Data Use
Soil and groundwater sampling data	IDEM. "Expanded Site Inspection Report." I Gurman and Son Site. June 2002.	IDEM; soil and groundwater samples; collected before 2000	This data will be used as a starting point to characterize the nature of contamination at the Elm Street site.	None
Soil and groundwater sampling data	IDEM. "Expanded Site Inspection Report." Bistate Products. June 2002.	IDEM; soil and groundwater samples; collected before 2000	This data will be used as a starting point to characterize the nature of contamination at the Elm Street site.	None
Soil and groundwater sampling data	URS Corporation. "Terre Haute Modified Phase I/Phase II Investigation. October 2005.	URS Corporation; soil and groundwater samples; collected in 2005	The groundwater sampling information was used to determine the drilling location on the Elm Street site.	None
Soil, groundwater and soil gas sampling data	SulTRAC. "Data Evaluation Summary Report-Phase I Remedial Investigation Sampling Results." July, 2011	SulTRAC; soil, groundwater and soil gas samples; collected in 2009	This data will be used to identify areas of the site requiring additional contaminant delineation, and any data gaps for the site to prepare the RI/FS report.	None

Note:

IDEM	Indiana Department of Environmental Management

QAPP WORKSHEET #14
SUMMARY OF PROJECT TASKS

Sampling Tasks:

1 – Collect soil from 46 investigative soil borings.
2 – Collect grab groundwater samples from 14 of the 46 investigative soil borings and 15 of the soil gas locations.
3 – Collect soil samples from seven newly installed monitoring wells.
4 – Collect groundwater samples from seven new and 27 existing monitoring wells, and four IAWC wells.
5 – Collect soil and groundwater samples from nine borings for VAS.
6 – Collect groundwater samples from 12 existing monitoring wells for VAS.
7 – Collect soil gas samples from 30 locations, including nine new wells.
8 – Take digital photographs to document activities.
9 - Log activities and tasks in a field notebook.
10 - Prepare sample documentation such as chain-of-custody forms, sample labels, custody seals, etc.

Analysis Tasks: All soil samples collected will be analyzed for VOCs; select samples will also be analyzed for SVOC, metals, PCBs, pesticides, and herbicides. Grab groundwater samples from the 40-foot soil borings will be analyzed for VOCs and five will also be analyzed for SVOCs. Groundwater samples collected from the monitoring wells and four IAWC wells will be analyzed for VOCs; monitoring well samples will also be analyzed for non-filtered and filtered TAL metals (including mercury and cyanide). Soil gas samples will be analyzed for all VOCs. The number of samples and analysis were chosen based upon data gaps identified and to delineate areas of contamination exceeding RSL's identified in the Phase I remedial investigation.

QC Tasks: The following QC samples will be collected and analyzed during the sampling event: field duplicates, MS/MSD samples, rinsate blanks, and trip blanks.

Secondary Data: See Worksheet #13

Data Management Tasks: Analytical data will be archived in an electronic database after validation.

Documentation and Records: All samples collected will be documented in a logbook using a ballpoint pen. The time of collection, identification number, sampling location, field observations, sampler's name, and analyses will be recorded in the logbook for each sample. Each page of the logbook will be dated, numbered, and signed by SulTRAC personnel. Field data records will be maintained at SulTRAC's Chicago office. SulTRAC will follow custody procedures outlined in SulTRAC's program-level QAPP for the RAC 2 contract. Further specifications are described in the Field Sampling Plan (FSP).

Assessment/Audit Tasks: Assessment/audit tasks will not be performed.

Data Review Tasks: EPA will perform limited computer-aided data review and evaluation (CADRE) for all CLP and CRL data, and will prepare a case narrative detailing any issues or inconsistencies discovered. The SulTRAC chemist will review the case narrative and will detail any analytical issues that may affect data quality in the RI/FS report. The SulTRAC chemist will review the QA/QC results from subcontracted laboratories and will provide an assessment of the validity of the results and any inconsistencies in the analytical methods or results.

QAPP WORKSHEET #15
REFERENCE LIMITS AND EVALUATION TABLE

Reference Limits Table – Soil

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
VOC/CLP	Dichlorodifluoromethane	75-71-8	9.4E+01	5.0E-03
VOC/CLP	Chloromethane	74-87-3	1.2E+02	5.0E-03
VOC/CLP	Vinyl chloride	75-01-4	6.0E-02	5.0E-03
VOC/CLP	Trichlorofluoromethane	75-69-4	8.0E+02	5.0E-03
VOC/CLP	Bromomethane	74-83-9	7.9E+02	5.0E-03
VOC/CLP	Chloroethane	75-00-3	1.5E+04	5.0E-03
VOC/CLP	1,1-Dichloroethene	75-35-4	2.4E+02	5.0E-03
VOC/CLP	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	4.3E+04	5.0E-03
VOC/CLP	Acetone	67-64-1	6.1E+04	1.0E-02
VOC/CLP	Carbon disulfide	75-15-0	8.2E+02	5.0E-03
VOC/CLP	Methyl acetate	79-20-9	7.8E+04	5.0E-03
VOC/CLP	Methylene chloride	75-09-2	1.1E+01	5.0E-03
VOC/CLP	trans-1,2-Dichloroethene	156-50-5	1.5E+02	5.0E-03
VOC/CLP	Methyl tert-butyl ether	1634-04-4	4.3E+01	5.0E-03
VOC/CLP	1,1-Dichloroethane	75-34-3	3.3E+00	5.0E-03
VOC/CLP	cis-1,2-Dichloroethene	156-59-2	1.6E+02	5.0E-03
VOC/CLP	2-Butanone	78-93-3	2.8E+04	1.0E-02
VOC/CLP	Bromochloromethane	74-97-5	1.6E+02	5.0E-03
VOC/CLP	Chloroform	67-66-3	2.9E-01	5.0E-03
VOC/CLP	1,1,1-Trichloroethane	71-55-6	8.7E+03	5.0E-03
VOC/CLP	Cyclohexane	110-82-7	7.0E+03	5.0E-03
VOC/CLP	Carbon tetrachloride	56-23-5	6.1E-01	5.0E-03
VOC/CLP	Benzene	71-43-2	1.1E+00	5.0E-03
VOC/CLP	1,2-Dichloroethane	107-06-2	4.3E-01	5.0E-03
VOC/CLP	1,4-Dioxane	123-91-1	4.9E+00	1.0E-01
VOC/CLP	Trichloroethene	79-01-6	2.8E+00	5.0E-03
VOC/CLP	Methylcyclohexane	108-87-2	NC	5.0E-03
VOC/CLP	1,2-Dichloropropane	78-87-5	9.4E-01	5.0E-03
VOC/CLP	Bromodichloromethane	75-27-4	1.6E+02	5.0E-03
VOC/CLP	cis-1,3-Dichloropropene	542-75-6	1.7E+00	5.0E-03

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
VOC/CLP	4-Methyl-2-pentanone	108-10-1	5.3E+03	1.0E-02
VOC/CLP	Toluene	108-88-3	5.0E+03	5.0E-03
VOC/CLP	trans-1,3-Dichloropropene	10061-02-6	1.7E+00	5.0E-03
VOC/CLP	1,1,2-Trichloroethane	79-00-5	1.1E+00	5.0E-03
VOC/CLP	Tetrachloroethene	127-18-4	5.5E-01	5.0E-03
VOC/CLP	2-Hexanone	591-78-6	2.1E+02	1.0E-02
VOC/CLP	Dibromochloromethane	124-48-1	6.8E-01	5.0E-03
VOC/CLP	1,2-Dibromoethane	106-93-4	4.3E-01	5.0E-03
VOC/CLP	Chlorobenzene	108-90-7	2.9E+02	5.0E-03
VOC/CLP	Ethylbenzene	100-41-4	5.4E+00	5.0E-03
VOC/CLP	o-Xylene	95-47-6	6.9E+02	5.0E-03
VOC/CLP	m,p-Xylene	179601-23-1	5.9E+02	5.0E-03
VOC/CLP	Styrene	100-42-5	6.3E+03	5.0E-03
VOC/CLP	Bromoform	75-25-2	6.2E+01	5.0E-03
VOC/CLP	Isopropylbenzene	98-82-8	2.1E+02	5.0E-03
VOC/CLP	1,1,2,2-Tetrachloroethane	79-34-5	5.6E-01	5.0E-03
VOC/CLP	1,3-Dichlorobenzene	541-73-1	NC	5.0E-03
VOC/CLP	1,4-Dichlorobenzene	106-46-7	2.4E+00	5.0E-03
VOC/CLP	1,2-Dichlorobenzene	95-50-1	1.9E+03	5.0E-03
VOC/CLP	1,2-Dibromo-3-chloropropane	96-12-8	5.4E-03	5.0E-03
VOC/CLP	1,2,4-Trichlorobenzene	120-82-1	2.2E+01	5.0E-03
VOC/CLP	1,2,3-Trichlorobenzene	87-61-6	4.9E+01	5.0E-03
SVOC/CLP	Benzaldehyde	100-52-7	7.8E+03	1.7E-01
SVOC/CLP	Phenol	108-95-2	1.8E+04	1.7E-01
SVOC/CLP	bis (2-Chloroethyl) ether	111-44-4	2.1E-01	1.7E-01
SVOC/CLP	2-Chlorophenol	95-57-8	3.9E+02	1.7E-01
SVOC/CLP	2-Methylphenol	95-48-7	3.1E+03	1.7E-01
SVOC/CLP	2,2'-Oxybis(1-chloropropane)	108-60-1	4.6E+00	1.7E-01
SVOC/CLP	Acetophenone	98-86-2	7.8E+03	1.7E-01
SVOC/CLP	4-Methylphenol	106-44-5	3.1E+02	1.7E-01
SVOC/CLP	N-Nitroso-di-n propylamine	621-64-7	6.9E-02	1.7E-01
SVOC/CLP	Hexachloroethane	67-72-1	3.5E+01	1.7E-01
SVOC/CLP	Nitrobenzene	98-95-3	4.8E+00	1.7E-01
SVOC/CLP	Isophorone	78-59-1	5.1E+02	1.7E-01

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
SVOC/CLP	2-Nitrophenol	88-75-5	NC	1.7E-01
SVOC/CLP	2,4-Dimethylphenol	105-67-9	1.2E+03	1.7E-01
SVOC/CLP	bis(2-Chloroethoxy) methane	111-91-1	1.8E+02	1.7E-01
SVOC/CLP	2,4-Dichlorophenol	120-83-2	1.8E+02	1.7E-01
SVOC/CLP	Naphthalene	91-20-3	3.6E+00	1.7E-01
SVOC/CLP	4-Chloroaniline	106-47-8	2.4E+02	1.7E-01
SVOC/CLP	Hexachlorobutadiene	87-68-3	6.2E+00	1.7E-01
SVOC/CLP	Caprolactam	105-60-2	3.1E+04	1.7E-01
SVOC/CLP	4-Chloro-3-methylphenol	59-50-7	NC	1.7E-01
SVOC/CLP	2-Methylnaphthalene	91-57-6	3.1E+02	1.7E-01
SVOC/CLP	Hexachlorocyclopentadiene	77-47-4	3.7E+02	1.7E-01
SVOC/CLP	2,4,6-Trichlorophenol	88-06-2	4.4E+01	1.7E-01
SVOC/CLP	2,4,5-Trichlorophenol	95-95-4	6.1E+03	1.7E-01
SVOC/CLP	1,1-Biphenyl	92-52-4	5.1E+01	1.7E-01
SVOC/CLP	2-Chloronaphthalene	91-58-7	6.3E+03	1.7E-01
SVOC/CLP	2-Nitroaniline	88-74-4	6.1E+02	3.3E-01
SVOC/CLP	Dimethylphthalate	131-11-3	NC	1.7E-01
SVOC/CLP	2,6-Dinitrotoluene	606-20-2	6.1E+01	1.7E-01
SVOC/CLP	Acenaphthylene	208-96-8	NC	1.7E-01
SVOC/CLP	3-Nitroaniline	99-09-2	NC	3.3E-01
SVOC/CLP	Acenaphthene	83-32-9	3.4E+03	1.7E-01
SVOC/CLP	2,4-Dinitrophenol	51-28-5	1.2E+02	3.3E-01
SVOC/CLP	Dibenzofuran	132-64-9	NC	1.7E-01
SVOC/CLP	2,4-Dinitrotoluene	121-14-2	1.6E+00	1.7E-01
SVOC/CLP	Diethylphthalate	84-66-2	4.9E+04	1.7E-01
SVOC/CLP	Fluorene	86-73-7	2.3E+03	1.7E-01
SVOC/CLP	4-Chlorophenyl-phenyl ether	7005-72-3	NC	1.7E-01
SVOC/CLP	4-Nitroaniline	100-01-6	2.4E+01	3.3E-01
SVOC/CLP	2-Methyl-4,6-dinitrophenol	534-52-1	NC	3.3E-01
SVOC/CLP	N-Nitrosodiphenylamine	86-30-6	9.9E+01	1.7E-01
SVOC/CLP	1,2,4,5-Tetrachlorobenzene	95-94-3	1.8E+01	1.7E-01
SVOC/CLP	4-Bromophenyl-phenylether	101-55-3	NC	1.7E-01
SVOC/CLP	Hexachlorobenzene	118-74-1	3.0E-01	1.7E-01
SVOC/CLP	Atrazine	1912-24-9	2.1E+00	1.7E-01

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
SVOC/CLP	Pentachlorophenol	87-86-5	8.9E-01	3.3E-01
SVOC/CLP	Phenanthrene	85-014-8	NC	1.7E-01
SVOC/CLP	Anthracene	20-12-7	1.7E+04	1.7E-01
SVOC/CLP	Carbazole	86-74-8	NC	1.7E-01
SVOC/CLP	Di-n-butylphthalate	84-74-2	6.1E+03	1.7E-01
SVOC/CLP	Fluoranthene	206-44-0	2.3E+03	1.7E-01
SVOC/CLP	Pyrene	129-00-0	1.7E+03	1.7E-01
SVOC/CLP	Butylbenzylphthalate	85-68-7	2.6E+02	1.7E-01
SVOC/CLP	3,3’-Dichlorobenzidine	91-94-1	1.1E+00	1.7E-01
SVOC/CLP	Benzo(a)anthracene	56-55-3	1.5E-01	1.7E-01
SVOC/CLP	Benzo(b)fluoranthene	205-99-2	1.5E-01	1.7E-01
SVOC/CLP	Benzo(k)fluoranthene	207-08-9	1.5E+00	1.7E-01
SVOC/CLP	Chrysene	218-01-9	1.3E+01	1.7E-01
SVOC/CLP	bis(2-Ethylhexyl)phthalate	117-81-7	3.5E+01	1.7E-01
SVOC/CLP	Di-n-octylphthalate	117-84-0	NC	1.7E-01
SVOC/CLP	Benzo(a) pyrene	50-32-8	1.5E-02	1.7E-01
SVOC/CLP	Indeno(1,2,3,-cd)pyrene	193-39-5	1.5E-01	1.7E-01
SVOC/CLP	Dibenzo(a,h)anthracene	53-70-3	1.5E-02	1.7E-01
SVOC/CLP	Benzo(g,h,i) perylene	191-24-2	NC	1.7E-01
SVOC/CLP	2,3,4,6-Tetrachlorophenol	58-90-2	1.8E+03	1.7E-01
PCB/CLP	Aroclor-1016	12674-11-2	3.9E+00	3.3E-02
PCB/CLP	Aroclor-1221	11104-28-2	1.4E-01	3.3E-02
PCB/CLP	Aroclor-1232	11141-16-5	1.4E-01	3.3E-02
PCB/CLP	Aroclor-1242	53469-21-9	2.2E-01	3.3E-02
PCB/CLP	Aroclor-1248	12672-29-6	2.2E-01	3.3E-02
PCB/CLP	Aroclor-1254	11097-69-1	2.2E-01	3.3E-02
PCB/CLP	Aroclor-1260	11096-82-5	2.2E-01	3.3E-02
PCB/CLP	Aroclor-1268	11100-14-4	2.2E-01	3.3E-02
Pesticides/CLP	alpha-BHC	319-84-6	7.7E-02	1.7E-03
Pesticides/CLP	Beta-BHC	319-85-7	2.7E-01	1.7E-03
Pesticides/CLP	delta-BHC	319-86-8	2.7E-01	1.7E-03
Pesticides/CLP	gamma-BHC (Lindane)	58-89-9	5.2E-01	1.7E-03
Pesticides/CLP	Heptachlor	76-44-8	1.1E-01	1.7E-03
Pesticides/CLP	Aldrin	309-00-2	2.9E-02	1.7E-03

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
Pesticides/CLP	Heptachlor epoxide	1024-57-3	5.3E-02	1.7E-03
Pesticides/CLP	Endosulfan I	115-29-7	3.7E+02	1.7E-03
Pesticides/CLP	Dieldrin	60-57-1	3.0E-02	3.3E-03
Pesticides/CLP	4,4'-DDE	72-55-9	1.4E+00	3.3E-03
Pesticides/CLP	Endrin	72-20-8	1.8E+01	3.3E-03
Pesticides/CLP	Endosulfan II	115-29-7	3.7E+02	3.3E-03
Pesticides/CLP	4,4'-DDD	72-54-8	2.0E+00	3.3E-03
Pesticides/CLP	4,4'-DDT	50-29-3	1.7E+00	3.3E-03
Pesticides/CLP	Endosulfan sulfate	1031-07-8	3.7E+02	3.3E-03
Pesticides/CLP	Methoxychlor	72-43-5	3.1E+02	1.7E-02
Pesticides/CLP	Endrin ketone	72-20-8	1.8E+01	3.3E-03
Pesticides/CLP	Endrin aldehyde	72-20-8	1.8E+01	3.3E-03
Pesticides/CLP	alpha-Chlordane	57-74-9	1.6E+00	1.7E-03
Pesticides/CLP	gamma-Chlordane	57-74-9	1.6E+00	1.7E-03
Pesticides/CLP	Toxaphene	8001-35-2	4.4E-01	1.7E-01
Metals/CLP	Aluminum	7429-90-5	7.7E+04	2.0E+01
Metals/CLP	Antimony	7440-36-0	3.1E+01	6.0E+00
Metals/CLP	Arsenic	7440-38-2	3.9E-01	1.0E+00
Metals/CLP	Barium	7440-39-3	1.5E+04	2.0E+01
Metals/CLP	Beryllium	7440-41-7	1.6E+02	5.0E-01
Metals/CLP	Cadmium	7440-43-9	7.0E+01	5.0E-01
Metals/CLP	Calcium	17852-99-2	NC	5.0E+02
Metals/CLP	Chromium	7440-47-3	1.2E+05	1.0E+00
Metals/CLP	Cobalt	7440-48-4	2.3E+01	5.0E+00
Metals/CLP	Copper	7440-50-8	3.1E+03	2.5E+00
Metals/CLP	Iron	7439-89-6	5.5E+04	1.0E+01
Metals/CLP	Lead	7439-92-1	4.0E+02	1.0E+00
Metals/CLP	Magnesium	7439-95-4	NC	5.0E+02
Metals/CLP	Manganese	7439-96-5	1.8E+03	1.5E+00
Metals/CLP	Mercury	7439-97-6	2.3E+01	1.0E-01
Metals/CLP	Nickel	7440-02-0	1.5E+03	4.0E+00
Metals/CLP	Potassium	7440-22-4	NC	5.0E+02
Metals/CLP	Selenium	7782-49-2	3.9E+02	3.5E+00
Metals/CLP	Silver	7440-22-4	3.9E+02	1.0E+00

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit - Soil (mg/kg)[1]	CRQL - Soil (mg/kg)
Metals/CLP	Sodium	7440-23-5	NC	5.0E+02
Metals/CLP	Thallium	7440-28-0	7.8E-01	2.5E+00
Metals/CLP	Vanadium	7440-62-2	3.9E+02	5.0E+00
Metals/CLP	Zinc	7440-66-6	2.3E+04	6.0E+00
Metals/CLP	Cyanide	74-90-8	1.6E+03	5.0E-01
Herbicides/CLP SAS	Acifluorfen	62476-59-9	NC	NC
Herbicides/CLP SAS	Chloramben	133-90-4	9.2E+02	1.0E-02
Herbicides/CLP SAS	2,4-D	94-75-7	6.9E+02	3.3E-04
Herbicides/CLP SAS	Dalapon	75-99-0	1.8E+03	3.3E-04
Herbicides/CLP SAS	2,4-DB	94-82-6	4.9E+02	NC
Herbicides/CLP SAS	Dicamba	1918-00-9	1.8E+03	NC
Herbicides/CLP SAS	Dichloroprop	120-36-5	NC	NC
Herbicides/CLP SAS	Dinoseb	88-85-7	6.1E+01	NC
Herbicides/CLP SAS	MCPA	94-74-6	3.1E+01	1.29E-01
Herbicides/CLP SAS	MCPP	93-65-2	6.1E+01	1.98E-01
Herbicides/CLP SAS	4-Nitrophenol	100-02-1	NC	1.02E-03
Herbicides/CLP SAS	Pentachlorophenol	87-86-5	8.9E-01	4.8E-04
Herbicides/CLP SAS	Picloram	1918-02-1	4.3E+03	NC
Herbicides/CLP SAS	2,4,5-T	93-76-5	6.1E+02	NC
Herbicides/CLP SAS	2,4,5-TP (Silvex)	93-72-1	4.9E+02	8.4E-04

Notes:

CAS	Chemical Abstract Services
CRQL	Contract-required quantitation limit
mg/kg	Milligram per kilogram`
NC	No criteria

1 U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011 (EPA 2011). Values listed are “resident soil” screening levels.

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Reference Limits Table –Water, Low Concentration

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
VOC/CLP	Dichlorodifluoromethane	75-71-8	1.9E+02	5.0E+00
VOC/CLP	Chloromethane	74-87-3	1.9E+02	5.0E+00
VOC/CLP	Vinyl chloride	75-01-4	2.0E+00[2]	5.0E+00
VOC/CLP	Bromomethane	74-83-9	7.0E+00	5.0E+00
VOC/CLP	Chloroethane	75-00-3	2.1E+04	5.0E+00
VOC/CLP	Trichlorofluoromethane	75-69-4	1.1E+03	5.0E+00
VOC/CLP	1,1-Dichloroethene	75-35-4	2,6E+02	5.0E+00
VOC/CLP	Acetone	67-64-1	1.2E+04	1.0E+01
VOC/CLP	Carbon disulfide	75-15-0	1.0E+03	5.0E+00
VOC/CLP	Methyl acetate	79-20-9	3.7E+04	5.0E+00
VOC/CLP	Methylene chloride	75-09-2	4.8E+00	5.0E+00
VOC/CLP	trans-1,2-Dichloroethene	156-50-5	1.1E+02	5.0E+00
VOC/CLP	Methyl tert-butyl ether	1634-04-4	1.2E+01	5.0E+00
VOC/CLP	1,1-Dichloroethane	75-34-3	2.4E+00	5.0E+00
VOC/CLP	cis-1,2-Dichloroethene	156-59-2	7.3E+02	5.0E+00
VOC/CLP	2-Butanone	78-93-3	7.1E+03	1.0E+01
VOC/CLP	Bromochloromethane	74-97-5	8.3E+01	5.0E+00
VOC/CLP	Chloroform	67-66-3	1.9E-01	5.0E+00
VOC/CLP	1,1,1-Trichloroethane	71-55-6	9.1E+03	5.0E+00
VOC/CLP	Cyclohexane	110-82-7	1.3E+04	5.0E+00
VOC/CLP	Carbon tetrachloride	56-23-5	5.0E+00[2]	5.0E+00
VOC/CLP	Benzene	71-43-2	5.0E+00[2]	5.0E+00
VOC/CLP	1,2-Dichloroethane	107-06-2	5.0E+00[2]	5.0E+00
VOC/CLP	1,4-Dioxane	123-91-1	6.7E-01	1.0E+02
VOC/CLP	Trichloroethene	79-01-6	5.0E+00[2]	5.0E+00
VOC/CLP	Methylcyclohexane	108-87-2	NC	5.0E+00
VOC/CLP	1,2-Dichloropropane	78-87-5	5.0E+00[2]	5.0E+00
VOC/CLP	Bromodichloromethane	75-27-4	1.2E-01	5.0E+00
VOC/CLP	cis-1,3-Dichloropropene	542-75-6	4.3E-01	5.0E+00

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
VOC/CLP	4-Methyl-2-pentanone	108-10-1	2.0E+03	1.0E+01
VOC/CLP	Toluene	108-88-3	2.3E+03	5.0E+00
VOC/CLP	trans-1,3-Dichloropropene	10061-02-6	4.3E-01	5.0E+00
VOC/CLP	1,1,2-Trichloroethane	79-00-5	5.0E+00[2]	5.0E+00
VOC/CLP	Tetrachloroethene	127-18-4	5.0E+00[2]	5.0E+00
VOC/CLP	2-Hexanone	591-78-6	4.7E+01	1.0E+01
VOC/CLP	Dibromochloromethane	124-48-1	8.0E-01	5.0E+00
VOC/CLP	1,2-Dibromoethane	106-93-4	5.0E-022	5.0E+00
VOC/CLP	Chlorobenzene	108-90-7	9.1E+01	5.0E+00
VOC/CLP	Ethylbenzene	100-41-4	7.0E+02[2]	5.0E+00
VOC/CLP	o-Xylene	95-47-6	2.0E+02	5.0E+00
VOC/CLP	m,p-Xylene	179601-23-1	2.0E+02	5.0E+00
VOC/CLP	Styrene	100-42-5	1.6E+03	5.0E+00
VOC/CLP	Bromoform	75-25-2	8.5E+00	5.0E+00
VOC/CLP	1,1,2,2-Tetrachloroethane	79-34-5	6.7E-02	5.0E+00
VOC/CLP	1,3-Dichlorobenzene	541-73-1	NC	5.0E+00
VOC/CLP	1,4-Dichlorobenzene	106-45-7	7.5E+012	5.0E+00
VOC/CLP	1,2-Dichlorobenzene	95-50-1	3.7E+02	5.0E+00
VOC/CLP	1,2-Dibromo-3-chloropropane	96-12-8	2.0E-01[2]	5.0E+00
VOC/CLP	1,2,4-Trichlorobenzene	120-82-1	7.0E+01[2]	5.0E+00
VOC/CLP	1,2,3-Trichlorobenzene	87-61-6	2.9E+01	5.0E+00
SVOC/CLP	Benzaldehyde	100-52-7	1.5E+03	5.0E+00
SVOC/CLP	Phenol	108-95-2	7.3E+03	5.0E+00
SVOC/CLP	bis (2-chloroethyl) ether	111-44-4	1.2E-02	5.0E+00
SVOC/CLP	2-Chlorophenol	95-57-8	7.1E+01	5.0E+00
SVOC/CLP	2-Methylphenol	95-48-7	7.2E+02	5.0E+00
SVOC/CLP	2,2'-Oxybis(1-chloropropane)	108-60-1	3.2E-01	5.0E+00
SVOC/CLP	4-Methylphenol	106-44-5	1.8E+02	5.0E+00
SVOC/CLP	Acetophenone	98-86-2	3.7E+03	5.0E+00
SVOC/CLP	N-Nitroso-di-n-propylamine	621-64-7	9.6E-03	5.0E+00
SVOC/CLP	Hexachloroethane	67-72-1	4.8E+00	5.0E+00

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
SVOC/CLP	Nitrobenzene	98-95-3	1.2E-01	5.0E+00
SVOC/CLP	Isophorone	78-59-1	7.1E+01	5.0E+00
SVOC/CLP	2-Nitrophenol	88-75-5	NC	5.0E+00
SVOC/CLP	2,4-Dimethylphenol	105-67-9	7.3E+02	5.0E+00
SVOC/CLP	2,4-Dichlorophenol	120-83-2	1.1E+02	5.0E+00
SVOC/CLP	Naphthalene	91-20-3	1.4E-01	5.0E+00
SVOC/CLP	4-Chloroaniline	106-47-8	3.4E-01	5.0E+00
SVOC/CLP	Hexachlorobutadiene	87-68-3	8.6E-01	5.0E+00
SVOC/CLP	Caprolactam	105-60-2	1.8E+04	5.0E+00
SVOC/CLP	4-Chloro-3-methylphenol	59-50-7	NC	5.0E+00
SVOC/CLP	2-Methylnaphthalene	91-57-6	1.5E+02	5.0E+00
SVOC/CLP	Hexachlorocyclopentadiene	77-47-4	2.2E+02	5.0E+00
SVOC/CLP	2,4,6-Trichlorophenol	88-06-2	6.1E+00	5.0E+00
SVOC/CLP	2,4,5-Trichlorophenol	95-95-4	3.7E+03	5.0E+00
SVOC/CLP	1,1-Biphenyl	92-52-4	8.3E-01	5.0E+00
SVOC/CLP	2-Chloronaphthalene	91-58-7	2.9E+03	5.0E+00
SVOC/CLP	2-Nitroaniline	88-74-4	3.7E+02	1.0E+01
SVOC/CLP	4,6-Dinitro-2-methylphenol	534-52-1	NC	1.0E+01
SVOC/CLP	N-Nitrosodiphenylamine	86-30-6	1.4E+01	5.0E+00
SVOC/CLP	1,2,4,5-Tetrachlorobenzene	95-94-3	1.1E+01	5.0E+00
SVOC/CLP	Hexachlorobenzene	118-74-1	4.2E-02	5.0E+00
SVOC/CLP	2,4,6-Trichlorophenol	88-06-2	6.1E+00	5.0E+00
SVOC/CLP	2,4,5-Trichlorophenol	95-95-4	3.7E+03	5.0E+00
SVOC/CLP	Dimethylphthalate	131-11-3	NC	5.0E+00
SVOC/CLP	2,6-Dinitrotoluene	606-20-2	3.7E+01	5.0E+00
SVOC/CLP	Acenaphthylene	208-96-8	NC	5.0E+00
SVOC/CLP	3-Nitroaniline	99-09-2	NC	1.0E+01
SVOC/CLP	Acenaphthene	83-32-9	2.2E+03	5.0E+00
SVOC/CLP	2,4-Dinitrophenol	51-28-5	7.3E+01	1.0E+01
SVOC/CLP	4-Nitrophenol	100-02-7	NC	1.0E+01
SVOC/CLP	Dibenzofuran	132-64-9	NC	5.0E+00

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
SVOC/CLP	2,4-Dinitrotoluene	121-14-2	2.2E-01	5.0E+00
SVOC/CLP	Diethylphthalate	84-66-2	2.9E+04	5.0E+00
SVOC/CLP	Fluorene	86-73-7	1.5E+03	5.0E+00
SVOC/CLP	4-Chlorophenyl-phenyl ether	7005-72-3	NC	5.0E+00
SVOC/CLP	4-Nitroaniline	100-01-6	3.4E+00	1.0E+01
SVOC/CLP	Atrazine	1912-24-9	2.9E-01	5.0E+00
SVOC/CLP	Pentachlorophenol	87-86-5	1.7E-01	1.0E+01
SVOC/CLP	Phenanthrene	85-014-8	NC	5.0E+00
SVOC/CLP	Anthracene	20-12-7	1.1E+04	5.0E+00
SVOC/CLP	Carbazole	86-74-8	NC	5.0E+00
SVOC/CLP	Di-n-butylphthalate	84-74-2	3.7E+03	5.0E+00
SVOC/CLP	Fluoranthene	206-44-0	1.5E+03	5.0E+00
SVOC/CLP	Pyrene	129-00-0	1.1E+03	5.0E+00
SVOC/CLP	Butylbenzylphthalate	85-68-7	3.5E+01	5.0E+00
SVOC/CLP	3,3’-Dichlorobenzidine	91-94-1	1.5E-01	5.0E+00
SVOC/CLP	Benzo(a)anthracene	56-55-3	2.9E-02	5.0E+00
SVOC/CLP	Chrysene	218-01-9	2.9E+00	5.0E+00
SVOC/CLP	Bis (2-ethylhexyl) phthalate	117-81-7	4.8E+00	5.0E+00
SVOC/CLP	Di-n-octylphthalate	117-84-0	NC	5.0E+00
SVOC/CLP	Benzo(b)fluoranthene	205-99-2	2.9E-02	5.0E+00
SVOC/CLP	Benzo(k)fluoranthene	207-08-9	2.9E-01	5.0E+00
SVOC/CLP	Benzo(a)pyrene	50-32-8	2.9E-03	5.0E+00
SVOC/CLP	Indeno(1,2,3,-cd) pyrene	193-39-5	2.9E-02	5.0E+00
SVOC/CLP	Dibenzo(a,h) anthracene	53-70-3	2.9E-03	5.0E+00
SVOC/CLP	Benzo(g,h,i)perylene	191-24-2	NC	5.0E+00
SVOC/CLP	2,3,4,6-Tetrachlorophenol	58-90-03	1.1E+03	5.0E+00
Metals/CLP	Aluminum	7429-90-5	1.6E+04	2.0E+02
Metals/CLP	Antimony	7440-36-0	6.0E+00	6.0E+01
Metals/CLP	Arsenic	7440-38-2	1.0E+01[2]	1.0E+01
Metals/CLP	Barium	7440-39-3	7.3E+03	2.0E+02

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
Metals/CLP	Beryllium	7440-41-7	7.3E+01	5.0E+00
Metals/CLP	Cadmium	7440-43-9	1.8E+01	5.0E+00
Metals/CLP	Calcium	17852-99-2	NC	5.0E+03
Metals/CLP	Chromium	7440-47-3	5.5E+04	1.0E+01
Metals/CLP	Cobalt	7440-48-4	1.1E+01	5.0E+01
Metals/CLP	Copper	7440-50-8	1.5E+03	2.5E+01
Metals/CLP	Iron	7439-89-6	2.6E+04	1.0E+02
Metals/CLP	Lead	7439-92-1	1.5E+01[2]	1.0E+01
Metals/CLP	Magnesium	7439-95-4	NC	5.0E+03
Metals/CLP	Manganese	7439-96-5	8.8E+02	1.5E+01
Metals/CLP	Mercury	7439-97-6	1.1E+01	2.0E-01
Metals/CLP	Nickel	7440-02-0	7.3E+02	4.0E+01
Metals/CLP	Potassium	7440-22-4	NC	5.0E+03
Metals/CLP	Selenium	7782-49-2	1.8E+02	3.5E+01
Metals/CLP	Silver	7440-22-4	1.8E+02	1.0E+01
Metals/CLP	Sodium	7440-23-5	NC	5.0E+03
Metals/CLP	Thallium	7440-28-0	3.7E-01	2.5E+01
Metals/CLP	Vanadium	7440-62-2	1.8E+02	5.0E+01
Metals/CLP	Zinc	7440-66-6	1.8E+04	6.0E+01
Metals/CLP	Cyanide	74-90-8	7.3E+02	1.0E+01

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Water--Trace Concentration

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
VOC/CLP Trace	Dichlorodifluoromethane	75-71-8	2.0E+02	5.0E-01
VOC/CLP Trace	Chloromethane	74-87-3	1.5E+02	5.0E-01
VOC/CLP Trace	Vinyl chloride	75-01-4	2.0E+02[2]	5.0E-01
VOC/CLP Trace	Bromomethane	74-83-9	8.7E+00	5.0E-01
VOC/CLP Trace	Chloroethane	75-00-3	2.1E+04	5.0E-01
VOC/CLP Trace	Trichlorofluoromethane	75-69-4	1.3E+03	5.0E-01
VOC/CLP Trace	1,1-Dichloroethene	75-35-4	3.4E+02	5.0E-01
VOC/CLP Trace	Acetone	67-64-1	2.2E+04	5.0E+00
VOC/CLP Trace	Carbon disulfide	75-15-0	1.0E+03	5.0E-01
VOC/CLP Trace	Methyl acetate	79-20-9	3.7E+04	5.0E-01
VOC/CLP Trace	Methylene chloride	75-09-2	4.8E+00	5.0E-01
VOC/CLP Trace	trans-1,2-Dichloroethene	156-50-5	1.1E+02	5.0E-01
VOC/CLP Trace	Methyl tert-butyl ether	1634-04-4	1.2E+01	5.0E-01
VOC/CLP Trace	1,1-Dichloroethane	75-34-3	2.4E+00	5.0E-01
VOC/CLP Trace	cis-1,2-Dichloroethene	156-59-2	7.3E+02	5.0E-01
VOC/CLP Trace	2-Butanone	78-93-3	7.1E+03	5.0E+00
VOC/CLP Trace	Bromochloromethane	74-97-5	8.3E+01	5.0E-01
VOC/CLP Trace	Chloroform	67-66-3	1.9E-01	5.0E-01
VOC/CLP Trace	1,1,1-Trichloroethane	71-55-6	9.1E+03	5.0E-01
VOC/CLP Trace	Cyclohexane	110-82-7	1.3E+04	5.0E-01
VOC/CLP Trace	Carbon tetrachloride	56-23-5	5.0E+00[2]	5.0E-01
VOC/CLP Trace	Benzene	71-43-2	5.0E+00[2]	5.0E-01
VOC/CLP Trace	1,2-Dichloroethane	107-06-2	5.0E+00[2]	5.0E-01
VOC/CLP Trace	1,4-Dioxane	123-91-1	6.7E-01	NA
VOC/CLP Trace	Trichloroethene	79-01-6	5.0E+00[2]	5.0E-01
VOC/CLP Trace	Methylcyclohexane	108-87-2	NC	5.0E-01
VOC/CLP Trace	1,2-Dichloropropane	78-87-5	5.0E+00[2]	5.0E-01
VOC/CLP Trace	Bromodichloromethane	75-27-4	1.2E-01	5.0E-01
VOC/CLP Trace	cis-1,3-Dichloropropene	542-75-6	4.3E-01	5.0E-01
VOC/CLP Trace	4-Methyl-2-pentanone	108-10-1	2.0E+03	5.0E+00

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Water (µg/L)[1]	CRQL - Water (µg/L)
VOC/CLP Trace	Toluene	108-88-3	2.3E+03	5.0E-01
VOC/CLP Trace	trans-1,3-Dichloropropene	10061-02-6	4.3E-01	5.0E-01
VOC/CLP Trace	1,1,2-Trichloroethane	79-00-5	5.0E+00[2]	5.0E-01
VOC/CLP Trace	Tetrachloroethene	127-18-4	5.0E+00[2]	5.0E-01
VOC/CLP Trace	2-Hexanone	591-78-6	4.7E+01	5.0E+00
VOC/CLP Trace	Dibromochloromethane	124-48-1	8.0E-01	5.0E-01
VOC/CLP Trace	1,2-Dibromoethane	106-93-4	5.0E-02[2]	5.0E-02
VOC/CLP Trace	Chlorobenzene	108-90-7	9.1E+01	5.0E-01
VOC/CLP Trace	Ethylbenzene	100-41-4	7.0E+02[2]	5.0E-01
VOC/CLP Trace	o-Xylene	95-47-6	2.0E+02	5.0E-01
VOC/CLP Trace	m,p-Xylene	179601-23-1	2.0E+02	5.0E-01
VOC/CLP Trace	Styrene	100-42-5	1.6E+03	5.0E-01
VOC/CLP Trace	Bromoform	75-25-2	8.5E+00	5.0E-01
VOC/CLP Trace	1,1,2,2-Tetrachloroethane	79-34-5	6.7E-02	5.0E-01
VOC/CLP Trace	1,3-Dichlorobenzene	541-73-1	NC	5.0E-01
VOC/CLP Trace	1,4-Dichlorobenzene	106-45-7	7.5E+01[2]	5.0E-01
VOC/CLP Trace	1,2-Dichlorobenzene	95-50-1	3.7E+02	5.0E-01
VOC/CLP Trace	1,2-Dibromo-3-chloropropane	96-12-8	2.0E-01[2]	5.0E-01
VOC/CLP Trace	1,2,4-Trichlorobenzene	120-82-1	7.0E+01[2]	5.0E-01
VOC/CLP Trace	1,2,3-Trichlorobenzene	87-61-6	2.9E+01	5.0E-01

Notes:

µg/L	Microgram per liter
CAS	Chemical Abstract Services
CRQL	Contract-required quantitation limit
NA	Not available
NC	No criteria

1 U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011 (EPA 2011). Values listed are ”tapwater” screening levels.

2 Maximum contaminant level (MCL), EPA. http://water.epa.gov/drink/contaminants/index.cfm

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Reference Limits Table—Soil Gas

Analytical Group	Analyte	CAS Number	Project Action Limit – Air ($\mu g/m^3$)[1]	PRQL - Air (ppbv)
VOC	Dichlorodifluoromethane	75-71-8	1.9E+02	1.0E+00
VOC	Chloromethane	74-87-3	9.4E+01	1.0E+00
VOC	Vinyl chloride	75-01-4	1.6E-01	1.0E+00
VOC	Bromomethane	77-83-9	5.2E+00	1.0E+00
VOC	Chloroethane	75-00-3	1.0E+04	1.0E+00
VOC	Trichlorofluoromethane	75-69-4	7.3E+02	1.0E+00
VOC	1,1-Dichloroethene	75-35-4	2.1E+02	1.0E+00
VOC	Acetone	67-64-1	3.2E+04	1.0E+01
VOC	Carbon disulfide	75-15-0	7.2E+02	1.0E+00
VOC	Methyl acetate	79-20-9	NC	1.0E+00
VOC	Methylene chloride	75-09-2	5.2E+00	1.0E+00
VOC	trans-1,2-Dichloroethene	156-50-5	6.3E+01	1.0E+00
VOC	Methyl tert-butyl ether	1634-04-4	9.4E+00	1.0E+00
VOC	1,1-Dichloroethane	75-34-3	1.5E+00	1.0E+00
VOC	cis-1,2-Dichloroethene	156-59-2	NC	1.0E+00
VOC	2-Butanone	78-93-3	5.2E+03	1.0E+01
VOC	Bromochloromethane	74-97-5	4.2E+01	1.0E+00
VOC	Chloroform	67-66-3	1.1E-01	1.0E+00
VOC	1,1,1-Trichloroethane	71-55-6	5.2E+03	1.0E+00
VOC	Cyclohexane	110-82-7	6.3E+03	1.0E+00
VOC	Carbon tetrachloride	56-23-5	4.1E-01	1.0E+00
VOC	Benzene	71-43-2	3.1E-01	1.0E+00
VOC	1,2-Dichloroethane	107-06-2	9.4E-02	1.0E+00
VOC	1,4-Dioxane	123-91-1	3.2E-01	1.0E+02
VOC	Trichloroethene	79-01-6	1.2E+00	1.0E+00
VOC	Methylcyclohexane	108-87-2	NC	1.0E+00
VOC	1,2-Dichloropropane	78-87-5	2.4E-01	1.0E+00
VOC	Bromodichloromethane	75-27-4	6.6E-02	1.0E+00
VOC	cis-1,3-Dichloropropene	542-75-6	6.1E-01	1.0E+00
VOC	4-Methyl-2-pentanone	108-10-1	3.1E+03	1.0E+01

QAPP WORKSHEET #15 (CONTINUED)
SUMMARY OF PROJECT TASKS

Analytical Group	Analyte	CAS Number	Project Action Limit – Air (µg/m^3)[1]	PRQL - Air (ppbv)
VOC	Toluene	108-88-3	5.2E+03	1.0E+00
VOC	trans-1,3-Dichloropropene	10061-02-6	6.1E-01	1.0E+00
VOC	1,1,2-Trichloroethane	79-00-5	1.5E-01	1.0E+00
VOC	Tetrachloroethene	127-18-4	4.1E-01	1.0E+00
VOC	2-Hexanone	591-78-6	3.1E+01	1.0E+01
VOC	Dibromochloromethane	124-48-1	9.0E-02	1.0E+00
VOC	1,2-Dibromoethane	106-93-4	4.1E-03	1.0E+00
VOC	Chlorobenzene	108-90-7	5.2E+01	1.0E+00
VOC	Ethylbenzene	100-41-4	9.7E-01	1.0E+00
VOC	o-Xylene	95-47-6	1.0E+02	1.0E+00
VOC	m,p-Xylene	179601-23-1	1.0E+02	1.0E+00
VOC	Styrene	100-42-5	1.0E+03	1.0E+00
VOC	Bromoform	75-25-2	2.2E+00	1.0E+00
VOC	1,1,2,2-Tetrachloroethane	79-34-5	4.2E-02	1.0E+00
VOC	1,3-Dichlorobenzene	541-73-1	NC	1.0E+00
VOC	1,4-Dichlorobenzene	106-46-7	2.2E-01	1.0E+00
VOC	1,2-Dichlorobenzene	95-50-1	2.1E+02	1.0E+00
VOC	1,2-Dibromo-3-chloropropane	96-12-8	1.6E-04	1.0E+00
VOC	1,2,4-Trichlorobenzene	120-82-1	2.1E+00	1.0E+00
VOC	1,2,3-Trichlorobenzene	87-61-6	NC	1.0E+00

Notes:

µg/m^3	Microgram per cubic meter
ppbv	Parts per billion by volume
CAS	Chemical Abstract Services
PRQL	Project-required quantitation limit
NC	No criteria

[1] U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011 (EPA 2011). Values listed are “resident air” screening levels.

QAPP WORKSHEET #16
PROJECT SCHEDULE/TIMELINE TABLE

Activity	Organization	Date Anticipated Date of Initiation	Date Anticipated Date of Completion	Deliverable	Deliverable Due Date
Field sampling	SulTRAC	May 2012	July 2012[2]	Phase II FSP Phase II QAPP	April 2012
Phase II Data Validation[1]	SulTRAC	August 2012	November 2012[2]	Phase II Data Validation Report	45 days after receipt of Phase I validated data

Note:

[1] Data evaluation and validation will occur after each sampling event.
[2] Completion date based upon availability of subcontractors and SAP approval for May 2012 event

QAPP WORKSHEET #17
SAMPLING DESIGN AND RATIONALE

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be collected, and the sampling frequency (including seasonal considerations). Based on the analytical results obtained during preliminary investigations by IDEM in 1999 and 2000, three source areas were identified as potentially contributing to the groundwater contamination at the Elm Street site. Previous investigations had determined that surface and subsurface contamination existed at the Gurman and Ashland properties. Groundwater contamination has been detected in monitoring wells near the Gurman, Ashland, and MTS properties, along with contamination detected in municipal supply wells located on the IAWC property. Primary contaminants of concern detected in the preliminary investigations include, PCE, TCE, *trans*-1,2-DCE, 1,1,1-TCA, and 1,1-DCA. The full list of contaminants of concern detected in preliminary investigations and sampling rationale for soil, groundwater, and soil gas are detailed in the Data Evaluation Summary Report (SulTRAC, 2012b). Based upon results of previous investigations, the source areas contributing to contamination and the nature and extent of the contamination at the site have not been delineated. The Phase I investigation provided some of the data required to evaluate whether the identified properties are potential contamination source areas, whether potential additional contamination source areas exist upgradient of the Gurman property, the concentrations and depths of contamination in soil at the identified properties, the impact to shallow and deep groundwater beneath the site, whether vapor intrusion is occurring at the Riverside apartment complex, and other potential soil gas receptors at the MTS and Gurman properties.

SulTRAC will conduct Phase II field activities including collecting the following samples: surface and subsurface soil samples from 71 soil borings; grab groundwater samples from 29 of the 62 soil borings; groundwater samples from 27 existing and seven new monitoring wells, and 4 IAWC wells; and 30 soil gas samples from 15 locations. Sampling locations are depicted in detail on Figure 4. Location specific analysis is detailed on Table 2 of this document in the attachments.

Surface soil, subsurface soil, and groundwater samples will be collected from 29 borings in the potential source areas. The soil sample depth intervals will be from 0-2 feet bgs, 2-10 feet bgs, 10-20 feet bgs, and 20-40 feet bgs. The borings will be located in the four quadrants as follows: (12) soil borings will be located on or in the general vicinity of the Gurman property, (9) borings will be advanced at locations of existing and new soil gas wells in the vicinity of the Riverside Apartment building (3) soil borings will be located west of the tank containment on the former Sinclair property; and (5) soil borings will be located on the MTS property. An additional 33 shallow soil borings will also be sampled; sampling depth intervals for 32 will be from 0-2 feet bgs and from 2-4 feet bgs, the remaining two borings will be sampled from 0-2 feet bgs and a 2-foot interval within the 2-10 feet bgs zone. Soil samples will be analyzed for VOCs, with select samples also being analyzed for SVOCs, metals, PCBs, pesticides, and herbicides. Grab groundwater samples will be analyzed for VOCs.

Soil gas samples will be collected from the area around the Riverside Apartment Complex located at the corner of North 1st Street and Locust Streets and north of the Elm Street site. Nine additional paired sets of soil gas wells and one replacement soil gas well will be installed and sampled along with the existing 6 paired sets of soil gas wells onsite. Three paired soil gas wells will be installed between the utility corridor along 2nd street and the Riverside Apartment complex. Three paired soil gas wells each will be installed around the perimeter of the Gurman and MTS properties.

QAPP Worksheet #17 (Continued)
Sampling Design and Rationale

Soil gas samples from new wells will be analyzed by a subcontracted laboratory. All soil gas samples from existing soil gas wells will be analyzed for VOCs through EPA's CLP.

SulTRAC will install an additional three nested pairs of monitoring wells and one replacement deep well at location MW-13D to delineate the extent of groundwater contamination, as well as to begin groundwater characterization on site. Each pair of nested monitoring wells will consist of one shallow well and one deep well. Shallow monitoring wells will be installed with 10 foot screens extending to approximately 40 to 55 feet bgs in the upper portion of the first water-bearing zone. Deep monitoring wells will be installed with 10 foot screens installed in the deeper portion of the first water-bearing zone between approximately 120 and 140 feet bgs, just above the shale bedrock formation. All monitoring wells will be developed upon completion of installation. After development, one round of groundwater sampling will be conducted on all monitoring wells. Groundwater samples from shallow wells will be analyzed for VOCs, and filtered and unfiltered Total Metals (including cyanide and mercury). Groundwater samples from deep wells will be analyzed for VOCs and filtered and unfiltered Total Metals (including cyanide and mercury). Groundwater from the IAWC wells will be analyzed for VOCs.

A full list of sample locations and analysis is identified in Table 2 of the Attachments. Sample locations are depicted on Figure 4.

SulTRAC will assess data from the soil, and groundwater samples for the analytical groups listed above to delineate the contamination present at the Elm Street site.

QAPP WORKSHEET #18
SAMPLING LOCATIONS/IDS, SAMPLE DEPTHS, SAMPLE ANALYSES AND SAMPLING PROCEDURES TABLE

Sampling Location[1]/ ID Number	**Matrix**	**Depth (feet bgs)**	**Analytical Group**	**Sampling SOP Reference[2]**
62 locations (up to 4 depths) Soil borings	Soil[3]	0-2 2-10 10-20 20-40	CLP SOW SOM01.2 (VOCs and select samples for PCBs, SVOCs, herbicides and pesticides) CLP SOW ISM01.3 (metals, mercury, and cyanide)	S-2, S-3
30 locations (2 depths each) Soil Gas	Soil Gas[4]	5 feet and within 2 feet above water table	Method TO 15 (VOCs)	S-1
9 locations (4 depths each) VAS soil borings	Soil	0-2 2-10 10-20 20-40	CLP SOW SOM01.2 (VOCs)	S-2
29 locations Grab Groundwater from soil borings and soil gas locations	Groundwater	Water Table	EPA Method 8260B Volatiles (mobile or subcontracted laboratory)	S-6
16 locations VAS soil boring and Monitoring Wells	Groundwater	Water Table	CLP SOW SOM01.2 (VOCs)	S-6
4 locations IAWC wells	Groundwater	89.5-124	CLP SOW SOMO1.2 (VOCS)	S-6

QAPP WORKSHEET #18 (CONTINUED)
SAMPLING LOCATIONS/IDS, SAMPLE DEPTHS, SAMPLE ANALYSES AND SAMPLING PROCEDURES TABLE

Sampling Location[1]/ ID Number	Matrix	Depth (feet bgs)	Analytical Group	Sampling SOP Reference[2]
17 locations	Groundwater (Deep)[5]	125-140	CLP SOW SOM01.2 (VOCs) CLP SOW ISM01.3 (metals, mercury, and cyanide – total and dissolved)	S-6
17 locations	Groundwater (Shallow)[6]	40-55	CLP SOW SOM01.2 (VOCs,) All samples analyzed for CLP SOW ISM01.3 (metals, mercury, and cyanide)	S-6

Notes:

ID Identification

1 See Figures 4 to for sampling locations, and Table 2 for specific samples ID.
2 See Worksheet #21 for a list of sampling methods
3 Samples will be collected from soil borings.
4 Samples will be collected from installed soil gas wells.
5 Samples will be collected from 17 shallow monitoring wells, 13 existing and 4 new wells.
6 Samples will be collected from 17 deep monitoring wells, 14 existing and 3 new wells.

QAPP WORKSHEET #19
ANALYTICAL METHODS, CONTAINERS, PRESERVATIVES, AND HOLDING TIMES TABLE

Matrix	Analytical Group	Analytical and Preparation Method	Containers (number, size, type)	Preservation Requirements (chemical, temperature, etc.)	Maximum Holding Time (preparation/analysis)[1]
Soil	VOCs	CLP SOW SOM01.2	Three 40-mL glass containers with PTFE-lined septa and open-top screw caps, pre-weighed and containing magnetic stir bars and one container of sample filled with no headspace for determination of moisture content or At least three coring tools used as transport devices (for example, 5-gram samplers) and one container of sample filled with no head space for determination of moisture content	Cool to 4 °C ± 2 °C immediately after collection or Frozen (-7 ºC to -15 ºC)	48 hours to preservation at laboratory/14 days for analysis following preservation Or 48 hours (frozen) to preservation at laboratory for analysis after preservation
Soil	SVOCs	CLP SOW SOM01.2	Two 4-ounce, wide-mouth glass jars	Cool to 4 °C ± 2 °C immediately after collection	14 days/40 days
Soil	PCBs	CLP SOW SOM01.2	Two 4-ounce, wide-mouth glass jars	Cool to 4 °C ± 2 °C immediately after collection	14 days/40 days
Soil	Pesticides/herbicides	CLP SOW SOM01.2 (Herbicides by modified analysis)	Two 4-ounce, wide-mouth glass jars	Cool to 4 °C ± 2 °C immediately after collection	14 days/40 days
Soil	Metals (including mercury and cyanide)	CLP SOW ISM01.3	One 8-ounce, wide-mouth glass jar	Cool to 4 °C ± 2 °C immediately after collection	6 months 14 days (Cyanide) 28 days (Mercury)

QAPP WORKSHEET #19 (CONTINUED)
ANALYTICAL METHODS, CONTAINERS, PRESERVATIVES, AND HOLDING TIMES TABLE

Matrix	**Analytical Group**	**Analytical and Preparation Method**	**Containers (number, size, type)**	**Preservation Requirements (chemical, temperature, etc.)**	**Maximum Holding Time (preparation/analysis)** [1]
Water	VOCs	CLP SOW SOM01.2	Three 40-mL glass vials with PTFE-lined septa and open-top screw caps	No headspace Cool to 4 ºC ± 2 ºC Adjust pH to less than 2 with HCl	7/14 days
Water	SVOCs	CLP SOW SOM01.2	Two 1-liter amber glass bottles fitted with PTFE-lined screw caps	Cool to 4 °C ± 2 °C immediately after collection; keep away from light	7 days/40 days
Water	Metals, including mercury (except cyanide)	CLP SOW ILM05.4	One 1-liter high-density polyethylene bottle	Acidify to pH < 2 with HNO_3 and cool to 4 ˚C (±2 ˚C) immediately after collection	6 months 28 days (mercury) 14 days (cyanide)
Soil Gas	VOCs	Method TO 15	One Summa canisters (6 Liter)	None	Up to 30 days

Notes:

HCl	Hydrochloric acid
HNO_3	Nitric acid
mL	Milliliter
PTFE	Polytetrafluoroethylene

1 Holding time is applicable from validated time of sample receipt and is measured to time of sample extraction and analysis.

QAPP WORKSHEET #20
FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Matrix	Analytical Group	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Samples	No. of Field Duplicates[2]	No. of MS/MSDs[3]	No. of Trip Blanks[4]	No. of Equipment Rinsates	Total No. of Samples to Laboratory
Soil[5]	CLP VOCs	A-1	90	254	26	13	10	5	295
Soil[5]	CLP SVOCs	A-1	57	162	17	9	0	5	193
Soil[8]	CLP PCBs	A-1	9	18	1	1	0	1	21
Soil[8]	CLP Pesticides/Herbicides	A-1	31	16/54	7	3	0	1	81
Soil[5]	CLP Metals	A-2	12	19	2	1	0	1	23
Soil Gas	TO-15	A-3	6	12	2	NA	0	0	14
Soil Gas	TO-15		6	12	2	NA	0	0	14
Groundwater	CLP VOCs	A-1	65	65	7	3	4	4	83
Groundwater	VOCs, EPA Method 8260B	A-1	30	90	9	3	4	3	109
Groundwater	CLP SVOCs	A-1	5	5	1	1	0	1	8
Groundwater	CLP Total Metals (with cyanide and mercury)	A-2	34	34	4	3	0	2	43
Groundwater	CLP Dissolved Metals (with cyanide and mercury)	A-2	34	34	4	3	0	2	43

Notes:

Sample numbers in this table reflect field QC samples collected during each sampling event.

1 Analytical and preparation SOPs are listed in Worksheet #23.
2 Field duplicates are collected at a rate of 1 per 10 investigative samples of the same matrix.
3 MS/MSD samples are collected at a rate of 1 per 20 investigative samples of the same matrix. MS/MSDS consist of extra sample volume and are not included in the total number of samples.
4 A trip blank will be provided with each shipping container with samples to be analyzed for VOCs.

QAPP WORKSHEET #21
PROJECT SAMPLING SOP REFERENCES TABLE

Reference Number	Title, Revision, Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
S-1	Draft Vapor Intrusion Pilot Program Guidance, Appendix II, April 2006	Indiana Department of Environmental Management	Summa canister with a pressure gauge, nylon tubing	N	None
S-2	Soil Sampling, SOP 005	Tetra Tech EM Inc.	Spoon or spatulas, trowel, split-spoon sampler, coring tools	N	None
S-3	Using the Geoprobe System, SOP 054	Tetra Tech EM Inc.	Shelby tube drive head, probe drive Geoprobe Systems	N	None
S-4	Monitoring Well Installation, SOP 020	Tetra Tech EM Inc.	Casing materials, well screen materials, filter pack materials, annular sealant, grouting materials, tremie pipe, surface completion and protective casing materials, concrete surface pad and bumper post, uncontaminated water	N	None
S-5	Monitoring Well Development, SOP 021	Tetra Tech EM Inc.	Pumps, air compressors, bailers, surge blocks	N	None
S-6	Groundwater Sample Using Micropurge Technology, SOP 015	Tetra Tech EM Inc.	PID, water level indicator, adjustable flow rate pump, discharge flow controller, flow-through cell, pH probe, dissolved oxygen probe, turbidity meter, oxidation and reduction probe, sampling containers.	N	None
S-7	Packaging and Shipping Samples, SOP 019-5	Tetra Tech EM Inc.	Cooler, chain of custody form, shipping materials	N	None
S-8	General Equipment Decontamination, SOP 002	Tetra Tech EM Inc.	Scrub brushes, large wash tubs or buckets, alconox, distilled water	N	None

Notes:

SOP	Standard Operating Procedure

QAPP WORKSHEET #22
FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

Field Equipment	Calibration Activity[1]	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
Multi-parameter Water Quality Meter[1,2]	Oxidation-reduction potential: 2 standard solutions pH: 2 standard solutions Conductivity: 1 standard solution Temperature: no standard solution Turbidity: 2 standard solutions Dissolved oxygen: 2 standard solutions	Daily before first field measurement and after final field measurement	± 10 millivolts ± 0.01 pH unit ± 3% ± 0.1 °C ± 10% ± 10%	Repeat calibration; correct measurements for drift if necessary	Field team leader or field team members	F-1 (Field Measurement of Groundwater Indicator Parameters, SOP 061, Revision No. 2)	See note below
PID[2]	Gas calibration standard or equivalent	Daily before first field measurement	10% of reading < 2,000 ppm 20% of reading > 2,000 ppm	Repeat calibration; correct measurements for drift if necessary	Field team leader or field team members	F-4 (Field Measurement of Organic Vapor Air, SOP 003, Revision No. 2)	None

Notes:

SulTRAC will measure water temperature, pH, turbidity, dissolved oxygen and specific conductance in purged groundwater until these parameters have stabilized within the identified tolerance.

ppm Part per million

[1] The field equipment will be calibrated per manufacturer’s instructions.

[2] Standard solutions and gases will be provided by the vendor to calibrate these instruments.

QAPP WORKSHEET #23
ANALYTICAL SOP REFERENCES TABLE

Reference Number	Title, Revision, Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
A-1	CLP SOW SOM01.2 for Organics Analysis, Multi-Media, Multi-Concentration or SW-846 Method 8260	Definitive	VOCs, SVOCs	GC/mass spectroscopy	CLP Laboratory EPA Mobile Laboratory Subcontractor Laboratory	No
A-1	CLP SOW SOM01.2 for Organics Analysis, Multi-Media, Multi-Concentration	Definitive	PCBs, Pesticides/ Herbicides	GC/electron capture detector	CLP Laboratory	Yes (Following SW-846 Method 8051 for herbicide analysis)
A-2	CLP SOW ISM01.3 for Inorganic Analysis, Multi-Media, Multi-Concentration	Definitive	Metals Cyanide	ICP/AES Cold vapor atomic absorption Colorimeter or spectrophotometer	CLP Laboratory	No
A-3	EPA Method TO-15 for Volatile Organic Compounds in Air	Definitive	VOCs	GC/mass spectrometry	CRL Laboratory Subcontractor Laboratory	No

Notes:

CLP	Contract Laboratory Program
CRL	Contract Regional Laboratory
AES	Atomic emission spectroscopy
ICP	Inductively coupled plasma
SOW	Statement of work
VOC	Volatile organic compound
SVOC	Semivolatile organic compound
PCB	Polychlorinated biphenyl

QAPP WORKSHEET #24
ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/Mass Spectroscopy (Soil & Water analysis)	VOCs: Run five calibration standard solutions and a blank SVOCs: Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria	Always, RRF ≥ 0.010 or per SOP Initial, RSD ≤ 20% or 40%, depending on compound. Continuing, %D ≤ 25 or 40 depending on compound.	Inspect the system for problems, clean the ion source, change the column, service the purge and trap device, and take corrective actions to achieve the technical acceptance criteria.	Laboratory Analyst (CLP, EPA Mobile Laboratory, or Subcontractor Laboratory)	A-1
GC/Mass Spectroscopy (Gas analysis)	VOCs: Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria. If the daily calibration acceptance criteria have not been met, calibrate after corrective action has been taken.	The calculated %RSD for the RRF must be less than 30% with at most two exceptions up to a limit of 40% depending on compound. The %D for each target compound in a daily calibration sequence must be within ±30 percent depending on compound.	Inspect the system for problems, clean the ion source, change the column, service the purge and trap device, and take corrective actions to achieve the technical acceptance criteria.	Laboratory Analyst (CRL or Subcontractor Laboratory)	A-3

QAPP WORKSHEET #24 (CONTINUED)
ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/Electron Capture Detector	Pesticides: Run five calibration standard solutions and a blank Herbicides: Run five calibration standard solutions and a blank PCBs: Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria	Always, resolution per SOP Initial, CF RSD ≤ 20% Continuing, CF %D ≤ 15 for opening and ≤ 50 for closing	Inspect the system for problems, change the column, bake out the detector, clean the injection port, and take other corrective actions to achieve the acceptance criteria.	CLP Laboratory Analyst	A-1
ICP/AES CVAA Spectrophotometer	Run five calibration mixed standard solutions and a blank	Each CCV analyzed shall reflect the conditions of analysis of all associated analytical samples (the preceding 10 analytical samples or the preceding analytical samples up to the previous CCV)	Deviation from the initial calibration verification: metals 90-110%, cyanide 85-115%	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	CLP Laboratory Analyst	A-2

Notes:

%D	Percent difference
CCV	Continuing calibration verification
CF	Calibration factor
RRF	Relative response factor
RSD	Relative standard deviation

QAPP WORKSHEET #25
ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE TESTING, AND INSPECTION TABLE

Instrument/ Equipment	Maintenance Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference[1]
GC/Mass Spectroscopy	Daily Check, Instrument tune (4-bromofluorobenzene or decafluorotriphenylphosphine)	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	See A-1 and A-3	See A-1 and A-3	Inspect the system for problems, clean the ion source, change the column, and service the purge and trap device.	Laboratory Analyst (CLP, CRL, EPA Mobile Laboratory, or Subcontractor Laboratory)	A-1 and A-3
GC/Electron Capture Detector	Daily Check, Initial Calibration Verification	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	See A-1	See A-1	Inspect the system for problems, change the column, bake out the detector, and clean the injection port.	CLP Laboratory Analyst	A-1
ICP/AES CVAA Spectrophotometer	Daily Check, Initial Calibration Verification	Nebulizer, injection tube, flame optimization, gas supply, and detector	See A-2	See A-2	Inspect the system for problems, clean the system, verify operating conditions, and take corrective actions to achieve the technical acceptance criteria.	CLP Laboratory Analyst	A-2

Note:

1 See Worksheet #23 for identification of analytical methods.

QAPP WORKSHEET #26
SAMPLE HANDLING SYSTEM

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field sampling personnel/SulTRAC
Sample Packaging (Personnel/Organization): Field sampling personnel/SulTRAC
Coordination of Shipment (Personnel/Organization): Field sampling personnel/SulTRAC
Type of Shipment/Carrier: Cooler packed with ice and packing material such as bubble wrap for soil and water samples, original shipping container with no ice for soil gas samples/FedEx or other overnight courier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory personnel/CLP, CRL, or subcontractor laboratory
Sample Custody and Storage (Personnel/Organization): Laboratory personnel/CLP, CRL, or subcontractor laboratory
Sample Preparation (Personnel/Organization): Laboratory personnel/CLP, CRL, or subcontractor laboratory
Sample Determinative Analysis (Personnel/Organization): Laboratory personnel/CLP, CRL, or subcontractor laboratory
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): See Worksheet # 27
SAMPLE DISPOSAL
Personnel/Organization: Laboratory personnel/CLP, CRL, or subcontractor laboratory
Number of Days from Analysis: TBD (or in accordance with individual laboratory SOP)

QAPP WORKSHEET #27
SAMPLE CUSTODY REQUIREMENTS

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to the laboratory): SulTRAC will use EPA's Scribe software to manage sample collection, documentation, chain of custody, and reporting. Field personnel will input data into Scribe and then use the software to generate sample labels, bottle tags, and chain-of-custody forms to track samples from the field to the laboratory. Because Scribe captures sample management information electronically, the information is easily exportable to databases or various reporting formats.

Chain-of-custody forms will be signed in ink by the samplers and the individual relinquishing custody. SulTRAC will then follow the sample packaging and shipment procedures summarized below to ensure that samples arrive at the laboratory with the chain of custody intact.

1- Immediately after sample collection, sample containers will be labeled with the appropriate identifiers. Clear tape will be placed over the sample container's labels to prevent smearing.

2- Soil and water samples will be placed in Ziploc plastic bags and then in a cooler containing double-sealed bags of ice and maintained at 4 degrees Celsius (^{o}C). Soil gas samples will be returned to their initial shipping containers and will be kept at ambient temperature. The coolers and shipping containers will remain in a secured area or in view of the sampler until it is properly sealed for shipment to the laboratory.

3- Prior to shipping, the chain-of-custody forms, airbills, and all other relevant documents will be completed. Chain-of-custody forms will be sealed in plastic bags and taped to the inside of the cooler or shipping container lid. Cushioning material, such as bubble-wrap, will be placed in the coolers and containers.

4- A temperature blank consisting of a jar or vial containing water will be included in every cooler used to ship soil and water samples. The temperature blank will be used by the laboratory to determine the cooler temperature at the time of sample receipt.

5- The shipping cooler/container will then be sealed with tape and custody seals in a manner that will indicate whether the cooler/container was opened. The preferred procedure includes placement of custody seals at diagonally opposite corners of the cooler/container. The custody seals will be covered with clear plastic tape or strapping tape.

The field sampler is personally responsible for the care and custody of the samples until they are transferred to other personnel or properly dispatched to an overnight carrier or directly to a laboratory. When transferring possession of the samples, the individuals relinquishing and receiving the samples sign, date, and note the time of transfer on the chain-of-custody form. Commercial carriers are not required to sign off on the chain-of-custody form as long as the form is sealed inside the sample cooler/shipping container and the custody seals remain intact.

QAPP WORKSHEET #27 (CONTINUED)
SAMPLE CUSTODY REQUIREMENTS

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): The laboratory sample custodian will receive all incoming samples and indicate receipt by signing the accompanying custody forms and retaining copies of the signed forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the sample, including the persons delivering and receiving the sample, the date and time received, the method by which the sample was transmitted to the laboratory, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample identification number, and any unique laboratory identification number associated with the sample. This information should be entered into a computerized laboratory information management system (LIMS).

The laboratory will provide a secure storage area, restricted to authorized personnel, for all samples. Only the custodian can distribute samples to laboratory personnel authorized to conduct the required analyses. Laboratory analytical personnel are responsible for the care and custody of the sample upon receipt.

At the completion of sample analysis, any unused portion of the sample, together with all identifying labels, will be returned to the custodian. The returned tagged sample will be retained in secure storage until the custodian receives permission to dispose of the sample. Sample disposal will occur only on the order of the laboratory project manager in consultation with EPA or SulTRAC, or when it is certain that the information is no longer required or the samples have deteriorated. Likewise, laboratory records will be maintained until the information is no longer required and final disposition is ordered by the laboratory project manager in consultation with EPA or SulTRAC.

Sample Identification Procedures: Sample identification will be as described in Section 8.2 of the FSP. Each sample will also be assigned an identifying number by SCRIBE. Before or during the sampling event, the user will enter information regarding the site, project, sampling team, analysis, location, matrix (SB – soil boring; VAS-vertical aquifer sample; MW – monitoring well; GWG – groundwater grab sample; IAWC – IAWC well sample; SG – soil gas), collection time and date, and sample and tag numbers.

When the laboratory receives a sample shipment, its LIMS will generate the in-house identification numbers in accordance with its sample receipt and chain-of-custody standard operating procedures (SOP).

QAPP WORKSHEET #28
QC SAMPLES TABLE

Matrix	Soil
Analytical Group	CLP VOCs
Concentration Level	Low concentration
Sampling SOP	S-2, S-3
Analytical Method/ SOP Reference	A-1
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory, Subcontractor Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
MS/MSD	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds	All samples	Reanalyze sample. If upon reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Soil
Analytical Group	CLP SVOCs
Concentration Level	Low concentration
Sampling SOP	S-2, S-3
Analytical Method/ SOP Reference	A-1
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
MS/MSD	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds	All samples	Reanalyze sample. If upon reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Soil
Analytical Group	CLP PCBs
Concentration Level	NA
Sampling SOP	S-2, S-3
Analytical Method/ SOP Reference	A-1
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
MS/MSD	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Surrogate Compounds	All samples	Reanalyze sample. If upon reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Soil
Analytical Group	CLP Pesticides, Herbicides
Concentration Level	NA
Sampling SOP	S-2, S-3
Analytical Method/ SOP Reference	A-1
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/ Bias Contamination	No target compounds > QL
MS/MSD	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Surrogate Compounds	All samples	Reanalyze sample. If upon reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Soil
Analytical Group	CLP Metals
Concentration Level	ICP-AES
Sampling SOP	S-2, S-3
Analytical Method/ SOP Reference	A-2
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Laboratory duplicate	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Precision	<20% RPD
MS	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	75-125 %R

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Water
Analytical Group	CLP VOCs
Concentration Level	Trace, Low concentration
Sampling SOP	S-6
Analytical Method/ SOP Reference	A-1
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
MS/MSD	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds	All samples	Reanalyze sample. If upon reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES TABLE

Matrix	Soil Gas
Analytical Group	VOCs
Concentration Level	NA
Sampling SOP	S-1
Analytical Method/ SOP Reference	A-3
Sampler's Name/ Organization	Brian Malone/SulTRAC
Analytical Organization	CLP Laboratory
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch of 20 samples maximum	If sufficient volume is available, reanalyze samples in affected batch.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
LCS, laboratory duplicate	1 per extraction batch of 20 samples maximum	Reanalyze LCS and laboratory duplicate, If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Internal Standard Compounds	All samples	Reanalyze sample. If upon reanalysis, the internal standard meets criteria, report reanalysis results. If upon reanalysis, the internal standard does not meet criteria, summarize problem in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #29
PROJECT DOCUMENTS AND RECORDS TABLE

Document	Where Maintained
Field notes/logbook	Project file (field data), SulTRAC offices
Chain of custody forms	Project file (laboratory data), SulTRAC offices
Laboratory raw data package	EPA for CLP laboratory and CRL laboratory data; project file for subcontractor laboratory data
Laboratory equipment calibration logs	EPA for CLP and CRL laboratory; subcontractor laboratory
Validated data	Project file (laboratory data), SulTRAC offices

QAPP WORKSHEET #30
ANALYTICAL SERVICES TABLE

Matrix	Analytical Group	Concentration Level	Sampling Location/ID Number	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person, and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Soil	VOCs SVOCs PCBs Pesticides Herbicides Metals	Low concentration Low concentration NA[1] NA[1] NA[1] ICP-AES	See Table 1 and Table 2, and Figure 4	A-1 A-1 A-1 A-1 A-1 A-2	21 days 21 days 21 days 21 days 21 days 21 days	CLP laboratory identified by EPA Region 5 or EPA Mobile Laboratory	CLP laboratory identified by EPA Region 5 or EPA Mobile Laboratory
Water	VOCs Metals	Low concentration ICP-AES	See Figure 4 See Table 2	A-1 A-2	21 days 21 days	CLP Laboratory identified by EPA Region 5 ,EPA Mobile Laboratory or subcontracted laboratory	CLP Laboratory identified by EPA Region 5,EPA Mobile Laboratory or subcontracted laboratory
Soil Gas	VOCs	NA[1]	See Figure 4 and See Table 2	A-3	21 days	EPA CRL or subcontracted laboratory	EPA CRL or subcontracted laboratory

Note:

1 Not applicable, only one concentration level is listed for the analytical method selected

QAPP WORKSHEET #31
QA MANAGEMENT REPORTS TABLE

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Name, Title, Organization)	Report Recipient(s) (Title and Organization)
Phase II Data Validation Report	Once for field sampling Phase II	21 days after receipt of Phase II analytical results from laboratory	Brian Malone, SulTRAC, Project Manager	Howard Caine, WAM, EPA Region 5
Phase II Data Evaluation Summary Report	Once for Phase II	45 days after receipt of validated data.	Brian Malone, SulTRAC, Project Manager	Howard Caine, WAM, EPA Region 5

QAPP WORKSHEET #32
VERIFICATION (STEP I) PROCESS TABLE

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Chain-of-custody forms	Chain-of-custody forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody form should be initialed by the reviewer, a copy of the chain-of-custody form should be retained in the project file, and the original and remaining copies should be taped inside the cooler for shipment.	Internal	TBD, SulTRAC
Field notes/ logbook	Field notes will be reviewed internally and placed in the project file. A copy of the field notes may be attached to the final report.	Internal	Brian Malone, SulTRAC
Laboratory data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified externally in accordance with the data validation procedures specified in Worksheet #35.	Internal External	CLP Laboratory Tracey Koach, SulTRAC

QAPP WORKSHEET #33
VALIDATION (STEPS IIA AND IIB) PROCESS TABLE

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)[1]
IIa	Chain of custody	Examine traceability of samples from sample collection to sample analysis	EPA (CADRE), Analytical Coordinator, SulTRAC
IIa	Holding time	Confirm that holding time requirements are met	EPA (CADRE), Chemist, SulTRAC
IIa	Instrument calibration	Confirm that instrument calibration requirements are met	EPA (CADRE), Chemist, SulTRAC
IIa	Analytical method	Confirm that analytical methods are specified in QAPP	EPA (CADRE), Chemist, SulTRAC
IIb	Performance criteria	Confirm that QC samples meet specified performance criteria; document any deviations in data evaluation summary report	EPA (CADRE), Chemist, SulTRAC

Note:

1 EPA is responsible for conducting CADRE of analytical data generated by the CLP laboratory and by the CRL. EPA will provide SulTRAC with a summary data review report. For analyses conducted in an EPA mobile laboratory, EPA will be responsible for conducting CADRE of analytical data if practical. If not practical, and for all analyses performed in a subcontractor laboratory, SulTRAC will carry out data review comparable in scope to CADRE. In all cases, the review will be conducted in accordance with CLP National Functional Guidelines (NFG) for data validation.

QAPP WORKSHEET #34
VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (Title and Organization)
IIa	Soil	VOCs	Low	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil	SVOCs	Low	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil	PCBs	NA	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil	Pesticides	NA	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil	Herbicides (modified analysis)	NA	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil	Metals (mercury and cyanide)	ICP-AES	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Groundwater	VOCs	Low	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Groundwater	SVOCs	Low	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Groundwater	Metals (mercury and cyanide)	ICP-AES	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC
IIa	Soil Gas	VOCs	NA	CADRE criteria and NFG	CADRE validation (EPA) and review of case narrative by SulTRAC

Note:

[1] EPA is responsible for conducting CADRE of analytical data generated by the CLP laboratory and by the CRL. EPA will provide SulTRAC with a summary data review report. For analyses conducted in an EPA mobile laboratory, EPA will be responsible for conducting CADRE of analytical data if practical. If not practical, and for all analyses performed in a subcontractor laboratory, SulTRAC will carry out data review comparable in scope to CADRE. In all cases, the review will be conducted in accordance with CLP National Functional Guidelines (NFG) for data validation.

QAPP WORKSHEET #35
USABILITY ASSESSMENT

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: A team of SulTRAC personnel will perform the data usability assessment. SulTRAC's project manager will be responsible for information in the usability assessment. The project manager will also be responsible for assigning task work to the individual task members who will be supporting the data usability assessment. Note that the data usability assessment will be conducted on validated data. The results of the data usability assessment will be presented in the final project report.

Precision – Results of laboratory duplicates will be presented separately in tabular format. For each duplicate pair, the RPD will be calculated for each analyte whose original and duplicate values are both greater than or equal to the QL. The RPDs will be checked against the measurement performance criteria presented in Worksheet #12. The RPDs exceeding criteria will be identified in the tables. A discussion will follow summarizing the laboratory precision results. Any conclusions about the precision of the analyses will be drawn, and any limitations on the use of the data will be described.

Accuracy/Bias – Results for laboratory method blanks and instrument blanks will be presented separately in tabular format for each analysis. The results for each analyte will be checked against the measurement performance criteria presented in Worksheet #12. Results for analytes that exceed criteria will be identified in the tables. A discussion will follow summarizing the laboratory accuracy/bias results. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn, and any limitations on the use of the data will be described.

Overall Accuracy/Bias – The results will be presented in tabular format to allow comparison of these results to the sample batch they apply to. These results will be compared to the requirements listed in Worksheet #12. A discussion will follow summarizing overall accuracy/bias results. Any conclusions about the overall accuracy/bias of the analyses will be drawn, and any limitations on the use of the data will be described.

Sensitivity – Results for all laboratory-fortified blanks will be presented separately in tabular format for each analysis. The results for each analyte will be checked against the measurement performance criteria presented in Worksheet #12 and cross-checked against the QLs presented in Worksheet #15. Results for analytes that exceed criteria will be identified on the tables. A discussion will follow summarizing the laboratory sensitivity results. Any conclusions about the sensitivity of the analyses will be drawn, and any limitations on the use of the data will be described.

Representativeness – The large numbers of samples collected in Phases I are considered representative of site conditions, as long as completeness criteria in Worksheet 12 are met.

Comparability – The results of this study will be used as a benchmark for determining comparability for data collected during any potential future sampling events using the same or similar sampling and analytical SOPs. The sampling and analytical methods were selected so that data will also be comparable with data collected during Phase I as well as data from earlier investigations at the site.

Completeness – A completeness check will be performed on all data generated by the laboratory. Completeness criteria are presented in

QAPP WORKSHEET #35 (CONTINUED)
USABILITY ASSESSMENT

Worksheet #12. Completeness will be calculated for each analyte as follows. For each analyte, completeness will be calculated as the number of data points for each analyte and individual matrix that meet the measurement performance criteria for precision, accuracy/bias, and sensitivity, divided by the total number of data points for each analyte. A discussion will follow summarizing the calculation of data completeness. Any conclusions about the completeness of the data for each analyte will be drawn, and any limitations on the use of the data will be described.
Describe the evaluative procedures used to assess overall measurement error associated with the project: project: NA
Identify the personnel responsible for performing the usability assessment: SulTRAC's analytical coordinator will review analytical data and the CADRE data review report to assess usability of the data. SulTRAC's project manager will review QC results for samples and assess the overall usability of the data set in close consultation with the EPA WAM.
Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: The usability assessment will be documented in the data validation letter report, which will be generated 21 days after Phase II analytical results are received from the CLP laboratory and the CRL.

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TABLES

(One Page)

TABLE 1
SOIL BORING LOCATIONS
ELM STREET RI/FS SITE

Location	Use and Environmental Concern	Number of Soil Borings/Depth (feet)	Number of Soil and Groundwater Samples
Gurman Property	Operating drum recycling facility where drums have historically been rinsed and cleaned, spilling contents on the ground surface.	4/4 9/40* SG 3/40* VAS 3/140	110
Ashland Property	Petroleum bulk storage in ASTs and chemical bulk storage in drums. USTs removed from the property.	9/4 2/10 VAS 3/140	64
MTS Property	Machining operations on the western portion of the site.	4/4 2/40* SG 3/40* VAS 3/140	75
Former Sinclair/Roundhouse Area	A former railroad roundhouse located on the central portion of the property. Petroleum bulk storage in ASTs on the eastern portion of the property.	13/4 3/40* MW 2(nested)/140	53
Riverside Apartment Building	Apartment building north of Ashland property with soil gas wells. One boring will be advanced at each soil gas well location.	SG 9/40*	45
Background East of US Highway 41	Evaluate potential for upgradient sources of contamination contributing to GW contamination.	1/40* MW 1(nested)/140	11
Downgradient	Re-drill MW-13S which was removed during storm sewer construction.	MW 1/40 (MW-13SR)	5

Note:

***** Number of samples indicated consists of four soil samples and one groundwater sample per boring and does not include QA/QC samples for each subset. This table excludes groundwater samples from monitoring wells and groundwater samples during VAS.

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	CLP Pests	CLP PCBs	CLP Metals	CLP Herbicides	Duplicate	MS/MSD
SB74-GUR-XXX-XXXX12	Soil boring	Field	SB74	Gurman	0-2	x	x	x	x			x	
SB74-GUR-XXX-XXXX12	Soil boring	Field	SB74	Gurman	2-10	x	x	x	x				
SB75-GUR-XXX-XXXX12	Soil boring	Field	SB75	Gurman	0-2	x	x	x	x				
SB75-GUR-XXX-XXXX12	Soil boring	Field	SB75	Gurman	2-10	x	x	x	x				
SB76-GUR-XXX-XXXX12	Soil boring	Field	SB76	Gurman	0-2	x	x	x	x				x
SB76-GUR-XXX-XXXX12	Soil boring	Field	SB76	Gurman	2-10	x	x	x	x				
SB77-GUR-XXX-XXXX12	Soil boring	Field	SB77	Gurman	0-2	x	x	x	x				
SB77-GUR-XXX-XXXX12	Soil boring	Field	SB77	Gurman	2-10	x	x	x	x				
SB78-GUR-XXX-XXXX12	Soil boring	Field	SB78	Gurman	0-2	x						x	
SB78-GUR-XXX-XXXX12	Soil boring	Field	SB78	Gurman	2-10	x							
SB78-GUR-XXX-XXXX12	Soil boring	Field	SB78	Gurman	10-20	x							
SB78-GUR-XXX-XXXX12	Soil boring	Field	SB78	Gurman	20-40	x							
SB79-GUR-XXX-XXXX12	Soil boring	Field	SB79	Gurman	0-2	x							
SB79-GUR-XXX-XXXX12	Soil boring	Field	SB79	Gurman	2-10	x							
SB79-GUR-XXX-XXXX12	Soil boring	Field	SB79	Gurman	10-20	x							
SB79-GUR-XXX-XXXX12	Soil boring	Field	SB79	Gurman	20-40	x							
SB80-GUR-XXX-XXXX12	Soil boring	Field	SB80	Gurman	0-2	x							
SB80-GUR-XXX-XXXX12	Soil boring	Field	SB80	Gurman	2-10	x							
SB80-GUR-XXX-XXXX12	Soil boring	Field	SB80	Gurman	10-20	x							
SB80-GUR-XXX-XXXX12	Soil boring	Field	SB80	Gurman	20-40	x							
SB81-GUR-XXX-XXXX12	Soil boring	Field	SB81	Gurman	0-2	x				x			x
SB81-GUR-XXX-XXXX12	Soil boring	Field	SB81	Gurman	2-10	x				x			
SB81-GUR-XXX-XXXX12	Soil boring	Field	SB81	Gurman	10-20	x				x			
SB81-GUR-XXX-XXXX12	Soil boring	Field	SB81	Gurman	20-40	x				x			
SB82-GUR-XXX-XXXX12	Soil boring	Field	SB82	Gurman	0-2	x				x			
SB82-GUR-XXX-XXXX12	Soil boring	Field	SB82	Gurman	2-10	x				x			
SB82-GUR-XXX-XXXX12	Soil boring	Field	SB82	Gurman	10-20	x				x			
SB82-GUR-XXX-XXXX12	Soil boring	Field	SB82	Gurman	20-40	x				x			
SB83-GUR-XXX-XXXX12	Soil boring	Field	SB83	Gurman	0-2	x							
SB83-GUR-XXX-XXXX12	Soil boring	Field	SB83	Gurman	2-10	x							x
SB83-GUR-XXX-XXXX12	Soil boring	Field	SB83	Gurman	10-20	x							
SB83-GUR-XXX-XXXX12	Soil boring	Field	SB83	Gurman	20-40	x							
SB84-GUR-XXX-XXXX12	Soil boring	Field	SB84	Gurman	0-2	x	x						
SB84-GUR-XXX-XXXX12	Soil boring	Field	SB84	Gurman	2-10	x	x						
SB84-GUR-XXX-XXXX12	Soil boring	Field	SB84	Gurman	10-20	x	x						
SB84-GUR-XXX-XXXX12	Soil boring	Field	SB84	Gurman	20-40	x	x						
SB85-GUR-XXX-XXXX12	Soil boring	Field	SB85	Gurman	0-2	x	x					x	
SB85-GUR-XXX-XXXX12	Soil boring	Field	SB85	Gurman	2-10	x	x						
SB85-GUR-XXX-XXXX12	Soil boring	Field	SB85	Gurman	10-20	x	x						
SB85-GUR-XXX-XXXX12	Soil boring	Field	SB85	Gurman	20-40	x	x						
SB86-GUR-XXX-XXXX12	Soil boring	Field	SB86	Gurman	0-2	x	x						
SB86-GUR-XXX-XXXX12	Soil boring	Field	SB86	Gurman	2-10	x	x						
SB86-GUR-XXX-XXXX12	Soil boring	Field	SB86	Gurman	10-20	x	x						x
SB86-GUR-XXX-XXXX12	Soil boring	Field	SB86	Gurman	20-40	x	x						
SB87-GUR-XXX-XXXX12	Soil boring	Field	SB87	Gurman	0-2	x	x						
SB87-GUR-XXX-XXXX12	Soil boring	Field	SB87	Gurman	2-10	x	x						
SB87-GUR-XXX-XXXX12	Soil boring	Field	SB87	Gurman	10-20	x	x						
SB87-GUR-XXX-XXXX12	Soil boring	Field	SB87	Gurman	20-40	x	x						
SB88-GUR-XXX-XXXX12	Soil boring	Field	SB88	Gurman	0-2	x	x						
SB88-GUR-XXX-XXXX12	Soil boring	Field	SB88	Gurman	2-10	x	x						
SB88-GUR-XXX-XXXX12	Soil boring	Field	SB88	Gurman	10-20	x	x					x	
SB88-GUR-XXX-XXXX12	Soil boring	Field	SB88	Gurman	20-40	x	x						
SB89-GUR-XXX-XXXX12	Soil boring	Field	SB89	Gurman	0-2	x	x						
SB89-GUR-XXX-XXXX12	Soil boring	Field	SB89	Gurman	2-10	x	x						
SB89-GUR-XXX-XXXX12	Soil boring	Field	SB89	Gurman	10-20	x	x						x
SB89-GUR-XXX-XXXX12	Soil boring	Field	SB89	Gurman	20-40	x							
SB90-GUR-XXX-XXXX12	Soil boring	Field	SB90	Gurman	0-2	x							
SB90-GUR-XXX-XXXX12	Soil boring	Field	SB90	Gurman	2-10	x							
SB90-GUR-XXX-XXXX12	Soil boring	Field	SB90	Gurman	10-20	x							

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	CLP Pests	CLP PCBs	CLP Metals	CLP Herbicides	Duplicate	MS/MSD
SB90-GUR-XXX-XXXX12	Soil boring	Field	SB90	Gurman	20-40	x							
SB91-GUR-XXX-XXXX12	Soil boring	Field	SB91	Gurman	0-2	x						x	
SB91-GUR-XXX-XXXX12	Soil boring	Field	SB91	Gurman	2-10	x							
SB91-GUR-XXX-XXXX12	Soil boring	Field	SB91	Gurman	10-20	x							
SB91-GUR-XXX-XXXX12	Soil boring	Field	SB91	Gurman	20-40	x							
SB92-GUR-XXX-XXXX12	Soil boring	Field	SB92	Gurman	0-2	x							
SB92-GUR-XXX-XXXX12	Soil boring	Field	SB92	Gurman	2-10	x							
SB92-GUR-XXX-XXXX12	Soil boring	Field	SB92	Gurman	10-20	x							
SB92-GUR-XXX-XXXX12	Soil boring	Field	SB92	Gurman	20-40	x							
SB93-ASH-XXX-XXXX12	Soil boring	Field	SB93	Ashland	0-2	x	x				x	x	
SB93-ASH-XXX-XXXX12	Soil boring	Field	SB93	Ashland	2-10	x	x				x		x
SB94-ASH-XXX-XXXX12	Soil boring	Field	SB94	Ashland	0-2	x	x				x		
SB94-ASH-XXX-XXXX12	Soil boring	Field	SB94	Ashland	2-10	x	x				x		
SB95-ASH-XXX-XXXX12	Soil boring	Field	SB95	Ashland	0-2	x	x				x		
SB95-ASH-XXX-XXXX12	Soil boring	Field	SB95	Ashland	2-10	x	x				x		
SB96-ASH-XXX-XXXX12	Soil boring	Field	SB96	Ashland	0-2	x	x				x		
SB96-ASH-XXX-XXXX12	Soil boring	Field	SB96	Ashland	2-10	x	x				x		
SB97-ASH-XXX-XXXX12	Soil boring	Field	SB97	Ashland	0-2	x	x				x		
SB97-ASH-XXX-XXXX12	Soil boring	Field	SB97	Ashland	2-10	x	x				x		
SB98-ASH-XXX-XXXX12	Soil boring	Field	SB98	Ashland	0-2	x	x				x		
SB98-ASH-XXX-XXXX12	Soil boring	Field	SB98	Ashland	2-10	x	x				x		
SB99-ASH-XXX-XXXX12	Soil boring	Field	SB99	Ashland	0-2	x	x				x	x	
SB99-ASH-XXX-XXXX12	Soil boring	Field	SB99	Ashland	2-10	x	x				x		
SB100-ASH-XXX-XXXX12	Soil boring	Field	SB100	Ashland	0-2	x	x				x		
SB100-ASH-XXX-XXXX12	Soil boring	Field	SB100	Ashland	2-10	x	x				x		
SB101-ASH-XXX-XXXX12	Soil boring	Field	SB101	Ashland	0-2	x	x				x		
SB101-ASH-XXX-XXXX12	Soil boring	Field	SB101	Ashland	2-10	x	x				x		
SB102-ASH-XXX-XXXX12	Soil boring	Field	SB102	Ashland	0-2	x	x				x		
SB102-ASH-XXX-XXXX12	Soil boring	Field	SB102	Ashland	2-10	x	x				x		
SB103-ASH-XXX-XXXX12	Soil boring	Field	SB103	Ashland	0-2	x	x						x
SB103-ASH-XXX-XXXX12	Soil boring	Field	SB103	Ashland	2-10	x	x						
SB104-ASH-XXX-XXXX12	Soil boring	Field	SB104	Ashland	0-2	x							
SB104-ASH-XXX-XXXX12	Soil boring	Field	SB104	Ashland	2-10	x						x	
SB104-ASH-XXX-XXXX12	Soil boring	Field	SB104	Ashland	10-20	x							
SB104-ASH-XXX-XXXX12	Soil boring	Field	SB104	Ashland	20-40	x							
SB105-ASH-XXX-XXXX12	Soil boring	Field	SB105	Ashland	0-2	x							
SB105-ASH-XXX-XXXX12	Soil boring	Field	SB105	Ashland	2-10	x							
SB105-ASH-XXX-XXXX12	Soil boring	Field	SB105	Ashland	10-20	x						x	
SB105-ASH-XXX-XXXX12	Soil boring	Field	SB105	Ashland	20-40	x							
SB106-ASH-XXX-XXXX12	Soil boring	Field	SB106	Ashland	0-2	x							
SB106-ASH-XXX-XXXX12	Soil boring	Field	SB106	Ashland	2-10	x							
SB106-ASH-XXX-XXXX12	Soil boring	Field	SB106	Ashland	10-20	x							
SB106-ASH-XXX-XXXX12	Soil boring	Field	SB106	Ashland	20-40	x							
SB107-MTS-XXX-XXXX12	Soil boring	Field	SB107	MTS	0-2	x						x	
SB107-MTS-XXX-XXXX12	Soil boring	Field	SB107	MTS	2-10	x							
SB108-MTS-XXX-XXXX12	Soil boring	Field	SB108	MTS	0-2	x							
SB108-MTS-XXX-XXXX12	Soil boring	Field	SB108	MTS	2-10	x							x
SB109-MTS-XXX-XXXX12	Soil boring	Field	SB109	MTS	0-2	x							
SB109-MTS-XXX-XXXX12	Soil boring	Field	SB109	MTS	2-10	x							
SB110-MTS-XXX-XXXX12	Soil boring	Field	SB110	MTS	0-2	x							
SB110-MTS-XXX-XXXX12	Soil boring	Field	SB110	MTS	2-10	x						x	
SB111-MTS-XXX-XXXX12	Soil boring	Field	SB111	MTS	0-2	x							
SB111-MTS-XXX-XXXX12	Soil boring	Field	SB111	MTS	2-10	x							
SB111-MTS-XXX-XXXX12	Soil boring	Field	SB111	MTS	10-20	x							
SB111-MTS-XXX-XXXX12	Soil boring	Field	SB111	MTS	20-40	x							
SB112-MTS-XXX-XXXX12	Soil boring	Field	SB112	MTS	0-2	x							
SB112-MTS-XXX-XXXX12	Soil boring	Field	SB112	MTS	2-10	x							
SB112-MTS-XXX-XXXX12	Soil boring	Field	SB112	MTS	10-20	x							
SB112-MTS-XXX-XXXX12	Soil boring	Field	SB112	MTS	20-40	x							

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	CLP Pests	CLP PCBs	CLP Metals	CLP Herbicides	Duplicate	MS/MSD
SB113-MTS-XXX-XXXX12	Soil boring	Field	SB113	MTS	0-2	x							
SB113-MTS-XXX-XXXX12	Soil boring	Field	SB113	MTS	2-10	x						x	
SB113-MTS-XXX-XXXX12	Soil boring	Field	SB113	MTS	10-20	x							
SB113-MTS-XXX-XXXX12	Soil boring	Field	SB113	MTS	20-40	x							
SB114-MTS-XXX-XXXX12	Soil boring	Field	SB114	MTS	0-2	x							
SB114-MTS-XXX-XXXX12	Soil boring	Field	SB114	MTS	2-10	x							
SB114-MTS-XXX-XXXX12	Soil boring	Field	SB114	MTS	10-20	x							
SB114-MTS-XXX-XXXX12	Soil boring	Field	SB114	MTS	20-40	x							x
SB115-MTS-XXX-XXXX12	Soil boring	Field	SB115	MTS	0-2	x							
SB115-MTS-XXX-XXXX12	Soil boring	Field	SB115	MTS	2-10	x							
SB115-MTS-XXX-XXXX12	Soil boring	Field	SB115	MTS	10-20	x							
SB115-MTS-XXX-XXXX12	Soil boring	Field	SB115	MTS	20-40	x							
SB116-MTS-XXX-XXXX12	Soil boring	Field	SB116	MTS	0-2	x							
SB116-MTS-XXX-XXXX12	Soil boring	Field	SB116	MTS	2-10	x							
SB116-MTS-XXX-XXXX12	Soil boring	Field	SB116	MTS	10-20	x							
SB116-MTS-XXX-XXXX12	Soil boring	Field	SB116	MTS	20-40	x							
SB117-MTS-XXX-XXXX12	Soil boring	Field	SB117	MTS	0-2	x	x			x (Hg)		~~x~~	
SB117-MTS-XXX-XXXX12	Soil boring	Field	SB117	MTS	2-10	x	x			x (Hg)			
SB117-MTS-XXX-XXXX12	Soil boring	Field	SB117	MTS	10-20	x	x			x (Hg)			
SB117-MTS-XXX-XXXX12	Soil boring	Field	SB117	MTS	20-40	x	x			x (Hg)			
SB118-MTS-XXX-XXXX12	Soil boring	Field	SB118	MTS	0-2	x	x			x (Hg)			
SB118-MTS-XXX-XXXX12	Soil boring	Field	SB118	MTS	2-10	x	x			x (Hg)			
SB118-MTS-XXX-XXXX12	Soil boring	Field	SB118	MTS	10-20	x	x			x (Hg)			~~x~~
SB118-MTS-XXX-XXXX12	Soil boring	Field	SB118	MTS	20-40	x	x			x (Hg)			
SB119-SIN-XXX-XXXX12	Soil boring	Field	SB119	Sinclair	0-2	x	x				x	x	
SB119-SIN-XXX-XXXX12	Soil boring	Field	SB119	Sinclair	2-10	x	x				x		
SB120-SIN-XXX-XXXX12	Soil boring	Field	SB120	Sinclair	0-2	x	x				x		
SB120-SIN-XXX-XXXX12	Soil boring	Field	SB120	Sinclair	2-10	x	x				x		
SB121-SIN-XXX-XXXX12	Soil boring	Field	SB121	Sinclair	0-2	x	x				x		
SB121-SIN-XXX-XXXX12	Soil boring	Field	SB121	Sinclair	2-10	x	x				x		
SB122-SIN-XXX-XXXX12	Soil boring	Field	SB122	Sinclair	0-2	x	x				x		
SB122-SIN-XXX-XXXX12	Soil boring	Field	SB122	Sinclair	2-10	x	x				x		
SB123-SIN-XXX-XXXX12	Soil boring	Field	SB123	Sinclair	0-2	x	x				x		
SB123-SIN-XXX-XXXX12	Soil boring	Field	SB123	Sinclair	2-10	x	x				x		
SB124-SIN-XXX-XXXX12	Soil boring	Field	SB124	Sinclair	0-2	x	x				x	x	
SB124-SIN-XXX-XXXX12	Soil boring	Field	SB124	Sinclair	2-10	x	x				x		
SB125-SIN-XXX-XXXX12	Soil boring	Field	SB125	Sinclair	0-2	x	x				x		
SB125-SIN-XXX-XXXX12	Soil boring	Field	SB125	Sinclair	2-10	x	x				x		
SB126-SIN-XXX-XXXX12	Soil boring	Field	SB126	Sinclair	0-2	x	x				x		
SB126-SIN-XXX-XXXX12	Soil boring	Field	SB126	Sinclair	2-10	x	x				x		
SB127-SIN-XXX-XXXX12	Soil boring	Field	SB127	Sinclair	0-2	x	x				x		x
SB127-SIN-XXX-XXXX12	Soil boring	Field	SB127	Sinclair	2-10	x	x				x		
SB128-SIN-XXX-XXXX12	Soil boring	Field	SB128	Sinclair	0-2	x	x				x		
SB128-SIN-XXX-XXXX12	Soil boring	Field	SB128	Sinclair	2-10	x	x				x		
SB129-SIN-XXX-XXXX12	Soil boring	Field	SB129	Sinclair	0-2	x	x		x		x		
SB129-SIN-XXX-XXXX12	Soil boring	Field	SB129	Sinclair	2-10	x	x		x		x	x	
SB130-SIN-XXX-XXXX12	Soil boring	Field	SB130	Sinclair	0-2	x							
SB130-SIN-XXX-XXXX12	Soil boring	Field	SB130	Sinclair	2-10	x							
SB131-SIN-XXX-XXXX12	Soil boring	Field	SB131	Sinclair	0-2	x							
SB131-SIN-XXX-XXXX12	Soil boring	Field	SB131	Sinclair	2-10	x							
SB132-SIN-XXX-XXXX12	Soil boring	Field	SB132	Sinclair	0-2	x	x					x	
SB132-SIN-XXX-XXXX12	Soil boring	Field	SB132	Sinclair	2-10	x	x						
SB132-SIN-XXX-XXXX12	Soil boring	Field	SB132	Sinclair	10-20	x	x						
SB132-SIN-XXX-XXXX12	Soil boring	Field	SB132	Sinclair	20-40	x	x						
SB133-SIN-XXX-XXXX12	Soil boring	Field	SB133	Sinclair	0-2	x	x						
SB133-SIN-XXX-XXXX12	Soil boring	Field	SB133	Sinclair	2-10	x	x						
SB133-SIN-XXX-XXXX12	Soil boring	Field	SB133	Sinclair	10-20	x	x						
SB133-SIN-XXX-XXXX12	Soil boring	Field	SB133	Sinclair	20-40	x	x					x	
SB134-SIN-XXX-XXXX12	Soil boring	Field	SB134	Sinclair	0-2	x	x						

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	CLP Pests	CLP PCBs	CLP Metals	CLP Herbicides	Duplicate	MS/MSD
SB134-SIN-XXX-XXXX12	Soil boring	Field	SB134	Sinclair	2-10	x	x						
SB134-SIN-XXX-XXXX12	Soil boring	Field	SB134	Sinclair	10-20	x	x						
SB134-SIN-XXX-XXXX12	Soil boring	Field	SB134	Sinclair	20-40	x	x						
SB135-SIN-XXX-XXXX12	Soil boring	Field	SB135	Sinclair	0-2	x	x			x			
SB135-SIN-XXX-XXXX12	Soil boring	Field	SB135	Sinclair	2-10	x	x						
SB135-SIN-XXX-XXXX12	Soil boring	Field	SB135	Sinclair	10-20	x	x						
SB135-SIN-XXX-XXXX12	Soil boring	Field	SB135	Sinclair	20-40	x	x						
SB136-SIN-XXX-XXXX12	Soil boring	Field	SB136	Sinclair	0-2	x	x			x		x	
SB136-SIN-XXX-XXXX12	Soil boring	Field	SB136	Sinclair	2-10	x							
SB136-SIN-XXX-XXXX12	Soil boring	Field	SB136	Sinclair	10-20	x							
SB136-SIN-XXX-XXXX12	Soil boring	Field	SB136	Sinclair	20-40	x							
SB137-RAC-XXX-XXXX12	Soil boring	Field	SB137	Riverside	0-2	x							
SB137-RAC-XXX-XXXX12	Soil boring	Field	SB137	Riverside	2-10	x							
SB137-RAC-XXX-XXXX12	Soil boring	Field	SB137	Riverside	10-20	x							
SB137-RAC-XXX-XXXX12	Soil boring	Field	SB137	Riverside	20-40	x							
SB138-RAC-XXX-XXXX12	Soil boring	Field	SB138	Riverside	0-2	x							
SB138-RAC-XXX-XXXX12	Soil boring	Field	SB138	Riverside	2-10	x							
SB138-RAC-XXX-XXXX12	Soil boring	Field	SB138	Riverside	10-20	x							
SB138-RAC-XXX-XXXX12	Soil boring	Field	SB138	Riverside	20-40	x							
SB139-RAC-XXX-XXXX12	Soil boring	Field	SB139	Riverside	0-2	x							
SB139-RAC-XXX-XXXX12	Soil boring	Field	SB139	Riverside	2-10	x						x	x
SB139-RAC-XXX-XXXX12	Soil boring	Field	SB139	Riverside	10-20	x							
SB139-RAC-XXX-XXXX12	Soil boring	Field	SB139	Riverside	20-40	x							
SB140-RAC-XXX-XXXX12	Soil boring	Field	SB140	Riverside	0-2	x							
SB140-RAC-XXX-XXXX12	Soil boring	Field	SB140	Riverside	2-10	x							
SB140-RAC-XXX-XXXX12	Soil boring	Field	SB140	Riverside	10-20	x							
SB140-RAC-XXX-XXXX12	Soil boring	Field	SB140	Riverside	20-40	x							
SB141-RAC-XXX-XXXX12	Soil boring	Field	SB141	Riverside	0-2	x							
SB141-RAC-XXX-XXXX12	Soil boring	Field	SB141	Riverside	2-10	x							
SB141-RAC-XXX-XXXX12	Soil boring	Field	SB141	Riverside	10-20	x							
SB141-RAC-XXX-XXXX12	Soil boring	Field	SB141	Riverside	20-40	x						x	
SB142-RAC-XXX-XXXX12	Soil boring	Field	SB142	Riverside	0-2	x							
SB142-RAC-XXX-XXXX12	Soil boring	Field	SB142	Riverside	2-10	x							
SB142-RAC-XXX-XXXX12	Soil boring	Field	SB142	Riverside	10-20	x							
SB142-RAC-XXX-XXXX12	Soil boring	Field	SB142	Riverside	20-40	x							
SB143-RAC-XXX-XXXX12	Soil boring	Field	SB143	Riverside	0-2	x							
SB143-RAC-XXX-XXXX12	Soil boring	Field	SB143	Riverside	2-10	x							
SB143-RAC-XXX-XXXX12	Soil boring	Field	SB143	Riverside	10-20	x							
SB143-RAC-XXX-XXXX12	Soil boring	Field	SB143	Riverside	20-40	x							
SB144-RAC-XXX-XXXX12	Soil boring	Field	SB144	Riverside	0-2	x							
SB144-RAC-XXX-XXXX12	Soil boring	Field	SB144	Riverside	2-10	x						x	
SB144-RAC-XXX-XXXX12	Soil boring	Field	SB144	Riverside	10-20	x							
SB144-RAC-XXX-XXXX12	Soil boring	Field	SB144	Riverside	20-40	x							
SB145-RAC-XXX-XXXX12	Soil boring	Field	SB145	Riverside	0-2	x							
SB145-RAC-XXX-XXXX12	Soil boring	Field	SB145	Riverside	2-10	x							
SB145-RAC-XXX-XXXX12	Soil boring	Field	SB145	Riverside	10-20	x							
SB145-RAC-XXX-XXXX12	Soil boring	Field	SB145	Riverside	20-40	x							
SB146-BKG-XXX-XXXX12	Soil boring	Field	SB146	Background	0-2	x							
SB146-BKG-XXX-XXXX12	Soil boring	Field	SB146	Background	2-10	x						x	
SB146-BKG-XXX-XXXX12	Soil boring	Field	SB146	Background	10-20	x							
SB146-BKG-XXX-XXXX12	Soil boring	Field	SB146	Background	20-40	x							
SB147-BKG-XXX-XXXX12	Soil boring	Field	SB147	Background	0-2	x	x			x			
SB147-BKG-XXX-XXXX12	Soil boring	Field	SB147	Background	2-10	x	x						
SB147-BKG-XXX-XXXX12	Soil boring	Field	SB147	Background	10-20	x	x						
SB147-BKG-XXX-XXXX12	Soil boring	Field	SB147	Background	20-40	x	x						
SB148-DWG-XXX-XXXX12	Soil boring	Field	SB148	Downgradient	0-2	x	x			x			
SB148-DWG-XXX-XXXX12	Soil boring	Field	SB148	Downgradient	2-10	x	x					x	
SB148-DWG-XXX-XXXX12	Soil boring	Field	SB148	Downgradient	10-20	x	x						
SB148-DWG-XXX-XXXX12	Soil boring	Field	SB148	Downgradient	20-40	x	x						

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	Duplicate	MS/MSD
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	40-50	x			x
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	50-60	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	60-70	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	70-80	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	80-90	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	90-100	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	100-110	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	110-120	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	120-130	x			
VAS78-GUR-XXX-XXXX12	Ground Water	Field	SB78	Gurman	130-140	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	40-50	x		x	
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	50-60	x			x
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	60-70	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	70-80	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	80-90	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	90-100	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	100-110	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	110-120	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	120-130	x			
VAS79-GUR-XXX-XXXX12	Ground Water	Field	SB79	Gurman	130-140	x			
VAS80-GUR-XXX-XXXX12	Ground Water	Field	SB80	Gurman	40-50	x		x	
VAS80-GUR-XXX-XXXX13	Ground Water	Field	SB80	Gurman	50-60	x			
VAS80-GUR-XXX-XXXX14	Ground Water	Field	SB80	Gurman	60-70	x			
VAS80-GUR-XXX-XXXX15	Ground Water	Field	SB80	Gurman	70-80	x			
VAS80-GUR-XXX-XXXX16	Ground Water	Field	SB80	Gurman	80-90	x			
VAS80-GUR-XXX-XXXX17	Ground Water	Field	SB80	Gurman	90-100	x			
VAS80-GUR-XXX-XXXX18	Ground Water	Field	SB80	Gurman	100-110	x			
VAS80-GUR-XXX-XXXX19	Ground Water	Field	SB80	Gurman	110-120	x			
VAS80-GUR-XXX-XXXX20	Ground Water	Field	SB80	Gurman	120-130	x			
VAS80-GUR-XXX-XXXX21	Ground Water	Field	SB80	Gurman	130-140	x			
GWG81-GUR-XXX-XXXX12	Ground Water	Field	SB81	Gurman	35-45	x		x	
GWG82-GUR-XXX-XXXX12	Ground Water	Field	SB82	Gurman	35-45	x			
GWG83-GUR-XXX-XXXX12	Ground Water	Field	SB83	Gurman	35-45	x			
GWG84-GUR-XXX-XXXX12	Ground Water	Field	SB84	Gurman	35-45	x			
GWG85-GUR-XXX-XXXX12	Ground Water	Field	SB85	Gurman	35-45	x			
GWG86-GUR-XXX-XXXX12	Ground Water	Field	SB86	Gurman	35-45	x			
GWG87-GUR-XXX-XXXX12	Ground Water	Field	SB87	Gurman	35-45	x			
GWG88-GUR-XXX-XXXX12	Ground Water	Field	SB88	Gurman	35-45	x			
GWG89-GUR-XXX-XXXX12	Ground Water	Field	SB89	Gurman	35-45	x			
GWG90-GUR-XXX-XXXX12	Ground Water	Field	SB90	Gurman	35-45	x			
GWG91-GUR-XXX-XXXX12	Ground Water	Field	SB91	Gurman	35-45	x			
GWG92-GUR-XXX-XXXX12	Ground Water	Field	SB92	Gurman	35-45	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	40-50	x			x
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	50-60	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	60-70	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	70-80	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	80-90	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	90-100	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	100-110	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	110-120	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	120-130	x			
VAS104-ASH-XXX-XXXX12	Ground Water	Field	SB104	Ashland	130-140	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	40-50	x		x	
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	50-60	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	60-70	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	70-80	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	80-90	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	90-100	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	100-110	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	110-120	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	120-130	x			
VAS105-ASH-XXX-XXXX12	Ground Water	Field	SB105	Ashland	130-140	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	40-50	x		x	
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	50-60	x			

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP SVOCs	Duplicate	MS/MSD
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	60-70	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	70-80	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	80-90	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	90-100	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	100-110	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	110-120	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	120-130	x			
VAS106-ASH-XXX-XXXX12	Ground Water	Field	SB106	Ashland	130-140	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	40-50	x		x	
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	50-60	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	60-70	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	70-80	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	80-90	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	90-100	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	100-110	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	110-120	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	120-130	x			
VAS111-MTS-XXX-XXXX12	Ground Water	Field	SB111	MTS	130-140	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	40-50	x		x	
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	50-60	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	60-70	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	70-80	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	80-90	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	90-100	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	100-110	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	110-120	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	120-130	x			
VAS112-MTS-XXX-XXXX12	Ground Water	Field	SB112	MTS	130-140	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	40-50	x		x	
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	50-60	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	60-70	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	70-80	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	80-90	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	90-100	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	100-110	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	110-120	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	120-130	x			
VAS113-MTS-XXX-XXXX12	Ground Water	Field	SB113	MTS	130-140	x			
GWG114-MTS-XXX-XXXX12	Ground Water	Field	SB114	MTS	35-45	x			x
GWG115-MTS-XXX-XXXX12	Ground Water	Field	SB115	MTS	35-45	x		x	
GWG116-MTS-XXX-XXXX12	Ground Water	Field	SB116	MTS	35-45	x			
GWG117-MTS-XXX-XXXX12	Ground Water	Field	SB117	MTS	35-45	x	x		
GWG118-MTS-XXX-XXXX12	Ground Water	Field	SB118	MTS	35-45	x	x		x
GWG132-SIN-XXX-XXXX12	Ground Water	Field	SB132	Sinclair	35-45	x	x	x	
GWG133-SIN-XXX-XXXX12	Ground Water	Field	SB133	Sinclair	35-45	x	x		
GWG134-SIN-XXX-XXXX12	Ground Water	Field	SB134	Sinclair	35-45	x	x		
GWG137-RAC-XXX-XXXX12	Ground Water	Field	SB137	Riverside	35-45	x			
GWG138-RAC-XXX-XXXX12	Ground Water	Field	SB138	Riverside	35-45	x		x	
GWG139-RAC-XXX-XXXX12	Ground Water	Field	SB139	Riverside	35-45	x			
GWG140-RAC-XXX-XXXX12	Ground Water	Field	SB140	Riverside	35-45	x			
GWG141-RAC-XXX-XXXX12	Ground Water	Field	SB141	Riverside	35-45	x			x
GWG142-RAC-XXX-XXXX12	Ground Water	Field	SB142	Riverside	35-45	x			
GWG143-RAC-XXX-XXXX12	Ground Water	Field	SB143	Riverside	35-45	x			
GWG144-RAC-XXX-XXXX12	Ground Water	Field	SB144	Riverside	35-45	x			
GWG145-RAC-XXX-XXXX12	Ground Water	Field	SB145	Riverside	35-45	x			
GWG146-BKG-XXX-XXXX12	Ground Water	Field	SB146	Background	35-45	x		x	
GWG147-BKG-XXX-XXXX12	Ground Water	Field	SB147	Background	35-45	x		x	

TABLE 2
SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID	Matrix	Sample Type	Station	Location	Depth (ft)[5]	CLP VOCs	CLP Total and Dissolved Metals	Duplicate	MS/MSD
MW06S-SIN-XXX-XXXX12	Ground Water	Field	MW06	Sinclair	40-55	x	x		
MW06D-SIN-XXX-XXXX12	Ground Water	Field	MW06	Sinclair	125-140	x	x		
MW-17S-SIN-XXX-XXXX12	Ground Water	Field	MW17	Sinclair	40-55	x	x		
MW-17D-SIN-XXX-XXXX12	Ground Water	Field	MW17	Sinclair	125-140	x	x		
MW18S-SIN-XXX-XXXX12	Ground Water	Field	MW18	Sinclair	40-55	x	x		
MW18D-SIN-XXX-XXXX12	Ground Water	Field	MW18	Sinclair	125-140	x	x		
MW16S-BKG-XXX-XXXX12	Ground Water	Field	MW16	Background	40-55	x	x		
MW16D-BKG-XXX-XXXX12	Ground Water	Field	MW16	Background	125-140	x	x		
MW13SR-DWG-XXX-XXXX12	Ground Water	Field	MW13	Downgradient	40-55	x	x		
IWAC2-OFF-XXX-XXXX12	Ground Water	Field	IWAC2	Off-site	96-118	x	x	x	
IWAC3-OFF-XXX-XXXX12	Ground Water	Field	IWAC3	Off-site	98-120	x	x		
IWAC5-OFF-XXX-XXXX12	Ground Water	Field	IWAC5	Off-site	104.5-124	x	x		
IWAC6-OFF-XXX-XXXX12	Ground Water	Field	IWAC6	Off-site	89.5-99.5	x	x		
MW1S-ASH-XXX-XXXX12	Ground Water	Field	MW1	Ashland	40-55	x	x		
MW1D-ASH-XXX-XXXX12	Ground Water	Field	MW1	Ashland	125-140	x	x		
MW2S-ASH-XXX-XXXX12	Ground Water	Field	MW2	Ashland	40-55	x	x		
MW2D-ASH-XXX-XXXX12	Ground Water	Field	MW2	Ashland	125-140	x	x		
MW3S-ASH-XXX-XXXX12	Ground Water	Field	MW3	Ashland	40-55	x	x	x	
MW3D-ASH-XXX-XXXX12	Ground Water	Field	MW3	Ashland	125-140	x	x	x	
MW4S-OFF-XXX-XXXX12	Ground Water	Field	MW4	Off-site	40-55	x	x		
MW4D-OFF-XXX-XXXX12	Ground Water	Field	MW4	Off-site	125-140	x	x		
MW5S-GUR-XXX-XXXX12	Ground Water	Field	MW5	Gurman	40-55	x	x		x
MW5D-GUR-XXX-XXXX12	Ground Water	Field	MW5	Gurman	125-140	x	x		x
MW7S-OFF-XXX-XXXX12	Ground Water	Field	MW7	Off-site	40-55	x	x		
MW7D-OFF-XXX-XXXX12	Ground Water	Field	MW7	Off-site	125-140	x	x		
MW8S-GUR-XXX-XXXX12	Ground Water	Field	MW8	Gurman	40-55	x	x		
MW8D-GUR-XXX-XXXX12	Ground Water	Field	MW8	Gurman	125-140	x	x		
MW9S-MTS-XXX-XXXX12	Ground Water	Field	MW9	MTS	40-55	x	x		x
MW9D-MTS-XXX-XXXX12	Ground Water	Field	MW9	MTS	125-140	x	x		x
MW10S-SIN-XXX-XXXX12	Ground Water	Field	MW10	Sinclair	40-55	x	x		
MW10D-SIN-XXX-XXXX12	Ground Water	Field	MW10	Sinclair	125-140	x	x		
MW11S-MTS-XXX-XXXX12	Ground Water	Field	MW11	MTS	40-55	x	x		
MW11D-MTS-XXX-XXXX12	Ground Water	Field	MW11	MTS	125-140	x	x		
MW12S-MTS-XXX-XXXX12	Ground Water	Field	MW12	MTS	40-55	x	x	x	
MW12D-MTS-XXX-XXXX12	Ground Water	Field	MW12	MTS	125-140	x	x	x	
MW13D-DWG-XXX-XXXX12	Ground Water	Field	MW13	Downgradient	125-140	x	x		
MW14S-UPG-XXX-XXXX12	Ground Water	Field	MW14	Upgradient	40-55	x	x		
MW14D-UPG-XXX-XXXX12	Ground Water	Field	MW14	Upgradient	125-140	x	x		
MW15S-UPG-XXX-XXXX12	Ground Water	Field	MW15	Upgradient	40-55	x	x		
MW15D-UPG-XXX-XXXX12	Ground Water	Field	MW15	Upgradient	125-140	x	x		

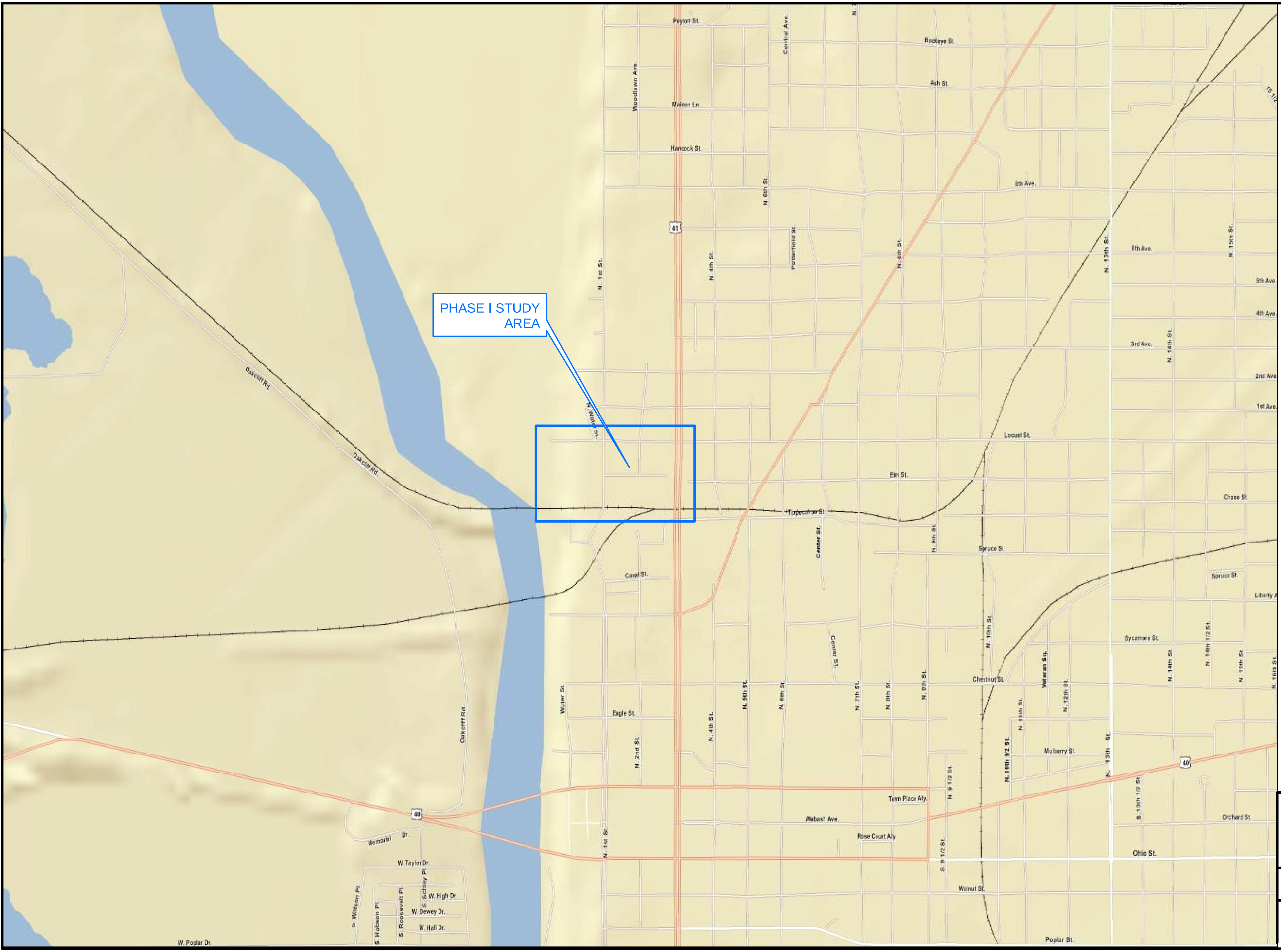
TABLE 2

SAMPLE IDENTIFICATION FOR ALL MATRICES

Sample ID		Matrix	Sample Type	Station	Location	Depth (ft)[5]	Sub TO-15 VOCs	CRL TO-15	Duplicate
SG010-GUR-XXX-XXXX12		Soil Gas	Field	SB81	Gurman	0-5	x		x
SG010-GUR-XXX-XXXX12		Soil Gas	Field	SB81	Gurman	35-45	x		x
SG011-GUR-XXX-XXXX12		Soil Gas	Field	SB82	Gurman	0-5	x		
SG011-GUR-XXX-XXXX12		Soil Gas	Field	SB82	Gurman	35-45	x		
SG012-GUR-XXX-XXXX12		Soil Gas	Field	SB83	Gurman	0-5	x		
SG012-GUR-XXX-XXXX12		Soil Gas	Field	SB83	Gurman	35-45	x		
SG013-MTS-XXX-XXXX12		Soil Gas	Field	SB114	MTS	0-5	x		
SG013-MTS-XXX-XXXX12		Soil Gas	Field	SB114	MTS	35-45	x		
SG014-MTS-XXX-XXXX12		Soil Gas	Field	SB115	MTS	0-5	x		
SG014-MTS-XXX-XXXX12		Soil Gas	Field	SB115	MTS	35-45	x		
SG015-MTS-XXX-XXXX12		Soil Gas	Field	SB116	MTS	0-5	x		
SG015-MTS-XXX-XXXX12		Soil Gas	Field	SB116	MTS	35-45	x		
SG001-RAC-XXX-XXXX12		Soil Gas	Field	SB137	Riverside	0-5		x	
SG001-RAC-XXX-XXXX12		Soil Gas	Field	SB137	Riverside	35-45		x	
SG002-RAC-XXX-XXXX12		Soil Gas	Field	SB138	Riverside	0-5		x	x
SG002-RAC-XXX-XXXX12		Soil Gas	Field	SB138	Riverside	35-45		x	x
SG003-RAC-XXX-XXXX12		Soil Gas	Field	SB139	Riverside	0-5		x	
SG003-RAC-XXX-XXXX12		Soil Gas	Field	SB139	Riverside	35-45		x	
SG004-RAC-XXX-XXXX12		Soil Gas	Field	SB140	Riverside	0-5		x	
SG004-RAC-XXX-XXXX12		Soil Gas	Field	SB140	Riverside	35-45		x	
SG005-RAC-XXX-XXXX12		Soil Gas	Field	SB141	Riverside	0-5		x	
SG005-RAC-XXX-XXXX12		Soil Gas	Field	SB141	Riverside	35-45		x	
SG006-RAC-XXX-XXXX12		Soil Gas	Field	SB142	Riverside	0-5		x	
SG006-RAC-XXX-XXXX12		Soil Gas	Field	SB142	Riverside	35-45		x	
SG007-RAC-XXX-XXXX12		Soil Gas	Field	SB143	Riverside	0-5	x		
SG007-RAC-XXX-XXXX12		Soil Gas	Field	SB143	Riverside	35-45	x		
SG008-RAC-XXX-XXXX12		Soil Gas	Field	SB144	Riverside	0-5	x		
SG008-RAC-XXX-XXXX12		Soil Gas	Field	SB144	Riverside	35-45	x		
SG009-RAC-XXX-XXXX12		Soil Gas	Field	SB145	Riverside	0-5	x		
SG009-RAC-XXX-XXXX12		Soil Gas	Field	SB145	Riverside	35-45	x		

FIGURES

(Four Pages)



2008-09-18 s:\cadd\g90210380102\mxd\figure 1 site location map.mxd TTEMI-NV joel.peters

N
W
E
S

LEGEND

▭ Site Boundary

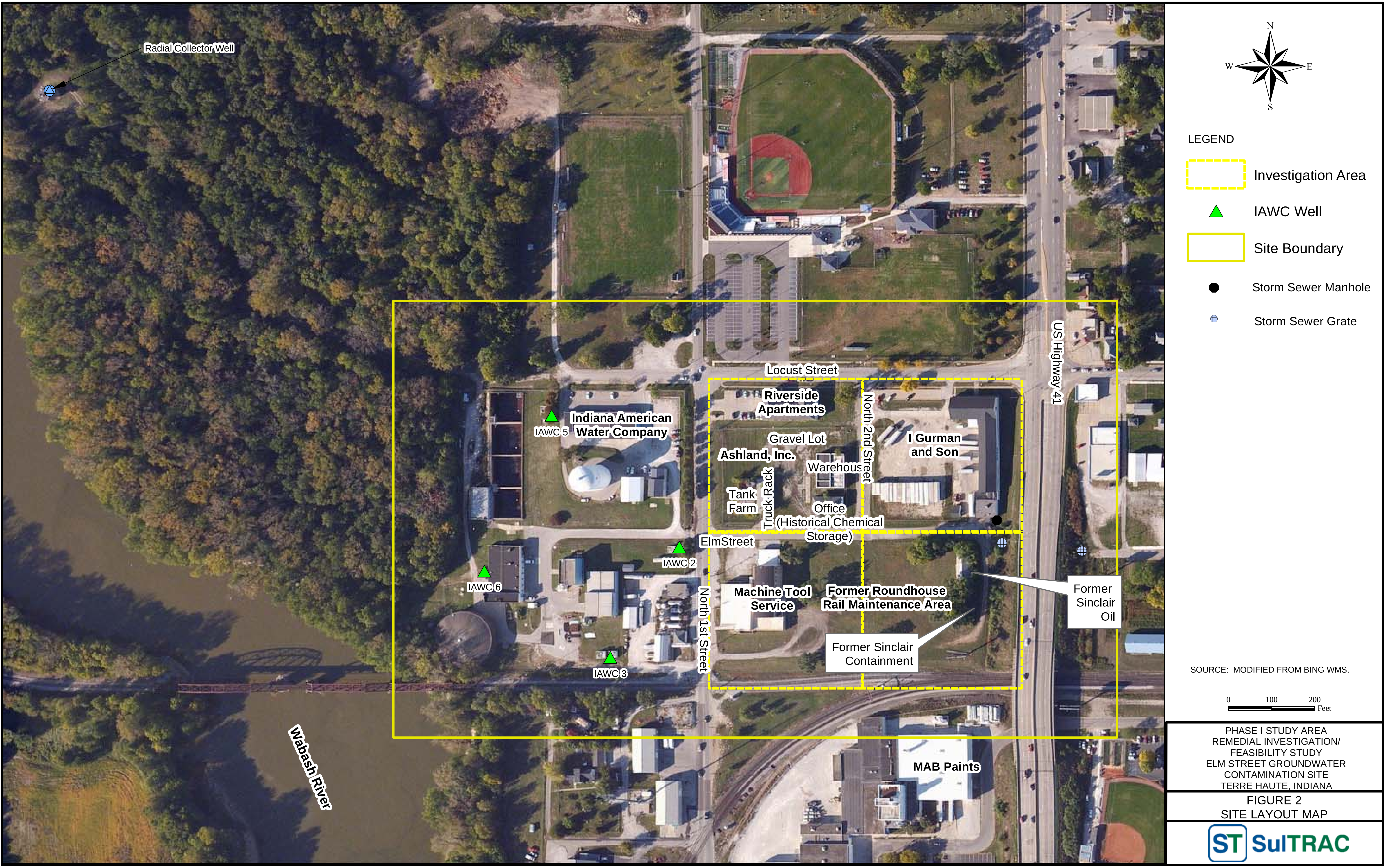
SOURCE: MODIFIED FROM INMAP, 2005.

0 500 1,000 Feet

PHASE I STUDY AREA
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, INDIANA

FIGURE 1
SITE LOCATION MAP

ST SulTRAC



SOURCE: MODIFIED FROM BING WMS.

PHASE I STUDY AREA
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, INDIANA

FIGURE 2
SITE LAYOUT MAP

ST SulTRAC

2009-07-15 s:\cadd\g\9021\0380102\mxd\figure 2b site layout map.mxd TTEMI-NV joel.peters

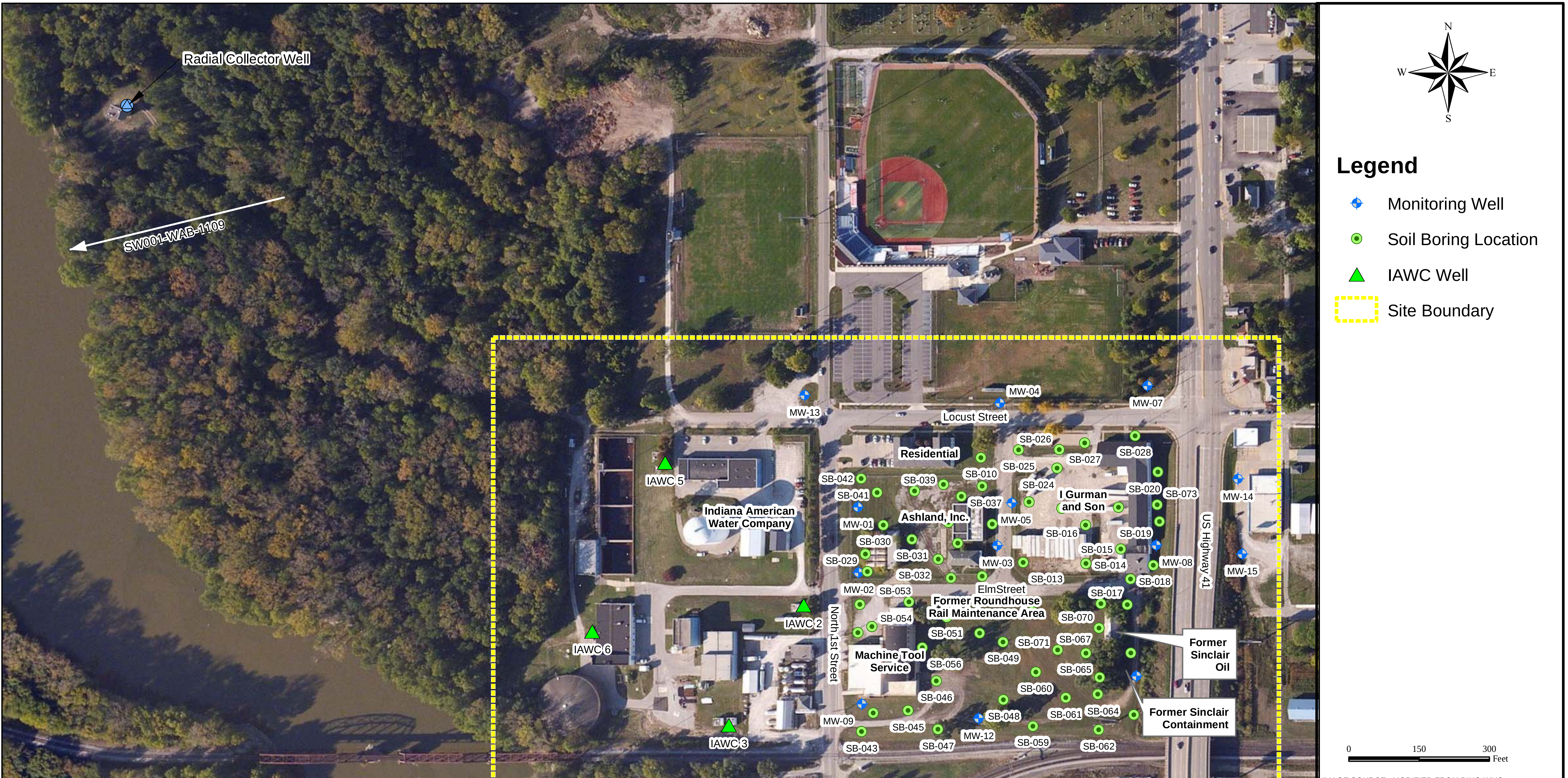


IMAGE SOURCE: MODIFIED FROM BING WMS.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE I
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 3
PREVIOUS INVESTIGATIONS

ST SulTRAC

2011-05-09 G:\G\9021\038 Elm Street\mxd\2011\Figure2_InvestigationandLayout.mxd m.banh

Date Saved: 4/26/2012 7:09:50 AM User: dale.vonbusch Path: C:\GIS_Workspace\TEMP ELM STREET\GIS\MXDs\DVB Modified Versions\Figure2_SiteLayoutMapPhaseII 4-26-12 DVB.mxd

N
W E
S

Legend

- ✚ Existing Monitoring Well Location to be re-sampled
- ▲ Existing IAWC to be re-sampled
- ⬟ Existing Soil Gas Sample Location to be re-sampled
- ✚ New Monitoring Well Location
- ⬟ New Soil Gas Location
- ◉ Phase II Proposed Soil Boring Location
- ■ Phase II Proposed Soil Boring VAS Location
- ◉ Phase I Soil Boring Location

0 125 250
Feet

SOURCE: MODIFIED FROM INMAP, 2005.

REMEDIAL INVESTIGATION FEASIBILITY STUDY:
PHASE II
ELM STREET GROUNDWATER
CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

FIGURE 4
SITE INVESTIGATION AND LAYOUT MAP
PROPOSED PHASE II SAMPLE LOCATIONS

ST SulTRAC

USEPA CLP Organics COC (LAB COPY) **CHAIN OF CUSTODY RECORD** **No: 5-052312-xfxxxxx-sample**

DateShipped: 5/23/2012
CarrierName:
AirbillNo:

Case #: 12345
Cooler #: a

Lab:
Lab Contact:
Lab Phone:

Organic Sample #	Matrix/Sampler	Coll. Method	Analysis/Turnaround	Tag/Preservative/Bottles	Station Location	Collected	Inorganic Sample #	For Lab Use Only
E5F99	Water/ Rob Kondreck		VOA-Low(7)	5-19501 (HCI) (3)	TL-RINSE3-0611	06/22/2011 18:00	ME5F99	

Special Instructions: Custody Seal #: 123456, 123457

Shipment for Case Complete? N

Samples Transferred From Chain of Custody #

Analysis Key: VOA-Low=CLP TCL VOC

Items/Reason	Relinquished by	Date	Received by	Date	Time		Items/Reason	Relinquished By	Date	Received by	Date	Time

USEPA CLP Inorganics COC (LAB COPY)

CHAIN OF CUSTODY RECORD

No: 5-052312-xxxxxx-sample

DateShipped: 5/23/2012
CarrierName: FedEx
AirbillNo:

Case #: 12345
Cooler #: 1

Lab:
Lab Contact:
Lab Phone:

Inorganic Sample #	Matrix/Sampler	Coll. Method	Analysis/Turnaround	Tag/Preservative/Bottles	Station Location	Collected	Organic Sample #	For Lab Use Only
ME5ED0	Water/ Dave Franc		ICP-MS(180)	5-19191 (HNO3 pH<2) (1)	TL-RINSE1-0611	06/20/2011 17:00	E5ED0	

Special Instructions:	**Shipment for Case Complete? N** **Samples Transferred From Chain of Custody #**
Analysis Key: ICP-MS=CLP TAL Metals ICP-MS	

Items/Reason	Relinquished by	Date	Received by	Date	Time		Items/Reason	Relinquished By	Date	Received by	Date	Time

REMEDIAL ACTION CONTRACT 2 FOR
REMEDIAL, ENFORCEMENT OVERSIGHT, AND
NON-TIME CRITICAL REMOVAL ACTIVITIES
IN REGION 5

PHASE II SITE MANAGMENT PLAN
ELM STREET GROUNDWATER CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

Prepared for
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604

Date Submitted:	August 15, 2012
US EPA Region:	5
Work Assignment No:	138-RICO-B5BF
Contract No:	EP-S5-06-02
Prepared by:	SulTRAC
Project Manager:	Brian Malone
Telephone No:	(440) 781-7944
US EPA Work Assignment Manager:	Howard Caine
Telephone No:	(312) 353-9685

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1.0 INTRODUCTION

SulTRAC has prepared this Phase II Site Management Plan (SMP) as a supporting document to the sampling and analysis plan (SAP) for the Elm Street Groundwater Contamination Site (Elm Street site) in Terre Haute, Indiana, under the U.S. Environmental Protection Agency (EPA) Remedial Action Contract (RAC) II for Region 5, Contract No. EP-S5-06-02, Work Assignment (WA) No. 138-RICO-B5BF. A Remedial Investigation (RI)/Feasibility Study (FS) is being conducted in two phases at the Elm Street site. The Phase I RI was conducted from September 29 to November 3, 2009, while Phase II will likely begin in the Summer of 2012. The RI/FS process includes collecting site data to characterize the nature and extent of contamination and evaluating human health and ecological risks that may be posed by site contamination. The SAP consists of the field sampling plan (FSP) and the quality assurance project plan (QAPP), which are among the site-specific plans to be prepared under the work assignment (WA) in accordance with Task 1 of the EPA statement of work (SOW) (EPA 2008). Other site-specific plans prepared for the Elm Street site includes the data management plan (DMP) and the health and safety plan (HASP). This SMP describes the management responsibilities during field activities regarding access, security, contingency procedures, connection of utilities, storage and disposal of investigation-derived waste (IDW), and other procedures to be followed in the field at the Elm Street Site. This SMP has been developed to address Phase II activities for the RI/FS at the Elm Street Site.

2.0 SITE INVESTIGATION ACTIVITIES

Field tasks during the RI/FS at the Elm Street Site will continue to proceed in phases. As previously stated, the Phase I RI was conducted from September 29 to November 3, 2009. The Phase II activities to be conducted are specified in the FSP (SulTRAC 2012a), and include the following: field investigation, field sampling activities, and disposal of IDW. The QAPP (SulTRAC 2012c) describes the project organization structure and management responsibilities.

For purposes of the Phase I investigation, SulTRAC divided the MTS property into two potential source areas, including the Machine Tool Service building and surrounding land (MTS property) and the former roundhouse and the former Sinclair Oil areas in the central and eastern part of the MTS property (former Sinclair/round house area). The site was further subdivided into the following four distinct investigation areas for the Phase I investigation: (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the Former Sinclair/Roundhouse Area. The same four investigation areas will be the focus of the Phase II RI. In addition, four Indiana American Water Company (IAWC) water supply wells will be sampled during the Phase II RI.

SulTRAC will perform various field activities or combinations of activities for data acquisition to support the RI/FS. The primary goals of the Phase II investigation are to (1) investigate any data gaps identified from the Phase I investigation including soil, groundwater, and soil gas (2) delineate areas of soil contamination exceeding the Residential Soil, Industrial Soil, and Protection of Groundwater generic values identified in the EPA Region Screening Levels for Chemical Contaminants and Superfund Sites (RSL) (3) further assess the potential vapor intrusion exposure pathway at the Riverside Apartment Complex, Gurman processing area, and the MTS facility (4) collect updated groundwater quality data, including additional information on background water quality, and (5) further investigate contaminant distribution in groundwater and aquifer characteristics. As specified in the FSP, the following field investigations at the Elm Street site will occur as part of the Phase II RI activities:

Preliminary Phase II Activities—Completed January 2011

- Pre-intrusive Verification Sampling – Collecting groundwater samples for volatile organic compound (VOC) analysis from upgradient monitoring wells MW-7S, MW-7D, MW-14S, MW-14D, MW-15S, and MW-15D and on-site monitoring wells MW-8S, MW-8D, MW-10S, and MW-10D due to detections of VOCs in these wells

- Soil Gas Sampling – Collecting soil gas samples for VOC analysis from soil gas wells SG001A, SG001B, SG002A, SG003A, SG003B, SG004A, SG004B,SG005A, SG005B,SG006A, and SG006B to further evaluate and verify VOCs detected at these locations

Phase II Activities – Planned Spring 2012

- Geological Investigation — SulTRAC will conduct geological investigations and collect surface and subsurface soil samples from a total of 46 soil borings at the Ashland, Gurman, MTS, the former Sinclair/roundhouse area, and two background locations east of Highway 31. Grab groundwater samples will be collected from 14 of the investigative soil boring locations.

- Vertical Aquifer Sampling (VAS) – SulTRAC will advance a total of 9 soil borings, collect surface and subsurface soil sample, and conduct vertical aquifer sampling. Monitoring wells MW-05, MW-03, MW-06 (NEW), MW-12, MW-01, MW-02, and MW-09 will be sampled in conjunction with the VAS program creating lines of VAS locations at three discreet areas of the site.

- Soil Gas Investigation — SulTRAC will conduct a soil gas investigation to assess the potential vapor intrusion exposure pathway near the Gurman building drum processing area, the MTS Machine Building, and three additional locations between the Riverside Apartment Complex and the utility corridors along Second Street. Nine new soil gas wells will be installed in paired sets with a shallow well and deep well at each location. Surface soil, subsurface soil and grab groundwater samples will be collected from each paired location. Soil gas sampling of existing and newly installed wells will be conducted following well installation and development.

- Aquifer Testing — SulTRAC will conduct a mechanical slug test on up to 11 wells to determine aquifer characteristics and variation site wide. SulTRAC will also monitor pumping effects of the IAWC wells and aquifer response from up to 4 monitoring wells on the east side of First Street. Transducers will be placed in monitoring wells to collect data while IAWC wells are activated in the normal cycling operation.

- Hydrogeologic Investigations — SulTRAC will install up to 7 monitoring wells, ranging in depth from about 50 to 150 feet. Three paired sets of new monitoring wells will be installed with one replacement well installed at MW-13D. Surface soil and subsurface soil samples will be collected from each location. Groundwater sampling of existing and newly installed monitoring wells will be conducted following well installation and development. In addition, four IAWC water supply wells will be sampled.

Completion of Phase II field tasks is expected to take about 6 weeks. The field team leader (FTL) is responsible to ensure that the tasks are conducted according to the specified standard operating procedures.

3.0 SITE ACCESS

The Elm Street Site is located in Vigo County, Terre Haute, Indiana. Public roads can be used for general access to the site. Access to specific locations included in the investigation has been granted in the form of voluntary access agreements between Gurman, Ashland, MTS, railroad-owned properties, the IAWC property and EPA. The property owners at the locations of the proposed up gradient monitoring wells; east of US Highway 41 between Locust Street to the north and the railroad tracks to the south, have been notified and completed access agreements. SulTRAC, through the potentially responsible parties' consultant, will notify each individual property owner prior to conducting work at the specific location. All proposed sampling locations are accessible; however, steep highway embankments, dense vegetation, unstable building structures, overhead or buried utilities, and other unforeseen hazards could render certain areas inaccessible.

4.0 SITE SECURITY

SulTRAC will establish a temporary field office using an office trailer measuring approximately 8 feet wide and 30 feet long at the IAWC facility just west of the four main investigation areas. The IAWC facility is completely fenced with an 8-foot-tall chain link fence and barbed wire. Site access is secured with a video monitor at each entrance and a call box to speak with gate attendants. A chained, key-locked gated entrance is on the east side of the facility; SulTRAC personnel and subcontractors will use this to access the site trailer and equipment storage areas. The facility is manned with 24-hour security, and the site trailer and entrance gate will be locked daily by the SulTRAC FTL at completion of daily activities.

The gated entrance to be used by SulTRAC and subcontractors will be opened daily only after sign-in at the main gate security entrance to the IAWC facility. All personnel entering the Elm Street Site will review and sign the health and safety plan (HASP) (SulTRAC 2012d).

5.0 IDENTIFICATION AND MANAGEMENT OF INVESTIGATION-DERIVED WASTE

IDW is waste generated from investigative activities. IDW includes solid and hazardous waste, and media (including soil, sediments, groundwater, and surface water). IDW may also include media and debris that is not hazardous, but is contaminated with hazardous constituents.

IDW generated during the field sampling activities at the Elm Street Site will include homogenized soil extracted by borings and monitoring well installation, purge water from well development and groundwater sampling, and wastewater from decontamination and equipment rinsate procedures. SulTRAC anticipates storage of IDW in 55-gallon drums or large polyethylene tanks at the MTS property which is secured with a chain link fence. The waste drums or tanks will be relocated from the area of investigation to the centralized IDW storage area daily.

6.0 WASTE MANAGEMENT REQUIREMENTS

All IDW will be disposed of as required by Indiana State and local regulations, following receipt of results for IDW soil and water analyses.

6.1 SOIL

Soil will be containerized in 55-gallon drums and relocated daily from the area of investigation to the MTS property for storage. Each drum will be clearly marked to indicate the date of collection, its waste contents, and other generator information. Prior to off-site disposal, the drums will be labeled with appropriate Department of Transportation (DOT) identification and classification information.

6.2 WATER

Groundwater and wastewater will be containerized in separate 55-gallon drums or large polyethylene tanks. Each drum will be clearly marked to indicate the date of collection, its waste contents, and other generator information. Prior to off-site disposal, the drums will be labeled with appropriate DOT identification and classification information.

6.3 MISCELLANEOUS

Additional IDW generated from soil sampling will include disposable personal protective equipment (PPE). Disposable PPE will be managed according to the level of contamination encountered during field activities. In general, PPE will be managed as nonhazardous solid waste, particularly if little contact occurs with the sampling media and low levels of contaminants are involved. SulTRAC anticipates that IDW in the form of PPE will be placed in garbage bags daily and disposed of outside of the SulTRAC field trailer in a 55-gallon drum for later disposal.

7.0 REFERENCES

EPA. 2012a. “RAC II Region 5 Statement of Work for Remedial Investigation/Feasibility Study, Elm Street Groundwater Contamination Superfund Site, Vigo County, Terre Haute, Indiana. March.

SulTRAC. 2012b. “Phase II Field Sampling Plan for Investigation at the Elm Street Groundwater Contamination Site.” August 15, 2012

SulTRAC. 2012c. “Phase II Quality Assurance Project Plan for Remedial Investigation at the Elm Street Groundwater Contamination Site.” August 15, 2012. .

SulTRAC. 2012d. “Health and Safety Plan for the Phase II Remedial Investigation/Feasibility Study, at the Elm Street Groundwater Contamination Site.” August 15, 2012.

RESPONSE ACTION CONTRACT 2 FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME CRITICAL REMOVAL ACTIVITIES IN REGION 5

PHASE II DATA MANAGEMENT PLAN
ELM STREET GROUNDWATER CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

Prepared for
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77 West Jackson Boulevard
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Date Submitted:	August 15, 2012
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Indiana American Water Company (IAWC) operates the city of Terre Haute municipal water system. Several municipal wells and a radial collector well are located adjacent to the site to the west. The municipal wells, which are installed in the deep portion of a surficial sand and gravel aquifer along the east bank of the Wabash River, have shown detectable levels of volatile organic compounds (VOC) including tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,2-dichloroethene (1,2-DCE) since 1988. Three potential source areas have been identified by the Indiana Department of Environmental Management (IDEM): I. Gurman (Gurman) property located at 800 North 3rd Street; the Ashland (formerly BiState Products) property located at 118 Elm Street; and the Machine Tool Service (MTS) property located at 117 Elm Street.

For purposes of the Phase I investigation, SulTRAC has subdivided the MTS property into two potential source areas, including the MTS building and surrounding land (MTS property) and the former roundhouse and the former Sinclair Oil areas in the central and eastern part of the MTS property (former Sinclair/round house area). The site was further subdivided into the following four distinct investigation areas for the Phase I investigation: (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the Former Sinclair/Roundhouse Area. The same four investigation areas will be the focus of the Phase II RI. In addition, four IAWC water supply wells will be sampled during the Phase II RI

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The groundwater, surface water and soil samples will be analyzed through EPA's Contract Laboratory Program (CLP). The soil gas samples will be analyzed through EPA's Central Regional Laboratory (CRL). Phase II will involve delineating the extent of contamination and addressing any data gaps in contamination characterization from Phase I.

Data management provides the orderly collection, identification, storage, retrieval, and analysis of information generated by the field activities proposed within the FSP at the Elm Street Site (SulTRAC 2012). The overall data goals for the site activities can be met only if the data generated in the field and by the analytical laboratory can be demonstrated and documented to meet data quality goals.

2.0 DATA MANAGEMENT STRATEGY

SulTRAC data management strategies require that all data collected from the Elm Street Site are stored electronically by the data coordinator and the SulTRAC project manager. Data are generated from four types of activities: field activities, GIS activities, laboratory analyses, and data validation. Data from all the activities will be converted to electronic files and archived by SulTRAC's analytical coordinator. The subsections below describe the data management strategy for data generated from the three types of activities.

2.1 FIELD DATA

The field team will collect the samples as specified in the field sampling plan (FSP). Examples of field data to be recorded include, but are not limited to, sampling location, sampling depth, sample matrix, sampling method, and other sample collection data.

After the sample collection, sample documentation (sample labels, chain-of-custody records, etc.) will be completed as described in Section 8.4 of the FSP. A quality control (QC) review will be conducted on the sample documentation. The primary sample documentation steps for the field sampling activities are as follows:

1. The field team collects the samples, and documents sample information under a chain of custody in accordance with the FSP. The field team records appropriate information in a field logbook.
2. The field team leader conducts a QC review of sample documentation.
3. Errors in sample documentation are corrected.
4. If the sample documentation is acceptable, samples are packaged and shipped to the off-site laboratory.

2.2 GIS DATA

The field team will collect the following Global Positioning System (GPS) data during the Phase II investigation:

- Soil boring location
- Soil sampling locations
- Vertical aquifer sampling locations
- Monitoring well locations
- Locations of potential conduits for contaminant migration (e.g., storm sewer grates, underground utilities)
- Other pertinent site-specific features.

The paragraphs below describe how the data will be collected, stored, and used for the Phase II investigation.

SulTRAC currently utilizes Environmental Systems Research Institute's (ESRI) software for a majority of projects using Geographic Information System (GIS). SulTRAC will manage the GIS data collected during the sampling event within an ESRI ArcGIS geodatabase built and designed for the project. GPS technology will also be utilized for accurate navigation to and capture of sampling locations and activities.

Using a site-specific geodatabase will ease delivery in GIS format of sampling features for EPA use and examination. A geodatabase is a database that contains certain tables, columns, and relationships among tables in a single file that allow use of that database by ESRI applications. Geodatabases have many advantages over traditional shapefiles. Spatial data reside within a single file, which eliminates need to store data in multiple shapefiles, thus eliminating many potential data management issues. A geodatabase also allows for more modeling, analysis, and cartographic functionality.

Trimble GeoXT handheld GPS units with an accuracy of less than 1 meter will be used in the field for data collection. These units have preloaded Trimble's GPS Correct Software to ensure differential correction of data captured, as well as Terrasync software, which will use basemap features such as aerial photography, utilities, and parcel boundaries acquired prior to commencement of field activities. SulTRAC will load the aforementioned GIS layers onto the GPS units for reference by the field team prior to commencing field activities.

Most GPS units, including the Trimble GeoXT, offer several settings that also serve as quality checks during data collection. For example, a minimum number of visible satellites, typically four, can be specified, thereby signaling a warning to the field team if a feature is to be collected when less than the minimum is available. Also, GPS units can calculate a Position Dilution of Precision (PDOP) value, with lower values leading to more accurate locations of features. Typically a PDOP value of 6 or less is desirable for more accurate data collection. These types of settings will be adjusted accordingly on the GPS units prior to start of field work in order to ensure the highest quality data capture.

Using GIS and Trimble GPS technology with the project geodatabase and applicable ESRI software will ensure sound data collection of sampling locations, and provide quality data to be processed upon completion of field work.

2.3 LABORATORY DATA

Laboratory data will include results from chemical analyses of all samples, as well as QC results for the respective analyses. The primary sample documentation steps for the laboratory are as follows:

1. A laboratory custodian receives and logs in the samples on the laboratory's custody forms.
2. Problems and corrective action are reported to the SulTRAC data coordinator and project manager.
3. Laboratory analysts perform the sample analyses.
4. Laboratory analysts and the laboratory supervisor conduct QC reviews of their work.
5. If data QC results are unacceptable, corrective action is taken to remedy the problem, and the samples are reanalyzed if necessary.

The laboratory will prepare a data package that includes a summary of sample and QC results, a record of chain of custody, raw data, and a summary report. Data package deliverables will be consistent with the CLP scope of work.

2.4 DATA VALIDATION

On preformatted analytical result forms, a chemist will routinely screen analytical data for accuracy as the data are received from the laboratory. Analytical data from this investigation will undergo data evaluation via computer-aided data review and evaluation (CADRE) processes only. The analytical coordinator and project manager will review the case narrative to ensure that project-required criteria have been achieved. Any CADRE-identified data quality issues will be communicated to the EPA work assignment manager in the data validation report prepared for each sampling event.

GIS data collected from the field will undergo a series of processing steps, including quality review by field team and GIS personnel, differential correction, and geodatabase import. Upon completion of field data collection, GIS personnel will perform a quality check and differential correction to ensure that all features captured are in the appropriate projection of the project, by overlaying these features with GIS reference data previously described. Additional attribute information may be populated for each feature (e.g., sample identification number) if not previously entered by field teams. Once the data have been differentially corrected and imported into the geodatabase, the geodatabase is ready for reporting and analysis.

3.0 DATA MANAGEMENT STRUCTURE

Field data sheets and field log books will be entered and/or scanned and stored electronically by SulTRAC's data coordinator or project manager. Sampling locations and details will be logged into the Scribe database. After receiving electronic data deliverables from the lab, data will be entered into Scribe for reviewing and querying data and GIS analysis as needed. All raw chemical data results forwarded by the laboratory will be stored electronically by SulTRAC's data coordinator and forwarded to the project manager for inclusion into the overall Elm Street Site electronic database. As a backup, data will also be maintained in hard copy format at the SulTRAC office in Chicago, Illinois. SCRIBE software will be used to carry out chain-of-custody procedures for CLP samples.

4.0 REFERENCES

SulTRAC. 2012. "Phase II Field Sampling Plan, Elm Street Contamination Groundwater Site, Terre Haute, Vigo County, Indiana." August 15, 2012.

REMEDIAL ACTION CONTRACT 2
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME CRITICAL REMOVAL ACTIVITIES
IN REGION 5

HEALTH AND SAFETY PLAN

PHASE II SITE MANAGMENT PLAN
ELM STREET GROUNDWATER CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

Prepared for
United States Environmental Protection Agency
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77 West Jackson Boulevard
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Appendix

Attachment

REVIEWS AND APPROVALS
CLIENT NAME: U.S. EPA Region 5
CONTRACT NO.: EP-S5-06-02
ELM STREET GROUNDWATER CONTAMINATION SITE
TERRE HAUTE, VIGO COUNTY, INDIANA

We the undersigned have read and approve of the health and safety guidelines presented in this health and safety plan for on-site work activities at the Elm Street Groundwater Contamination Site.

Name	Signature	Date
Chis Draper SulTRAC EM Inc. (SulTRAC) Health and Safety Representative	Chris Draper	4/26/12
Brian Malone SulTRAC Project Manager		6/05/12

This certifies that SulTRAC has assessed the type, risk level, and severity of hazards for the project and has selected appropriate personal protective equipment for site personnel in accordance with Occupational Safety and Health Administration Title 29 of the *Code of Federal Regulations*, Part 1910.132.

Certified by

Ron Riesing SulTRAC Technical Reviewer	RRiesing	6/05/12

EMERGENCY INFORMATION
POST ON SITE
EMERGENCY CONTACTS AND ROUTE TO HOSPITAL

Emergency Contact	**Telephone No.**
U.S. Coast Guard National Response Center	(800) 424-8802
InfoTrac Chemical Monitoring System	(800) 535-5053
WorkCare	(800) 455-6155
Fire Department	911
Police Department	911
SulTRAC EM Inc. Personnel:	
Human Resource Development: Amy Clark	(626) 470-2516
Health and Safety Representative: Chris Draper	(615) 969-1334
Office Health and Safety Coordinator: Greg Kern	(513) 333-3672
Project Manager: Brian Malone	(440) 781-7944
Site Safety Coordinator: TBD	
Client Contact:	
Howard Caine, EPA Region 5, Work Assignment Manager	(312) 353-9685

Medical Emergency

Hospital Name: Union Hospital

Hospital Address: 1606 North 7th Street
Terre Haute, IN 47804

Hospital Telephone No.: Emergency - (812) 238-7000
General - (812) 238-7000

Ambulance Telephone No.: 911

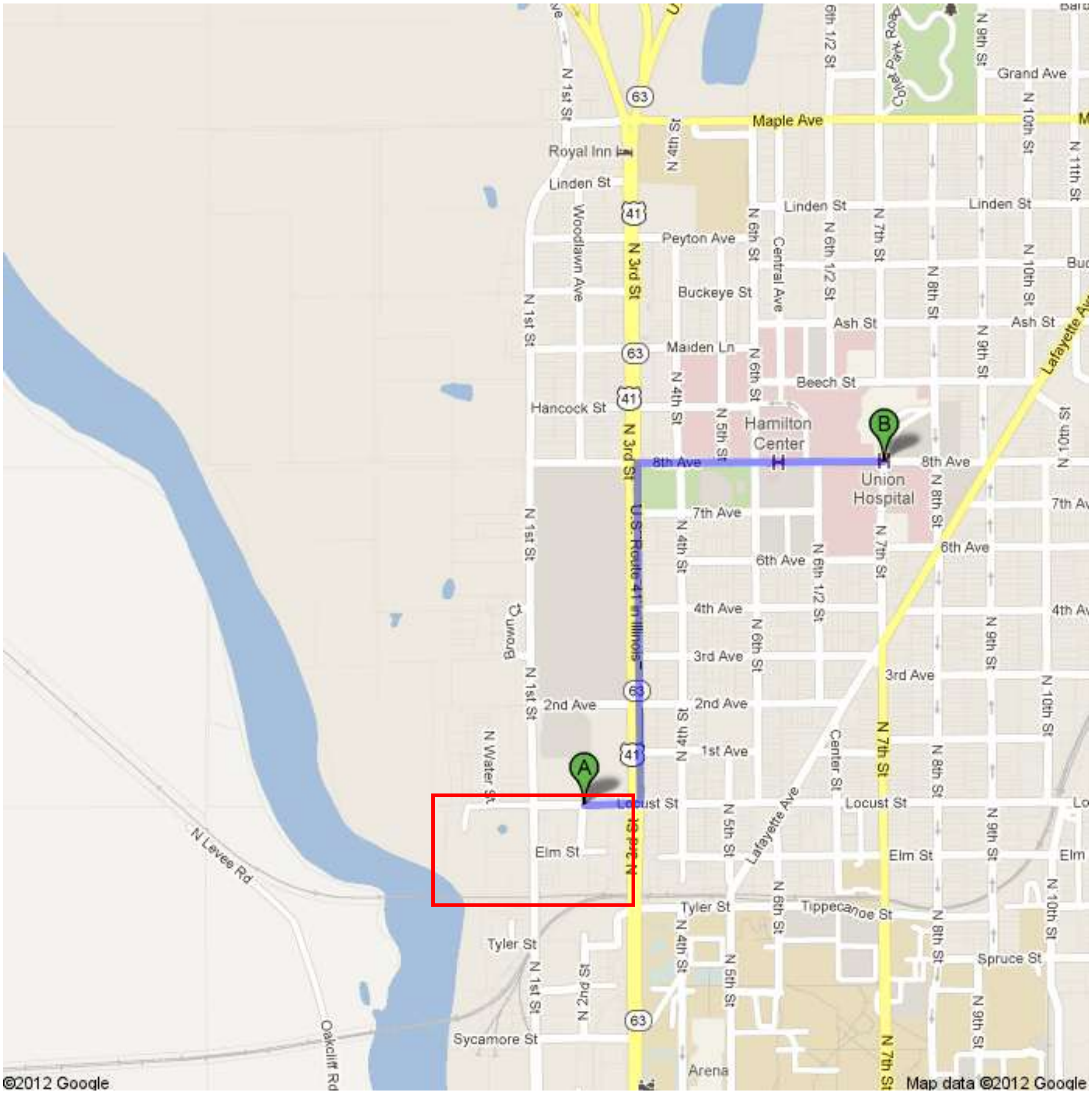
Route to Hospital: (see next page hospital route map)

Locust St

1. Head east on Locust St toward N 3rd St — go 436 ft, total 436 ft
2. Take the 1st left onto N 3rd St — About 2 mins — go 0.5 mi, total 0.6 mi
3. Turn right onto 8th Ave — About 1 min — go 0.4 mi, total 0.9 mi

Union Hospital
1606 North 7th Street, Terre Haute, IN 47804 - (812) 238-7000

EMERGENCY INFORMATION
POST ON SITE
HOSPITAL ROUTE MAP



Note: **This sheet must be posted on site.**

ACRONYMS AND ABBREVIATIONS

bgs	Below ground surface
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
DCE	Dichloroethene
DNAPL	Dense-nonaqueous phase liquid
DPT	Direct-push technology
EPA	U.S. Environmental Protection Agency
ESI	Expanded site inspection
FS	Feasibility study
FSP	Field sampling plan
ft	Feet
FTL	Field team leader
GIS	Geographic Information System
GPS	Global positioning system
HASP	Health and safety plan
MCL	Maximum contaminant level
ND	None detected
NPL	National Priorities List
Ohio EPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCE	Tetrachloroethene
PID	Photoionization detector
PPE	Personal protective equipment
RAC	Remedial action contract
RD	Remedial design
RI	Remedial investigation
SAP	Sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act

SOP	Standard operating procedure
SOW	Statement of work
SVOC	Semivolatile organic compound
TAL	Target analyte list
TCA	Trichloroethane
TCE	Trichloroethene
TCL	Target compound list
TOC	Top of casing
UST	Underground storage tanks
VAS	Vertical aquifer sampling
VOC	Volatile organic compound

1.0 INTRODUCTION

SulTRAC, a joint venture between Sullivan International (Sullivan) and Tetra Tech EM Inc. (Tetra Tech), received Work Assignment No. 138-RICO-B5BF from the U.S. Environmental Protection Agency (EPA) under Contract No. EP-S5-06-02 to conduct a remedial investigation and feasibility study (RI/FS) at the Elm Street Groundwater Contamination Site (Elm Street Site) in Terre Haute, Indiana. The site-specific health and safety provisions in this document have been developed for use during field investigation activities to be performed at the Site. SulTRAC will perform various field activities or combinations of activities for data acquisition to support the RI/FS. The primary goals of the Phase II investigation are to (1) investigate any data gaps identified from the Phase I investigation including soil, groundwater and soil gas; (2) delineate areas of soil contamination exceeding the Residential Soil, Industrial Soil and Protection of Groundwater generic values identified in the EPA Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites; (3) further assess the potential vapor intrusion exposure pathway at the Riverside Apartment Complex, Gurman processing area and MTS facility; (4) collect updated groundwater quality data, including additional information on background water quality; and (5) further investigate contaminant distribution in groundwater and aquifer characteristics. For this reason, the project approach has been designed to maximize efficiency by combining planning and data collection activities wherever practical. Following this approach, one health and safety plan (HASP) has been prepared to include sampling and investigation activities to be conducted onsite. This document addresses items specified under Occupational Safety and Health Administration (OSHA) Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.120 (b), “Final Rule.” This HASP will be available to all on-site personnel who enter the site and may be exposed to hazardous on-site conditions, including SulTRAC and subcontractor personnel participating in sampling and investigation activities, and all site visitors, including regulatory agency representatives.

The purpose of this HASP is to define requirements and designate protocols to be followed during sampling and investigation activities at the Site. All personnel on site, including SulTRAC and subcontractor employees and site visitors, must be informed of site emergency response procedures and any potential fire, explosion, health, or safety hazards associated with on-site activities. This HASP summarizes potential hazards and defines protective measures planned for site activities.

This plan must be reviewed and approved by the SulTRAC health and safety representative (HSR) or a designee and the SulTRAC project manager (see the Reviews and Approvals form after the Contents in this document). The Compliance Agreement form in Appendix A must be signed by all personnel before they enter the site. Protocols established in this HASP are based on site conditions and health and safety hazards known or anticipated to be present and on available site data. This plan is intended solely for use during proposed activities described in the corresponding site-specific work plans. Specifications herein are subject to review and revision based on actual conditions encountered in the field during site activities. Significant revisions to this plan must be approved by the SulTRAC project manager and the SulTRAC HSR. SulTRAC employees must also follow safety requirements taught during safety training and described in the Tetra Tech "Health and Safety Manual."

2.0 HEALTH AND SAFETY PERSONNEL AND PLAN ENFORCEMENT

This section describes responsibilities of project personnel, summarizes requirements for subcontractors and visitors who wish to enter the Site, and discusses HASP enforcement.

2.1 PROJECT PERSONNEL

The following personnel and organizations are associated with planned activities at the site. The organizational structure will be reviewed and updated as necessary during the course of the project.

Name/Title	Responsibility	Telephone No.
Client Representative:		
Howard Caine	EPA Region 5, Work Assignment Manager	(312) 353-9685
SulTRAC Personnel:		
Brian Malone	Project Manager	(440) 781-7944
Chris Draper	HSR	(615) 969-1334
Chris Burns	Site Safety Coordinator (SSC)	(570) 417-1280
Brian Malone	Field Manager	(440) 781-7944
Subcontractors:		
Sonic Drilling and Vertical Aquifer Sampling Subcontractor:		
WDC	Project Manager	Daniel Harrison
Geoprobe Drilling, Groundwater Sampling and Soil Gas Installation Subcontractor:		

Roberts Drilling	Project Manager	Travis Roberts
Topographic Survey Subcontractor:		
TBD	Project Manager	TBD
Electrical Subcontractor:		
Hef Services	Project Manager	Mitch Fuqua

The SulTRAC project manager, field manager, SSC, and HSR will be responsible for implementation and enforcement of the provisions of this HASP. Their duties and the expectations for SulTRAC employees are described in the following sections.

2.1.1 Project Manager and Field Manager

The SulTRAC project manager (Brian Malone) has ultimate responsibility for ensuring implementation of the requirements set forth in this HASP. Some of this responsibility may be achieved through delegation to site-dedicated personnel that report directly to the project manager. The project manager shall regularly confer with site personnel regarding safety and health compliance.

The SulTRAC field manager (Brian Malone) will oversee and direct field activities and has day-to-day responsibility for ensuring implementation of the HASP. Subcontractor compliance with the HASP shall be monitored by the field manager. The field manager will report directly to the project manager any health and safety-related issues.

2.1.2 Site Safety Coordinator

Site Safety Coordinators (SSC) are assigned by the project manager (PM) and approved by the HSR to provide health and safety oversight for a specific project. SSCs must be assigned for all Hazardous Waste Operations and Emergency Response (HAZWOPER) work, construction work, and whenever contractually required. HSRs may also require a SSC on non-HAZWOPER projects if warranted by site hazards or non-routine operations. If qualified by experience and training, the SSC may also serve as the “competent person” as required by federal or state health and safety regulations and by the corporate health and safety program (for example, for excavations, asbestos, fall protection, and scaffolding). Determinations of appropriate qualifications shall be made by the HSR in coordination with the PM on a project-by-project basis. The HSR has the right and responsibility to review the scope of work and site hazards in order to ensure that the SSC selected is adequately-trained and experienced to manage site safety for a specific project. The SSC is responsible for the following:

- Being on site during all work activities or designating a qualified alternate SSC in his or her absence.
- Overseeing health and safety issues for SulTRAC employees, subcontractors, and visitors at the site where he or she is assigned.
- Implementing hazard communication, respiratory protection, personal protective equipment, and other associated safety and health programs.
- Implementing site-specific HASP.
- Verifying that on-site personnel read and understand site health and safety documents, such as health and safety plans (HASPs), Construction-related HASPs (C-HASPs), project specific material safety data sheets (MSDS), and activity hazard analysis (AHAs).
- Verify that the HASP accurately reflects ALL site hazards and is revised or amended as new tasks are assigned or new hazards are recognized.
- Verifying on-site personnel have all necessary training, medical clearance, and respirator fit-tests as specified by the HASP.
- Advising the PM and/or client of any field practices or conditions that may endanger the health and safety of field personnel, subcontractors, or visitors.
- Recommending corrective actions to any conditions that may endanger the health and safety of field personnel, subcontractors, or visitors.
- Selecting, inspecting, maintaining, and enforcing proper use, cleaning, and maintenance of protective clothing and equipment.
- Monitoring on-site hazards and conditions.
- Maintaining visual or verbal communication with all site workers.
- Stopping work if they feel any worksite condition, practice, or operation causes or presents a hazard that can reasonably be expected to result in immediate death, serious physical harm, or severe damage to the environment.
- Working closely with the project-specific PM to determine appropriate corrective action and/or prompt resolution to all hazards.

- Conducting daily health and safety briefings for site personnel and initial site training for new personnel.

- Establishing and maintaining work zones and control points by overseeing control of entry and exit at site access points and recording the names and job assignments of all personnel who enter and exit the site.

- Arranging for work area and personal or ambient hazard monitoring (for occupational exposure assessments related to inhalation, noise, heat/cold stress, and other potential exposure hazards).

- Ensuring that all monitoring equipment used on site has been properly calibrated and is operated in accordance with manufacturer's recommendations and approved sampling methodologies.

- Creating and maintaining records of employee exposure and monitoring results for all on-site personnel.

- Determining the need for additional safety equipment (such as respirators and fall protection equipment), depending on planned tasks and site-specific conditions.

- Monitoring workers for signs of occupational health exposures, such as chemical exposure, heat stress and fatigue.

- Determine, implement and verify the efficacy of site personnel and equipment decontamination procedures, including ensuring that all necessary equipment is available, functional, and used as required.

- Conducting scheduled and unscheduled field site safety audits.

- Coordinating and supervising emergency response and providing emergency first aid and cardiopulmonary resuscitation (CPR) to team members, if required.

- Reporting all occupational illness, injuries, incidents and near-misses to the HSR and PM immediately after stabilization of the incident.

- Assisting in preparing reports of illnesses, injuries, motor vehicle accidents, or property damage.

2.1.3 Health and Safety Representative

The SulTRAC HSR (Chris Draper) is responsible for administration of the company health and safety program. The HSR will act in an advisory capacity to project managers and site personnel for project-specific health and safety issues. The SulTRAC project manager will establish a liaison between officers and representatives of EPA and the HSR on matters relating to health and safety.

2.1.4 SulTRAC Employees

SulTRAC employees are expected to fully participate in implementing the site HASP by obtaining necessary training, attending site safety meetings, always wearing designated personal protective equipment (PPE), complying with site safety and health rules, and advising the SulTRAC SSC of health and safety concerns at the site. Additionally, all SulTRAC employees have the following rights and responsibilities:

- SulTRAC employees are expected to and responsible for reporting safety hazards they face while performing their work. As such, employee reports of safety hazards are viewed as positive interactions and no employee of Tetra Tech will retaliate against any other employee who reports a safety hazard.
- SulTRAC employees have the right to refuse to perform work involving significant safety hazards they feel have not been addressed.
- Every SulTRAC employee has the right to stop work if he/she feels any worksite condition, practice, or operation causes or presents a hazard that can reasonably be expected to result in immediate death, serious physical harm, or severe damage to the environment.

2.2 SUBCONTRACTORS

Subcontractor personnel participating in sampling and investigation activities will be required to read and comply with all sections of this plan. All subcontractor personnel entering the site must sign the Compliance Agreement form (see Appendix A). Subcontractor personnel must comply with all applicable 29 CFR 1910.120 training, fit testing, and medical surveillance requirements. Subcontractors are responsible for providing PPE required by this plan for their personnel (see Section 6.1, Protective Equipment and Clothing) and are directly responsible for the health and safety of their employees, including drafting its own HASP and/or AHAs that are adequately protective of their employees.

2.3 VISITORS

All site visitors will be required to read the HASP and sign the Compliance Agreement form (see Appendix A). Visitors will be expected to comply with relevant OSHA requirements. Visitors will also be expected to provide their own PPE required by the HASP. Visitors who have not met OSHA training, medical surveillance, and PPE requirements are not permitted to enter areas where exposure to hazardous materials is possible.

2.4 HEALTH AND SAFETY PLAN ENFORCEMENT

This HASP applies to all site activities and all personnel working on the Site. HASP enforcement shall be rigorous. Violators of the HASP will be verbally notified upon first violation, and the violation will be noted by the SulTRAC SSC in a field logbook. Upon second violation, the violator will be notified in writing, and the SulTRAC project manager and the violator's supervisor will be notified. A third violation will result in a written notification and violator's eviction from the site. The written notification will be sent to human resources development and the HSR.

Personnel will be encouraged to report to the SSC any conditions or practices that they consider to be detrimental to their health or safety or those they believe are in violation of applicable health and safety standards. Such reports may be made orally or in writing. Personnel who believe that an imminent danger threatens human health or the environment will be encouraged to bring the matter to the immediate attention of the SSC for resolution.

At least one copy of this HASP will be available to all site personnel at all times. Minor changes in HASP procedures will be discussed at the beginning of each work day by the SSC at the daily tailgate safety meeting. Significant plan revisions must be discussed with the HSR and project manager.

3.0 SITE BACKGROUND

Sampling and investigation activities at the Site are being conducted to gather design-supporting data, further delineate groundwater and surface and subsurface soil contamination, address soil vapor intrusion issues, and other related issues associated with volatile organic compound (VOC) contamination at the site. Sampling and investigation activities are described in Section 3.3. Sampling methodology is described in the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) (SulTRAC 2012a and 2012b). The following sections describe the Site, its history, and activities planned for this project.

3.1 SITE DESCRIPTION

The Elm Street site is located in Terre Haute, Indiana. Surrounding land includes an apartment complex and open/recreational land to the north, commercial and residential property to the east, commercial and industrial property to the south, and the Indiana American Water Company (IAWC) and the Wabash River to the west. Therefore, the site is roughly bounded by Locust Street to the north, North 3rd Street

(Highway 41) to the east, railroad tracks to the south, and the Wabash River to the west. The study area for the Elm Street site, located in Terre Haute, Vigo County, Indiana, encompasses 18.5 acres, including active facility buildings, abandoned buildings and related underground utilities, streets, railroad lines, and surrounding properties (Figure 3-1 Site Layout). Sampling of municipal wells along the east bank of the Wabash River has shown detectable levels of VOC contamination since 1988. The three potential source areas include (1) the Gurman property located at 800 North 3rd Street, (2) the Ashland (formerly BiState Products) property located at 118 Elm Street, and (3) the MTS property located at 701 North 1st Street. As previously noted, the site has been subdivided into four distinct investigation areas for the Phase II investigation; (1) the Gurman property, (2) the Ashland property, (3) the MTS property, and (4) the former Sinclair/roundhouse area (Figure 3-2 Site Layout).

3.2 SITE HISTORY

The Gurman facility has been in operation since 1922. The northern one-third of the property was residential prior to the early 1980s. From 1930 to 1980, Gurman primarily reconditioned and sold steel barrels. Since 1980, Gurman primarily sold paper and plastic containers and reconditioned customer-owned drums. It is believed that Gurman accepted drums with various types and likely small quantities of residual product or waste material. The standard practice for most of its operational history from the 1950s to the 1980s was to open the drums and dump their contents onto the ground surface, then rinse the remaining contents down the storm sewer in the process area before they were refurbished. During IDEM’s screening site inspection (SSI) in 1987, about 4,000 barrels were believed to be on site. About 1,000 barrels were believed to be on site during the 1999 expanded site inspection (ESI).

The Ashland facility (formerly BiState) served as a local supplier of Texaco products from the 1930s through the 1980s. Petroleum products were stored in bulk and distributed, and solvents were used for parts cleaning at local service stations. In 1980, MTS purchased the property and leased it to BiState, which operated the facility for satellite collection and storage of waste oils. In the late 1980s, the property was purchased by Consolidated Recycling for petroleum recycling. In the early 1990s, the property was transferred to Valvoline Oil Company (Valvoline). From 1990 through 1998, the property was owned and operated by First Recovery, a former division of Valvoline. In 1999, many Valvoline recycling facilities were transferred to Safety-Kleen; however, Ashland, the current owner of Valvoline, stated that in 1999, Safety-Kleen did not take possession of the property, but removed some real property in early 2000. In addition, two underground storage tanks (UST) were removed near the warehouse area in 1986 and 1988, respectively (IDEM 2002). The used oil storage operations that followed may have accepted oils containing solvents; however, the presence of chlorinated VOCs in the raw municipal well water predates the oil recycling operations.

According to historical records, in 1911, MTS property housed the Terre Haute Oil Company. Multiple storage tanks, a coal shed, and empty barrels were reportedly present on the property. By 1950, the Terre Haute Oil Company was no longer present. MTS purchased the property in 1975; however, historical research indicates the buildings were used for machine tool and equipment repair since 1967. The MTS facility also stored petroleum products and solvents on the eastern portion of the property, which includes a remnant bulk oil containment with aboveground storage tanks (AST) and small warehouse building (IDEM 2002). Furthermore, a former locomotive repair and maintenance facility (roundhouse) existed on the central portion of the property. Although no evidence exists to substantiate the use of solvents during locomotive repair operations at the facility, the use of solvents is considered to have been a common practice during that period. In addition, a Sinclair Oil facility was on the eastern portion of the property.

IAWC, which operates the municipal water works in Terre Haute, began noticing chlorinated VOCs in samples from the deep wells in the early 1980s during required monitoring of its well field (IDEM 2002). The site discovery process for the Elm Street site began by IDEM in 1987 based on information submitted by IAWC.

Sources of metals on the Elm Street site could be attributed to multiple distinct operations site wide — specifically, remnant metals contamination in waste solvents in drums recycled at the Gurman property, locomotive repair operations at the former roundhouse, machining operations at the MTS property, and distribution along the Penn Central Railroad from hauling raw ores or scrap metals via open-box rail cars. Additionally, lead contamination from repair of locomotives is suspected in the area of the former roundhouse.

Many documented potential organic contaminant sources led IDEM to suspect potential contamination by semivolatile organic compounds (SVOC) and VOCs at the Elm Street site. VOC and SVOC use have been pervasive at the Gurman, MTS, and Ashland properties and the former Sinclair/roundhouse area, as detailed in the following list of source candidates for potential soil and groundwater contamination:

- Gasoline or coal-powered locomotives used for moving cars along the southern boundary of the site.
- Locomotive repair at the roundhouse.

- Presence of numerous above ground storage tanks at the former Sinclair containment area and the Ashland Property.
- Underground storage tanks formerly located at the Ashland Property.
- Machinery and engine oils used at the roundhouse.
- Coal burning at the roundhouse.
- The presence of carbon tetrachloride fire extinguishers.
- The presence of engine/machine shops.

Polychlorinated biphenyl (PCB) contamination may also be found in surface soils of the Elm Street site. PCBs were used in electrical transformers manufactured between 1929 and 1977. The removal and disposal of these transformers is not documented; thus, PCB soil contamination may be found in the vicinity of former transformer sites.

FIGURE 3-1
SITE LOCATION

FIGURE 3-2
SITE LAYOUT

3.3 PLANNED ACTIVITIES

Field activities will be performed in accordance with the Phase II FSP and QAPP (SulTRAC 2012a and 2012b). Field activities to be performed during the sampling and investigation activities include the following tasks:

Preliminary Phase II Activities — Completed January 2011

- Pre-intrusive Verification Sampling – Collecting groundwater samples for volatile organic compound (VOC) analysis from upgradient monitoring wells MW-7S, MW-7D, MW-14S, MW-14D, MW-15S, and MW-15D; and on-site monitoring wells MW-8S, MW-8D, MW-10S, and MW-10D due to detections of VOCs.
- Soil Gas Sampling – Collecting soil gas samples for VOC analysis from soil gas wells SG001A, SG001B, SG002A, SG003A, SG003B, SG004A, SG004B,SG005A, SG005B,SG006A, and SG006B to further evaluate and verify VOCs detected at these locations

Phase II Activities – Planned Summer 2012

- Geological Investigation — SulTRAC will conduct geological investigations and collect surface and subsurface soil samples from a total of 46 soil borings at the Ashland, Gurman, MTS, the former Sinclair/roundhouse area, and two background locations east of Highway 31. Grab groundwater samples will be collected from 14 of the investigative soil boring locations.
- Vertical Aquifer Sampling (VAS) – SulTRAC will advance a total of 9 soil borings, collect surface and subsurface soil samples, and conduct vertical aquifer sampling. Monitoring wells MW-05, MW-03, MW-06 (NEW), MW-12, MW-01, MW-02, and MW-09 will be sampled in conjunction with the VAS program creating lines of VAS locations at three discreet areas of the site.
- Soil Gas Investigation — SulTRAC will conduct a soil gas investigation to assess the potential vapor intrusion exposure pathway near the Gurman building drum processing area, the MTS Machine Building, and three additional locations between the Riverside Apartment Complex and the utility corridors along Second Street. Nine new soil gas wells will be installed in paired sets with a shallow well and deep well at each location. Surface soil, subsurface soil and grab groundwater samples will be collected from each paired location. Soil gas sampling of existing and newly-installed wells will be conducted following well installation and development.
- Aquifer Testing — SulTRAC will conduct a mechanical slug test on up to 11 wells to determine aquifer characteristics and variation site-wide. SulTRAC will also monitor pumping effects of the IAWC wells and aquifer response from up to four (4) monitoring wells on the east side of First Street. Transducers will be placed in monitoring wells to collect data while IAWC wells are activated in the normal cycling operation.

- Hydrogeologic Investigations — SulTRAC will install up to seven (7) monitoring wells, ranging in depth from about 50 to 150 feet. Three paired sets of new monitoring wells will be installed with one replacement well installed at MW-13D. Surface soil and subsurface soil samples will be collected from each location. Groundwater sampling of existing and newly installed monitoring wells will be conducted following well installation and development. In addition, four IAWC water supply wells will be sampled.

Completion of Phase II field tasks is expected to take about 6 weeks. The field manager is responsible to ensure that the tasks are conducted according to the specified standard operating procedures.

4.0 SITE-SPECIFIC HAZARD EVALUATION

Field activities and physical features of the site may expose field personnel to a variety of hazards. This section provides information on potential hazards related to site activities and the nature of hazardous material impacts. Potential chemical and physical hazards related to site activities are discussed below.

4.1 CHEMICAL HAZARDS

Chemicals that may be present at the site are listed in Table 4-1. These chemicals pose various physical, chemical, and toxicological hazards. Potential routes of exposure include dermal (skin) contact, inhalation, and ingestion. The chemicals may also contaminate equipment, vehicles, instruments, and personnel. The overall health threat from exposure to these chemicals is uncertain because (1) actual concentrations that personnel could be exposed to cannot be predicted, (2) the actual duration of exposure is unknown, and (3) the effects of low-level exposure to a mixture of chemicals cannot be predicted. However, SulTRAC believes that the potential for high-level exposure is limited.

Specific information on potential chemical hazards at the site is provided in Table 4-1, including exposure limits, anticipated exposure routes, and toxic characteristics. Table 4-2 provides a task hazard analysis of the planned field activities listed in Section 3.3. The Material Safety Data Sheets (MSDS) included in the attachment to this HASP summarize health and safety information for hazardous materials that will be brought to the site, such as laboratory reagents, decontamination solutions, and sample preservatives. These materials are as follows:

- Hydrochloric Acid
- Nitric Acid
- Sodium Hydroxide
- Alconox

TABLE 4-1
POTENTIAL CHEMICAL HAZARDS
ELM STREET SITE

Chemical and Media	Exposure Limits and IDLH Level	Exposure Routes	Toxic Characteristics
PCBs - assume 54% chlorine (in soil)	PEL = 0.5 mg/m^3 REL = 0.001 mg/m^3 TLV = 0.5 mg/m^3 IDLH = Ca [5 mg/m^3]	inhalation, skin absorption, ingestion, skin and/or eye contact	Eye irritation, chloracne, liver damage, reproductive effects, potential carcinogen
Carbon tetrachloride	PEL = 10 ppm REL = 2 ppm TLV = 10 ppm TWA IDLH = Ca [200 ppm]	inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; central nervous system depression; nausea, vomiting; liver, kidney injury; drowsiness, dizziness, incoordination; [potential occupational carcinogen]
1,1,1-Trichloroethane	PEL = 350 ppm REL = 350 ppm TLV = 350 ppm IDLH = 700 ppm	inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage
cis- 1,2-Dichloroethylene	PEL = 200 ppm REL = 200 ppm TLV = 200 ppm IDLH = 1,000 ppm	inhalation, ingestion, skin absorption, skin and/or eye contact	Irritation eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]
1,1-Dichloroethane	PEL = 100 ppm TWA REL = 100 ppm TWA TLV = 100 ppm IDLH = 3,000 ppm	inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation skin; central nervous system depression; liver, kidney, lung damage
Chloroform	PEL = 50 ppm REL = Ca 2 ppm [60-minute] TLV = 10 ppm IDLH = Ca [500 ppm]	inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]

Chemical and Media	Exposure Limits and IDLH Level	Exposure Routes	Toxic Characteristics
Tetrachloroethene (PCE)	PEL: 100 ppm TWA, 200 ppm C REL: 25 ppm TWA, 2 ppm STEL TLV: 10 ppm TWA, 25 ppm STEL IDLH: Ca [1,000 ppm]	inhalation, skin absorption, ingestion, skin and/or eye contact	Iirritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]
Trichloroethene (TCE)	PEL = 100 ppm TWA REL = Ca TLV = 50 ppm TWA IDLH = Ca [1,000 ppm]	inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation of eyes, skin; headache; visual disturbance; lassitude (weakness, exhaustion), dizziness; tremor; drowsiness, nausea; vomiting; dermatitis; cardiac arrhythmias; paresthesia; liver injury; potential male reproductive toxin; [potential occupational carcinogen]
1,2-Dichloroethene (DCE)	PEL = 200 ppm TWA REL = 200 ppm TWA TLV = 200 ppm TWA IDLH = 1,000 ppm	inhalation, ingestion, and eye or skin contact	Exposure to the vapor of dichloroethylene may cause burning of the eyes. Other symptoms of acute exposure are nausea, vomiting, and epigastric distress. Symptoms of exposure-related narcosis including drowsiness, tremor, incoordination, dizziness, and weakness; these symptoms clear quickly after exposure is terminated. Repeated skin exposure may cause irritation and dermatitis.
Toluene	PEL = 200 ppm REL = 100 ppm TLV = 50 ppm ILDH = 2,000 ppm	inhalation, ingestion, and eye or skin contact	Irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage

Notes:

ACGIH	American Conference of Governmental Industrial Hygienists
Ca	Potential occupational carcinogen
IDLH	Immediately dangerous to life or health
mg/m^3	Milligram per cubic meter
ND	Not determined
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppm	Part per million
REL	Recommended exposure limit
STEL	Short-term exposure limit for a 15-minute TWA exposure
TLV	Threshold limit value
TWA	Time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek

Sources: American Conference of Governmental Industrial Hygienists (ACGIH). "Threshold Limit Values and Biological Exposure Indices for 2011." Latest edition.

National Institute for Occupational Safety and Health. "Pocket Guide to Chemical Hazards." U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. http://www.cdc.gov/niosh/npg/ Online service accessed on April 25, 2012.

TABLE 4-2
TASK HAZARD ANALYSIS
ELM STREET SITE

Task Number	Task	Potential Hazard	Controls	Initial Level of Protection	Upgraded Level of Protection
1	Soil Gas Sampling (RI)	Exposure to chemicals listed in Table 4-1; Heat and/or cold stress; Sun exposure; Uneven, muddy, sandy, marshy, or rugged terrain; General slips, trips, and falls; Heavy equipment (drills, etc.); Overhead and underground utilities;High noise; Heavy lifting; Biohazards, including poisonous animals, poisonous plants, ticks, and mosquitoes	Follow General Safe Work Practices HAZWOPER (SWP 5-2); Heat Stress and/or Cold Stress (SWP 5-15, SWP 5-16); Follow Prevention of Sun Exposure (SWP 5-26); wear hats and sunscreen as needed to limit sun exposure; Follow Safe Lifting Practices (SWP 5-19); Follow Working Near Heavy Equipment (SWP 5-7); keep away from heavy equipment; be aware of the swing radius of equipment; and ensure eye contact is made with the operator before approaching machinery; Follow Safe Drilling Practices (SWP 5-4), Follow Safe Direct Push Practices (SWP 5-5), Follow Hearing Conservation Program (DCN 2-4); wear hearing protection in areas >85 dB; use rule of thumb and wear hearing protection whenever you have to raise your voice to be heard and understood from 2 feet away;, Keep out or limit time in grassy and wooded areas; use insect repellent as necessary and follow Biohazards (SWP 5-17); Use and maintain respirators in accordance with Respirator Cleaning and Use of Air Purifying Respirators (SWP 5-27, SWP 5-28)	Level D ensemble: Clothing: work uniform or coveralls Head and face: Hardhat and safety glasses or goggles Respirator: N/A Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank Other: high-visibility vest, personal floatation device (within 15 feet of water), ear plugs (near heavy equipment or in high noise areas), sunscreen, and insect repellant	Level C ensemble: Respirator: full-face air purifying respirator with organic vapor P100 cartridge Tyvek QC or SL as needed to avoid contamination Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank If personnel do not have a respirator, personnel must leave area until H&S concern subsides

Task Number	Task	Potential Hazard	Controls	Initial Level of Protection	Upgraded Level of Protection
2	Surface and Subsurface Soil Sampling (RI/FS)	Exposure to chemicals listed in Table 4-1; Heat and/or cold stress; Sun exposure; Uneven, muddy, sandy, marshy, or rugged terrain; General slips, trips, and falls; Heavy equipment (drills, etc.); Overhead and underground utilities; High noise; Heavy lifting; Biohazards, including poisonous animals, poisonous plants, ticks, and mosquitoes	Follow General Safe Work Practices HAZWOPER (SWP 5-2); Heat Stress and/or Cold Stress (SWP 5-15, SWP 5-16); Follow Prevention of Sun Exposure (SWP 5-26); wear hats and sunscreen as needed to limit sun exposure; Follow Safe Lifting Practices (SWP 5-19); Follow Working Near Heavy Equipment (SWP 5-7); keep away from heavy equipment; be aware of the swing radius of equipment; and ensure eye contact is made with the operator before approaching machinery; Follow Safe Drilling Practices (SWP 5-4), Follow Safe Direct Push Practices (SWP 5-5), Follow Hearing Conservation Program (DCN 2-4); wear hearing protection in areas >85 dB; use rule of thumb and wear hearing protection whenever you have to raise your voice to be heard and understood from 2 feet away;, Keep out or limit time in grassy and wooded areas; use insect repellent as necessary and follow Biohazards (SWP 5-17); Use and maintain respirators in accordance with Respirator Cleaning and Use of Air Purifying Respirators (SWP 5-27, SWP 5-28)	Level D ensemble: Clothing: work uniform or coveralls Head and face: Hardhat and safety glasses or goggles Respirator: N/A Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank Other: high-visibility vest, personal floatation device (within 15 feet of water), ear plugs (near heavy equipment or in high noise areas), sunscreen, and insect repellant	Level C ensemble: Respirator: full-face air purifying respirator with organic vapor P100 cartridge Tyvek QC or SL as needed to avoid contamination Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank If personnel do not have a respirator, personnel must leave area until H&S concern subsides

Task Number	Task	Potential Hazard	Controls	Initial Level of Protection	Upgraded Level of Protection
3	Groundwater Sampling (RI/FS)	Exposure to chemicals listed in Table 4-1; Heat and/or cold stress; Sun exposure; Uneven, muddy, sandy, marshy, or rugged terrain; General slips, trips, and falls; Heavy equipment (drills, etc.); Overhead and underground utilities; High noise; Heavy lifting; Biohazards, including poisonous animals, poisonous plants, ticks, and mosquitoes	Follow General Safe Work Practices HAZWOPER (SWP 5-2); Heat Stress and/or Cold Stress (SWP 5-15, SWP 5-16); Follow Prevention of Sun Exposure (SWP 5-26); wear hats and sunscreen as needed to limit sun exposure; Follow Safe Lifting Practices (SWP 5-19); Follow Working Near Heavy Equipment (SWP 5-7); keep away from heavy equipment; be aware of the swing radius of equipment; and ensure eye contact is made with the operator before approaching machinery; Follow Safe Drilling Practices (SWP 5-4), Follow Safe Direct Push Practices (SWP 5-5), Follow Hearing Conservation Program (DCN 2-4); wear hearing protection in areas >85 dB; use rule of thumb and wear hearing protection whenever you have to raise your voice to be heard and understood from 2 feet away;, Keep out or limit time in grassy and wooded areas; use insect repellent as necessary and follow Biohazards (SWP 5-17); Use and maintain resirators in accordance with Respirator Cleaning and Use of Air Purifying Respirators (SWP 5-27, SWP 5-28)	Level D ensemble: Clothing: work uniform or coveralls Head and face: Hardhat and safety glasses or goggles Respirator: N/A Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank Other: high-visibility vest, personal floatation device (within 15 feet of water), ear plugs (near heavy equipment or in high noise areas), sunscreen, and insect repellant	Level C ensemble: Respirator: full-face air purifying respirator with organic vapor P100 cartridge Tyvek QC or SL as needed to avoid contamination Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank If personnel do not have a respirator, personnel must leave area until H&S concern subsides

Task Number	Task	Potential Hazard	Controls	Initial Level of Protection	Upgraded Level of Protection
4	Monitoring Well Installation (RI/FS)	Exposure to chemicals listed in Table 4-1; Heat and/or cold stress; Sun exposure; Uneven, muddy, sandy, marshy, or rugged terrain; General slips, trips, and falls; Heavy equipment (drills, etc.); Overhead and underground utilities; High noise; Heavy lifting; Biohazards, including poisonous animals, poisonous plants, ticks, and mosquitoes	Follow General Safe Work Practices HAZWOPER (SWP 5-2); Heat Stress and/or Cold Stress (SWP 5-15, SWP 5-16); Follow Prevention of Sun Exposure (SWP 5-26); wear hats and sunscreen as needed to limit sun exposure; Follow Safe Lifting Practices (SWP 5-19); Follow Working Near Heavy Equipment (SWP 5-7); keep away from heavy equipment; be aware of the swing radius of equipment; and ensure eye contact is made with the operator before approaching machinery; Follow Safe Drilling Practices (SWP 5-4), Follow Safe Direct Push Practices (SWP 5-5), Follow Hearing Conservation Program (DCN 2-4); wear hearing protection in areas >85 dB; use rule of thumb and wear hearing protection whenever you have to raise your voice to be heard and understood from 2 feet away;, Keep out or limit time in grassy and wooded areas; use insect repellent as necessary and follow Biohazards (SWP 5-17); Use and maintain respirators in accordance with Respirator Cleaning and Use of Air Purifying Respirators (SWP 5-27, SWP 5-28)	Level D ensemble: Clothing: work uniform or coveralls Head and face: Hardhat and safety glasses or goggles Respirator: N/A Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank Other: high-visibility vest, personal floatation device (within 15 feet of water), ear plugs (near heavy equipment or in high noise areas), sunscreen, and insect repellant	Level C ensemble: Respirator: full-face air purifying respirator with organic vapor P100 cartridge Tyvek QC or SL as needed to avoid contamination Gloves: Leather work or polyvinyl alcohol Boots: leather steel toe/steel shank If personnel do not have a respirator, personnel must leave area until H&S concern subsides

Notes:

H&S	Health and Safety
N/A	Not Applicable
RI/FS	Remedial Investigation/Feasibility Study
SWP	Safe Work Practices

4.2 PHYSICAL HAZARDS

Physical hazards associated with site activities present a potential threat to on-site personnel. Dangers are posed by heavy equipment, utility and power lines, slippery surfaces, unseen obstacles, noise, heat, cold, and poor illumination.

Injuries may result, for example, from the following:

- Accidents caused by slipping, tripping, or falling
- Use of improper lifting techniques
- Moving or rotating equipment
- Equipment mobilization and operation (such as electrocution from contact with overhead or underground power lines)
- Improperly maintained equipment

Injuries resulting from physical hazards can be avoided by using safe work practices (SWP) and employing caution when working with machinery. Specific SWPs applicable to the Site are listed in Section 9.5 and are provided in Appendix B of this HASP. To ensure a safe workplace, the SSC will conduct and document regular safety inspections and will make sure that all SulTRAC workers and visitors are informed of any potential physical hazards related to the site. Physical hazards that have been identified at this site include the following:

- Biological Hazards (plants and insects)
- Loud noise
- Hazardous chemicals (see Table 4-2)
- Heat/cold stress
- Sun exposure
- Use of portable hand tools
- Flying dust and debris
- Working over or near water
- Operating near heavy machinery (drill rigs)

5.0 TRAINING REQUIREMENTS

All on-site personnel who may be exposed to hazardous conditions, including SulTRAC and subcontractor personnel and site visitors who will participate in on-site activities, will be required to meet the 40-hour training and refresher training requirements outlined in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." Further, at least the SulTRAC project manager or SSC will be required to meet the management and supervisor training requirements outlined in 29 CFR 1910.120(e)(4). All personnel and visitors entering the site will be required to review this HASP and sign the Compliance Agreement form (HSP-4), and site workers will be required to sign the Daily Tailgate Safety Meeting form (HST-2) (see Appendix A).

Before on-site activities begin, the SulTRAC SSC will present a briefing for all personnel who will participate in on-site activities. The following topics will be addressed during the prework briefing:

- Names of the SSC and the designated alternate
- Site history
- Work tasks
- Hazardous chemicals that may be encountered on site
- Physical hazards that may be encountered on site
- PPE, including type or types of respiratory protection to be used for work tasks
- Training requirements
- Environmental surveillance (air monitoring) equipment use and maintenance
- Action levels and situations requiring upgrade or downgrade of level of protection
- Site control measures, including site communications, control zones, and SWPs
- Decontamination procedures
- Emergency communication signals and codes
- Environmental accident emergency procedures (in case contamination spreads outside the exclusion zone)
- Personnel exposure and accident emergency procedures (in case of falls, exposure to hazardous substances, and other hazardous situations)
- Fire and explosion emergency procedures
- Emergency telephone numbers
- Emergency routes

Any other health and safety-related issues that may arise before on-site activities begin will also be discussed during the pre-work briefing.

Issues that arise during implementation of on-site activities will be addressed during tailgate safety meetings to be held daily before the workday or shift begins and will be documented in the Daily Tailgate Safety Meeting form (Form HST-2 in Appendix A). Any changes in procedures or site-specific health and safety-related matters will be addressed during these meetings.

6.0 PERSONAL PROTECTION REQUIREMENTS

The levels of personal protection to be used for work tasks at the Site have been selected based on known or anticipated physical hazards; types and concentrations of contaminants that may be encountered on site; and contaminant properties, toxicity, exposure routes, and matrixes. The following sections describe protective equipment and clothing; reassessment of protection levels; limitations of protective clothing; and respirator selection, use, and maintenance.

6.1 PROTECTIVE EQUIPMENT AND CLOTHING

Personnel will wear protective equipment when (1) site activities involve known or suspected atmospheric contamination; (2) site activities may generate vapors, gases, or particulates; or (3) direct contact with hazardous materials may occur. The anticipated levels of protection selected for use by field personnel during site activities are listed in Table 4-2, Task Hazard Analysis. Based on the anticipated hazard level, personnel will initially perform field tasks in Level D protection. If site conditions or the results of air monitoring performed during on-site activities warrant a higher level of protection, all field personnel will withdraw from the site, immediately notify the SulTRAC SSC, and wait for further instructions. Descriptions of equipment and clothing required for Level D and Level C protection are provided below and specific air monitoring action levels and required actions are depicted in Table 8-1.

- Level D
    - Coveralls or work clothes, if applicable
    - Chemical-resistant clothing (such as Tyvek® or Saranex® coveralls)(optional)
    - Outer gloves (leather or polyvinyl alcohol), if applicable
    - Disposable inner gloves (such as latex or nitrile)(optional)

  - Boots with steel-toe protection and steel shanks
  - Disposable boot covers or chemical-resistant outer boots (optional)
  - Safety glasses or goggles
  - Hardhat (face shield optional)
  - High-visibility vest (class 2 or better)
  - Type II Personal Floatation Device when on or near the water
  - Hearing protection (for areas with a noise level exceeding 85 decibels on the A-weighted scale)
- Level C
  - Coveralls or work clothes, if applicable
  - Chemical-resistant clothing (such as Tyvek® or Saranex® coveralls)
  - Outer gloves (leather or polyvinyl alcohol), if applicable
  - Disposable inner gloves (latex or nitrile)
  - Boots with steel-toe protection and steel shanks
  - Disposable boot covers or chemical-resistant outer boots
  - Full- or half-face, air-purifying respirator with National Institute for Occupational Safety and Health (NIOSH)-approved cartridges to protect against organic vapors, dust, fumes, and mists (cartridges used for gas and vapors must be replaced in accordance with the change-out schedule described in the Respiratory Hazard Assessment form [Form RP-2] in Appendix D)
  - Safety glasses or goggles (with a half-face respirator only)
  - Hardhat (face shield optional)
  - Hearing protection (for areas with a noise level exceeding 85 decibels on the A-weighted scale)

6.2 REASSESSMENT OF PROTECTION LEVELS

PPE levels shall be upgraded or downgraded based on a change in site conditions or investigation findings. When a significant change in site conditions occurs, hazards will be reassessed. Some indicators of the need for reassessment are as follows:

- Commencement of a new work phase, such as the start of a significantly different sampling activity or work that begins on a different portion of the site
- A change in job tasks during a work phase

- A change of season or weather
- Temperature extremes or individual medical considerations limiting the effectiveness of PPE
- Discovery of contaminants other than those previously identified
- A change in ambient levels of airborne contaminants (see the action levels listed in Table 8-1)
- A change in work scope that affects the degree of contact with contaminated media

6.3 LIMITATIONS OF PROTECTIVE CLOTHING

PPE clothing ensembles designated for use during site activities have been selected to provide protection against contaminants at known or anticipated on-site concentrations and physical states. However, no protective garment, glove, or boot is entirely chemical-resistant, nor does any protective clothing provide protection against all types of chemicals. Permeation of a given chemical through PPE depends on the contaminant concentration, environmental conditions, physical condition of the protective garment, and resistance of the garment to the specific contaminant. Chemical permeation may continue even after the source of contamination has been removed from the garment.

All site personnel will use the procedures presented below to obtain optimum performance from PPE. When chemical-protective coveralls become contaminated, don a new, clean garment after each rest break or at the beginning of each shift.

- Inspect all clothing, gloves, and boots both before and during use for the following:
  - Imperfect seams
  - Nonuniform coatings
  - Tears
  - Poorly functioning closures
- Inspect reusable garments, boots, and gloves both before and during use for visible signs of chemical permeation, such as the following:
  - Swelling
  - Discoloration
  - Stiffness
  - Brittleness
  - Cracks

  - Any sign of puncture
  - Any sign of abrasion

Reusable gloves, boots, or coveralls exhibiting any of the characteristics listed above must be discarded. Reusable PPE will be decontaminated in accordance with procedures described in Section 10.0 and will be neatly stored in the support zone away from work zones.

6.4 RESPIRATOR SELECTION, USE, AND MAINTENANCE

SulTRAC and subcontractor personnel will be informed of the proper use, maintenance, and limitations of respirators during annual health and safety refresher training and the prework briefing. Any on-site personnel who will use a tight-fitting respirator must, at a minimum, pass a qualitative fit test for the respirator that follows the fit testing protocol provided in Appendix A of the OSHA respirator standard (29 CFR 1910.134). Fit testing must be repeated annually or when a new type of respirator is used.

Respirator selection is based on the assessment of the nature and extent of hazardous atmospheres anticipated during field activities. This assessment includes a reasonable estimate of employee exposure to respiratory hazards and identification of each contaminant’s anticipated chemical form and physical state.

For each work task requiring respirator use at the Site, a respiratory hazard assessment will be conducted. The results of this assessment are documented in the Respiratory Hazard Assessment form (Form RP-2), which has been approved by the HSR. Form RP-2 is included in Appendix C and defines respiratory protection requirements for the project. If air monitoring is conducted Form RP-2 will be completed to assess potential hazards. Amendments to this HASP and to Form RP-2 will be discussed during daily tailgate safety meetings.

When the atmospheric contaminant is an identified gas or vapor and its concentration is known or can be reasonably estimated, respiratory protection options include the following:

- An atmosphere-supplying respirator (air-line or SCBA)
- An air-purifying respirator equipped with a NIOSH-certified, end-of-service-life indicator (ESLI) for the identified contaminant. If no ESLI is available, a change-out schedule for cartridges must be developed based on objective data or information. Respirator cartridge selection and change-out schedules will be evaluated by the HSR at the time of the respiratory hazard assessment. The

Respiratory Hazard Assessment, Form RP-2, will describe the information and data used as the basis for the cartridge change-out schedule and the proposed change schedule.

For protection against particulate contaminants, approved respirators can include the following:

- An atmosphere supplying respirator
- A respirator equipped with a filter certified by NIOSH under 32 CFR Part 11 or 42 CFR Part 84 as a P100 filter (formerly known as a high-efficiency particulate [HEPA] air filter)

For any tasks performed in Level C PPE, a full- or half-face, air-purifying respirator equipped with NIOSH-approved cartridges or filters will be selected to protect against vapors, gases, and aerosols.

Air-purifying respirators will be used only in conjunction with breathing-space air monitoring, which must be conducted in adherence to the action levels outlined in Table 8-1. Air-purifying respirators will be used only when they can provide protection against the substances encountered on site.

Factors precluding use of Level C and air-purifying respirators are as follows:

- Oxygen-deficient atmosphere (less than 19.5 percent oxygen)
- Concentrations of substances that may be immediately dangerous to life and health
- Confined or unventilated areas that may contain airborne contaminants not yet characterized
- Unknown contaminant concentrations or concentrations that may exceed the maximum use levels for designated cartridges documented in the selected cartridge manufacturer's instructions
- Unidentified contaminants
- High relative humidity (more than 85 percent, which reduces the sorbent life of the cartridges)
- Respirator cartridges with an undetermined service life

Use, cleaning, and maintenance of respirators are described in SWP 5-27, Respirator Cleaning Procedures, and SWP 5-28, Safe Work Practices for Use of Respirators. These SWPs are included in Appendix B.

7.0 MEDICAL SURVEILLANCE

The following sections describe SulTRAC's medical surveillance program, including health monitoring requirements, site-specific medical monitoring, and medical support and follow-up requirements. Procedures documented in these sections will be followed for all activities at the Site. Additional requirements are defined in the Tetra Tech EM, Inc., "Health and Safety Manual."

7.1 HEALTH MONITORING REQUIREMENTS

All SulTRAC and subcontractor personnel involved in on-site activities at the Site must participate in a health monitoring program as required by 29 CFR 1910.120(f). Tetra Tech has established a health monitoring program with WorkCare, Inc., of Orange, California, and Sullivan has established an equivalent monitoring program with another provider. Under the above programs, SulTRAC personnel receive baseline and annual or biennial physical examinations consisting of the following:

- Complete medical and work history
- Physical examination
- Vision screening
- Audiometric screening
- Pulmonary function test
- Resting electrocardiogram
- Chest x-ray (required once every 3 years)
- Blood chemistry, including hematology and serum
- Urinalysis

For each employee, SulTRAC receives a copy of the examining physician's written opinion after postexamination laboratory tests have been completed; the SulTRAC employee also receives a copy of the written opinion. This opinion includes the following information (in accordance with 29 CFR 1910.120[f][7]):

- The results of the medical examination and tests

- The physician's opinion as to whether the employee has any medical conditions that would place the employee at an increased risk of health impairment from work involving hazardous waste operations or during an emergency response
- The physician's recommended limitations, if any, on the employee's assigned work; special emphasis is placed on fitness for duty, including the ability to wear any required PPE under conditions expected on site (for example, temperature extremes)
- A statement that the employee has been informed by the physician of the medical examination results and of any medical conditions that require further examination or treatment

All subcontractors must have health monitoring programs conducted by their own clinics in compliance with 29 CFR 1910.120(f). Any visitor or observer at the site will be required to provide records in compliance with 29 CFR 1910.120(f) before entering the site.

7.2 SITE-SPECIFIC MEDICAL MONITORING

For activities at the Elm Street Site, there are no site-specific medical monitoring requirements.

7.3 MEDICAL SUPPORT AND FOLLOW-UP REQUIREMENTS

As a follow-up to an injury requiring care beyond basic first aid or to possible exposure above established exposure limits, all employees are entitled to and encouraged to seek medical attention and physical testing. Such injuries and exposures must be reported to the HSR. Depending on the type of injury or exposure, follow-up testing, if required, must be performed within 24 to 48 hours of the incident. It will be the responsibility of the employer's medical consultant to advise the type of test required to accurately monitor for exposure effects. The Accident and Illness Investigation Report (Form AR-1 in Appendix A) must be completed by the SulTRAC SSC in the event of an accident, illness, or injury. A copy of this form must be forwarded to the HSR for use in determining the recordability of the incident and for inclusion in SulTRAC's medical surveillance records.

8.0 ENVIRONMENTAL MONITORING AND SAMPLING

Environmental monitoring or sampling will be conducted for selected sampling activities (See Table 8-1) to assess personnel exposure levels as well as site or ambient conditions and to determine appropriate levels of PPE for work tasks. The following sections discuss initial and background air monitoring, personal monitoring, ambient air monitoring, monitoring parameters and devices, use and maintenance of survey equipment, thermal stress monitoring, and noise monitoring. Site-specific air monitoring requirements and action levels are provided in Table 8-1. All monitoring conducted as part of this project will be ambient/area monitoring.

8.1 INITIAL AND BACKGROUND AIR MONITORING

Initial and background air monitoring are not planned during the RI/FS. Open excavations, large vehicle traffic, and other activities that would cause airborne soil particles will not be conducted as part of the RI/FS. As a result, site-wide air monitoring will not be a safety concern. SulTRAC may implement an air monitoring program during site investigation activities if site conditions warrant i.e., if action levels described in Table 8-1 are exceeded in the breathing zone.

8.2 PERSONAL MONITORING

Personal air monitoring is not planned during RI/FS investigations. While personal will be exposed to soil during subsurface investigations, the small quantity and the moistness of the soil will mitigate any hazards that would cause airborne soil particles to become a safety concern. SulTRAC may implement an air monitoring program during the site investigation activities if site conditions warrant.

TABLE 8-1

SITE-SPECIFIC AIR MONITORING REQUIREMENTS AND ACTION LEVELS

Contaminant or Hazard	Task(s)	Monitoring Device	Action Level	Monitoring Frequency	Action[a] (see comments)	Comments
Organic vapors	1, 2, and 3	MultiRAE Plus PID (11.7 eV) or Foxboro PID/FID	0.1 to 10.0 ppm above background	Every 5 minutes during intrusive operations	Use Level D[a] PPE and begin monitoring continuously	1. Obtain initial and periodic background (BG) levels, monitor source areas (such as DPT boreholes), 2. If readings above BG are observed at a source area, then monitor worker breathing zone (BZ) areas, • PID Action Level: 10 ppm above BG in BZ areas for no more than 4 exposures of 5 minutes in one work day, 3. If BZ readings exceed daily established BG levels, don level C[a] ensemble or retreat upwind to a safe area (where BG levels exist) and allow work area to ventilate, 4. Re-approach work area while monitoring and if BG levels have been lowered in BZ areas, resume work, continue monitoring, and downgrade PPE when levels stabilize near BG, 5. If instead BZ readings remain above BG, retreat upwind and contact Health and Safety for further direction
			10.1 to 20 ppm above background	Continuous	Use Level C[a] PPE (unless specific chemicals are identified and evaluated using detector tube)	
			≥ 20.1 ppm above background	NA	Stop work and evacuate area; implement vapor suppression controls	
Carbon monoxide	As needed	MultiRAE Plus PID or similar CGI	0 to 9 ppm	As needed	Continue work in Level D[a] PPE	
			≥ 10 ppm		Stop work, evacuate area, and allow to naturally ventilate	
Hydrogen sulfide	As needed	MultiRAE Plus PID or similar CGI	0 to 9 ppm	As needed	Continue work in Level D[a] PPE	
			≥ 10 ppm		Stop work, evacuate area, and allow to naturally ventilate	
Combustible atmosphere	As needed	MultiRAE Plus PID or similar CGI	0 to 10% LEL	As needed	Continue work in Level D[a] PPE	
			10 to 25% LEL		Continue work with extreme caution	
			> 25% LEL		Stop work, evacuate area, and allow to naturally ventilate	
Oxygen-deficient or enriched atmosphere	As needed	MultiRAE Plus PID or similar CGI	19.5 to 23.5%	As needed	Continue work in Level D[a] PPE	
			< 19.5% or >23.5%		Stop work, evacuate area, and allow to naturally ventilate	

Notes:

CGI	Combustible gas indicator	PID	Photoionization detector
FID	Flame ionization detector	PPE	Personal protective equipment
LEL	Lower explosive limit	ppm	Part per million

[a] Refer to Table 4-2 for specific types of gloves, chemical resistant clothing, respirators, and cartridges.

8.3 AMBIENT AIR MONITORING

Most tasks will require monitoring of the general work area or ambient site conditions. Ambient monitoring will generally be conducted using direct-reading survey instrumentation or compound-specific instruments and/or detector tubes.

Initial ambient air monitoring will be performed as a minimum requirement when any of the situations listed below arise.

- Intrusive activities (drills, sampling, etc.) are being conducted.
- Work begins on a different portion of the site.
- Contaminants other than those previously identified are encountered.
- A different type of operation is initiated (for example, well installation is initiated after drilling activities).
- Workers handle leaking containers or work in areas with obvious liquid contamination (for example, spill or lagoon areas).
- Obvious lithologic changes are noticed during drilling activities.
- Workers experience physical difficulties.

Periodic ambient air monitoring will be performed at the frequency listed in Table 8-1.

8.4 MONITORING PARAMETERS AND DEVICES

The following sections below briefly describe the use and limitations of instruments used to monitor for organic vapors, combustible atmospheres, percent oxygen, and particulates. Site-specific air monitoring requirements and action levels are listed in Table 8-1.

All monitors will be calibrated in accordance with manufacturer recommendations at the beginning of every workday, if possible. Calibration results along with air monitoring data will be recorded in the field logbook.

8.4.1 Organic Vapors

A direct-reading organic vapor monitor, such as a flame ionization detector (FID) or photoionization detector (PID), will be used to determine the presence of VOC. Table 8-1 specifies the instrument that will be used for the project. The concentrations of individual VOCs of concern cannot usually be determined using the instrument because the detector responds to the total VOC mixture.

8.4.2 Known Individual Compounds

If individual compounds must be identified, compound-specific instrumentation or colorimetric detector tubes may be required. Table 8-1 specifies compound-specific instruments or detector tubes needed for this project, as required. Monitoring frequency and action levels for organic vapors during site activities are also listed in Table 8-1. Generally, action levels for organic vapors are set at one-half of the permissible exposure limit (PEL) or threshold limit value (TLV) of the compound with the lowest PEL or TLV.

No known individual compounds will need to be identified at the Site. However, hydrogen sulfide and/or carbon monoxide sensors may be present on certain combination instruments. If these sensors are present, action levels for these chemicals have been included in Table 8-1.

8.4.3 Combustible Atmospheres

When a flammable compound reaches a certain concentration in air, it can become explosive when exposed to an ignition source. The lowest concentration able to support combustion is known as the lower explosive limit (LEL). Each flammable compound has its own LEL. Monitoring indicates how close to this limit the airborne concentration of a flammable compound is. Site activities will cease when the airborne concentration of any flammable vapor or gas reaches 25 percent of its LEL (10 percent in a confined space). The monitoring device, monitoring frequency, and general action levels for combustible atmospheres during site activities are outlined in Table 8-1. SulTRAC will only monitor for combustible atmospheres as needed based on site conditions or if using a combination monitor, such as a MultiRAE Plus PID. Action levels for percent oxygen are included in Table 8-1.

8.4.4 Percent Oxygen

Hazardous conditions exist whenever the oxygen level is too high or too low. Monitoring for percent oxygen will be conducted to verify that a safe oxygen level is present for site activities. Workers must never enter or remain in low-oxygen atmospheres unless they are wearing supplied air respirators (air-line or SCBA). An oxygen-enriched atmosphere is hazardous because it causes an increased risk of fire. The monitoring device, monitoring frequency, and general action levels for oxygen-deficient and -enriched atmospheres during site activities are outlined in Table 8-1. SulTRAC will only monitor for percent oxygen as needed based on site conditions or if using a combination monitor, such as a MultiRAE Plus PID. Action levels for percent oxygen are included in Table 8-1.

8.4.5 Particulates

Aerosols are a group of airborne materials that include particulates, fumes, mists, and smoke. Particulates are the primary aerosol of concern at hazardous waste sites. If climatic conditions, surface soil conditions, or site operations (such as excavation activities) adversely impact ambient air quality by increasing particulate matter for extended periods of time, air monitoring using a direct-reading instrument for particulates may become necessary. If elevated (visible) particulate matter conditions persist for 5 minutes or longer, the SulTRAC SSC is responsible for sampling the breathing zone with a particulate monitor.

Generally, particulate monitors are capable of measuring both solid and liquid particulates within the size range of 0.1 to 10 micrometers (the respirable range). A monitor indicates the concentration of these particulates in units of milligrams per cubic meter of air.

Action levels for particulates will be based on the type of dust and hazardous materials that may contribute to the composition of the particulates and will be determined with the assistance of the SulTRAC HSR or designee. Table 8-1 lists the monitoring device, monitoring frequency, and general action levels expected to be used during site activities.

SulTRAC does not anticipate monitoring for particulates for reasons described in Section 8.1 and 8.2.

8.5 USE AND MAINTENANCE OF SURVEY EQUIPMENT

All personnel using field survey equipment must have training in its operation, limitations, and maintenance. Maintenance and internal or electronic calibration will be performed in accordance with manufacturer recommendations by individuals familiar with the devices before their use on site. Repairs, maintenance, and internal or electronic calibration of these devices will be recorded in an equipment maintenance logbook. The equipment maintenance logbook for each instrument will be kept in that instrument's case. For rented monitoring equipment, repairs and maintenance will be conducted by the rental company. Results of routine calibration will be recorded in the field logbook.

Air monitoring equipment (such as combustible gas indicators, oxygen meters, and PIDs) will be calibrated daily before work begins. Only basic maintenance (such as changing batteries) will be performed by on-site personnel. Any additional maintenance or repairs will be performed by a trained service technician.

8.6 THERMAL STRESS MONITORING

Heat stress and cold stress are common and serious threats at hazardous waste sites. SWPs 5-15 and 5-16 discuss heat and cold stress, respectively, and include monitoring methods appropriate for the season and location of work (see Appendix B).

8.7 NOISE MONITORING

In most cases, high noise levels at a work site are caused by heavy equipment, such as drill rigs and backhoes, or sources associated with the work site, such as factory equipment and vehicles. When noise levels at the Site are suspected to equal or exceed an 8-hour time-weighted average (TWA) of 85 decibels on an A-weighted scale in slow response mode (85 dBA), the SulTRAC SSC will evaluate the work area to characterize the noise source and exposure levels. A sound level meter may be used for the evaluation but a noise dosimeter is recommended for documenting full-shift noise exposures. If neither instrument is available, the SSC may use a simple rule-of-thumb test to determine whether noise levels exceed 85 dBA. The test requires the SSC to determine how loud he or she must speak to be heard at an arm's length from another person. If the SSC must raise his or her voice to be heard, the average noise level likely exceeds 85 dBA.

If employees are exposed to noise levels that exceed the action level of 85 dBA, hearing protection must be worn. The protectors will be ear plugs or muffs that must provide sufficient attenuation to limit noise exposure to less than 85 dBA. The SSC will supervise use of hearing protectors at the work site as necessary. Table 8-1 lists the monitoring device and action levels to be used.

9.0 SITE CONTROL

Site control is an essential component in HASP implementation. The following sections discuss measures and procedures for site control, such as on-site communications, site control zones, site access control, site safety inspections, and SWPs.

9.1 ON-SITE COMMUNICATIONS

Successful communication between field teams and personnel in the support zone is essential. The following communication systems will be available during site activities:

- Cellular telephones

The hand signals listed below will be used by site personnel in emergency situations or when verbal communication is difficult.

Signal	Definition
Hands clutching throat	Out of air or cannot breathe
Hands on top of head	Need assistance
Thumbs up	Okay, I am all right, or I understand
Thumbs down	No or negative
Arms waving upright	Send backup support
Gripping partner’s wrist	Exit area immediately

9.2 SITE CONTROL ZONES

To control the spread of contamination and employee exposures to chemical and physical hazards, on-site work areas may be divided into an exclusion zone, a decontamination zone, and a support zone. Access to the exclusion and decontamination zones will be restricted to authorized personnel. Any visitors to these areas must present proper identification and be authorized to be on site. The SulTRAC SSC will identify work areas that visitors or personnel are authorized to enter and will enforce site control measures.

The following sections describe the exclusion zone, the decontamination zone, and the support zone as well as procedures to be followed in each.

9.2.1 Zone 1: Exclusion Zone

An activity has the potential to cause harm to personnel. The perimeter of the exclusion zone and an appropriate radius around work task areas will be demarcated by a physical barrier, such as barricade tape or traffic cones, to restrict access. A daily roster with the date of each person's entrance into the exclusion zone; the person's name, signature, and organization; and the time of entry and exit will be kept for all personnel working in the zone. Visitors will not be permitted to enter the exclusion zone without proper qualifications, equipment, and SulTRAC SSC authorization. Due the expansive nature of the field investigation, each work area will be isolated as appropriate based on the hazards present (i.e. chemicals, high noise, open excavations, etc.) and access will be restricted.

Adherence to the *Buddy System* will be required when personnel enter the established exclusion zones, as well as isolated work areas. The buddy system promotes personnel safety by organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency. Additionally, eating, drinking, use of tobacco products, or application of cosmetics is prohibited within any established exclusion zone or isolated work area.

Site control/work zones will be established for drilling operations in order to ensure that only authorized, trained employees wearing appropriate PPE are permitted to enter the area. Further, a decontamination zone will also be established to ensure that personnel and/or equipment leaving the exclusion zone are decontaminated prior to moving to the next drilling location.

9.2.2 Zone 2: Decontamination Zone

A cleaning area for decontamination of heavy equipment (i.e. drill rigs) and vehicles may be established at a location readily accessible from work areas. Equipment decontamination procedures are described in Section 10.0. Visitors will not be permitted to enter the decontamination zone without proper qualifications and SulTRAC SSC authorization.

Unless grossly contaminated, dry PPE doffing techniques and appropriate hand washing and chemical hygiene practices, including frequent hand washing, should suffice for personnel decontamination.

9.2.3 Zone 3: Support Zone

A support zone may consist of any uncontaminated and nonhazardous part of the site. The support zone should be situated in an area generally upwind of any exclusion zone whenever possible. Site visitors not meeting training, medical surveillance, and PPE requirements must stay in the support zone. Exclusion zone includes areas where contamination is either known or likely to be present or, because of work

9.3 SITE ACCESS CONTROL

The Elm Street Site is located in Vigo County, Terre Haute, Indiana. Public roads can be used for general access to the site. Access to specific locations included in the investigation is contingent on receipt of voluntary access agreements between Gurman, Ashland, MTS, railroad-owned properties, the IAWC property and EPA. The property owners at the locations of the proposed up gradient monitoring wells; east of US Highway 41 between Locust Street to the north and the railroad tracks to the south, will also need to be identified and contacted for access agreements with the EPA. Access to private properties will be coordinated through EPA.

9.4 SITE SAFETY INSPECTIONS

Periodic site safety inspections shall be conducted by the SulTRAC SSC to ensure safe work areas and compliance with this HASP. Results of the site safety inspections will be recorded in the field logbook or on a Field Audit Checklist (Form AF-1 in Appendix A).

9.5 SAFE WORK PRACTICES

Various SWPs are applicable to the Site. These SWPs are included in Appendix B to this HASP. The following SWPs and safety programs apply to the site:

- DCN 2-4, Hearing Conservation Program
- SWP 5-1, General Safe Work Practices for Field Work
- SWP 5-2, General Safe Work Practices for Hazardous Waste Activities
- SWP 5-4, Safe Drilling Practices
- SWP 5-5, Safe Direct-Push Boring Practices
- SWP 5-6, Working Over or Near Water
- SWP 5-7, Use of Heavy Equipment
- SWP 5-15, Heat Stress Prevention and Monitoring
- SWP 5-16, Cold Stress Safe Work Practices
- SWP 5-17, Biohazard Safety
- SWP 5-19, Safe Lifting Procedures
- SWP 5-26, Protection from Sun Exposure
- SWP 5-27, Respirator Cleaning Procedures
- SWP 5-28, Safe Work Practices for Use of Respirators

10.0 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants on personnel or equipment. When properly conducted, decontamination procedures protect workers from contaminants that may have accumulated on PPE, tools, and other equipment. Proper decontamination also prevents transport of potentially harmful materials to uncontaminated areas. Personnel and equipment decontamination procedures are described in the following sections.

10.1 PERSONNEL DECONTAMINATION

Personnel decontamination at the site will be limited by using disposable PPE whenever possible. Any personnel decontamination procedures will follow guidance in the *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH and others 1985). Personnel and PPE will be decontaminated with potable water or a mixture of detergent and water. Liquid and solid wastes generated during decontamination will be collected and drummed.

The decontamination procedures listed below will be conducted if personnel decontamination is required.

- Wash neoprene boots or disposable booties with a Liquinox® or Alconox® solution, and rinse them with water. Remove and retain neoprene boots for reuse, if possible. Place disposable booties in plastic bags for disposal.
- Wash outer gloves in a Liquinox® or Alconox® solution, and rinse them in water. Remove outer gloves and place them in a plastic bag for disposal.
- Remove chemical-resistant clothing, and place it in a plastic bag for disposal.
- Remove the air-purifying respirator, if used, and place the spent filter in a plastic bag for disposal. The filter must be changed in accordance with the Respiratory Hazard Assessment form (Form RP-2 in Appendix C). Clean and disinfect the respirator in accordance with SWP 5-27, and place it in a plastic bag for storage.
- Remove inner gloves and place them in a plastic bag for disposal.
- Thoroughly wash the hands and face with water and soap.

Used, disposable PPE will be collected in sealable containers and will be disposed of in accordance with procedures described in the Phase II FSP (SulTRAC 2012a). Personnel decontamination procedures may be modified as necessary while on site.

10.2 EQUIPMENT DECONTAMINATION

Decontamination of all drilling, sampling, and field monitoring equipment used during site activities will be required. Decontamination of on-site heavy equipment and sampling equipment will follow procedures defined in the Phase II FSP (SulTRAC 2012a).

10.2.1 Heavy Equipment

Heavy equipment, such as drilling and excavating vehicles, will be decontaminated at a designated location in the decontamination zone. Gross decontamination will be performed using a cleaning brush to loosen debris, and steam-cleaning with a high-pressure steam spray. If equipment still has soil on it after steam-cleaning, an appropriate cleaning brush will be used to further loosen debris, and the equipment will be steam-cleaned again. All wastewater generated from decontamination activities will be collected and stored in 55-gallon drums until proper disposal is arranged. The Phase II FSP contains additional information regarding heavy equipment decontamination (SulTRAC 2012a).

10.2.2 Sampling Equipment

Sampling equipment, such as split spoons, vertical aquifer profiling equipment, and other reusable sampling equipment, will be decontaminated before and after each use as described below.

- Scrub the equipment with a brush in a bucket containing Liquinox® or Alconox® solution and distilled water.
- Triple-rinse the equipment with distilled water, and allow it to air-dry.
- Reassemble the equipment, and place it on plastic or aluminum foil in a clean area. If aluminum foil is used, wrap the equipment with the dull side of the aluminum foil toward the equipment.

11.0 EMERGENCY RESPONSE PLANNING

This section describes emergency response planning procedures to be implemented for the site. This section is consistent with local, state, and federal disaster and emergency management plans. The following sections discuss pre-emergency planning, personnel roles and lines of authority, emergency recognition and prevention, evacuation routes and procedures, emergency contacts and notifications, hospital route directions, emergency medical treatment procedures, protective equipment failure, fire or explosion, weather-related emergencies, spills or leaks, emergency equipment and facilities, and reporting.

11.1 PRE-EMERGENCY PLANNING

During the pre-work briefing and daily tailgate safety meetings, all on-site employees will be trained in and reminded of the provisions of Section 11.0, site communication systems, and site evacuation routes. The emergency response provisions will be reviewed on a regular basis by the SulTRAC SSC and will be revised, if necessary, to ensure that they are adequate and consistent with prevailing site conditions.

11.2 PERSONNEL ROLES AND LINES OF AUTHORITY

The SulTRAC SSC has primary responsibility for responding to and correcting emergency situations and for taking appropriate measures to ensure the safety of site personnel and the public. Possible actions may include evacuation of personnel from the site area. The SSC is also responsible for ensuring that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed. Individual subcontractors are required to cooperate with the SSC, within the parameters of their scopes of work.

Personnel are required to report all injuries, illnesses, spills, fires, and property damage to the SSC. The SSC must be notified of any on-site emergencies and is responsible for ensuring that the appropriate emergency procedures described in this section are followed. The local fire or emergency response department will be supplied with a copy of this HASP before site work begins.

11.3 EMERGENCY RECOGNITION AND PREVENTION

Table 4-1 lists potential on-site chemical hazards, and Table 4-2 provides information on the hazards associated with the different tasks planned for the site. On-site personnel will be made familiar with this information and with techniques of hazard recognition through prework training and site-specific briefings.

11.4 EVACUATION ROUTES AND PROCEDURES

In the event of an emergency that necessitates evacuation of a work task area or the site, the SulTRAC SSC shall contact all nearby personnel using the on-site communications discussed in Section 9.1 to advise the personnel of the emergency. The personnel will proceed along site roads to a safe distance upwind from the hazard source. The personnel will remain in that area until the SSC or an authorized individual provides further instructions.

11.5 EMERGENCY CONTACTS AND NOTIFICATIONS

The emergency information before Section 1.0 of this HASP provides names and telephone numbers of emergency contact personnel. THIS PAGE MUST BE POSTED ON SITE OR MUST BE READILY AVAILABLE AT ALL TIMES. In the event of a medical emergency, personnel will notify the appropriate emergency organization and will take direction from the SulTRAC SSC. In the event of a fire, explosion, or spill at the site, the SSC will notify the appropriate local, state, and federal agencies and will follow procedures discussed in Section 11.9 or 11.11.

11.6 HOSPITAL ROUTE DIRECTIONS

Before performing any site activities, SulTRAC personnel will conduct a pre-emergency hospital run to familiarize themselves with the route to the local hospital. A map showing the hospital route is provided in the emergency information before Section 1.0 of this HASP.

11.7 EMERGENCY MEDICAL TREATMENT PROCEDURES

Any person who becomes ill or injured during work tasks may require decontamination. If the illness or injury is minor, any decontamination necessary will be completed and first aid should be administered prior to patient transport. If the patient's condition is serious, partial decontamination will be completed (such as complete disrobing of the person and redressing in the person in clean coveralls or wrapping in a blanket). First aid should be administered until an ambulance or paramedics arrive. All injuries and illnesses must be reported immediately to the SulTRAC project manager and HSR.

Any person transported to a clinic or hospital for chemical exposure treatment will be accompanied by information on the chemical he or she has been exposed to at the site, if possible. Table 4-1 contains this information.

11.8 PROTECTIVE EQUIPMENT FAILURE

If any worker in the exclusion zone experiences a failure of protective equipment (either engineering controls or PPE) that affects his or her personal protection, the worker and all coworkers will immediately leave the exclusion zone. Re-entry to the exclusion zone will not be permitted until (1) the protective equipment has been repaired or replaced, (2) the cause of the equipment failure has been determined, and (3) the equipment failure is no longer considered to be a threat.

11.9 FIRE OR EXPLOSION

In the event of a fire or explosion on site, the local fire department will be immediately summoned. The SulTRAC SSC or a site representative will advise the fire department of the location and nature of any hazardous materials involved. Appropriate provisions of Section 11.0 will be implemented by site personnel.

11.10 WEATHER-RELATED EMERGENCIES

Site work shall not be conducted during severe weather conditions, including high-speed winds or lightning. In the event of severe weather, field personnel will stop work, secure and lower all equipment (for example, drilling masts), and leave the site.

Thermal stress caused by excessive heat or cold may occur as a result of extreme temperatures, workload, or the PPE used. Heat and cold stress treatment will be administered as described in SWPs 5-15 and 5-16, respectively.

11.11 SPILLS OR LEAKS

In the event of a severe spill or a leak, site personnel will follow the procedures listed below.

- Evacuate the affected area and relocate personnel to an upwind location.
- Inform the SulTRAC SSC, a SulTRAC office, and a site representative immediately.
- Locate the source of the spill or leak, and stop the flow if it is safe to do so.
- Begin containment and recovery of spilled or leaked materials.
- Notify appropriate local, state, and federal agencies.

11.12 EMERGENCY EQUIPMENT AND FACILITIES

The following emergency equipment will be available on site:

- First aid kit
- Eye wash (portable)
- Mobile telephone

11.13 REPORTING

All emergency situations require follow-up and reporting. Appendix A includes the SulTRAC Accident and Illness Investigation Report (Form AR-1). This report must be completed and submitted to the SulTRAC project manager within 24 hours of an emergency situation. The project manager will review the report and then forward it to the SulTRAC HSR for review. The report must include proposed actions to prevent similar incidents from occurring. The HSR must be fully informed of the corrective action process so that she may implement applicable elements of the process at other sites.

12.0 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH). “Threshold Limit Values and Biological Exposure Indices for 1998.” Latest edition.

National Institute for Occupational Safety and Health (NIOSH) and others. 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. October.

NIOSH. 2005 “Pocket Guide to Chemical Hazards.” U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

SulTRAC. 2012a,.“Phase II Field Sampling Plan for Investigation at the Elm Street Groundwater Contamination Site.” August 15, 2012

SulTRAC. 2012b. “Phase II Quality Assurance Project Plan for Remedial Investigation at the Elm Street Groundwater Contamination Site.” August 15, 2012.

APPENDIX A

SULTRAC FORMS

(Nine Sheets)

- Compliance Agreement (Form HSP-4)
- Daily Tailgate Safety Meeting (Form HST-2)
- Daily Site Log (Form SSC-1)
- Accident and Illness Investigation Report (Form AR-1)
- Field Audit Checklist (Form AF-1)

APPENDIX B

SAFE WORK PRACTICES

(61 Sheets)

- DCN 2-4, Hearing Conservation Program
- SWP 5-1, General Safe Work Practices for Field Work
- SWP 5-2, General Safe Work Practices for Hazardous Waste Activities
- SWP 5-4, Safe Drilling Practices
- SWP 5-5, Safe Direct-Push Boring Practices
- SWP 5-6, Working Over or Near Water
- SWP 5-7, Use of Heavy Equipment
- SWP 5-15, Heat Stress Prevention and Monitoring
- SWP 5-16, Cold Stress Safe Work Practices
- SWP 5-17, Biohazard Safety
- SWP 5-19, Safe Lifting Procedures
- SWP 5-22 Hydrographic Data Collection
- SWP 5-26, Protection from Sun Exposure
- SWP 5-27, Respirator Cleaning Procedures
- SWP 5-28, Safe Work Practices for Use of Respirators

APPENDIX C

RESPIRATORY HAZARD ASSESSMENT (FORM RP-2)

(Two Pages)

Note: This assessment form will be finalized when site air monitoring data are collected and evaluated. Until the assessment is completed, air purifying respirator cartridges will be disposed of every 8 hours.

ATTACHMENT

MATERIAL SAFETY DATA SHEETS

(17 Sheets)

- Hydrochloric Acid
- Nitric Acid
- Sodium Hydroxide
- Alconox

APPENDIX A

SULTRAC FORMS

(Nine Sheets)

- Compliance Agreement (Form HSP-4)
- Daily Tailgate Safety Meeting (Form HST-2)
- Daily Site Log (Form SSC-1)
- Accident and Illness Investigation Report (Form IR-1)
- Field Audit Checklist (Form AF-1)

TETRA TECH, INC.

HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

Project Name: ______________________________

Project Number: ______________________________

I have read and understand the health and safety plan indicated above and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Name	Signature	Employer	Date

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM

Date: ______________ Time: ________________ Project No.: ________________

Client: __________________________________ Site Location: __________________________

Site Activities Planned for Today: ____

____

Safety Topics Discussed
Protective clothing and equipment:
Chemical hazards:
Physical hazards:
Environmental and biohazards:
Equipment hazards:
Decontamination procedures:
Other:
Review of emergency procedures:
Employee Questions or Comments:

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Attendees	
Printed Name	**Signature**

Meeting Conducted by:

Name ________________________ Title ________________________

Signature ________________________

TETRA TECH, INC.

DAILY SITE LOG

Site Name:____ Date: ____________________________

Name (print)	Company	Time	
		In	Out

Comments:

____

____

____

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT REPORT

Report Date	Report Prepared By	Incident Report Number

INSTRUCTIONS:

All incidents (including those involving subcontractors under direct supervision of Tetra Tech personnel) must be documented on the IR Form.

Complete any additional parts to this form as indicated below for the type of incident selected.

TYPE OF INCIDENT (Check all that apply)	**Additional Form(s) Required for this type of incident**	
Near Miss (No losses, but could have resulted in injury, illness, or damage)	☐	Complete IR Form Only
Injury or Illness	☐	Complete Form IR-A; Injury or Illness
Property or Equipment Damage, Fire, Spill or Release	☐	Complete Form IR-B; Damage, Fire, Spill or Release
Motor Vehicle	☐	Complete Form IR-C; Motor Vehicle

INFORMATION ABOUT THE INCIDENT

Name of Affected Employee

Description of Incident

____

____

____

____

____

Note: If no employee was directly affected, enter the employee that witnessed the event or who would have been impacted. If the individual involved is a subcontractor directly supervised by a Tetra Tech employee, check below and enter the supervisor or project manager above.

Subcontractor ☐

Date of Incident	**Time of Incident**
	_______________ AM ☐ PM ☐ *OR* Cannot be determined ☐
Weather conditions at the time of the incident	**Was there adequate lighting?**
	___________________________Yes ☐ No ☐

Location of Incident

_______________________________________ Was location of incident within the employer's work environment? Yes ☐ No ☐

Street Address	**City, State, Zip Code and Country**
Operating Unit	**Office Location**
Project Name / Project#	**Client**
Tt Supervisor or Project Manager	**Was supervisor on the scene?**
	Yes ☐ No ☐

WITNESS INFORMATION (attach additional sheets if necessary)

Name	**Company**
Street Address	**City, State and Zip Code**
Telephone Number(s)	

RESPONSE ACTIONS

Response action(s) immediately taken by unit reporting the incident:

____

____

____

____

____

NOTIFICATIONS

Title				
Project Manager or Supervisor	**Printed Name**	**Signature**	**Telephone Number**	**Date**
Site Safety Coordinator or Office H&S Representative				
Operating Unit H&S Representative				
Other: ______________________				

The signatures provided above indicate that appropriate personnel have been notified of the incident.

TETRA TECH, INC.
FIELD AUDIT CHECKLIST

Revision Date: 5/28/09
Document Control Number:
AF-1
Page 1 of 3

Project Name: ______________________________ Project No.: ______________________

Field Location: ______________________________ Completed by: ____________________

Project Manager: ______________________ Site Safety Coordinator: ____________________

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator present			
6	Daily tailgate safety meetings conducted and documented			
7	On-site personnel meet HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	Compliance with specified safe work practices			
9	Documentation of training, medical examinations, and fit tests available from employer			
10	Exclusion, decontamination, and support zones delineated and enforced			
11	Windsock or ribbons in place to indicate wind direction			
12	Illness and injury prevention program reports completed (California only)			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			

16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
18	Eyewash stations in place			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
23	Environmental and personnel monitoring performed as specified in HASP			

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
1	Splash suit			
2	Chemical protective clothing			
3	Safety glasses or goggles			
4	Gloves			
5	Overboots			
6	Hard hat			
7	Dust mask			
8	Hearing protection			
9	Respirator			
Instrumentation				
10	Combustible gas meter			
11	Oxygen meter			

12	Organic vapor analyzer			
Supplies				
13	Decontamination equipment and supplies			
14	Fire extinguishers			
15	Spill cleanup supplies			
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

Note: NA = Not applicable

Auditor’s Signature

Site Safety Coordinator’s Signature

Date

APPENDIX B

SAFE WORK PRACTICES

- DCN 2-4, Hearing Conservation Program
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- SWP 5-26, Protection from Sun Exposure
- SWP 5-27, Respirator Cleaning Procedures
- SWP 5-28, Safe Work Practices for Use of Respirators

TETRA TECH, INC.
HEARING CONSERVATION PROGRAM

Revision Date: 10/1/2008

Document Control Number:

2-4

This hearing conservation program has been established by Tetra Tech to protect employees from the harmful effects of noise exposure. This program is designed to comply with the Occupational Safety and Health Administration (OSHA) occupational noise exposure standard in Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.95, as well as federal, state, local, and contractual requirements.

The hearing conservation program elements describe how the criteria specified by the OSHA standard shall be implemented, reviewed and maintained. Program elements include responsibilities, action levels, monitoring, employee notification, audiometric testing, hearing protection, warning signs and information, and training. This hearing conservation program shall be made available upon request to employees and their representatives.

1.0 SCOPE

An action level for noise has been established by OSHA based on an 8-hour, time-weighted average (TWA) of 85 decibels measured on the A-weighted scale (dBA) in the slow response mode. When employees are exposed to sound that exceeds this action level, employers must implement a hearing conservation program. All employees exposed to sound levels exceeding the action level of 85 dBA fall under the scope of this Hearing Conversation Program.

2.0 RESPONSIBILITIES

Operating unit health and safety managers (HSMs) are responsible for application and oversight of the hearing conservation program within their respective organizations. Each HSM will maintain records of all noise exposure measurements for at least two (2) years, in accordance with Tetra Tech Recordkeeping and Reporting Requirements (Document Control Number (DCN) 1-4). The HSM is also responsible for identifying employees to be included in the audiometric testing program and for scheduling audiometric exams through the Tetra Tech corporate medical surveillance provider.

Project managers are responsible for ensuring compliance with hearing conservation controls and protection at their project sites. Site safety coordinators (SSCs) are responsible for identifying noise control areas or operations and implementing the program on a site-specific basis. The HSM will assist project managers and SSCs with assessing the need for and implementing hearing conservation programs at individual sites. Employees are responsible for wearing appropriate hearing protection devices and following hearing conservation procedures in noise control areas.

3.0 PROGRAM ELEMENTS

Permissible Exposure Limits

The following table identifies OSHA permissible exposure limits for noise exposures. Whenever possible, administrative or engineering controls will be used to reduce sound levels. If controls are not feasible or fail to reduce sound levels to below 85 dBA, hearing protection will be provided to employees to reduce sound exposures to below the 85 dBA limit. This Tetra Tech hearing conservation program ***mandates*** the use of hearing protection for 8-hour, TWA exposures of 85 dBA or greater.

TABLE 1 - PERMISSIBLE NOISE EXPOSURES*

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
½	110
¼ or less	115

* When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C(1)/T(1) + C(2)/T(2) C(n)/T(n) exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Monitoring

In most instances, high noise levels at a project site are generated by heavy equipment, such as drill rigs and backhoes, or sources associated with the work site operations such as operating equipment and vehicles. Most common high-noise-level sources have been measured, and instances where hearing protection is required shall be indicated in the site-specific hazard assessment documents such as a health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), or permit. When noise exposures at a work site are suspected to equal or exceed an 8-hour, TWA of 85 dBA resulting from noise sources not previously measured, the SSC will conduct an evaluation to characterize the noise sources and exposure levels.

A portable sound-level meter is recommended for surveying general work areas and for estimating noise exposure when the noise levels are relatively constant. Noise dosimeters are recommended for documenting full-shift noise exposures when noise sources fluctuate, are intermittent, or otherwise difficult to document with the sound-level meter. Monitoring for occupational noise exposure will be conducted for each representative task or job position that the SSC deems necessary. The HSM shall assist with sound level monitoring and reporting as necessary.

All noise measurements will be taken in the hearing zone of the affected employee. The hearing zone is an area within a radius not to exceed 12 inches from the ear closest or in most direct proximity to the noise source.

Monitoring equipment must be in factory calibration and will be checked in the field with an appropriate field calibration check standard according to the equipment manufacturer’s recommendation before and after each set of measurements. Documentation of test field calibration checks will be kept with the field data collected.

In some cases, such as on short-term projects, the SSC may forgo actual noise level measurements and use a simple rule-of-thumb test to determine if noise levels are in excess of 85 dBA. The test requires the SSC to determine how loud he or she must speak to be heard at arm’s length from another person. If the SSC must raise his or her voice to be heard, average noise levels likely exceed 85 dBA.

Employee Notification

The SSC is responsible for informing employees exposed at or above an 8-hour, TWA of 85 dBA of the results of the monitoring.

Audiometric testing

Audiometric testing shall be conducted for all Tetra Tech employees potentially exposed to sounds levels greater than 85 dBA TWA. The audiometric testing program consists of baseline audiograms, annual audiograms, and termination audiograms. Employees will be informed of the results of these tests at the time of their examination. Audiometric test results will be retained for Tetra Tech by the corporate medical advisor and will become a part of each employee’s permanent medical record. Exposure and audiometric records will be made available to employees upon request.

Hearing Protection

Tetra Tech will provide hearing protection to all personnel that may experience noise exposures at or greater than 85 dBA. Hearing protection must provide sufficient attenuation to limit employee noise exposure to an 8-hour, TWA of less than 85 dBA. Hearing protection will be replaced as necessary. The SSC will supervise the correct use of hearing protection at a work site. Personnel will receive instruction in proper fitting during initial and refresher hearing conservation training classes.

Warning Signs and Information

The SSC will post “Hearing Protection Required” signs in areas where noise levels have been measured and determined to exceed the 85-dBA, TWA action level. Signs may also be posted in areas where monitoring has not been conducted but noise levels are expected to exceed the 85-dBA, TWA level based on similarity to past activities or on the judgment of the SSC.

For short-duration projects or where personnel exposure in the high-noise area is limited and controlled, the SSC may provide verbal notice of the need for hearing protection in place of the signs described above.

4.0 Training

Hearing conservation training may be conducted as a stand-alone course or may be included in HAZWOPER, construction safety, or other health and safety training. Hearing Conservation training will include the following:

- Effects of noise on hearing;
- The purpose of hearing protectors;
- The advantages, disadvantages, and attenuation of various types of hearing protection;
- Instruction on selection, fitting, use, and care of hearing protectors; and
- The purpose of audiometric testing and an explanation of the test procedure.

Documentation of initial and refresher training will be through class attendance records and course agendas.

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TETRA TECH, INC.
GENERAL SAFE WORK PRACTICES FOR FIELD WORK

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SWP 5-1

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards. These SWPs establish a pattern of general precautions and measures for reducing risks associated with field operations not conducted on hazardous waste sites. This list is not inclusive and may be amended as necessary.

- Be familiar with and knowledgeable of and adhere to all instructions in the construction health and safety plan (C-HASP), job safety analysis, job hazard analysis, work permit or other health and safety documentation.
- At a minimum, a safety meeting will be held at the start of each project to discuss the hazards of the site and site work. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.
- Be aware of the location of the nearest telephone and all emergency telephone numbers.
- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.
- Plan and delineate entrance, exit, and emergency escape routes.
- Rehearse unfamiliar operations prior to implementation.
- Use the “buddy system” whenever respiratory protection, fall protection, or other protective equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.
- In order to assist each other in the event of an emergency, buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity.
- Do not bring nonessential vehicles and equipment onto the site.
- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).
- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech personnel, subcontractor personnel, and project site visitors; and other information related to safety matters.

- A portable eyewash station should be located in the support zone if corrosive materials are used or stored on the site.
- Smoking is not allowed on Tetra Tech projects sites, except in designated smoking areas.
- Do not bring matches and lighters in the exclusion zone or contamination reduction zone.
- Observe coworkers for signs of toxic exposure and heat or cold stress.
- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.
- Anyone known to be under the influence of drugs or intoxicating substances that impair the employee’s ability to safely perform assigned duties shall not be allowed on the job while in that condition.
- Horseplay, scuffling, and other acts that tend to have an adverse influence on the safety or well-being of the employees is prohibited.
- Work shall be well planned to prevent injuries in the handling of materials and when working with equipment.
- No one shall knowingly be permitted or required to work while the employee’s ability or alertness is so impaired by fatigue, illness, or other causes that might unnecessarily expose the employee or others to injury.
- Use proper lifting techniques. Heavy objects will be lifted using the large muscles of the leg instead of the smaller muscles of the back.
- Wear appropriate footwear and all other protective equipment required for work.
- Cleanse thoroughly after handling hazardous substances.
- Maintain all tools and equipment in good condition.
- First aid kits shall be located in a prominent location and stocked with basic first aid supplies.

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	TETRA TECH, INC. GENERAL SAFE WORK PRACTICES for HAZARDOUS WASTE SITE ACTIVITIES	Revision Date: 10/1/2008 Document Control Number: SWP 5-2 Page 1 of 3

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards on hazardous waste sites. These SWPs establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations. This list is not inclusive and may be amended as necessary.

- Do not eat, drink, chew gum or tobacco, take medication, or smoke in contaminated or potentially contaminated areas or where the possibility for contact with site contamination exists.

- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. If a source of potable water is not available at the work site that can be used for hands-washing, the use of waterless hand cleaning products will be used, followed by actual hand-washing as soon as practicable upon exiting the site. A thorough shower and wash must be conducted as soon as possible if excessive skin contamination occurs.

- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on drums, equipment, or the ground. Do not place monitoring equipment on potentially contaminated surfaces.

- Remove beards or facial hair that interferes with a satisfactory qualitative respirator fit test or routine pre-entry positive and negative pressure checks.

- Be familiar with and knowledgeable of and adhere to all instructions in the site-specific health and safety plan (HASP). At a minimum, a safety meeting will be held at the start of each project to discuss the HASP. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.

- Be aware of the location of the nearest telephone and all emergency telephone numbers.

- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.

- Plan and delineate entrance, exit, and emergency escape routes.

- Rehearse unfamiliar operations prior to implementation.

- Use the “buddy system” whenever respiratory protection equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.
- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.
- Minimize the number of personnel and equipment in contaminated areas (such as the exclusion zone). Nonessential vehicles and equipment should remain within the support zone.
- Establish appropriate support, contamination reduction, and exclusion zones.
- Establish appropriate decontamination procedures for leaving the site.
- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).
- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech personnel, subcontractor personnel, and project site visitors; air quality and personal exposure monitoring data; and other information related to safety matters. Form SSC-1, Daily Site Log, may be used to record names of on-site personnel.
- A portable eyewash station should be located in the support zone if chemical splashes to eyes are possible.
- Do not bring matches and lighters in the exclusion zone or contamination reduction zone. Flames and open fires are not permitted on site.
- Observe coworkers for signs of toxic exposure and heat or cold stress.
- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.

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TETRA TECH, INC.
SAFE DRILLING PRACTICES

Revision Date: 10/1/2008

Document Control Number:

SWP 5-4

This document establishes safe work practices (SWP) to follow during drilling operations. These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Before beginning any drill operation, each employee must conform to the following requirements:

- Wear a hard hat, safety glasses or goggles, steel-toed work boots, a shirt and full-length pants when working with or near the drill rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the drill rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that drill masts or other projecting devices will be farther than 25 feet in any direction from overhead power lines.
- Ensure that the drill rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Drill rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the drill rig is operating, employees must:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving drill rig parts.

- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.
- Maintain adequate clearance of the drill rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate drill rigs.
- Workers should not assume that the drill rig operator is keeping track of the rig's exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with drill rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Auger sections and other equipment are extremely heavy. All lifting precautions should be taken before moving heavy equipment. Appropriate equipment, such as chains, hoists, straps, and other equipment, should be used to safely transport heavy equipment too heavy to safely lift.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.
- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).

- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded to prevent the buildup of static electricity.

- Keep drill rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.

- Engage parking brakes when equipment is not in use.

- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.

- Store tools in clean, secure areas to prevent damage, loss, or theft.

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	TETRA TECH, INC. SAFE BORING PRACTICES USING DIRECT PUSH TECHNOLOGY	Revision Date: 10/1/2008
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		SWP 5-5
		Page 1 of 4

This document establishes safe work practices (SWP) to follow during operating involving boring using direct push technology (DPT). These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Conventional and sonic drilling rigs can penetrate virtually any material to great depth, but they are expensive and cumbersome to operate in environmental investigations. Contaminated material brought to the surface requires special handling and can be a safety concern for workers. An alternative, the direct-push cone penetrometer, was developed in the 1930s in The Netherlands. This device uses up to 40,000 pounds of hydraulic force to push a steel instrumented cone or a sampling device into the ground. No material comes to the surface unless soil or groundwater samples are being collected. Direct-push technology eliminates the need for disposal of cuttings and solidification of drilling fluid. Therefore, DPT is frequently used for environmental investigation applications as an alternative to conventional drilling.

Before beginning any DPT operation, employees must understand and comply with the following requirements:

- Safety glasses or goggles, steel-toed work boots, hard hat, a shirt and full-length pants must be worn when working with or near the direct push rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the direct push rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that the direct push rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Direct push rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the direct push rig is operating, employees should be aware of the following:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving direct push rig parts.
- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.
- Maintain adequate clearance of the direct push rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate direct push rigs.
- Workers should not assume that the direct push rig operator is keeping track of their exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with direct push rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.

- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).
- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded and grounded to prevent the buildup of static electricity.
- Keep direct push rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.
- Engage parking brakes when equipment is not in use.
- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Store tools in clean, secure areas to prevent damage, loss, or theft.

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	TETRA TECH, INC. SAFE WORK PRACTICES for WORKING OVER OR NEAR WATER	Revision Date: 10/1/2008 Document Control Number: SWP 5-6 Page 1 of 3

The following sections discuss general procedures for working over or near water, underwater work, and cold water procedures.

1.0 SCOPE

This safe work practice (SWP) provides guidelines for all Tetra Tech employees and subcontractors who work over or near bodies of water three (3) or more feet deep or swiftly moving water. This SWP was developed in accordance with the Occupational Safety and Health Administration (OSHA) standard specified in Title 29 of the *Code of Federal Regulations* (CFR), Part 1926.106, "Working Over or Near Water."

2.0 RESPONSIBILITIES

The project manager (PM) is responsible for identifying all health and safety requirements of each project, including all tasks that may involve worker exposure to hazards or working in or near bodies of water. The PM will appoint a site safety coordinator (SSC) to ensure that this SWP is followed in the field. Workers will follow this SWP whenever working near or in any body of water that is over three (3) feet deep or swiftly moving.

3.0 GENERAL PROCEDURES

When working over or near water, the following precautions will be taken:

- All staff and team members must wear a personal flotation device (PFD) when working within 15 feet of a water body. Personnel will be provided with U.S. Coast Guard (USCG)-approved life jackets or work vests. The PFD should be Class III, which will support the head of an unconscious person above water.
- Life jackets and work vests will be inspected before and after each use.
- Ring buoys with at least 90 feet of line shall be provided and readily available for employee rescue operations.
- The distance between ring buoys shall not exceed 200 feet.

- A USCG-approved life-saving skiff will be available.
- Under no circumstances will team members enter water bodies without protective clothing such as rubber boots or waders.
- At least one person will remain on shore as a look-out.

If a team member falls into the water, a ring buoy, branch, paddle, pole, or other floating object should be extended to the person in the water. Resist the impulse to dive in; employees should not attempt a deep water rescue unless they have been trained in water lifesaving skills. When the person in the water grabs the extended item, the worker should be pulled toward the shore or boat. If the person is unconscious, the PFD, clothing, or hair should be hooked to pull the person toward the shore or boat. Once the person has been safely retrieved, necessary emergency medical procedures should be performed by qualified personnel. If none are necessary, the retrieved team member should change into dry clothing as soon as possible after any necessary personal decontamination.

4.0 UNDERWATER WORK

Underwater work should be performed in accordance with the procedures and guidelines of the Diving Safety Program (Document Control No. 2-15).

5.0 COLD WATER PROCEDURES

When the water temperature is below 45 °F, hypothermia is a serious risk. A person can loose feeling in the extremities within 5 minutes. Additional protective equipment such as cold water immersion suits may be required. All field staff members should be familiar with cold water survival techniques or should receive training from an American Red Cross-certified swimming instructor in cold water survival techniques when site conditions warrant such knowledge. Cold water safe work practices must be addressed in site specific safety documents.

After a person has been rescued from cold water, he or she should change into dry clothes as soon as possible. If the person who has fallen into the water displays hypothermia symptoms, he or she should be treated immediately and taken to a medical facility. Under no circumstances should the hypothermia victim be given hot liquids because this could accelerate shock. Drinks no warmer than normal body temperature are acceptable. If symptoms are severe and evacuation to a medical facility cannot be quickly conducted, any wet clothing should be removed, the victim should be placed in blankets or sleeping bags in a sheltered location, and the rescuer should climb into the blankets or sleeping bag with victim to provide additional warmth. The victim should also be treated continuously for shock, elevating feet and monitoring the victim's pulse and breathing rate.

If a team member falls into cold water, he or she should not remove any clothing while in the water because clothing provides additional insulation. Although clothing creates an added drag while swimming, the insulation outweighs the disadvantage of the additional drag. Each team member should carry a wool hat to place on his or her head in case he or she falls into the water. A wool hat, even when wet, provides good insulation for the head, where a large amount of body heat is lost.

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	TETRA TECH, INC. SAFE WORK PRACTICES FOR USE OF HEAVY EQUIPMENT	Revision Date: 10/1/2008
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		5-7
		Page 1 of 3

Truck-mounted heavy equipment and field trucks are among the types of equipment that may be used during field work. Heavy equipment can present a substantial hazard to workers. General requirements for motor vehicles and material-handling equipment are provided in the Occupational Safety and Health Administration (OSHA) Construction Industry Standards, 29 CFR 1926, Subpart O. The following precautions will be followed when heavy equipment (such as drill rigs, front-end loaders, and backhoes) is in use:

- Heavy equipment will be inspected by the operator before each work shift. The site safety coordinator (SSC) will ensure compliance with these precautions.

- Equipment operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.

- Only qualified and licensed personnel will operate heavy equipment.

- Hard hats, steel-toed boots, and safety glasses or goggles will be worn at all times around heavy equipment. Other personal protective equipment (PPE) may be required as specified in the site health and safety plan (HASP); construction site health and safety plan (C-HASP); Job Hazard Analysis (JHA), Job Safety Analysis (JSA) or other site-specific health and safety documentation.

- Workers will not assume that the equipment operator is keeping track of the exact location of operating equipment. Workers will never walk directly behind or to the side of heavy equipment without the operator's knowledge.

- Workers in close proximity to heavy equipment will maintain visual contact with equipment operators at all times.

- When an operator must maneuver equipment in tight quarters, the presence of a second person will be required to ensure adequate clearance. If backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator’s normal field of vision to relay signals.

- All heavy equipment used at a contaminated work site will be kept in the exclusion zone until the work has been completed. Such equipment will then be decontaminated within the designated decontamination area.

- Hand-signal communications will be established when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

- Equipment with an obstructed rear view must have an audible alarm that sounds when the equipment is moving in reverse (unless a spotter guides the operator).

- Parking brakes will be kept engaged when equipment is not in use.

- Blades, buckets, dump bodies, and other hydraulic systems will be kept fully lowered when equipment is not in use.

- Equipment cabs will be kept free of all nonessential and loose items.

- Seat belts must be present in all vehicles having a rollover protective structure (ROPS).

- With certain exceptions, all material-handling equipment must be equipped with ROPS.

- Material-handling equipment that lacks a ROPS will not be operated on a grade unless the grade can safely accommodate the equipment involved.

- Drilling auger sections and other equipment are extremely heavy. All precautions must be taken before moving heavy equipment. Appropriate equipment must be used to transport heavy equipment.

- Only chains, hoists, straps, and other equipment that safely aids transport of heavy materials will be used.

- Proper personal lifting techniques will be used. Workers will lift using their legs, not their backs.

- A safety barrier will be used to protect workers when tires are inflated, removed, or installed on split rims.

- An ongoing maintenance program for all tools and equipment must be in place. All tools and moving equipment will be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate according to manufacturer specifications. Defective items will be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Tools will be stored in clean, secure areas to prevent damage, loss, or theft.
- Workers will not use equipment with which they are not familiar. This precaution applies all equipment and tolls.
- Loose-fitting clothing and loose, long hair will be prohibited around moving machinery.
- Workers will make sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines present a hazard in the work area.
- All personnel who are not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.
- Workers will remain alert at all times.

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TETRA TECH, INC.
GENERAL SAFE WORK PRACTICE for HEAT STRESS PREVENTION and MONITORING

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SWP 5-15

This safe work practice (SWP) describes situations where heat stress is likely to occur and provides procedures for the prevention and treatment of heat-related injuries and illnesses. Wearing personal protective equipment (PPE), especially during warm weather, puts employees at considerable risk of developing heat-related illness. Health effects from heat stress may range from transient heat fatigue or rashes to serious illness or death.

Many factors contribute to heat stress, including PPE, ambient temperature and humidity, workload, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors are elevated ambient temperatures in combination with fluid loss. Because heat stress is one of the more common health concerns that may be encountered during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat stress. Heat stroke is the most serious heat-related illness—it is a threat to life and has a 20 percent mortality rate. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age directly affect the tendency to heat stroke. Table 1 lists the most serious heat conditions, their causes, signs and symptoms, and treatment.

Training is an important component of heat stress prevention. Employees are instructed to recognize and treat heat-related illnesses during 8-hour health and safety refresher and first aid training courses. When working in hot environments, specific steps should be taken to lessen the chances of heat-related illnesses. These include the following:

- Ensuring that all employees drink plenty of fluids (Gatorade® or its equivalent)
- Ensuring that frequent breaks are scheduled so overheating does not occur
- Revising work schedules, when necessary, to take advantage of the cooler parts of the day (such as working from 5:00 a.m. to 11:00 a.m. and 6:00 p.m. to nightfall).

When PPE must be worn (especially Levels A and B), suggested guidelines relating to ambient temperature and maximum wearing time per excursion are as shown in Table 2.

TABLE 1
HEAT STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 105 or 106 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions

TABLE 2
SUGGESTED GUIDELINES WHEN WEARING PPE

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Source: National Institute for Occupational Safety and Health (NIOSH). 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

To monitor the level of an employee's heat stress, the following should be measured:

- Heart Rate: Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period; if heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next period, shorten the following work cycle by one-third.

- Oral Temperature: Use a clinical thermometer (3 minutes under the tongue) to measure the oral temperature at the end of the work period. If oral temperature exceeds 99.6 °F (37.6 °C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6 °F at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear impermeable PPE when his or her oral temperature exceeds 100.6 °F (38.1 °C).

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	TETRA TECH, INC. GENERAL SAFE WORK PRACTICES for COLD STRESS	**Revision Date: 10/1/2008**
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This safe work practices (SWP) describes situations where cold stress is likely to occur and discusses procedures for the prevention and treatment of cold-related injuries and illnesses. Cold conditions may present health risks to employees during field activities. The two primary factors that influence the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Other factors that increase susceptibility to cold stress include age (very young or old), smoking, alcohol consumption, fatigue, and wet clothing. Hypothermia can occur at temperatures above freezing if the individual has on wet or damp clothing or is immersed in cold water. The combined effect of temperature and wind can be evaluated using a wind chill index as shown in Table 1.

Bare flesh and body extremities that have high surface area-to-volume ratios such as fingers, toes, and ears are most susceptible to wind chill or extremely low ambient temperatures. Because cold stress can create the potential for serious injury or death, employees must be familiar with the signs and symptoms and various treatments for each form of cold stress. Table 2 provides information on frostbite and hypothermia, the two most common forms of cold-related injuries.

Training is an essential component of cold stress prevention. Employees are instructed to recognize and treat cold-related injuries during 8-hour health and safety refresher and first aid training courses. When working in cold environments, specific steps should be taken to lessen the chances of cold-related injuries. These include the following:

- Protecting of exposed skin surfaces with appropriate clothing (such as face masks, handwear, and footwear) that insulates, stays dry, and blocks wind;
- Shielding the work area with windbreaks to reduce the cooling effects of wind;
- Providing equipment for keeping workers' hands warm by including warm air jets and radiant heaters in addition to insulated gloves;
- Using adequate insulating clothing to maintain a body core temperature of above 36 °C;
- Providing extra insulating clothing on site;
- Reducing the duration of exposure to cold; and
- Changing wet or damp clothing as soon as possible.

During periods of extreme cold (10 °F or less) workers should use the buddy system to ensure constant protective observation.

Specific monitoring criteria are not established for cold stress. However, employees should be thoroughly cognizant of the signs and symptoms of frostbite and hypothermia (see Table 1) in themselves as well as in coworkers. All instances of cold stress should be reported to the site safety coordinator. Work schedules may be adjusted and warm-up regimes imposed as needed to deal with temperature and wind conditions.

TABLE 1
COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE

Estimated Wind Speed (in miles per hour - mph)	**Actual Temperature Reading (°F)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
CALM	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* in less than 1 hour with dry skin; maximum danger from false sense of security				*INCREASING DANGER* from freezing of exposed flesh within 1 minute				*GREAT DANGER* that flesh may freeze within 30 seconds			

Trench foot may occur at any point on this chart.

Source: Modified from American Conference of Governmental Industrial Hygienists. 1997. "Threshold Limit Values for Chemical Substances and Physical Agents."

TABLE 2
COLD STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

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TETRA TECH, INC.
BIOHAZARD SAFETY

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Biological hazards, or “biohazards,” include plants, animals or their products, and parasitic or infectious agents that may present potential risks to worker health. This safe work practice (SWP) discusses procedures for working with biohazards, preventive guidelines, and first-aid procedures for the most common hazards field staff are likely to encounter. This SWP does not address biohazards such as those associated with medical waste. Procedures for working with this type of biohazard should be addressed in the site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job safety analyses (JSAs), activity hazard analyses (AHAs), or other health and safety project planning documents on a case-by-case basis.

During preparation for site work, the document preparer should consider which plants, animals, and other biological agents may be encountered; assess their potential risk to project personnel; and attach this SWP to the document if necessary. Office health and safety representatives should become familiar with biological hazards indigenous to the geographical area in which most of their office personnel work and assist in evaluating the risks to personnel on projects staffed from their offices. SWPs for insects, snakes, animals, plants, waterborne pathogens (giardia), and hantavirus are provided below.

1.0 INSECTS

SWPs for reducing the chance of insect bites or stings and for treating bites or stings are listed below.

- Workers should keep as much skin area covered as possible by wearing long-sleeved shirts, long pants, and a hat. Pant legs should be tucked into socks or boots and shirts into pants. In addition, workers should wear light colored clothing.
- A proven insect repellent should be used on bare skin and clothing.
- When possible, tall grasses and brush that could harbor ticks should be avoided.
- Several times during the day and at the end of the work day, each worker should perform a check for evidence of imbedded ticks or previous bites. Particular attention should be paid to the scalp, neck, ankles, back of the legs, and waist.

- When opening well covers, vaults, or other closed items, workers should watch for hornet or wasp nests and black widow or brown recluse spiders. Workers should never reach into spaces with unprotected arms.

- Workers should watch carefully for bees around open soft drinks or food.

- If a worker is stung by a bee, the stinger should be carefully removed, if present. The wound should be washed and a cold pack applied. Allergic reaction should be watched for and is evidenced by extreme swelling, redness, pain, or difficulty breathing.

- If a worker is stung or bit by a spider or scorpion, medical attention should be obtained immediately.

2.0 SNAKES

SWPs for encounters with snakes and for treating snakebites are listed below.

- Workers should avoid walking in areas known to harbor snakes. Workers should be cautious when picking up or moving items that have been on the ground.

- Workers should wear boots made of heavy material that protect the ankles and pants. Heavy work gloves should be worn for picking up items.

- If one snake is encountered, others may be present. Workers should leave the area by retracing their steps.

- If a worker is bitten, the wound should be washed and the injured area immobilized and kept lower than the heart, if possible. Ice or a tourniquet should not be applied to a snake bite. The wound should not be cut. If medical care is more than 30 minutes away from a work site, a snakebite kit should be available on site and workers should know how to use it.

3.0 ANIMALS

SWPs for encounters with animals and for treating associated wounds are listed below.

- If workers encounter a wild animal, the animal should be observed for unusual behavior such as a nocturnal animal out during the day, drooling, an appearance of partial paralysis, irritability, meanness, or a strangely quiet demeanor.
- Workers should never touch the body of a dead animal because certain diseases could be carried by fleas still on the body.
- Workers should avoid animal droppings (including bird droppings). Pathogens, some of which can become airborne, may still be present in the droppings.
- If a worker is bitten, he or she should get away from the animal to avoid further bites. Workers should not try to stop, hold, or catch the animal.
- If the wound is minor, it should be washed with soap and water. Any bleeding should then be controlled, and an antibiotic ointment and dressing should be applied. All animal bite wounds should be watched for signs of infection.
- If the wound is bleeding seriously, the bleeding should be controlled but the wound should not be cleaned. Medical assistance should be summoned immediately.
- If a rabid animal is suspected, immediate medical attention should be summoned. If possible, workers should try to remember what the rabid animal looked like and the area in which it was last seen. The animal should be reported by calling the local emergency number.

4.0 PLANTS

SWPs for plants are as follows:

- Workers should be aware of the types and appearances of poisonous plants in the work site area. Poison ivy, oak, and sumac are the most frequently encountered plants that can cause reaction from casual contact. If a worker is extremely sensitive to these plants, he or she should avoid the area entirely because airborne drift could be sufficient to cause a reaction. Other plants, such as fireweed, can cause painful, short-term irritation and should be avoided as well. Workers should avoid touching face and eye areas after contact with any suspicious plant.

- Workers should wear proper clothing if working in or near overgrown areas. Disposable outerwear should be used, if necessary, and workers should not touch the material with bare hands during removal if the outerwear may have contacted poisonous plants.

- If contact with a poisonous plant has occurred, the affected area should be immediately washed thoroughly with soap and water. If a rash or weeping sore has already begun to develop, a paste of baking soda and water should be applied to the area several times a day to reduce discomfort. Lotions such as Calamine or Caladryl should be applied to help soothe the area. If the condition gets worse and affects large areas of the body or the face, a doctor should be consulted.

- Bushy and wooded areas should be thoroughly checked for thorn-bearing trees, brush, and bramble. In some cases, impalement can cause severe pain or infection.

5.0 WATERBORNE PATHOGENS-GIARDIA

Giardia is a waterborne pathogen consisting of a protoplasmic parasite of the mammalian digestive tract. Giardia is present worldwide, with the highest occurrence in areas with poor sanitation. In the United States, most reported cases are in mountainous regions where drinking water is obtained from streams and is unfiltered or untreated.

Giardia is contracted by ingesting water contaminated with giardia cysts in the dormant state. Giardia parasites can only thrive in the digestive tracts of mammals. Dormant giardia organisms enter water through the feces of infected animals or humans. Giardia symptoms include severe diarrhea and upset stomach. Some people are asymptomatic but can transmit the disease to others. Medical treatment of giardia can be difficult and unpleasant; therefore, prevention is critical. Precautions for preventing exposure to giardia are listed below.

- Workers should assume that all fresh water streams are infected with the giardia organism and not drink any untreated water.

- Team members collecting sediment and water samples from streams should wash their hands thoroughly with soap and water after collecting the samples.

- Giardia parasites are relatively easy to destroy or filter. Water should be treated for drinking or cooking with iodine or another recommended giardia treatment before use.

6.0 HANTAVIRUS

Hantavirus pulmonary syndrome (HPS) is a potentially fatal infection caused by a rodent-borne hantavirus. HPS begins with a brief illness most commonly characterized by fever, muscle pain, headache, coughing, and nausea or vomiting. Other early symptoms include chills, diarrhea, shortness of breath, abdominal pain, and dizziness. In the first identified cases of HPS, this stage of the infection lasted 2 to 5 days before victims were hospitalized. Typically, by the time of hospitalization, victims were found to have tachycardia (a heart rate of greater than 100 beats per minute) and tachypnea (a breathing rate of greater than 20 breaths per minute). Fever was also common. In most cases, death occurred within 2 to 16 days of the onset of symptoms, and victims exhibited pulmonary edema and severe hypotension.

Currently, experts believe that HPS is spread by the deer mouse (*Peromyscus maniculatus*). Though the deer mouse has been found to be the primary host of hantavirus, several other rodent species have also tested positive for the virus. Pinon mice (*Peromyscus truei*), brush mice (*Peromyscus boylii*), and western chipmunks (*Tamia spp.*) are also likely to carry the virus. Also, cases of HPS have been reported in areas of the United States where these particular rodents are not indigenous.

Infected rodents shed the virus in their urine, feces, and saliva. Humans can be exposed to the virus through (1) inhalation of suspended rodent excreta or dust particles containing rodent excreta, (2) introduction of rodent excreta into the eyes or broken skin, and (3) ingestion of food or water contaminated by rodent excreta. HPS has a reported mortality rate of 55 percent. Transmission of hantavirus from infected individuals to healthy persons has not been documented.

Prevention of HPS infection is essential because no known antidote and no specific treatment exists for treating HPS. Therefore, employees should practice risk reduction and control measures. Guidelines for workers in locations that may have rodent infestations or habitats are listed below.

- The best approach for HPS control and prevention is through environmental hygiene practices that deter rodents from colonizing the work environment.

- Information about the symptoms of HPS and detailed guidance on preventive measures should be provided to all employees assigned to field activities.

- Medical attention should be sought immediately for workers who develop a febrile or respiratory illness within 45 days of the last potential exposure to rodents. Attending physicians should be advised of each worker's potential for occupational exposure to hantavirus. Physicians should contact local health authorities promptly if hantavirus-associated illness is suspected. A blood sample should be obtained from the affected worker and forwarded with the baseline serum sample through the state health department to the Centers for Disease Control and Prevention for hantavirus antibody testing.

- Respiratory protective equipment should be worn when handling rodents, when removing rodents from traps, and when working in areas with evidence of rodent droppings or hair. Respiratory protective equipment should include, at a minimum, a half-face air-purifying respirator (APR) or powered APR equipped with a high-efficiency particulate air (HEPA) filter (P100). Full-face regulators may be needed under some circumstances. Respiratory protective equipment should be used in accordance with Occupational Safety and Health Administration regulations.

- Dermal protection should be worn when handling rodents or traps containing rodents, or if contact with contaminated surfaces could occur. Dermal protection should include rubber or plastic gloves that should be washed and disinfected before removal.

- A trap contaminated with rodent urine or feces or in which a rodent was captured should be disinfected with a commercial disinfectant or a 0.4 percent bleach solution. A dead rodent should be disposed of by placing the carcass in a plastic bag containing enough general-purpose household disinfectant to thoroughly wet the carcass. The bag should be sealed and disposed of by burning or by burying it in a 2- to 3-foot-deep hole. Local and state health departments can also provide appropriate disposal methods.

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To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when lifting and carrying while in an office or field environment. These SWPs establish a pattern of general precautions and measures for reducing risks associated with back injury and trauma associated with improper lifting and carrying of heavy objects. This list is not inclusive and may be amended as necessary.

- First, inspect the area where the load will be lifted, transported, and then deposited. Remove any obstacles that could present a tripping or other hazard.

- Perform a "test lift" by slightly pushing or moving the object to gauge your ability to safely lift/move/deposit the item without injuring yourself. IF YOU ARE NOT CONFIDENT THAT YOU CAN MOVE THE OBJECT WITHOUT INJYURING YOURSELF - THEN EITHER GET A MECHANICAL LIFTING AID OR GET HELP. DO NOT ATTEMPT TO MOVE THE OBJECT YOURSELF.

- Get as close to the object as you can, and bend at the knees (not at the back).

- Assure that can get a firm grasp on the object.

- Keeping the load as close to you body as possible, lift with your legs, and avoid turning or twisting while lifting, carrying, or depositing the load.

- Carry the object in a manner that it does not obstruct your vision and so that you can maintain a clear line of sight of your path of travel and the area where you will set it down.

- Set the object down using the same techniques as you did in lifting it (don't turn or twist, keep it close to your body, use your legs - not your back).

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TETRA TECH, INC.

GENERAL SAFE WORK PRACTICES for HYDROGRAPHIC DATA COLLECTION

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SWP 5-22

This safe work practice (SWP) is intended for all employees involved in hydrographic data collection and all activities related to such work when working in or near moving water. While every facet of the work cannot be discussed or foreseen, it is assumed that each employee will hold paramount his or her safety and the safety of the other crew members when collecting hydrographic data.

River data collection involves an array of different working environments such as driving field vehicles; towing, launching, and operating boats; using sampling equipment; and operating surveying equipment. Each task poses different safety concerns. Table 1 lists the general tasks of data collection, the potential safety hazards involved with each task, steps to take to avoid the hazard, and steps to take if an incident does occur.

Safety factors must be considered in addition to the individual tasks of data collection. Emergency preparation procedures, general concerns, and incident reporting are discussed below.

1.0 EMERGENCY PREPARATION PROCEDURES

Emergency telephone numbers for the location where data collection is being conducted must be posted at the site. This list should be updated by the crew chief prior to commencing any work in a new location.

Typically each field crew will have at least one mobile telephone that can be utilized in an emergency. Additionally, the field crew may carry two-way radios to allow communication between crew members for data collection purposes and in case of emergency.

First aid kits must be available in every vehicle and on every boat in use. Fire extinguishers must be located on each boat that has a motor and gas can. Throw ropes must also be provided on each boat.

2.0 GENERAL CONCERNS

When working in the field, exposure to the elements can be extreme. Do not underestimate the power of the weather. It is recommended that at least 50 ounces (1.5 liters) of drinking water be consumed every 8 hours while working in the river environment, regardless of the air temperature.

Heat problems are common in the river environment. Hot weather causes dehydration, as does cold water through the effects of cold water diruesis. Both heat exhaustion and heat stroke can result from exposure to the heat and lack of fluids in the body. Additional information about recognizing and treating heat stress are provided in SWP 5-15.

Cold stress is also a serious problem, especially when working in cold water and in colder climates that can lead to hypothermia. Below is an excerpt about immersion in cold water from the *Swiftwater Rescue Technical I Manual* (Croslin and others 1983).

> *The first effect of cold water is to shut down the circulation to the arms and legs in order for the body to keep warm blood in the core. This shunting makes it difficult for the cold water immersion victim to swim purposefully after only a few minutes. It also causes immersion diuresis. Since the extra blood goes to the core, the kidneys are fooled into thinking there is a fluid overload. The result is frequent urination, and the loss of vital fluids and salts. So the victim on the verge of becoming hypothermic is perhaps shivering, has cold extremities, sluggish circulation to the brain, and is hypovolemic, or low fluid volume due to profuse urination.*
>
> *The patient that still retains a gag reflex can and should be aggressively treated in the field, with warm fluids, external warmth, and even hot air or oxygen if possible. With no aggressive efforts, the patient will continue to deteriorate. The rescuer is cautioned that best efforts may even then not be successful.*

People working in the field are not expected to perform rescues or practice any medical techniques; however, they should be aware of the signs to look for in themselves and coworkers when exposed to extreme conditions. SWP 5-16 provides additional information on cold stress.

Exposure to ultraviolet rays should also not be overlooked when working in the river environment. Sunscreen and good eye protection is highly recommended. The river environment is home to several animals, and insects, some of which are dangerous to humans. Rattlesnakes are not uncommon and should be looked for, especially in rocky and riprapped areas, in the cooler hours of the morning and evening.

Storms can move in quickly; be aware of the weather conditions at all times and know the availability of shelter. Use caution when using tall, conductive equipment such as level rods (up to 25 feet) and cable guides when there is a possibility of lightning.

The work load can be taxing. If a crew member feels the effects of fatigue, stop the work and rest or switch tasks with another crew member.

Proper clothing should be worn when working in the field. River boots, waders, dry jackets, and personal flotation devices (PFD) must be worn. Each crew member should also bring proper clothing for various types of weather. Hard hats and florescent safety vests will be worn when working within 500 feet of heavy, large machinery or in designated hard hat areas when construction activities are occurring or expected to be occurring. Prior to working in a construction zone, the crew chief should notify the person supervising construction of the data collection activities that will be occurring. The crew chief should coordinate such issues as places to park vehicles and traffic flow.

If a tag line must be strung across a river, the crew chief must notify appropriate state or local authorities. Extreme caution must be used when the tag line is across a river in areas of recreational use. If the area experiences large amounts of boat traffic, place a large, highly visible sign upstream of the work location notifying boaters of a tag line across the river downstream. Also, tie flagging to the tag line to help boaters to see the line.

3.0 INCIDENT REPORTING

Should an incident occur, the investigation and report will comply with the Tetra Tech, Inc. (Tetra Tech) Incident Reporting and Investigation Program, Document Control Number 2-2. The person directly responsible for the supervision of the employee or employees involved in an incident, usually the crew chief, must report the incident within 8 hours of the occurrence, regardless of whether or not medical attention was sought.

4.0 REFERENCE

Croslin, Make, M.D., Barry Edwards, and Jim Segerstrom (Croslin and others). 1983. *Swiftwater Rescue Technician I Manual*. Rescue 3 International.

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TABLE 1
SAFETY CONCERNS INVOLVED WITH HYDROGRAPHIC DATA COLLECTION

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Loading equipment	Strained muscles, back, legs, arms, and so on	Use proper lifting techniques. Lift with legs, not back.	Report the accident. Seek medical attention if necessary.
	Equipment shifting, sliding, or falling out of vehicle	Take extra time to load equipment so that it rides well without a lot of disturbance.	Rearrange the equipment so that it rides without moving in the vehicle.
Loading and transporting a boat with a vehicle	Trailer becomes unattached from the towing vehicle if the ball hitch is not on securely and safety chains not latched	Be sure the trailer is securely attached to the ball hitch and the safety hitch pin is secure in the hitch. Be sure both chains are securely attached to the towing vehicle.	Stop the vehicle as soon as physically possible. Retrieve the boat and reattach if possible.
	No signal lights if electrical wires not hooked up	Be sure electrical wires are connected and test all lights prior to driving the vehicle.	If connections are not working, try to find the source and correct the problem, otherwise take the trailer to someone who can professionally rewire it.
	Boat does not ride well if not secure to trailer	Be sure boat is centered on trailer, is securely fastened to the trailer and if there is an engine, that it is held securely in place.	Restrap the boat onto the trailer or add more straps to firmly secure the boat onto the trailer.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
	Wheels on trailer heat up and deteriorate	Always check to be sure the wheel bearings are lubricated and well packed.	Feel the wheels regularly, if they are hot, have the bearing lubricated or repacked.
Driving to work site	Accidents due to unfamiliar terrain, transporting equipment, boats, trailers, and so on	Become familiar with the terrain before driving, if necessary, walk the area first. Use maps and aerials to help guide you on the best path	Report the accident and take the steps necessary to remedy the situation, call a tow truck, dig yourself out if stuck, and so forth
Launching boat into water	Strained muscles	Back the boat into the water as much as possible. Use all of the crew members to help launch into the water.	Report any accident and seek medical attention if necessary.
	Swamped boat	Try to back the boat into the water so that the back end will not become submerged when the boat is pushed off of the trailer.	Secure the boat to the bank. Remove important items from the boat that may sink or float away. Try to pull the boat back onto the trailer or up on shore to avoid completely sinking the boat.
	Vehicle or trailer gets stuck	Be aware of the river bed material and the slope of the bank. Avoid launching in areas of thick mud or fines.	Try different measures to get the vehicle or trailer unstuck depending on the situation.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Stringing a tag line - person pulling the line on a boat or wading	Tag line gets caught around puller	Be aware of the amount of slack in the line and how the line is positioned with your body. In all crossings, stay in good communication with the person braking the line. Leave a minimum of loose tag line. Hold the tag line so it is not looped or wrapped around the hand or any other part of the body. The tag line should be held so that if the hand is opened, the line freely falls away from the person.	Immediately stop moving across the river and untangle the line. If the wrap is life threatening, cut the line.
	Tag line gets caught on boat parts, engine, propeller, or so on.	Be aware of the amount of slack in the line and how the line is positioned with the boat.	The driver of the boat should hold the position of the boat steady while the puller untangles the line. If the line becomes caught in the propeller, throw the anchor, kill the engine, and untangle the line.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Stringing a tag line - person pulling the line on a boat or wading (Continued)	Tag line gets in water and pulls downstream	Be aware of the amount of slack in the line.	Let the braker know how to put more tension on the line. If the line has traveled far downstream, tell the braker not to let out any more line. Pull the line out of the water as much as possible. If necessary, tie the line off on both ends and then pull the slack out of the water. If it becomes too difficult to get the line out of the water, the puller should simply let go of the line and the braker should reel the line back in.
Stringing a tag line - person braking the line (running the reel)	Hands become burned from heat of friction	Always wear gloves when braking the line. It is sometimes helpful to wet the gloves before braking. If the line is being taken across the river by boat, the driver of the boat needs to proceed slowly across the river at a speed similar to walking.	Let the puller know that there is a problem. Tie the line off temporarily and cool hands off. Get proper protection for hands.
Stringing a tag line - person braking the line (running the reel) (Continued)	Tag lines becomes tangled around person braking, the reel, or other obstructions in the vicinity of the reel	Try to place the reel in a clear, level area before stringing the line. Use both hands to try to control the tension and backlash in the line so there is no slack to get caught.	Let the puller know that there is a problem. Untangle the line and continue, tie off temporarily if necessary.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Stringing the line - general	People or instruments downstream of the line could get caught or knocked over by the line	Never position yourself downstream of the tag line while it is being strung. Never place any equipment downstream of the tag line before it has been completely strung.	If someone or something gets caught, stop stringing the line and take the necessary steps to untangle the person or equipment.
	Boaters or ATV users (when in a dry river bed) may not see the tag line across the river	Place a sign upstream in areas of heavy recreational use warning boaters of the line. Place florescent flagging on the line to help boaters see the line. When possible, employ a spotter to watch for upstream traffic.	If the boaters do or do not see the line, either lift the line for them to cross under safely, or release the line and let them boat over it.
Reeling in a tag line	Tag line could get caught on boat or debris	Always park the boat upstream of the line, never downstream of the line. Try to strategically place cable guides or people (if safe) to help keep the line out of debris while reeling it back in. Always undo any knots that may accidentally form on the tag line and always remove the line clamp before reeling.	If the line does gets caught, first try to unsnag it from the shore. If it is safe, either wade or use the boat (avoid any extra line downstream of the snag) to get close to the snag. Use extreme caution when working near snags as they may be mobile.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Reeling in a tag line	Tag line gets in water and pulls downstream; this can cause the puller and braker to be pulled along the line	Try to maintain a fair amount of tension on the line. Stay in good communication with the puller. Sometimes it is helpful to move the reel to a location where the braker can see the water if the endpoint is far away from the river bank. When possible, install additional tag line guide posts to suspend the cable above the water (this may not be possible if the flow is deep).	Apply more tension to the line. Work with the puller to get the line out of the water.
Operating the boat	Hitting obstructions in the river, snags, debris piles, jacks, bridge abutments, and so on	Try to always look for and avoid snags, debris piles, jacks, and so on. Review the notes of the previous surveys for locations in areas of known hazards such as the CA, CC, and BI-lines. Be wary of old pilings or abutments in the close vicinity of the bridge. Also large amounts of debris typically pile up on the upstream side of the bridge abutments.	Evaluate the severity and danger of the situation. Get the boat off of the snag, jack, or other obstruction either by pulling it off with ropes, motoring off, or some other means if possible without putting crew members in danger of injury or drowning.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
Operating the boat (Continued)	Motor stops running	Keep the engine well greased, monitor the water exhaust (cooling water) from the engine, avoid motoring over dunes and so on that will cause sediment to get into the engine	Throw the anchor or paddle to avoid obstructions. Lift the motor and try to determine the reason it stopped running: clogged water exhaust line, poor spark plug connection, debris around propeller, debris in the jet intake grate, and so on. Water exhaust may be back flushed with the "turkey baster."
	Slip - climbing in, out, and around the boat	Wear proper footgear, felt-soled shoes when possible. Try to keep the boat as clean as possible; silts and clays become very slippery when wet.	Report the accident and seek medical attention if necessary.
	Fall out of the boat	Move carefully about the boat to ensure solid footing.	Help the person back in the boat if close by pulling them up by their PFD. Use a throw rope if the person is far away from the boat or shore.
Using cable guides	Pointed metal ends and sharp surfaces can cause scrapes and punctures	Be aware of the location of and your proximity to other people when carrying the cable guides. Take care to place the cable guides out of the way, especially in the boat.	Report the accident and seek medical attention if necessary.
Wading or swimming in river	Slipping on banks or river beds	Walk carefully and wear proper footwear.	Report the accident and seek medical attention if necessary.

Data Collection Tasks	Potential Safety Hazards	Steps to Avoid the Hazard	What to Do if a Problem Occurs
	Getting caught in water; foot entrapment in debris piles, jacks, or so on	Always wear a PFD. As a general rule, if the velocity multiplied by the depth is more than 10, use extra caution when attempting to wade the river. Be aware of the dynamics of the water around obstructions such as boulders, snag piles, overhanging debris, and jacks. There is often a lot more debris below the surface of the water that cannot be easily seen.	Employ the help of other crew members to get you out of danger. Call for emergency help if available and necessary.
Carrying equipment to the work site	Strained muscles	Take only what is feasible for you to carry; remember that more than one trip can be made.	Report the accident and seek medical attention if necessary.
Carrying equipment to the work site	Tripping and falling	Try not to obstruct your view while you are walking to the site. There is often a lot of debris, fallen trees, and so on in the area around rivers.	Report the accident and seek medical attention if necessary.
Using sampling equipment	Strained muscles	When lifting equipment over 50 pounds, employ the help of a coworker.	Report the accident and seek medical attention if necessary.
	Pinched extremities	Lift and handle the sampling equipment carefully	Report the accident and seek medical attention if necessary.
Loading the boat on the trailer	Same as launching a boat	Same as launching a boat	Same as launching a boat

TETRA TECH, INC.
PREVENTION of SUN EXPOSURE

Revision Date: 10/1/2008

Document Control Number:

SWP 5-26

By far, the most common cause of skin cancer is overexposure to the sun. Ninety percent of all skin cancers occur on parts of the body that not usually covered by clothing. People who sunburn easily, and those with fair skin and red or blond hair are more prone to develop skin cancer. The amount of time spent in the sun also affects a person's risk of skin cancer. Premature aging of the skin also occurs with prolonged sun exposure. Tetra Tech encourages personnel to avoid prolonged exposure to the sun, and recommends the following:

- Sunburn can occur during any time of the year. To avoid sunburn, wear hats with wide brims.
- Use sunscreen with a Sun Protective Factor (SPF) rating of 15 or higher.
- To prevent skin cancer:
    - Cover up with a wide brimmed hat and a bandanna for your neck. Wear long-sleeved shirts and pants which the sun cannot penetrate.
    - Use sunscreens to help prevent skin cancer as well as premature aging of your skin. Use a Sun Protective Factor (SPF) rating of 15 or higher.
    - Apply sunscreen at least an hour before going into the sun and again after swimming or perspiring a lot.
    - Do not use indoor sun lamps, tanning salons/parlors, or tanning pills.
- You can still get burned on a cloudy day. Try to stay out of the direct sun at midday, because sun rays are their strongest between 10 a.m. and 3 p.m. Beware of high altitudes - where there is less atmosphere to filter out the ultraviolet rays. Skiers should remember that snow reflects the sun's rays, too.
- Know your skin. Whatever your skin type, do a monthly self-examination of your skin to note any moles, blemishes or birthmarks. Check them once a month and if you notice any changes in size, shape or color, or if a sore does not heal, see your physician without delay.

Disclaimer: This safe work practice (SWP) is the property of Tetra Tech, Inc. (Tetra Tech). Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
10/1/2008	Chris McClain		NEW
	Rick Lemmon		

This safe work practice (SWP) provides guidelines for proper and thorough cleaning of respiratory protection equipment. The Occupational Safety and Health Administration (OSHA) regulates the use of respiratory protection for general industry in Title 29 of the *Code of Federal Regulations* (CFR) Part 1910.134, "Respiratory Protection." Appendix B-2 of the standard outlines mandatory requirements for respirator cleaning and is used as the basis for this SWP. This SWP supplements Document Control Number (DCN) 2-6, "Respiratory Protection Program." It provides specific respirator cleaning and disinfection procedures and shall be included as an attachment to the site-specific health and safety plan for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of respirators with reusable facepieces.

Respirators shall be cleaned and disinfected as discussed below.

- Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.
- Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals.
- Respirators maintained for emergency use shall be cleaned and disinfected after each use.
- Respirators used in fit testing and training shall be cleaned and disinfected after each use.

2.0 CLEANING AND DISINFECTION PROCEDURES

Mandatory respirator cleaning procedures as defined in 29 CFR Part 1910.134, Appendix B-2, are listed below. All wash and rinse water should be warm, with a maximum temperature of 110 °F (43 °C).

1. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, and any other components as recommended by the manufacturer. Discard or repair any defective parts.

2. Wash components in warm water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

3. Rinse components thoroughly in clean, warm, preferably running water. Drain all components.

4. When the cleaner does not contain a disinfecting agent, respirator components should be immersed for 2 minutes in one of the following:

    - Hypochlorite solution [50 parts per million (ppm) of chlorine] made by adding approximately one milliliter of laundry bleach to 1 liter of warm water

    - Aqueous solution of iodine [50 ppm iodine made by adding approximately 0.8 milliliter of tincture of iodine (6 to 8 grams ammonium and/or potassium iodide per 100 cubic centimeters of 45 percent alcohol) to 1 liter of warm water]

    - Other commercially available cleansers of equivalent disinfectant quality when used as directed if their use is recommended or approved by the respirator manufacturer

5. Rinse components thoroughly in clean, warm, preferably running water. Drain all components. The importance of thorough rinsing cannot be over emphasized. Detergents or disinfectants that dry on facepieces may cause dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

6. Components should be air-dried or hand-dried with a clean, lint-free cloth.

7. Reassemble the facepiece. Replace filters, cartridges, and canisters prior to next use.

8. Test the respirator to ensure that all components work properly.

9. Place the respirator in a clean bag and seal for storage.

Depending on work conditions, respirator facial sealing surfaces may need periodic cleaning during the course of daily use. Cleaning of the facial sealing surface during work breaks can reduce the chance of facial irritation caused by sweat, natural skin oil, or irritating materials that may have deposited on the facepiece. Facial sealing surfaces can be cleaned using disinfectant wipes soaked in isopropyl alcohol or benzalkonium chloride. After use of the disinfectant wipe, the sealing surface should air dry or be dried thoroughly using paper towels or tissues.

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Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
10/1/2008	Chris McClain		Update from 1998 format
	Rick Lemmon		

TETRA TECH, INC.
GENERAL SAFE WORK PRACTICES for USE OF AIR PURIFYING RESPIRATORS

This safe work practice (SWP) was developed to ensure the proper use of respirators in routine and foreseeable emergency situations. The SWP supplements Document Control No. 2-6, “Respiratory Protection Program.” This SWP shall be included as an attachment to the site-specific health and safety plan (HASP) for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of air purifying respirators and shall not be used for situations involving the use of supplied air systems such as self-contained breathing apparatuses and air-line apparatuses.

2.0 ROUTINE RESPIRATOR USE PROCEDURES

The procedures below apply to the routine use of air purifying respirators.

- Respirators shall not be issued to or worn by individuals when conditions prevent valve function or a good facial seal. These conditions may include but are not limited to facial hair, such as the growth of beard, sideburns, or excessive mustaches, and possibly the wearing of corrective eyeglasses.

- If spectacles, goggles, face shields, or welding helmets must be worn with a facepiece, they will be worn so as not to adversely affect the seal of the facepiece to the face.

- For all tight-fitting respirators, a positive and negative pressure seal check shall be performed each time the respirator is donned. Seal checks shall be performed as follow:

  - *Negative pressure check:* Close off the inlet opening of the canister or cartridge(s) by covering it with the palm of the hand(s), inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is satisfactory.

  - *Positive pressure check*: Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. The exhalation valve cover may have to be removed to perform this procedure.

  - *Manufacturer's recommended seal check*: If the respirator manufacturer recommends specific procedures for performing a user seal check, these procedures may be used instead of the negative and positive pressure checks.

- Work areas must be monitored for conditions that may adversely affect the effectiveness of respiratory protection. Employees may leave the work area where respirators are required under the following conditions:
  - To wash the face and respirator facepieces as necessary to prevent eye or skin irritation;
  - If vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece is detected;
  - To replace the respirator or the filter, cartridge, or canister elements;
  - If established monitoring instrument action levels are exceeded; or
  - For any other criteria as established in a site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit or other site-specific health and safety document.

3.0 RESPIRATOR USE DURING EMERGENCY SITUATIONS

Emergency situations may arise during the wearing of respiratory protection. These situations could include medical emergency, respirator failure, fire, chemical spills or leaks, and other events that pose an immediate risk. Procedures for respirator use during emergency situations are summarized below.

- When an emergency situation arises that creates or has the potential to create immediately dangerous to life and health (IDLH) conditions, the work environment shall be evacuated immediately and shall not be reentered by employees without suitable protective gear.
- Work environments with the potential for the development of atmospheres that may present IDLH conditions shall only be entered by employees using the buddy system.

- When an emergency situation arises that includes physical hazards that may interfere with the proper use of respiratory protection, the work environment shall be evacuated.

- Under no circumstances shall respirator users remove facepieces in hazardous atmospheres. In the event of respirator malfunction, users should leave the hazardous environment immediately and proceed to a known safe location before removal of the facepiece.

- Episodes of respirator failure shall be thoroughly investigated before work activities begin again. The investigation shall include re-evaluation of work area atmospheric conditions, review of the respirator selection criteria and service life calculations, and an evaluation of the working conditions under which respirator failure occurred.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
10/1/2008	Chris McClain		Update from 1998 format
	Rick Lemmon		

APPENDIX C

RESPIRATORY HAZARD ASSESSMENT (FORM RP-2)

(Two Pages)

Note: This assessment form will be finalized when site air monitoring data are collected and evaluated. Until the assessment is completed, air purifying respirator cartridges will be disposed of every 8 hours.

Revision Date: 10/1/2008

Document Control Number:

TETRA TECH, INC.
RESPIRATORY HAZARD ASSESSMENT

FORM RP-2

Project Name:

Project No.:

Location:

Project Manager:

Type: ☐ Baseline ☐ Reassessment

Date:

Valid for _____ days

Job/Task Description:

☐ Routine ☐ Escape

Hazard Identification and Source:

Workplace Factors:

Temperature: ___________

Humidity: _______________

Other: _________________

User Factors:

Work rate: _______________________

Protective clothing: ______________

Other: ___________________________

Chemical:					
PEL:					
ACGIH TLV:					
Form (part/gas/vapor):					
IDLH:					
Eye Irritant (Y/N):					
Skin Absorption(Y/N):					
Monitoring (Y/N) :*					
Frequency:					
Maximum Concentration Estimated:**					

* Monitoring Method:

☐ PID

☐ FID

☐ Detector tube: ___________

☐ NIOSH method: ____________

☐ Vapor badge: _____________

☐ Other: ___________________

Respirator Type:

☐ Half-face disposable Brand: ________________________

☐ Half-face reusable Brand: ________________________

☐ Full-face Brand: ________________________

☐ Air-supplied airline Brand: ________________________

☐ Air-supplied SCBA Brand: ________________________

☐ PAPR Brand: ________________________

☐ ESCBA Brand: ________________________

** If concentrations exceed the immediately dangerous to life and health (IDLH) value, use air-supplied systems.

Vapor and Gas Cartridge Exchange: ESLI: ☐ Yes ☐ No

Exchange frequency: ___________________________________

Cartridge/Filter Selection

☐ N100

☐ N99

☐ N95

☐ Organic vapor

☐ Mercury

☐ Combo: _______________

☐ R100

☐ R99

☐ R95

☐ Acid gas

☐ Formaldehyde

☐ Other: ____________________

☐ P100

☐ P99

☐ P95

☐ Ammonia

Basis for Exchange Frequency

☐ Manufacturer's data

☐ Experimental methods

☐ Predictive modeling

☐ OSHA Regulation: ___________________________________

☐ Other: ____

☐ Workplace simulations

☐ AIHA "Rules of Thumb"

☐ Analogous chemical structure

_________________________ _____________

Completed by Date

_________________________ _____________

Reviewed by Date

The online version of this form supersedes all other versions. Paper copies of this document are uncontrolled.
The controlled version of this document can be found on the Tetra Tech Intranet.

RESPIRATORY HAZARD ASSESSMENT (Continued)

DEFINITIONS AND ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ESLI	End of service life indicator
FID	Flame ionization detector
IDLH	Immediately dangerous to life and health
NIOSH	National Institute for Occupational Safety and Health
N100/99/95	Non-oil-proof particulate filter
OSHA	Occupational Safety and Health Administration
P100/99/95	Oil-proof particulate filter
PEL	Permissible exposure limit
PID	Photoionization detector
PPE	Personal protective equipment
R100/99/95	Oil-resistant particulate filter
SCBA	Self-contained breathing apparatus
TLV	Threshold limit value

Note: This form must be reviewed by the operating unit health and safety manager (or designee) only and must be attached to the site-specific health and safety plan, construction health and safety plan, or other site-specific health and safety documentation, once completed. A copy must also be placed in the project files.

ATTACHMENT

MATERIAL SAFETY DATA SHEETS

- Hydrochloric Acid
- Nitric Acid
- Sodium Hydroxide
- Alconox

Material Safety Data Sheet
(MSDS-HCL)

PRODUCT IDENTIFICATION

Product Name	Hydrochloric Acid Solution 20 Deg. Be – 31.5% 22 Deg. Be – 35.2%
Trade Names and Synonyms	Hydrogen Chloride (Aqueous) Muriatic Acid
Manufacturer/Distributor	Trans Chem, Inc. 1415 Mengel Road Baton Rouge, Louisiana 70807 (504) 355-9977 Various others
Transportation Emergency	**800-255-3924 (24 hrs -- *CHEM • TEL*)**

HAZARDOUS COMPONENTS

Material or Component	**CAS No.**	**TLV**	**PEL**
Hydrochloric Acid	7647-01-0	7mg/m^3	5PPM

N/A = Not assigned NE = Not established

PHYSICAL DATA

Boiling Point	127° F
Vapor Pressure	24mm Hg – 20 Deg. Be 100mm Hg – 22 Deg. Be
Solubility in Water	Complete
Specific Gravity	1.16 @ 15.5° C 20 Deg. Be 1.1789 @ 15.5° C 22 Deg. Be
Melting Point	N/A
Vapor Density	Similar to Water
Evaporation Rate	Not Applicable
Appearance and Odor	Clear Colorless to Yellowish Fuming Liquid, Pungent and Irritating

HAZARDOUS REACTIVITY

Stable under ordinary conditions of use and storage. Does not polymerize. Incompatible with aluminum and aluminum alloys, carbon steel, copper and copper alloys, and nylon. Hydrogen gas will be formed if acid contacts metal.

FIRE AND EXPLOSION DATA

Flashpoint	Not Flammable
Extinguishing Media	Use any means suitable for extinguishing surrounding fire.
Decomposition Products	Contact with most metals may produce Hydrogen gas to potentially explosive limits.
Unusnal Explosion	Containers may explode when heated. Consult the 2000 Emergency Response Guidebook, Guide 157 for further details.

HEALTH HAZARDS / FIRST AID

Inhalation	Inhalation causes severe irritation of upper respiratory tract. FA: Remove person to to fresh air. If not breathing, give artificial respiration. Call physician.
Ingestion	CORROSIVE ! Ingestion of Hydrochloric Acid can cause burns of the mouth, throat, esophagus and gastrointestinal tract. FA: DO NOT INDUCE VOMITING. Give large quantities of water or milk of magnesia. Never give anything by mouth to an unconscious person. Get immediate medical attention.
Skin Contact	CORROSIVE ! Can cause redness, pain and skin burns. Can cause some tissue destruction. FA: Immediately flush with water.
Eye Contact	CORROSIVE ! FA: Continuously flush eyes with large amounts of water for at least 20 minutes. If irritation continues, seek medical attention.

SPILL OR LEAK PROCEDURES

Spill/leak	In the event of a spill or leak, keep upwind. Ventilate enclosed areas until spill or leak is contained, neutralized and prepared for removal.
Waste disposal	Disposal of waste material or residue may be subject to federal, state, or local regulation. Before transporting waste material see 49 CFR 172.

SPECIAL PROTECTION INFORMATION

Ventilation	Use only in areas with adequate ventilation.
Eye Protection	Use chemical safety goggles, plus a safety shield is recommended. Contact lenses should not be worn when working with this material.
Skin Protection	Wear impervious protective clothing; i.e., Boots, Gloves, Lab Coat, Apron or Coveralls to prevent skin contact.
Other	If working in an area of potential exposure, use an NIOSH approved respirator when material is fuming and exceeds the TLV.

STORAGE CONDITIONS

Store and handle only in containers suitably lined with or constructed of materials specified, by the manufacturer, for the product. Protect against physical damage. Keep separated from incompatible materials.

REGULATORY INFORMATION

Proper shipping name	Hydrochloric acid
Hazard class	8
UN Number	UN1789
DOT Label & Placard	Corrosive
NFPA / HMIS Ratings	Health – 3; Flammability – 0; Reactivity – 0
SARA Title III	Reporting Sections 302, 311 & 313

The information contained in this Material Safety Data Sheet is based upon available data and believed to be correct; however, as such has been obtained from various sources, including the manufacturer and independent laboratories, it is given without warranty or representation that it is complete, accurate, and can be relied upon. *OWEN COMPLIANCE SERVICES, INC.* has not attempted to conceal in any manner the deleterious aspects of the product listed herein, but makes no warranty as to such. Further, *OWEN COMPLIANCE SERVICES, INC.* cannot anticipate nor control the many situations in which the product or this information may be used; there is no guarantee that the health and safety precautions suggested will be proper under all conditions. It is the sole responsibility of each user of the product to determine and comply with the requirements of all applicable laws and regulations regarding its use. This information is given solely for the purposes of safety to persons and property. Any other use of this information is expressly prohibited.

For further information contact:	David W. Boston, President ***OWEN COMPLIANCE SERVICES, INC.*** 8805 Forum Way P.O. Box 40150 Fort Worth, TX 76140	
	Telephone number:	817-551-0660
	FAX number:	817-551-1032
MSDS prepared by:	Allen M. Sweeney	
	Original publication date:	8/5/1999
	Revision date	11/2/00

MSDS Number: **N3660** * * * * * *Effective Date:* ***11/07/08*** * * * * * *Supercedes:* ***02/15/08***

MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

NITRIC ACID, 50-70%

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%
CAS No.: 7697-37-2
Molecular Weight: 63.01
Chemical Formula: HNO_3
Product Codes:
J.T. Baker: 5371, 5796, 5801, 5826, 5856, 5876, 5896, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9608, 9610, 9616, 9617, 9670, 9761
Mallinckrodt: 1409, 2704, 2705, 2706, 2707, 2716, 6623, H862, H988, H993, H998, V077, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Water spray may be used to keep fire exposed containers cool. Do not get water inside container.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.

Odor:
Suffocating, acrid.

Solubility:
Infinitely soluble.
Specific Gravity:
1.41
pH:
1.0 (0.1M solution)
% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
122C (252F)
Melting Point:
-42C (-44F)
Vapor Density (Air=1):
2-3
Vapor Pressure (mm Hg):
48 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Light and heat.

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11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

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--------\Cancer Lists\------------------------------------------------------
                                              ---NTP Carcinogen---
Ingredient                                    Known    Anticipated    IARC Category
------------------------------------          -----    -----------    -------------
Nitric Acid (7697-37-2)                        No         No             None
Water (7732-18-5)                              No         No             None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                       TSCA  EC   Japan  Australia
-----------------------------------------------  ----  ---  -----  ---------
Nitric Acid (7697-37-2)                           Yes  Yes   Yes      Yes
```

Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------------------------------

Ingredient	Korea	--Canada-- DSL	 NDSL	Phil.
Nitric Acid (7697-37-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	 TPQ	------SARA 313------ List	 Chemical Catg.
Nitric Acid (7697-37-2)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.

Remove and wash contaminated clothing promptly.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 14.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **S4037** * * * * * *Effective Date: **08/02/01*** * * * * * *Supercedes: **08/20/98***

SODIUM HYDROXIDE SOLUTIONS (MORE THAN 10% NaOH)

1. Product Identification

Synonyms: Caustic soda solution; lye solution; sodium hydroxide liquid; sodium hydrate solution,Sodium Hydroxide Concentrate Solution StandARd®, Sodium Hydroxide, DILUT-IT® Analytical Concentrates, sodium hydroxide volumetric solutions
CAS No.: 1310-73-2
Molecular Weight: 40.00
Chemical Formula: NaOH in water
Product Codes:
J.T. Baker: 0337, 0338, 0339, 3719, 3725, 3727, 3729, 4689, 4690, 5000, 5661, 5666, 5668, 5669, 5671, 5672, 5674, 5676
Mallinckrodt: 6290, 7701, 7702, 7703, 7705, 7706, 7775, H369, H382, H385, V038, V679

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Hydroxide	1310-73-2	10 - 60%	Yes
Water	7732-18-5	40 - 90%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES BURNS TO ANY AREA OF CONTACT. REACTS WITH WATER, ACIDS AND OTHER MATERIALS.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

Inhalation:
Severe irritant. Effects from inhalation of mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may occur.
Ingestion:
Corrosive! Swallowing may cause severe burns of mouth, throat, and stomach. Severe scarring of tissue and death may result. Symptoms may include bleeding, vomiting, diarrhea, fall in blood pressure. Damage may appears days after exposure.
Skin Contact:
Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.
Eye Contact:
Corrosive! Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Chronic Exposure:
Prolonged contact with dilute solutions or dust has a destructive effect upon tissue.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician, immediately. Wash clothing before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Perform endoscopy in all cases of suspected sodium hydroxide ingestion. In cases of severe esophageal corrosion, the use of therapeutic doses of steroids should be considered. General supportive measures with continual monitoring of gas exchange, acid-base balance, electrolytes, and fluid intake are also required.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Hot or molten material can react violently with water.
Can react with certain metals, such as aluminum, to generate flammable hydrogen gas.
Explosion:
May cause fire and explosions when in contact with incompatible materials.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Adding water to caustic solution generates large amounts of heat.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Contain and recover liquid when possible. Do not flush caustic residues to the sewer. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulfuric. Absorb neutralized caustic residue on clay, vermiculite or other inert substance and package in a suitable container for disposal.
US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRACIT®-2 or BuCAIM® caustic neutralizers are recommended for spills of this product.

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Store above 16C (60F) to prevent freezing. Always add the caustic to water while stirring; never the reverse. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Do not store with aluminum or magnesium. Do not mix with acids or organic materials.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
2 mg/m3 Ceiling
- ACGIH Threshold Limit Value (TLV):
2 mg/m3 Ceiling
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect

workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Physical data is displayed for 10%, 30% and 50% aqueous sodium hydroxide solutions. (Merck Index).
Appearance:
Clear, colorless solution.
Odor:
Odorless.
Solubility:
Completely miscible with water.
Density:
10% solution - 1.11; 30% solution - 1.33; 50% solution - 1.53
pH:
14.0 (10%, 30% and 50% solutions)
% Volatiles by volume @ 21C (70F):
No information found.
Boiling Point:
For 10% solution = 105C (221F); for 30% solution = 115C (239F); for 50% solution = 140C (284F).
Melting Point:
For 10% solution = -10C (14 F); for 30% solution = 1C (34F); for 50% solution = 12C (53.6F).
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
13 @ 60C (140F) (50% solution)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Sodium oxide. Decomposition by reaction with certain metals releases flammable and explosive hydrogen gas.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Sodium hydroxide in contact with acids and organic halogen compounds, especially trichloroethylene, may causes violent reactions. Contact with nitromethane and other similar nitro compounds causes formation of shock-sensitive salts. Contact with metals such as aluminum, magnesium, tin, and zinc cause formation of flammable hydrogen gas. Sodium hydroxide, even in fairly dilute solution, reacts readily with various sugars to produce carbon monoxide. Precautions should be taken including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.
Conditions to Avoid:
Heat, moisture, incompatibles.

---

11. Toxicological Information

Sodium hydroxide: irritation data: skin, rabbit: 500 mg/24H severe; eye rabbit: 50 ug/24H severe. Investigated as a mutagen.

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--------\Cancer Lists\------------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC Category
------------------------------------    -----    -----------    -------------
Sodium Hydroxide (1310-73-2)             No          No             None
Water (7732-18-5)                        No          No             None
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12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SODIUM HYDROXIDE SOLUTION
Hazard Class: 8
UN/NA: UN1824
Packing Group: II
Information reported for product/size: 360LB

International (Water, I.M.O.)

Proper Shipping Name: SODIUM HYDROXIDE, SOLUTION
Hazard Class: 8
UN/NA: UN1824
Packing Group: II
Information reported for product/size: 360LB

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15. Regulatory Information

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  --------\Chemical Inventory Status - Part 1\---------------------------------
  Ingredient                                       TSCA  EC   Japan  Australia
  -----------------------------------------------  ----  ---  -----  ---------
  Sodium Hydroxide (1310-73-2)                      Yes  Yes   Yes      Yes
  Water (7732-18-5)                                 Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
                                                            --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Sodium Hydroxide (1310-73-2)                      Yes   Yes   No     Yes
  Water (7732-18-5)                                 Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\----------------
                                           -SARA 302-    ------SARA 313------
  Ingredient                               RQ    TPQ     List  Chemical Catg.
  -----------------------------------------  ---   -----   ----  --------------
  Sodium Hydroxide (1310-73-2)             No    No      No         No
  Water (7732-18-5)                        No    No      No         No

  --------\Federal, State & International Regulations - Part 2\----------------
                                                      -RCRA-    -TSCA-
  Ingredient                               CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Sodium Hydroxide (1310-73-2)             1000       No         No
  Water (7732-18-5)                        No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: Yes         (Mixture / Liquid)
```

Australian Hazchem Code: 2R
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **1**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES BURNS TO ANY AREA OF

CONTACT. REACTS WITH WATER, ACIDS AND OTHER MATERIALS.

Label Precautions:

Do not get in eyes, on skin, or on clothing.
Do not breathe mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.

Label First Aid:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **A2052** * * * * * *Effective Date:* ***05/14/03*** * * * * * *Supercedes:* ***02/18/03***

ALCONOX®

1. Product Identification

Synonyms: Proprietary blend of sodium linear alkylaryl sulfonate, alcohol sulfate, phosphates, and carbonates.
CAS No.: Not applicable.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: A461

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Alconox® proprietary detergent mixture	N/A	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{\textbf{(tm)}}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
May cause irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.

Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. When mixed with water, material foams profusely. Small amounts of residue may be flushed to sewer with plenty of water.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moisture may cause material to cake. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White powder interspersed with cream colored flakes.
Odor:
No information found.
Solubility:
Moderate (1-10%)
Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

```
  --------\Cancer Lists\------------------------------------------------------
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC Category
  ------------------------------------   -----    -----------    -------------
  Alconox®                                No          No            None
  proprietary detergent mixture
```

12. Ecological Information

Environmental Fate:
This product is biodegradable.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\---------------------------------
  Ingredient                                       TSCA  EC   Japan  Australia
  -----------------------------------------------  ----  ---  -----  ---------
  Alconox®                                          Yes  No    No       No
  proprietary detergent mixture

  --------\Chemical Inventory Status - Part 2\---------------------------------
                                                        --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Alconox®                                          No    No    Yes    No
  proprietary detergent mixture

  --------\Federal, State & International Regulations - Part 1\----------------
                                           -SARA 302-    ------SARA 313------
  Ingredient                               RQ    TPQ     List  Chemical Catg.
  -----------------------------------------  ---   -----   ----  --------------
  Alconox®                                 No    No      No         No
  proprietary detergent mixture

  --------\Federal, State & International Regulations - Part 2\----------------
                                                      -RCRA-    -TSCA-
  Ingredient                               CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Alconox®                                 No         No         No
  proprietary detergent mixture
```

```
Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes.
Keep container closed.
Use with adequate ventilation.
Avoid breathing dust.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:

Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:
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