FINAL
DESIGN, OPERATIONS AND MONITORING PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Contract No. DACW41-02-D-0004
Delivery Order 0003

August 2006

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Prepared for

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Kansas City District
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LIST OF ACRONYMS AND ABBREVIATIONS

ABC™	Anaerobic BioChem
APP	Accident Prevention Plan
BA	bioaugmentation
BART™	Biological Reactivity Reaction Test
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cis-1,2,-DCE	*cis*-1,2,-dichloroethene
CO_2	carbon dioxide
DHC	Dehalococcoides ethenogenes
DO	dissolved oxygen
DoD	Department of Defense
DOMP	Design, Operations. and Monitoring Plan
DPT	Direct-push technology
ECD	electron capture detector
ERD	Enhanced Reductive Dechlorination
EPS	Environmental Priority Services
FSP	Field Sampling Plan
FUDS	Formerly Utilized Defense Site
HGL	HydroGeoLogic Inc.
IDW	investigation derived waste
ISCO	In-Situ Chemical Oxidation
KSU	Kansas State University
MIP	membrane interface probe
ORP	oxidation reduction potential
OU1	Operable Unit 1
PS	Priority Services
psi	pounds per square inch
PSTS	Pilot Scale Treatability Study
PWS	Performance Work Statement

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
QMP	commercial supplier
qPCR	quantitative polymerase chain reaction
redox	oxidation-reduction
RI/FS	remedial investigation/feasibility study
ROI	radius of influence
SAA	Salina Airport Authority
SAP	Sampling and Analysis Plan
AFB	Air Force Base
TCE	trichloroethene
TO	task order
TOC	total organic carbon
TOD	total oxidant demand
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds
ZVI	zero-valent iron

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1.0 INTRODUCTION

This Design, Operations and Monitoring Plan (DOMP) has been prepared by HydroGeoLogic, Inc. (HGL) for the U.S. Army Corps of Engineers (USACE), Kansas City District under Contract Number DACW41-02-D-0004, Delivery Order (DO) number 0003. The period of performance for this task order is from March 3, 2006, to June 29, 2007. This document describes the design, field operations and monitoring activities for the Pilot Scale Treatability Study (PSTS) to be conducted at the former Schilling Air Force Base (AFB) in Salina, Kansas (Figure 1.1). The Field Sampling Plan (FSP) included as Appendix A and Quality Assurance Project Plan (QAPP) included as Appendix B constitute the Sampling and Analysis Plan (SAP). The DOMP and SAP comprise the Work Plan for the PSTS as specified in the Performance Work Statement (PWS). The Accident Prevention Plan (APP) included as Appendix C addresses potential hazards and safety issues associated with the planned field activities, and the personal protective equipment and monitoring that will be employed during the field activities to protect site workers.

1.1 PROJECT DESCRIPTION

The PWS dated December 23, 2005, describes the purpose, scope and requirements for the PSTS. The PWS consists of providing the equipment, labor and materials to design and implement a PSTS at two former source areas located near Building 837 and near the former Wash Rack area between Buildings 606/626. The purpose of the PSTS is to determine the applicability, effectiveness and cost of two candidate remedial technologies. In-situ enhanced bioremediation, also referred to as Enhanced Reductive Dechlorination (ERD), is the remedial technology selected for the Building 837 source area. In-situ chemical oxidation (ISCO) is the remedial technology to be evaluated for the former Wash Rack source area located near Buildings 606/626 (Figure 1.2).

1.2 REPORT ORGANIZATION AND SUPPORTING DOCUMENTS

This DOMP is organized by sections as follows:

Section Number	Title	Description
1.0	Introduction	Presents a general description of the project and PSTS for the two study areas.
2.0	Project Organization	Describes the roles and responsibilities of project team members and key personnel.
3.0	Building 837 Study Area	Presents background information and the design, field operations and monitoring associated with the PSTS for this study area.
4.0	Buildings 606/626 Study Area	Presents background information and the design, field operations and monitoring associated with the PSTS for this study area.
5.0	Reporting	Presents the information to be reported and the deliverables for the treatability study.
6.0	Project Schedule	Presents a schedule for completion of the treatability study activities.
7.0	References	Lists the references cited during the preparation of this document.
Appendix	**Title**	**Description**
A	Field Sampling Plan	Provides design details and detailed methods and procedures for the field activities and monitoring system.
B	Quality Assurance Project Plan	Identifies project specific quality requirements for sample collection, laboratory analysis, data validation, and data management.
C	Accident Prevention Plan	Addresses potential hazards and safety issues associated with the planned field activities. The plan describes personal protective equipment and monitoring to be used during the field activities.

This DOMP is supplemented by the following documents prepared by USACE-Kansas City District or HGL:

- **Remedial Investigation Report**, Operable Unit 1 (OU1), USACE-Kansas City District, 2005: The report includes a description of the facility and its history, site geology and hydrogeology, previous investigations, and the nature and extent of contamination (USACE, 2005).
- **Quality Control Plan**, HGL, 2006: The Quality Control Plan (QCP) describes the Quality Control (QC) processes and criteria to be used during field and office activities of the PSTS. The QCP also describes the QC organization and

the roles and responsibilities of the project team and key personnel (HGL, 2006).

1.3 PROJECT OVERVIEW

The former Schilling Air Force Base is being investigated and remediated by USACE – Kansas City District for the U.S. Department of Defense (DoD) under USACE's Formerly Utilized Defense Site (FUDS) program. Site restoration under the FUDS program is based on the remedial investigation/feasibility study (RI/FS) process described in the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The remedial investigation of OU1 for the Former Schilling AFB was completed by USACE-Kansas City District in 2005 (USACE, 2005). The PSTS is being implemented as part of an FS to be completed in 2007. The overall regulatory objective of the RI/FS process is to gather information sufficient to support an informed risk management decision regarding which remedy (or remedies) appears to be most appropriate for the site.

The FS process may include bench or pilot scale treatability studies to better evaluate technology performance. Treatability studies are conducted primarily to satisfy the following FS objectives:

- Provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis and to support the remedial design of the selected alternative.
- Reduce cost and performance uncertainties for the treatment alternatives to acceptable levels so that a remedy can be selected.

1.3.1 Treatability Study Objectives

Preliminary screening of remediation alternatives for the former Schilling AFB sites has identified ERD and ISCO as potential technologies for remediation of source areas. The specific objectives of the ERD treatability study include:

- Evaluate the effectiveness of ERD in treating the dissolved phase chlorinated solvent contamination at the Building 837 source area.
- Obtain site specific performance data to assess the effectiveness of the selected substrate and method of injection.
- Develop preliminary parameters (i.e., substrate loading) and costs for detailed evaluation of this technology and design of full-scale implementation.

Similarly, the specific objectives of the ISCO treatability study include:

- Evaluate the effectiveness of ISCO in treating the chlorinated solvents detected in the vadose zone and groundwater at the Building 606/626 source area.
- Obtain site specific performance data to assess the effectiveness of the selected oxidant and method of injection.

- Develop preliminary parameters (i.e., oxidant loading) and costs for detailed evaluation of this technology and design of full-scale implementation.

1.3.2 Project Set-Up

The PSTS will be performed at two distinct locations at the former Schilling AFB in Salina, Kansas: the Building 837 study area and the Former Wash Racks (Building 606/626) study area. A numbering system has been used throughout this document to identify soil sample locations, monitoring well locations and injection point locations at each of the study areas. The numbering system includes a parent number followed by an activity number. The parent number for the Building 837 study area is TS837. The activity numbers for the Building 837 study area include monitoring wells (for example, MW-01, MW-02, and so on) and injection points (B01 to B06 for BA; S07 to S09 for substrate only; and Z10 to Z15 for ZVI). Monitoring wells are identified as type A (shallow wells) or type B wells (deeps wells). The parent number for the Former Wash Racks (Building 606/626) study area is TS626. The activity numbers for this study area include monitoring wells (MW), injection points (IP), and confirmation soil samples (CS). For ease of reading in the remainder of the document, the parent number is not used when describing the samples to be collected at each study area.

The following ancillary activities will be performed before field activities are conducted, and after all field work has been accomplished:

Regulatory Permits: Underground Injection Control Regulations are governed by Kansas Administrative Regulation 28-46. When temporary injection points are used for projects, KDHE has not required injection permits. However, documentation of the proposed injection details along with concurrence from the KDHE Project Manager will be required for submittal to the KDHE Bureau of Water for formal approval.

Property Owner Coordination: All field work and access agreements will be coordinated with the property owner though the USACE-Kansas City District Project Manager, Ms. Robyn Kiefer or her designeé. The property owner for the Building 837 study area is Kansas State University (KSU). The property owner for the Former Wash Racks (Building 606/626) study area is the Salina Airport Authority (SAA). SAA leases Buildings 606 and 626 to Raytheon. HGL will request a contact name for Raytheon to facilitate access to the site and arrange for alternate employee parking and access to Building 626 during the field activities.

Utility Clearance: Utility clearance will be obtained before any intrusive field work is conducted. Field personnel are cautioned that existing utilities in the Building 837 study area include a buried water main and underground piping and sprinkler heads associated with an existing landscape irrigation system. Other nearby utilities may include underground electrical service that connects with the pedestrian lighting system located along the existing sidewalks and buildings. Utility clearance will be performed following preliminary layout of the proposed monitoring wells and injection points. KSU personnel have indicated that their maintenance staff will field locate the underground piping and sprinkler heads associated with the landscape irrigation system. At the Former Wash Racks (Building 606/626) study area, known existing

buried utilities in the study area include a water main, gas line, and storm drains. Overhead utilities include telephone and power. Additionally, SAA and Raytheon personnel may have knowledge of existing utilities in the study area.

Site Restoration and Closure: Site restoration and closure activities will be performed at the conclusion of the final performance sampling event. These activities will include:

- Removal/abandonment of all temporary monitoring wells. Refer to the FSP (Appendix A) for details.
- Removal of any materials and supplies in temporary staging areas.
- Removal of any temporary fencing.
- Restoration of any areas of land disturbance including leveling with topsoil and reseeding.

Upon completion of the site restoration and closure activities, HGL will request a final acceptance inspection by USACE – Kansas City and KSU and SAA as appropriate.

1.3.3 Health and Safety

Health and safety is an integral part of the PSTS. A detailed APP has been prepared to guide field personnel in safe execution of the field activities at the site. A hazard analysis was conducted for each feature of work, and the APP designed to ensure that safe work practices, including the use of hazard avoidance techniques and personal protective equipment are employed during all field activities. The APP is included as Appendix C.

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Filename: X:/KAN004/TO_103/DOMP/MAPS Site_Location_Map.cdr
Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/09/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

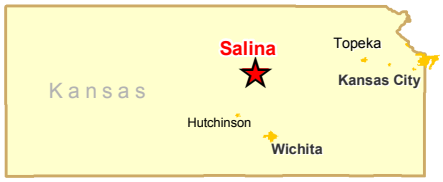

Figure 1.1
Site Location Map
Former Schilling AFB

Filename: X:/KAN004/TO_103/DOMP/MAPS
Site_Location_Map.cdr
Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/23/06 CV
Source: ESRI StreetMap USA

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Legend

Study Area

Figure 1.2
Location Map of Buildings 837 and 626/606 Study Areas

2.0 PROJECT ORGANIZATION AND KEY PERSONNEL

The key organizations and their functional roles and responsibilities for this project are highlighted below in Table 2.1. Please refer to the QCP for a description of the QC organization and key personnel.

Key personnel for USACE-Kansas City District and HGL, and their roles and responsibilities are summarized in Table 2.2.

Table 2.1
Organizational Roles and Responsibilities

Name of Organization	Area of Responsibility	Specific Responsibilities
USACE – Kansas City District	Lead Agency for Cleanup of Former Schilling AFB.	• Overall management of the PSTS. • Coordination with property owners and other stakeholders. • Quality assurance surveillance of the field and analytical activities. • Review and approval of project deliverables.
HGL	Prime contractor for design and implementation of the PSTS.	• Overall planning and execution of the PSTS. • Management of team subcontractors. • Quality control of field and analytical activities, and project deliverables. • Enforcement of health and safety requirements for the project. • Contract compliance with project milestones and deliverables.
Redox Tech	Team subcontractor for chemical injection.	• Execution of injection activities. • Supplier of substrate, oxidant and related amendments. • Total Oxidant Demand testing
Environmental Priority Services (EPS)	Team subcontractor for temporary monitoring well installation.	• Installation and development of temporary wells for monitoring system. • Drilling and sampling of soils for pre-injection sampling and testing.
Microbial Insights	Team subcontractor for microbial analysis.	• Microbial analysis of samples from baseline and performance monitoring.
Severn Trent Laboratories	Analytical services for monitoring program.	• Analytical services during baseline and performance monitoring, and IDW testing.
Waste Express	Investigation-derived Waste (IDW) Disposal	• IDW disposal following waste characterization.
Kansas Department of Health and Environment (KDHE)	Lead agency for the State of Kansas	• Review of work plans and project related documents. • Environmental permits.
Kansas State University (KSU)	Property owner	• Property owner for Building 837 study area.
Salina Airport Authority (SAA)	Property owner	• Property owner for Building 606/626 study area.

Table 2.2
Key Personnel

Name	Title	Telephone No.	Area(s) of Responsibility
USACE – Kansas City District			
Robyn Kiefer	Project Manager	816-389-3615	• Overall project management. • Coordination with stakeholders. • Primary point of contact with HGL.
Frank Bales	Environmental Engineer	816-389-3591	• Technical lead for USACE.
Justin Cofer	Contract Specialist	816-389-3805	• Contracting Officer.
HGL			
Don Jones, P.E.	Program Manager	916-614-8770	• Program management and senior technical review.
Robert Overfelt, P.G.	Contractor Quality Control Manager	913-317-8860	• QC of field activities • Review and approval of project deliverables.
Miquette Rochford, P.G.	Project Manager	970-243-3893	• Project management.
Chris Williams, PG	Site Supervisor	913-317-8860	• Supervision of field activities.
Alan Rittgers, P.G.	Project Hydrogeologist	913-317-8860	• Oversight of field work; interpretation of results.
Wayne Smith, P.E.	Engineering Supervisor	913-317-8860	• Supervision of engineering activities.
Charles Smith, CHMM	Quality Control Inspector/Chemist	913-317-8860	• QC review • Analytical review
Mary Ann Heaney	Health and Safety (H&S) Officer	303-665-8528	• Review and approval of APP • H&S audits of field activities.

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3.0 BUILDING 837 STUDY AREA

This section describes the PSTS activities to be performed at the Building 837 study area.

3.1 SITE BACKGROUND INFORMATION

3.1.1 LOCATION

The Building 837 study area is located within the west-central portion of the KSU-Salina Campus. The study area is bounded on the north by Crompton Road, on the west by Hein Avenue, on the south by KSU's Technology Center (which includes Building 837), and on the east by a grassy area and sidewalk that runs north-south between the Technology Center and the Tullis Building (Building 849) located immediately south of Crompton Road.

3.1.2 SITE AND SUBSURFACE CONDITIONS

The Building 837 study area lies within a large, open grassy landscape area between the existing Technology Center Buildings and Crompton Road. The topography of this area is relatively flat to gently sloping. The landscape area is mowed regularly by the KSU maintenance staff during spring through fall. Existing utilities in the area include an underground water line, landscape irrigation system and buried electrical lines for the lighting system along the existing sidewalks in the area.

The Building 837 study area has been defined by previous site characterization activities and consists of an elongated area measuring approximately 190 feet long by 15 to 30 feet wide (Figure 3.1). Previous investigative activities within the study area include in-situ contaminant screening for organic compounds using a membrane interface probe (MIP)/electron capture detector (ECD). Over 30 locations were screened within the general area. High to moderate contaminant levels were detected at 5 MIP screening locations which define the study area (MIP ID Nos. K-C12, K-E10, K-E8, K-E6, and K-G5). The depth of contamination generally ranged between 10 and 35 feet below ground surface (bgs). One monitoring well (99M24) exists in the study area and was installed as part of previous characterization activities for groundwater sampling. A generalized geologic cross section of the study area with the target treatment zone is shown in Figure 3.1.

The subsurface profile includes shallow fills and topsoil overlying alluvial deposits extending to bedrock. The upper alluvium is predominantly fine grained soils consisting of sandy, silty clays extending to approximately 25 to 30 feet bgs. The fine grained soils transition to the deeper alluvium consisting of interbedded silts, sands and clays. Although no borings have been extended to bedrock in this area, the previous MIP/ECD data indicated that bedrock (shale) is present at depths of 60 to 80 feet bgs. The depth to groundwater in this area varies from approximately 8 to 10 feet bgs. Groundwater flow is generally to the north-northeast.

TCE and several of its breakdown products have been detected in monitoring well 99M24 during previous sampling events. The previous contaminant concentrations at this well location are summarized below:

- TCE concentrations ranged from5,303 micrograms per liter (μg/L) to 79,000 μg/L.
- *Cis*-1,2,-DCE concentrations ranged from 87.1 μg/L to 13,000 μg/L.
- Vinyl chloride concentrations ranged from non-detect to 14 μg/L.

3.2 TECHNOLOGY DESCRIPTION

The remedial technology selected for the PSTS at the Building 837 study area is In-Situ Enhanced Bioremediation. Bioremediation is a general term used to describe the destruction of contaminants in soil and groundwater by biological mechanisms, including indigenous microorganisms such as bacteria. In-situ bioremediation involves treating the contaminated media within its natural setting or environment. The term "enhanced" refers to measures taken to improve the effectiveness of the biological mechanisms in the natural environment. These measures can include the addition of nutrients or exogenous (non-native) microorganisms to the subsurface environment to accelerate the biodegradation process.

Bioremediation can take place under aerobic or anaerobic conditions. For the Building 837 study area, the PSTS will focus on anaerobic bioremediation of the contaminated aquifer utilizing microorganisms that do not require oxygen for growth (anaerobic conditions). Only one species of bacteria, *Dehalococcoides ethenogenes* (DHC), has been identified that is capable of complete degradation of TCE under anaerobic conditions. The specific In-situ Bioremediation technology for anaerobic degradation of TCE utilizing DHC is referred to as Enhanced Reductive Dechlorination (ERD).

Reductive dechlorination of TCE is sensitive to oxidation-reduction (redox) reactions involving electron transfer between the organic and inorganic chemical constituents found in an aquifer. Reductive dechlorination involves a series of sequential reactions where chlorine atoms are removed from a chlorinated organic compound (such as TCE) by adding electrons and hydrogen atoms. Hydrogen is produced by fermentation of organic carbon and serves as the electron donor for the successfully reducing aquifer redox processes. Each sequential breakdown step requires more highly reducing conditions than the previous step. When complete reductive dechlorination occurs, TCE is reduced to *cis*-1,2-DCE; *cis*-1,2-DCE is reduced to vinyl chloride; and vinyl chloride is transformed to ethene/ethane and/or carbon dioxide. Ethene/ethane and carbon dioxide pose little health concerns unlike TCE, *cis*-1,2-DCE, and vinyl chloride.

The basic requirements for dechlorination of TCE include: 1) the presence of a sufficient electron donor (usually derived from a fermentable carbon source) to achieve strongly reducing conditions, and 2) the presence of sufficient DHC to achieve complete dechlorination. The presence of a fermentable carbon source helps to deplete any naturally occurring electron acceptors that may be present in the aquifer, including dissolved oxygen, nitrate, manganese

(IV), iron (III), sulfate, and carbon dioxide. These electron acceptors are consumed in sequentially occurring redox processes known as oxygen reduction, nitrate reduction, manganese reduction, iron reduction, sulfate reduction, and CO2 reduction (methanogenesis). Electron acceptors are consumed in this order because each successive electron acceptor releases less energy than the previous, and the DHC bacteria preferentially use electron acceptors that provide the greatest energy. When the electron donor is sufficient to deplete naturally occurring electron acceptors down to sulfate, DHC that reduces TCE can finally derive enough energy to compete and become active. Due to the low energy available from dechlorination of *cis*-1,2-DCE and vinyl chloride, DHC can generally only carry out this process when sufficient electron donor is present to create methanogenic conditions (carbon dioxide being the electron acceptor).

Upon depletion of dissolved oxygen, an aquifer is considered to be anaerobic and becomes more reducing with the depletion of each successive electron acceptor. As the naturally occurring electron acceptors are depleted over time, a healthy and thriving population of DHC serves to discharge electrons to TCE and its breakdown products. However, all of the conditions required for efficient and complete dechlorination of TCE are not present at every site. In these situations, strategic use of enhancements can create more favorable aquifer conditions that support the dechlorination process. Common enhancements include: 1) injection of a fermentable carbon source (hereafter referred to as "substrate") to serve as an abundant electron donor source, 2) bioaugmentation (BA) to increase the DHC population, and/or 3) a combination of enhancements.

There are several types of electron donors including soluble and insoluble carbohydrates. Soluble electron donors include lactate and molasses. Both have been widely used as quick release electron donors for injection in groundwater. These donors are completely soluble in water and are injected into the aquifer in a dilute solution to minimize any potential impacts on aquifer conductivity. Once injected, the soluble electron donor will move downgradient at a somewhat slower rate than groundwater because of donor consumption by the bacteria associated with the redox processes. One of the advantages of an injected soluble electron donor is a larger downgradient treatment zone than can be achieved using an insoluble donor alone.

Insoluble electron donors include various types of vegetable oils, cheese whey, and compost. Each has been widely used as slow release electron donors. At some sites, injection of non-emulsified oil has resulted in resulted in plugging of the aquifer at the point of injection and poor radial distribution. To overcome this problem, insoluble electron donors are typically injected as oil emulsifications with a small oil droplet size. Ultimately, there are many factors to be considered in selection of an electron donor including its effectiveness, longevity, material and application costs, and aesthetic considerations.

BA involves the addition of a DHC containing microbial culture to site groundwater. While BA is not difficult to implement, its success is dependent on material handling considerations and aquifer conditions before and after injection. Reducing conditions must be present for BA to

be effective; otherwise a high mortality rate is likely. The DHC must flourish for ERD to be effective.

Other recent technologies for in-situ treatment of TCE in groundwater include permeable reactive barriers containing granular zero-valent iron (ZVI). In this application, ZVI has been shown to be an effective reducing agent. More recently, ERD sites have used substrates amended with ZVI to achieve strong reducing conditions and accelerate the dechlorination process.

The reader is cautioned that although ERD is a promising technology for in-situ treatment of chlorinated solvents in groundwater, there are many factors which can impact its effectiveness. Site specific conditions, aquifer properties, the type of electron donor used, and the population density of DHC can influence the effectiveness and time required for ERD.

3.3 DESIGN AND OPERATION

This section of the DOMP provides the design, operation details and rationale for the PSTS at the Building 837 study area. This section includes cross references to the FSP where detailed information can be found regarding the proposed field activities described in the DOMP.

3.3.1 TECHNICAL APPROACH

The technical approach for the PSTS is summarized below:

- Reductive dechlorination appears to be occurring at the site to a limited degree as indicated by the presence of TCE, *cis*-1,2-DCE, and vinyl chloride in groundwater. The reductive dechlorination process may be limited by a lack of sufficient electron donor to achieve the strongly reducing conditions necessary for dechlorination, and/or the existing population of DHC may be also be limited.
- The PSTS will address the potential need for sufficient electron donor to achieve reducing conditions by injecting a commercially available substrate into the study area. The target treatment zone, based on the previous MIP/ECD data, will focus on the saturated alluvial deposits extending from the groundwater table (approximately 10 feet bgs) to a depth of 35 feet bgs.
- The potential need to increase the DHC population will be addressed through microbial analysis of the aquifer prior to injection of the substrate. If the DHC population is absent or sparse, then BA will be included in portions of the study area using a commercially available enriched dechlorinating culture, such as RTB-1.
- The PSTS will also include enhancement of the substrate with ZVI to assess its effectiveness in accelerating the ERD process. Portions of the study area will be injected with substrate amended with ZVI, a long-term energy source for the microorganisms. Use of this amendment is expected to provide data on the effectiveness of ZVI in quickly producing a reductive environment.

- The design of the PSTS will include a monitoring system to document changes in redox conditions and contaminant concentrations in response to the substrate, ZVI and BA. The monitoring system will also be used to assess the potential for biofouling and the effectiveness of the injection technique in distributing the substrate horizontally and vertically across the treatment zone. The time period for monitoring will be approximately 6 months.
- Groundwater elevation data will be collected during each sampling event to detect changes in flow direction.

The general sequence of activities at the Building 837 study area (following approval of the work plans) is summarized below:

- Coordination with USACE-Kansas City District and KSU in advance of field work, including providing injection details to KDHE as described in Section 1.3.2.
- Preliminary field layout of monitoring wells and injection points for utility clearance.
- Utility clearance and adjustment of monitoring well and injection point locations as needed.
- Installation of monitoring well network including collection of samples for microbial analysis and total oxidant demand testing.
- Baseline groundwater sampling.
- Review of microbial analysis with USACE-Kansas City to finalize BA details.
- Mobilization and completion of injection activities.
- Performance monitoring at approximately 1 month, 3 months, and 6 months after injection.
- Site restoration and site closure.

Additional information on specific aspects of the PSTS is provided in the following sections.

3.3.2 SUBSTRATE

The substrate selected for the Building 837 study area is Anaerobic BioChem (ABC™) developed by Redox Tech. This substrate has been pilot tested or fully implemented at numerous DoD sites with favorable results for dechlorination of TCE and its breakdown products. The ABC™ substrate is a mixture of fatty acids, lactates and a phosphate buffer. It has been designed to promote anaerobic biodegradation of chlorinated solvents using slow and long-term releasing compounds. The ABC™ will provide an immediate and long term carbon source to promote dechlorination. Previous studies have shown that ABC™ continues to be an active electron donor up to 1 year after injection.

ABC™ is completely soluble in water and will be injected at the site as a dilute solution. The design ABC™ formula loading rate is 550 pounds for every 8,000 cubic feet of aquifer to be treated. The design formula loading rate is based on the estimated hydrogen demand associated with the organic and inorganic compounds present in both the soil and groundwater.

The estimated hydrogen demand is based on an aquifer porosity of 30 percent and conservative ("worst case") assumptions for geochemical parameters (i.e., an aerobic environment with high dissolved oxygen concentrations, nitrate, sulfate, manganese, etc.). From experience at other sites, a safety factor of 10 has been applied to the estimated hydrogen demand to account for potential significant off-gassing of hydrogen that does not get consumed (i.e., loss). The high safety factor ensures that adequate hydrogen is produced to drive the geochemical conditions to an anaerobic state, therefore promoting reductive dechlorination. The proposed ABC™ formula loading rate for this PSTS is consistent with the maximum loading rate used by Redox Tech at other sites.

3.3.3 SUBSTRATE AMENDMENTS

Zero Valent Iron (ZVI): ABC™ has been successfully amended with ZVI to assist in quickly producing a reductive environment. The ZVI will be provided by Redox Tech using a commercial supplier (QMP) in Canada. A typical particle size distribution of the micro-scale ZVI is as follows:

U.S. Sieve Size	% Retained
#40	0
<#40 to #60	trace
<#60 to #100	5.5
<#100 to #200	37.6
<#200	56.9

The ZVI will be packaged in 50 pound steel pails for delivery to the site. The commercially available ZVI includes a thin oxide coating to minimize potential oxidation from exposure to the atmosphere. The coating slowly dissolves when the material is placed in water. The ZVI will be mixed with ABC™ at a 20 percent by weight addition. This same loading rate has been used by Redox Tech at 5 sites in the central and eastern United States within the past 6 months. The ZVI at these sites has proven to be beneficial in quickly achieving a reducing environment and providing chemical dechlorination of the target compounds.

Bioaugmentation: BA for the treatment of chlorinated solvents entails the injection of indigenous or exogenous microorganisms to facilitate complete and rapid dechlorination. In-situ BA is typically combined with the addition of a carbon substrate and microbial nutrients to promote conditions for the proliferation of the dechlorinating microorganisms. Assuming that baseline sampling and microbial analysis at the study area (refer to Section 3.3.8) shows that the indigenous DHC at the site are sparsely populated, the PSTS for the Building 837 study area will include BA using a commercially available microbial consortia from Redox Tech referred to as RTB-1. RTB-1 is an enriched dechlorinating culture that has been shown to be effective in degrading TCE, *cis*-1,2-DCE; and vinyl chloride to innocuous ethene and ethane. The DHC strain in RTB-1 dechlorinates vinyl chloride to ethene by halorespiration and not by less efficient co-metabolic processes.

The design of the PSTS is based on mixing RTB-1 with the ABC™ solution at a rate of 1 liter of RTB-1 per 100 gallons of the ABC™ solution. The mortality of the injected microbial consortia is expected to be high unless reducing conditions are present at the time of injection. The baseline groundwater monitoring results will be reviewed prior to injection to assess redox conditions. Depending on the results, injection of the microbial culture may be delayed until reducing conditions are established after the initial injection of ABC™ substrate. More information concerning details of the RTB-1 injection can be found in the Field Sampling Plan.

Baseline groundwater sampling will include the collection of geochemical parameters (DO, pH, sulfate, etc), contaminants of concern (TCE, cis-DCE), and samples for qPCR analysis (microbial analysis). The qPCR analysis will provide information on the amount of DHC present, as well as their functional genes. DHC are unique bacteria in that they are able to completely mineralize chlorinated solvents under anaerobic conditions. All of the parameters collected during the baseline sampling will be used to determine if BA is necessary, or if adequate colonies are present to promote reductive dechlorination. The microbial communities will be reported in cells per volume of material. Typical values for adequate cell mass are 10^2 – 10^3 cells/volume.

If an adequate microbial community is present then there will be no need to inject further microbes. The growth of microbial communities will be enhanced by injecting ABC solution, which is a food source to promote microbial growth.

However, if qPCR analysis suggests that adequate microbial communities or specific strains of bacteria are not present, then the BA approach will be used. In order for BA to be successful the geochemical parameters must be such as to not inhibit the growth of the microbial communities when emplaced in the subsurface. In particular, the presence of dissolved oxygen above 0.5 mg/L would inhibit the growth of these communities. If DO levels are below 0.5 mg/L, then injection of RTB-1 and ABC will proceed. If DO concentrations are above 0.5 mg/l, then only injection of ABC will occur. This will be the first injection work conducted at the site. It is expected that the remaining injection work proposed at the site will require 2 weeks to complete. At the completion of that work, the DO levels will be re-measured. If the DO concentrations are found to be below 0.5 mg/L, then the injection of RTB-1 will proceed. If the DO concentrations have not decreased to below 0.5 mg/L, then a remobilization event will be required when conditions are favorable. The remobilization event, if necessary, will be a change to the project scope which will require a cost modification.

3.3.4 SYSTEM DESIGN

The effectiveness of ERD will be influenced by the distribution of the substrate in the subsurface environment. The Building 837 study area poses challenges in achieving a uniform distribution given the presence of silts, clays interbedded fine and coarse grained soils within the treatment zone whose hydrogeologic properties (e.g., conductivity) can vary across several orders of magnitude. Based on the observed subsurface conditions and experience at similar sites, the PSTS will feature a one-time injection along two rows of grid points distributed across the width and length of the study area. The resulting design features 15 injection

points, spaced 20 feet on-center (radius of influence [ROI] of 10 feet) distributed spatially across two rows to encompass the total study area. The design locations and spacing of the injection points are illustrated on Figure 3.2.

The design of the injection layout will feature six injection points in the northern portion of the study area where the substrate will be amended with ZVI. Assuming the DHC population density at the site is sparse, BA will be implemented at six injection points in the southern portion of the site. The remaining three injection points in the central area of the study area will feature the ABC™ substrate without ZVI or BA. The collection of monitoring data from these three areas should provide useful information in evaluating ERD and the advantages and disadvantages of the selected enhancements.

The substrate loading rate as described in Section 3.3.2 will result in approximately 11,000 pounds of ABC™ to treat the target area. This equates to approximately 733 pounds of ABC™ per injection point.

3.3.5 SUBSTRATE DELIVERY METHOD

Direct-push methods will be used to deliver the substrate to the treatment zone. This method is commonly used for shallow groundwater applications in unconsolidated formations at depths less than 50 feet. The depth of the treatment zone (10 to 35 feet) and the properties of the alluvium (primarily silts and clays with sands at depth) are consistent with use of direct-push equipment for substrate injection.

The use of direct push equipment for substrate delivery will be based on manual injections using direct-push equipment with batch mixing of the substrate and its amendments. The substrate injection will be performed using a Geoprobe Model 6610DT track mounted rig. Related field equipment will include mixing tanks, various pumps and valves, associated piping and fittings, pressure gauge and ancillary equipment. Details of the mixing process are provided in the FSP (Appendix A).

The substrate will be injected into the treatment zone using drill rods equipped with a proprietary injection point that promotes radial flow of the substrate. The drill rods will be advanced to a depth of 35 feet for the initial injection. The rods will then be retracted in 3 foot increments for injection until reaching the top of the treatment zone (10 feet). Injection flow rates are expected to range from 2 to 10 gallons per minute under injection pressures of 50 to 125 pounds per square inch (psi). The injection pressure will be adjusted in the field based on site observations. The initial injection will begin at the lower range of injection pressures to observe the rate of injection. If the injection rate is very slow, the injection pressure may be increased in small increments to improve its effectiveness. Given the variation in soil types with depth at the site, some variation in injection pressures can be expected with depth. Higher pressures will likely be required where silts and clays are encountered. Reduced injection pressures are expected to be effective where sandy soils are encountered.

Short-circuiting and substrate bypass may be encountered during pressurized injection of the substrate. Particular care will be made during the shallow injections to minimize "day-lighting" where the injection fluids flow upwards along the drill rods and exit at the ground surface. The deeper sand deposits will provide the pathway of least resistance during injection of the substrate. Particular care will be exercised in the field to avoid by-passing injection of the silts and clays in favor of the sand deposits.

Even with special precautions during substrate injection, the heterogeneous nature of the alluvial deposits is expected to result in some variation in substrate distribution within the depth of the treatment zone. Over time, the variation in substrate distribution will decrease as the dissolved organic substrate migrates into the lower permeability soils via diffusion and groundwater transport.

3.3.6 DELIVERY OF SUBSTRATE AMENDED WITH ZERO VALET IRON

Specially designed equipment will be used to mix the substrate and ZVI. Details of the equipment and mixing/injection process are described in the FSP. Approximately 125 to 150 pounds of ZVI will be mixed with the substrate at each injection point. The ZVI will be delivered to the site in 50 pound steel pails.

3.3.7 DELIVERY OF SUBSTRATE AMENDMENTS FOR BIOAUGMENTATION

BA is planned concurrently with substrate injection using RTB-1, a commercially available dechlorinating microbial culture. Various factors including the site biogeochemistry, microbiology and flow conditions play a role in the effectiveness of BA. The PSTS provides for treatment with and without BA to provide data to assess its effectiveness.

RTB-1 will be shipped to the site in 10 liter sealed stainless steel cylinders. The containers are equipped with an inlet and outlet port. Nitrogen gas is connected to the inlet port and is use to force the RTB-1 solution into the injection line to evacuate the cylinder. The cylinder includes a sight glass that allows field personnel to observe how much RTB-1 has been injected. The equipment provides for direct mixing and injection of the RTB concurrent with injection of the ABC without exposing the RTB-1 to the atmosphere. Details of the mixing/injection process are provided in the FSP. Once injected, the fate of the RTB-1 culture will be influenced by the biogeochemistry of the aquifer. Temperature, pH, carbon source, nutrient levels, background bacterial populations, redox conditions, and other factors will influence proliferation of the culture.

3.3.8 PRE-INJECTION SAMPLING AND BENCH-SCALE STUDIES

Microbial Analysis: Field activities associated with substrate injection will be preceded by installation of the monitoring system as described in Section 3.4.2. As part of the planned field activities for the monitoring system, four groundwater samples from two monitoring well clusters (MW-05A/B and MW-10A/B) will be collected and analyzed for quantitative polymerase chain reaction (qPCR) which is a DNA based approach that provides a means to

obtain direct information regarding the dominant biological processes occurring within the subsurface. The four samples will be collected from monitoring wells screened in the upper (MW-05A and MW-10A) and lower (MW-05B and MW-10B) saturated alluvium to assess differences in the microbial population versus aquifer materials across the site. The microbial analysis will be performed by Microbial Insights. Decisions on whether to include BA in the PSTS will be made in consultation with USACE based on the results of the microbial analysis. (Note: For preliminary planning purposes, it is assumed that BA will be included in the PSTS.)

Details of the microbial analysis including sample collection procedures, sample locations, etc. are described in the FSP (Appendix A).

Total Oxidant Demand: Although ISCO is not being considered for the Building 827 study area, the pre-injection sampling and bench-scale studies will include bench scale testing of two samples from MW-07B (one sample of fine-grained soil, one sample of coarse grained soil) to evaluate Total Oxidant Demand (TOD). The samples will be submitted to Redox Tech for the bench scale testing. Details of the TOD testing are described in the FSP.

3.4 MONITORING

This section provides design and operational details of the Building 837 study area monitoring program.

3.4.1 Technical Approach

Monitoring will be performed for several purposes:

- Characterize baseline conditions prior to substrate injection to provide data for comparison with performance monitoring data.
- Assess the effectiveness of the injection method in distributing the substrate within the targeted treatment area (horizontally and vertically).
- Characterize aquifer conditions following injection of the substrate (performance monitoring) to assess the effectiveness of the substrate and its amendments, the need for additional injections during full scale implementation to improve the efficiency of ERD, and the potential for biofouling.

As described in Section 3.2, ERD is a complicated process and there is no single monitoring parameter that by itself can uniquely define aquifer conditions. For this reason, baseline and performance monitoring will focus on a suite of field and analytical parameters that inventory general water quality parameters, important redox species, and VOCs. Additionally, microbial analysis will be important in understanding whether sufficient DHC populations emerge at the site to achieve dechlorination of TCE and its breakdown products. The final round of sampling will include analysis for biofouling using the Biological Reactivity Reaction Test (BART^{TM}). The specific field parameters and analytes selected for the monitoring program are provided in Section 3.4.3.

The monitoring program will include DNA microbial analysis by Microbial Insights. Selected samples collected during baseline monitoring will be analyzed for quantitative polymerase chain reaction (qPCR) which is a DNA-based approach that provides a means to obtain direct information regarding the dominant biological processes occurring within the subsurface. The locations and frequency of microbial analysis is detailed in Section 3.3.8.

In order to assess the potential for biofouling, groundwater samples from the final round of groundwater sampling (refer to Section 3.4.4) will be analyzed using the Biological Activity Reaction Test (BART™). This field screening test is used to identify the presence of different types of bacteria that have the potential to cause biofouling. These bacteria include acid producing, sulfate reducing, iron-related, slime-forming, and heterotropic aerobic types of bacteria. Groundwater samples from three monitoring wells will be analyzed using BART™ field test kits.

Details of sample collection procedures, field equipment, and methods of analysis associated with the ground water monitoring program are provided in the FSP.

3.4.4 BASELINE AND PERFORMANCE MONITORING

Four groundwater sampling events are planned during the PSTS. An initial baseline sampling event will be conducted after installation of the monitoring well network and prior to injection. Following injection, performance sampling will be performed at approximately 1 month, 3 months, and 6 months after injection.

Baseline sampling will include the complete monitoring well network described in Section 3.4.2 and shown on Figure 4-2. Each well will be sampled and analyzed for the field and analytical parameters described in Section 3.4.3, except the outer wells used to assess ROI (MW-01A/B and MW-06A/B) will be analyzed for field parameters only. Microbial analysis will be performed on 2 samples from monitoring wells screened in the upper alluvium (MW-05A and MW-10A) and 2 samples from monitoring wells screened in the deeper alluvium (MW-05B and MW-10B).

Performance sampling will include the complete monitoring well network. Each well will be sampled and analyzed for the field and analytical parameters described in Section 3.4.3, except that the two outer well clusters used to assess ROI (MW-01A/B and MW-06A/B) will be sampled for field parameters only. Microbial analysis will be performed on samples collected from MW-05A/B and MW-10A/B during the 6 week and 24 week sampling events.

3.5 STAGING AREA(S)

KSU has approved the use of a vacant landscape area north of Crompton Road for use as a temporary staging area. This is an unsecured area which may be used for temporary storage of field supplies. Field personnel will coordinate use of this area with the USACE-Kansas City District Project Manager or her designee.

Table 3.1
Field Parameters

Field Parameters	Rationale/Comments
pH	General water quality parameter. Presence of substrate may be indicated by changes in pH. Biodegradation of organic compounds may generate enough acid to impact pH. Microbial growth sensitive to pH.
Temperature	General water quality parameter; aquifer temperature can impact biological activity.
Conductance	General water quality parameter; presence of substrate is expected to cause an increase in conductance.
Turbidity	General water quality parameter.
Dissolved Oxygen (DO)	Important indicator of aquifer redox conditions. Decreasing DO levels with values less than 0.5 mg/L indicate anaerobic conditions conducive to dechlorination.
Oxidation Reduction Potential (ORP)	Important inidicator of aquifer redox conditions. ORP values less than 0.0 mV are indicative of reducing conditions conducive to dechlorination.

Table 3.2
Analytical Parameters

Analytical Parameters	Rationale/Comments
VOCs	TCE (parent compound) and its dechlorination products, *cis*-1,2-DCE and vinyl chloride, are the contaminants of concern; data trends for these parameters will be used to assess the effectiveness of ERD.
Ethene/Ethane and Carbon Dioxide	Indicators of complete dechlorination.
Manganese, Nitrate, Iron, Sulfate, Carbon Dioxide	Important electron acceptors. Decreasing concentrations may be indicative of strongly reducing conditions conducive to dechlorination.
Alkalinity	Indicator of changes in aquifer conditions. Alkalinity buffers the aquifer against acids generated during anaerobic biodegradation. There is a positive correlation between microbial activity and increased alkalinity.
Chloride	Indicator of changes in aquifer conditions. Increasing chloride concentrations may be indicative of biological activity and dechlorination.
Phosphate	Micronutrient for microbial activity; positive indicator of substrate distribution.
Volatile Fatty Acids	Increases in VFAs may be indicative of substrate distribution. VFAs are produced during microbial degradation of the substrate. Their distribution may indicate the type and efficiency of the degradation pathways for anaerobic dechlorination.
Deoxyribonucleic Acid (DNA)	Used to monitor for the species of bacteria, *Dehalococcoides ethenogenes* (DHC), which has been identified as capable of complete degradation of TCE under anaerobic conditions.
Total Organic Carbon (TOC)	Baseline indicator of natural carbon source for ERD; indicator of substrate strength following injection.

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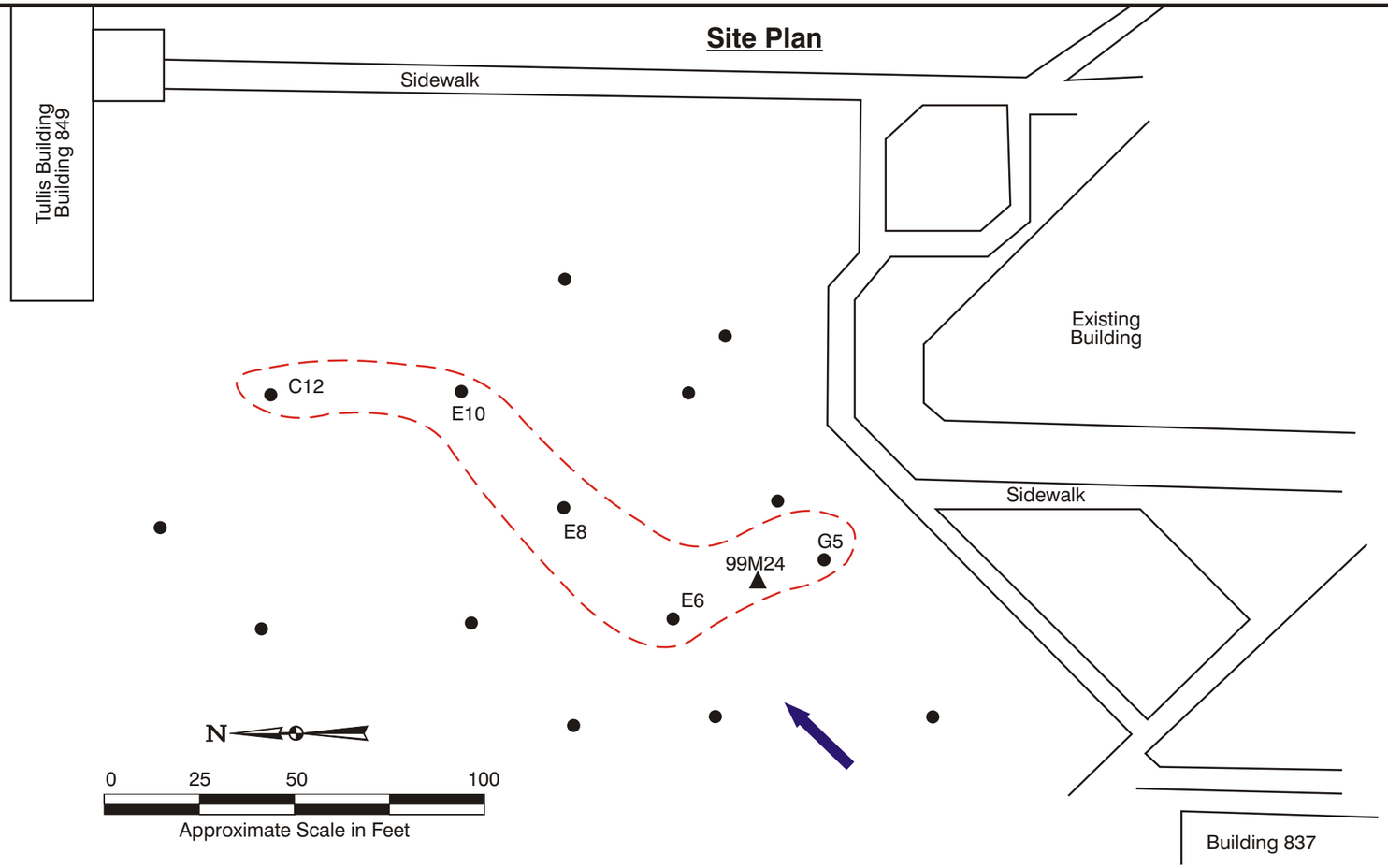
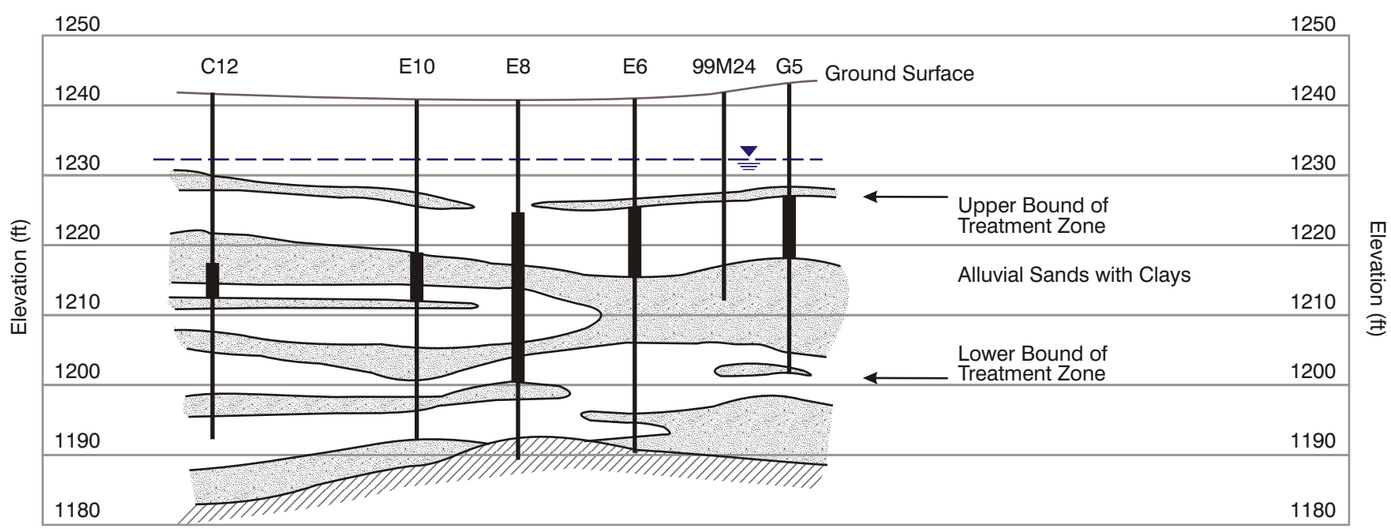
Figure 3.1
Site and Subsurface Conditions
Building 837 Study Area

Site Plan



Subsurface Conditions



Legend

- Approximate Limits of Study Area
- E8 — Membrane Interface Probe (MIP) Location and Designation
- 99M24 — Existing Monitoring Well Location and Designation
- Significant Response to MIP/ECD
- General Direction of Groundwater Flow
- Relatively Fine-Grained Alluvial Deposits
- Relatively Coarse-Grained Alluvial Deposits
- Residuum and Shale

Notes:

1. Subsurface soils include shallow fills associated with site development (not shown in cross-section).
2. Existing utilities within study area include water lines for landscape Irrigation system.

Filename: X:/KAN004/TO_103/DOMP/MAPS/
Saturated_Zone_Activites_Map.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/23/06 CV
Source: USACE Remedial
Investigation Report, 2005

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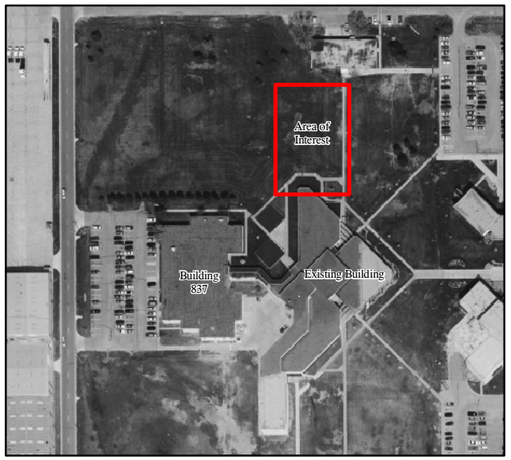
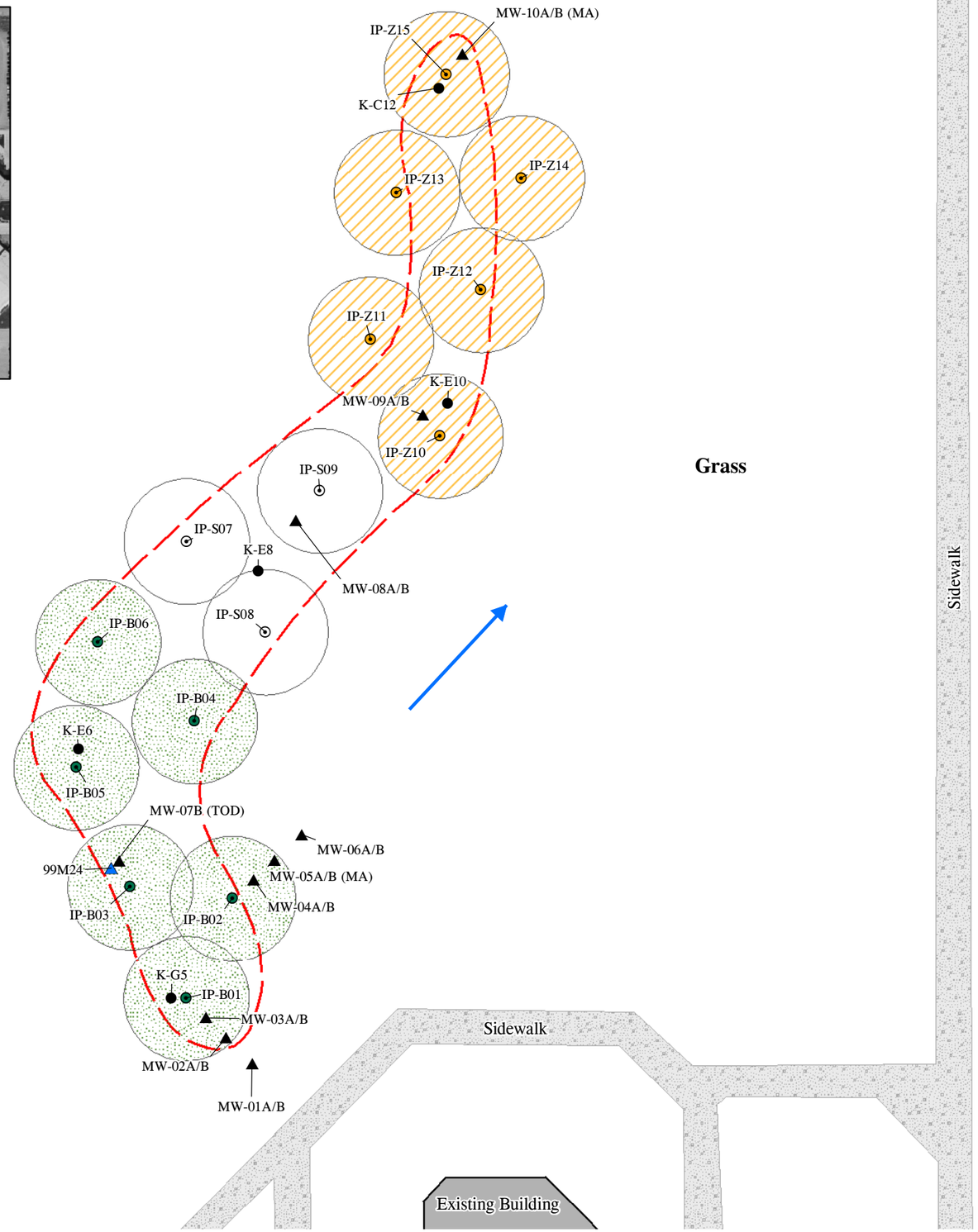
HydroGeoLogic, Inc





HydroGeoLogic, Inc.—Design, Operations and Monitoring Plan
Former Schilling AFB, Kansas

Figure 3.2
Building 837 Study Area
Saturated Zone Field Activities Map

Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Existing Monitoring Well
- Groundwater Flow Direction

Previous Activities

- Membrane Interface Probe (MIP)

Proposed Activities

- Study Area
- Substrate Only
- Substrate and Zero Valent Iron
- Substrate with Potential Bio Augmentation Pending Biological Analysis
- Estimated Radius of Influence of 10 ft
- Monitoring Well Cluster
  A-Screened in Upper Alluvium
  B-Screened in Lower Alluvium
  MA-Baseline Groundwater Sampling
  Includes Microbial Analysis
  TOD-Baseline Soil Sampling
  Includes Total Oxidant Demand Testing

0 10 20 40
Feet

N

Filename: X:/KAN004/TO_103/DOMP/MAPS Building_837_Study_Area.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 07/27/06 CV
Source: USACE Remedial Investigation Report, 2005

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4.0 FORMER WASH RACKS (BUILDING 606/626) STUDY AREA

This section describes the PSTS activities to be performed at the Former Wash Racks (Building 606/626) study area.

4.1 SITE BACKGROUND INFORMATION

4.1.1 LOCATION

The Former Wash Racks (Building 606/626) study area is located immediately west of Building 626 on property owned by the SAA and leased to Raytheon (Figure 4.1). The general area is bounded on the south by Ganey Road and on the north by Lucas Road. Access to the site is restricted; a gated entrance to the Raytheon industrial complex is located east of Building 626 along Ganey Road. Access to the Raytheon industrial complex is controlled by security personnel.

4.1.2 SITE AND SUBSURFACE CONDITIONS

Building 626 is a former hangar featuring single story construction with masonry exterior walls and a high roof line. The building design includes an entrance along the west exterior wall immediately south of the study area. Other construction at the site includes a small, tall brick chimney-like structure, sidewalks, pavements and utilities. Approximately 40 percent of the study area is covered with thick concrete pavement; the remaining ground surface is covered in grass and other landscaping. Portions of the existing pavement are used for by Raytheon employees for parking. Site utilities include buried water and gas lines along the center and south perimeter of the study area, storm drains to the west of the study area, and overhead electrical and telephone lines that run north-south through the area (Figure 4.2).

Subsurface conditions include shallow surface fills overlying alluvial deposits. The upper alluvium is primarily silty clays with sand layers; the deeper alluvium includes interbedded sands and clays. Residuum and shale were identified at depths of 21 to 29 feet bgs. The depth to groundwater ranged from approximately 8 to 10 feet bgs. A generalized geologic cross section of the site is shown on Figure 4.1.

Previous remedial investigation activities at the site included direct push sampling and chemical analysis of soil and groundwater. There are no monitoring wells in the immediate vicinity of the study area, but three wells are located in the surrounding area. Monitoring well 99M02 is located near the southeast corner of Building 606; 99M04 is located approximately 250 feet to the northwest of the study area; and 99M05 is located approximately 200 feet to the north of the northeast corner of Building 626. According to well logs from the RI, bedrock was encountered at these well at depths 10 to 15 feet shallower than conditions identified at Building 626.

TCE and several of its breakdown products as well as fuel-related constituents were detected in soil samples and monitoring wells in the surrounding area during the previous remedial investigation activities. The reported contaminant concentrations in soil and groundwater for TCE and its breakdown products are summarized below:

- TCE concentrations ranged from 73.7 μg/L to 2,206 μg/L in groundwater and from 260 micrograms per kilogram (μg/kg) to 220,000 μg/kg in soil.
- *Cis*-1,2-DCE concentrations ranged from 3.8 μg/L to 583 μg/L in groundwater and from 75 μg/kg to 12,000 μg/kg in soil.
- Vinyl chloride concentration ranged from non-detect to 1 μg/L in groundwater and from non-detect to 39 μg/kg in soil.

4.2 TECHNOLOGY DESCRIPTION

The remedial technology selected for the PSTS at the Former Wash Racks (Building 606/626) study area is ISCO. Remediation of soil and groundwater using ISCO involves delivery of a chemical oxidant into the source area of contamination. The oxidant reacts with the contaminants of concern, producing harmless substances such as carbon dioxide and water. A variety of oxidants can be used for source area mass reduction and treatment of dissolved phase groundwater plumes. Common oxidants include permanganate, persulfate, hydrogen peroxide, Fenton's agent, and ozone. ISCO is applicable to many contaminants including chlorinated solvents, polynuclear aromatic hydrocarbons, and petroleum products. The successful application of this technology depends on carefully matching the oxidant and delivery system to the site contaminants and site conditions.

ISCO can be applied to a wide range of soil types including sands with high permeability and clays with low permeability. The effectiveness of the oxidant is dependent on achieving adequate contact between the oxidant and contaminant. Subsurface heterogeneities and low permeability soils can pose challenges to uniform distribution of the oxidant in the subsurface. The depth of contamination is not usually a limitation for ISCO.

Several types of delivery systems can be used to distribute the oxidant to the subsurface. Shallow/deep soil mixing is a common technique that promotes uniform distribution and mixing of the oxidant and contaminants. An alternate technique involves using direct-push equipment to inject the oxidant into the subsurface.

ISCO has several important advantages over conventional remedial technologies:

- It minimizes material handling and does not generate significant quantities of waste materials that require treatment or disposal.
- It can be implemented over a relatively short time period, thereby reducing overall costs.
- The technology has been used at many sites and conventional equipment is readily available for delivery of the oxidant to the subsurface.

As with use of any chemical, health and safety considerations are important in successful implementation of ISCO. The oxidants used in ISCO are strong agents with inherent risks if not handled properly. Some oxidants are more aggressive than others posing risks not only to remedial personnel, but also to buried utilities and structures that come in contact with the oxidant.

4.3 DESIGN AND OPERATION

This section of the DOMP provides design, operational details, and rationale for the PSTS at the Building 626 study area. This section includes cross-references to the FSP where detailed requirements and information can be found regarding the proposed field activities described in this document.

4.3.1 TECHNICAL APPROACH

The technical approach for the PSTS at the Former Wash Racks (Building 606/626) study area is summarized below:

- The study area as defined from the previous remedial investigation activities is an elongated area measuring approximately 10 to 20 feet wide and 85 feet long. The PSTS must address site contaminants in both the vadose zone and saturated zone. The target treatment zone for the vadose zone extends from approximately 4 feet bgs to the groundwater surface (approximately 10 feet bgs). The target treatment zone for the saturated soils extends from the groundwater surface to a depth of about 20 feet bgs (Figure 4.1).
- The existing overhead power lines that cross the study area limit the head space available for field equipment. Although soil mixing is considered the best method of achieving a uniform distribution of oxidant in soil, injection techniques for oxidant distribution will include using direct-push equipment in the vadose zone. This injection technique requires less equipment head room and reduces the risk of potential disturbance to existing facilities. Injection within the saturated zone will be accomplished using temporary injection wells. The depth to the bottom of the targeted treatment zone is approximately 20 feet bgs.
- The oxidant(s) selected for this study must be compatible with site conditions. Aggressive oxidants which could damage the existing underground utilities or alter the properties of the subsurface soils and potentially induce settlement of the existing structures will be avoided.
- The alluvial soils within the treatment zone are predominantly silty clays with occasional sand layers at depth. The low permeability of the clayey alluvium will control the distribution of the chemical oxidant during injection. A conservative spacing between injection points will increase the likelihood that the oxidant is distributed throughout the treatment zone.
- The natural oxidant demand of the subsurface soils will compete with treatment of the site contaminants. The design of the PSTS and the oxidant loading will

consider TOD of the site soils as determined by bench-scale studies to be completed prior to injection.

- The design of the PSTS will include a monitoring system to assess the effectiveness of the oxidants delivery system and to document the effectiveness of the oxidants via changes in contaminant concentrations in the treatment zone.
- Groundwater elevation data will be collected during each sampling event to detect changes in flow direction.
- The site is an active industrial facility where workers may be in proximity to the study area during field activities. Health and safety considerations for the on-site workers and pilot study field personnel are important considerations in the selection of the chemical oxidants and the design/implementation of field activities.

The general sequence of activities at the Former Wash Racks (Building 606/626) study area (following approval of the work plan documents) is summarized below:

- Coordination with USACE-Kansas City District and SAA in advance of field work.
- Preliminary field layout of pre-injection sampling locations, monitoring wells and injection points for utility clearance.
- Utility clearance and adjustment of pre-injection sampling locations, monitoring wells and injection point as needed to avoid utility conflicts.
- Pre-injection soil sampling and installation of the proposed monitoring well network including collection of samples for microbial analysis and total oxidant demand testing.
- Baseline groundwater sampling and pre-injection building elevation survey.
- Review of total oxidant demand testing to finalize chemical loading requirements.
- Mobilization and completion of injection activities including initial post-injection building elevation survey.
- Performance groundwater monitoring at 1 month, 3 months, and 6 months after injection; post-injection soil sampling at 1 month and 3 months after injection.
- Site restoration and closure.

Detailed information on the specific activities for the treatability study is provided in the following sections.

4.3.2 OXIDANTS

Based on the site contaminants, site conditions and design considerations, two oxidant have been selected for the PSTS, one for the vadose zone (potassium permanganate) and one for the saturated zone (sodium persulfate).

Vadose Zone: Potassium permanganate has been selected for treatment of contaminants in the vadose zone. It has been successfully used at many sites for treatment of chlorinated solvents.

Potassium permanganate is available in powdered crystalline form (5 gallon plastic containers), which makes it easier to handle than many other oxidants and reduces the risk of accidental exposure to field personnel and industrial workers during mixing and injection. One of the benefits of potassium permanganate is that it can be injected in slurry form which provides a more prolonged oxidant source than persulfate. Additionally, potassium permanganate is less corrosive to metals than other oxidants and minimizes the possibility of damaging existing utilities. Potassium permanganate exhibits a purple color in slurry form. Field observation of soil discoloration will be made to confirm distribution of the oxidant within the treatment zone (refer to Sections 4.3.4 and 4.4.1).

As described in Section 4.3.1, the final oxidant loading will be determined based on TOD tests results. A preliminary oxidant loading has been estimated based on the following assumptions: 1) total oxidant demand of 2 grams of oxidant per kilogram of soil, 2) study area dimensions of approximately 20 feet by 95 feet, and 3) treatment of 6 feet of soil in the vadose zone (depths of 4 to 10 feet) and 10 feet in the saturated zone (depths of 10 to 20 feet). Based on these assumptions, treatment of the vadose zone is estimated to require approximately 2,700 pounds of potassium permanganate. The potassium permanganate will be mixed in slurry form (approximately 50 percent by volume with water) in preparation for injection.

Field personnel are cautioned that although potassium permanganate is a more stable oxidizing agent than many other available oxidants, handling and mixing of permanganate has inherent risks. Accidental fire and/or explosion can occur if the permanganate inadvertently comes in contact with or is mixed with combustible or flammable compounds.

Saturated Zone: Sodium persulfate has been selected for treatment of site contaminants in the saturated treatment zone. This oxidant has been applied at many sites for in-situ treatment of chlorinated solvents and petroleum hydrocarbons. Persulfate is a more powerful oxidant than permanganate and has the potential for degrading metals such as copper or brass. It can be further enhanced with a base catalyst or the application of heat. Persulfate is available in powdered form (55 pound plastic bags) for ease of handling. It is very soluble in water and mixes easily.

The quantity of sodium persulfate required for treatment of the saturated zone has been estimated based on assumptions similar to those used to estimate oxidant quantities for the vadose zone. Treatment of the saturated zone is estimated to require approximately 6,300 pounds of sodium persulfate. The persulfate will be mixed with water at a 20 percent by weight solution (6,300 pounds of persulfate results in approximately 3,800 gallons of solution at a 20 percent by weight mixture). A base catalyst of sodium hydroxide will be mixed with the persulfate solution at a rate of approximately 10 gallons of 25 percent sodium hydroxide per 500 gallons of persulfate solution (approximately 80 gallons of catalyst required for the study).

Field personnel are cautioned that sodium persulfate is a strong oxidizing agent and must be handled carefully to minimize exposure to field personnel and on-site workers. Accidental fire

and/or explosion can occur if the persulfate inadvertently comes in contact with or is mixed with combustible substances and reducing agents.

4.3.3 SYSTEM DESIGN

The effectiveness of ISCO will be influenced by the distribution of the oxidant in the subsurface environment. To be effective, direct contact between the oxidant and contaminants is needed. The subsurface heterogeneity and depositional features of the alluvial deposits at the site are important factors in design of the injection spacing and selection of oxidant delivery techniques.

Vadose Zone: The design of the injection layout for the vadose zone will feature a one-time injection along two rows of grid points distributed across the width and length of the study area. The resulting design features 17 injection points distributed spatially across two rows to encompass the study area. The spacing between injection points spaced 10 feet on-center, equivalent to a ROI of 5 feet. The design locations and spacing of the injection points are illustrated on Figure 4.2. Some adjustment of the injection locations is anticipated during the field activities to avoid conflicts with the existing utilities.

The total estimated quantity of potassium permanganate required for the vadose zone treatment is 2,700 pounds, the equivalent of 159 pounds per injection point.

Saturated Zone: The design of the injection layout for the saturated zone will feature a one-time injection along two rows of grid points distributed across the width and length of the study area. The resulting design features 10 injection points distributed spatially across two rows to encompass the study area. The spacing between injection points will be approximately 20 feet on-center, equivalent to a ROI of 10 feet. The design locations and spacing of the injection points are illustrated on Figure 4.3. Similar to the layout for the vadose zone, some adjustment of the injection locations for the saturated zone may be required during the field activities to avoid existing utilities.

The total estimated quantity of sodium persulfate required for the saturated zone treatment is 6,300 pounds, the equivalent of 630 pounds per injection point (or 360 gallons of mixed solution plus 8 gallons catalyst per location).

4.3.4 Oxidant Delivery Method

Vadose zone: Direct push methods will be used to deliver the substrate to the vadose zone. As described in Section 3.3.5, this method is applicable for the depth of the treatment zone (4 to 10 feet) and the properties of the alluvial soils observed at the site.

The use of direct push equipment for oxidant delivery will be based on manual injections using DPT equipment with batch mixing of the oxidant. The oxidant injection will be performed using a Geoprobe Model 6610DT track mounted drill rig equipped with batch mixing

equipment, piping/hoses, valves/regulators, pressure gauges and ancillary equipment. Details of the mixing and injection process are provided in the FSP.

The potassium permanganate will be injected into the treatment zone using drill rods equipped with an expendable tip. Once the target depth is reached, the drill rods are withdrawn slightly to expose the tip to the formation. Typically, the potassium permanganate solution will be mixed in batches with each batch containing sufficient oxidant for 1 or 2 injection locations. At each location, discrete injections will be performed at two foot internals beginning at 4 feet bgs and continuing at 6 feet, 8 feet and 10 feet. Based on 4 injection depths at each of the 17 locations, approximately 40 pounds of permanganate will be injected at each injection interval. Detailed injection procedures are provided in the FSP.

The 5-foot ROI requires a relatively tight spacing of injection points to promote uniform distribution of the oxidant throughout the vadose zone. One of the objectives of the study is to assess the effectiveness of the injection technique. Direct field observation of the oxidant distribution in the vadose zone is planned following completion of the vadose zone injections at three locations (refer to Section 4.4.1 for details). The DPT equipment will be used to collect soil samples from probe locations offset from the injection points. Visual observation of purple soil staining is considered a positive indicator of the presence of the permanganate. If the results of these observations show relatively uniform distribution, the remaining injections will be completed as planned based on a ROI of 5 feet. If the results show non-uniform distribution of the oxidant, the ROI may be decreased slightly in the field. With any increase in the number of injection points, the quantity of oxidant per injection point will be recalculated accordingly.

As discussed in Section 3.3.5, “daylighting” of the oxidant may be a concern during injection within the vadose zone. Field personnel will be alert to this potential problem and be prepared to take correction action if daylighting is observed. Several injection variables may be adjusted in the field based on observed conditions. These include the injection pressure, time interval for injection, and the mixing ratio for the permanganate and water.

Saturated Zone: Sodium persulfate is more corrosive than potassium permanganate. While use of DPT equipment for injection of this oxidant is feasible, corrosion of the equipment and drill rods makes this delivery technique less attractive than other alternatives. The oxidant delivery method for sodium persulfate will be accomplished using temporary injection points constructed with 3/4-inch PVC well screens and risers. Each injection point will consist of two nested injection wells, screened from 10 to 15 feet bgs and 15 to 20 feet bgs. The purpose of the nested injection points is to ensure that adequate vertical distribution of the oxidant solution is achieved. The temporary injection points will be installed by Redox Tech at the beginning of field work at this study area. Details of the temporary injection well design are provided in the FSP. The temporary injection wells will be removed upon completion of the injection activities.

The persulfate will be mixed in batches as injection progresses. Based on injection at 20 temporary wells distributed across the site, approximately 315 pounds of persulfate will be injected at each temporary well.

4.3.5 Pre-Injection Baseline Vadose Zone Sampling and Bench-Scale Studies

Baseline Vadose Zone Sampling: Before injection, a series of three baseline soil borings will be drilled and sampled using DPT equipment to obtain information on the site stratigraphy and to collect soil samples for chemical analysis. These borings will be approximately 8 to 10 feet deep. The borings will be located within the three subareas referred to as Subarea CS-1, Subarea CS-2 and Subarea CS-3 on Figure 4.2 (one boring per subarea). Two soil samples from each boring will be collected for chemical analysis (6 total samples). Sampling intervals will be within the targeted treatment zone: 5 to 6 feet and 7 to 8 feet. The samples will be submitted for analysis of VOCs and TPH. The analytical data from these borings will serve to document contaminant concentrations prior to injection. As discussed below in Section 4.4.1, these same three subareas will be resampled for chemical analysis after injection. Comparison of contaminant concentrations before and after injection will provide data on the effectiveness of ISCO in the vadose zone.

Detailed information on the soil sampling procedures, chemical analysis, method of analysis, field documentation, and other relevant information is provided in the FSP.

Total Oxidant Demand: The pre-injection sampling and bench-scale studies for ISCO will include bench scale testing of soil samples from the Former Wash Racks (Building 606/626) study area to evaluate TOD. Soil samples for TOD analysis will be collected from two borings identified on Figure 4.3 as well locations MW-01B and MW-05B. Three samples from each boring will be collected for testing. One sample from each boring will be collected within the vadose zone (4 to 10 feet) and two samples from each boring will be collected within the saturated zone (10 to 20 feet). Field personnel will select the specific sample depths to provide a variety of soil types (clays and sands) for testing. The six samples will be submitted to Redox Tech for bench scale testing. Details of the TOD sample collection procedures and method of analysis are described in the FSP.

Microbial Analysis: Although ERD is not being considered for the Former Wash Racks (Building 606/626) study area, the pre-injection sampling activities will include microbial analysis of two samples from this area. The samples will be collected as part of installation and baseline groundwater sampling of the monitoring well network described in Section 4.4.2.2. One sample from MW-05A and one sample from MW-05B will be submitted to Microbial Insights for microbial analysis. Details of the microbial analysis including sample collection procedures are described in the FSP.

4.4 MONITORING

This section provides the design and operational details of the Former Wash Racks (Building 606/626) study area monitoring program. The ISCO pilot study is directed at treatment of site

contaminants in the vadose zone and saturated zone. To evaluate the effectiveness of this technology, monitoring systems must be designed for both the vadose zone and saturated zone.

4.4.1 Vadose Zone Monitoring

This section provides the technical approach and details of vadose zone monitoring at the Former Wash Racks (Building 606/626) study area.

Vadose zone monitoring will focus on pre- and post-injection characterization of contaminant concentrations (VOCs and TPH) in the vadose zone soils. The technical approach for vadose zone monitoring as described will include:

- Pre-injection soil sampling of the vadose zone in three subareas of the study area to characterize baseline conditions.
- Field observations of the oxidant distribution during the initial injections to assess the effectiveness of the injection method in distributing the oxidant within the targeted treatment area (horizontally and vertically).
- Post-injection soil sampling of the vadose zone within same subareas and sampling intervals as the pre-injection soil sampling.

Field Assessment of Oxidant Distribution: The need for field assessment of the oxidant distribution during the initial injections was initially described in Section 4.3.4. Oxidant injection in the vadose zone will begin with IP-V05, IP-V06, and IP-V07. When these three injection points are completed, the DPT equipment will be used to sample a series of probe locations to observe the presence of absence of soil discoloration as an indicator of permanganate distribution. The first probe will be offset 2 feet from an injection point (e.g., IP-V05) and two soil samples will be collected for observation from depths of 6 feet and 8 feet. Assuming positive confirmation of permanganate distribution, the next probe shall be off-set 4 feet from the injection point and two samples will be collected for observation from depths of 6 feet and 8 feet. Assuming positive confirmation of permanganate distribution, no further probing will be required. If positive confirmation of the oxidant distribution cannot be made, two additional probes shall be sampled at 6 feet and 8 feet with off-set distances of 2 feet and 4 feet from IP-V06. Based on these field observations, field personnel in consultation with USACE will make adjustments in the spacing and layout of the final injection points.

Pre- and Post-Injection Soil Sampling: The monitoring program for the vadose zone will focus on chemical analysis of VOCs and TPH in soils. The oxidation process will begin upon injection and post-injection performance monitoring over time is important to observe reaction kinetics and to estimate the mass of contaminants degraded over time.

As described previously in Section 4.3.5, three subareas of the study area have been designated for pre- and post-injection soil sampling. These areas are identified as Subareas CS-1, CS-2 and CS-3 on Figure 4.2. Pre-injection sampling in each of these subareas will include collection of 2 samples from each subarea at depths of 6 and 8 feet using DPT equipment. The DPT sampling locations will be off-set 2.5 feet from the closest injection point in each subarea.

The soil samples will be analyzed for VOCs and TPH to establish baseline contaminant concentrations prior to injection.

Following injection, post-injection soil sampling will be performed in each of the three subareas in the same manner as the pre-injection sampling. The DPT probe locations will be off-set 2.5 feet from the closest injection point and approximately 6 inches from the pre-injection sampling location.

The post-injection sampling will be performed approximately 1 month, and 3 months after injection.

Details of the sample collection procedures and methods of analysis are provided in the FSP (Appendix A).

4.4.2 Saturated Zone Monitoring

4.4.2.1 Technical Approach

Saturated zone monitoring will focus on pre- and post-injection characterization of groundwater within the treatment zone. The technical approach for saturated zone monitoring will include:

- Baseline groundwater monitoring to document contaminant concentrations prior to oxidant injection.
- Downgradient and sidegradient monitoring from selected injection locations to assess the effectivenss of the injection method in distributing the oxidant within the targeted treatment area (horizontally and vertically).
- Performance monitoring following injection to assess the effectiveness of the substrate in remediating the site contaminants, and the need for additional injections during full scale implementation to improve the effectiveness of ISCO.

The ISCO monitoring program for the saturated zone will focus on sampling of groundwater and analysis for VOCs, TPH, and metals. Although the in-situ oxidation process will begin immediately upon injection, the reaction kinetics with the organic contaminants in the saturated zone may cause transient increases and decreases in contaminant levels. The performance monitoring period of 6 months should be sufficient to establish trends in contaminant levels and to assess the effectiveness of ISCO.

The monitoring program for the saturated zone will include analysis of dissolved metals in groundwater. Certain redox sensitive metals can be oxidized to a more soluble state following oxidant injection. Metals mobilization, if it should occur, is usually a transient condition until the metals are attenuated to background conditions by naturally occurring chemical reduction processes. Again, the performance monitoring period of 6 months should be sufficient to establish trends in metals concentrations and to assess if metals mobilization at the site should be of concern.

4.4.2.2 Groundwater Monitoring System

The monitoring well network for the Building 626 study area is shown in Figure 4.3. The monitoring well network will include 8 temporary well clusters consisting of 2 wells per cluster. The temporary wells have been distributed across the site to provide monitoring data in the southern and northern portions of the treatment zone. The locations of two monitoring well clusters (MW-01A/B and MW-05A/B) were selected to coincide with the previous MIP locations (D8 and B7).

The majority of the monitoring wells will be located 4.5 feet from the closest injection point to assure that the monitoring data is representative of the treatment zone. As shown on Figure 4.3, three of the well clusters (MW-06A/B, MW-07A/B, and MW-08A/B) will be located downgradient of injection point IP-G10, and three well clusters (MW-02A/B, MW-03A/B and MW-04A/B) will be located sidegradient of injection point IP-G04. These wells will be spaced with increasing distance (4.5, 9 and 15 feet) from their companion injection point. These well clusters will provide data to assess the effectiveness of the injection technique in distributing the substrate horizontally and vertically in the aquifer.

The deep well locations MW-01B, MW-03B, MW-05B and MW-07B will be sampled and logged to document site stratigraphy and select the screen intervals for monitoring well installation. The design of the temporary monitoring well clusters provides for 2 wells per cluster with 5 foot screen intervals within the upper and lower portions of the treatment zone. Preliminary screen intervals will be from 10 to 15 feet for the shallow wells and from 15 to 20 feet in the deeper wells. The wells will consist of 1-inch Schedule 40 PVC with pre-packed well screens. The temporary wells will be installed using DPT. The temporary wells will be removed from the site at the conclusion of the PSTS.

Details of the well design, installation techniques, and well development are described in the FSP. All IDW generated during the monitoring well installation activities will be managed in accordance with the FSP.

4.4.2.3 Monitoring Parameters

The design of the monitoring system provides for collection of field and analytical parameters to document general water quality parameters, important redox sensitive metals, and the concentrations of the contaminants of concern (Table 4.2).

The monitoring program will include DNA microbial analysis by Microbial Insights. Selected samples collected during baseline monitoring will be analyzed for quantitative polymerase chain reaction (qPCR) which is a DNA-based approach that provides a means to obtain direct information regarding the dominant biological processes occurring within the subsurface. The locations and frequency of microbial analysis is detailed in Section 4.3.5.

Details of sample collection procedures, field equipment, and methods of analysis associated with the ground water monitoring program for the Former Wash Racks (Building 606/626) study area are provided in the FSP.

4.4.2.4 Baseline and Performance Monitoring

Four groundwater sampling events are planned during the PSTS. An initial baseline sampling event will be conducted after installation of the monitoring well network and prior to injection. Following injection, performance sampling will be performed at approximately 1 month, 3 month, and 6 months after injection.

Baseline sampling will include the complete monitoring well network described in Section 4.4.2.2 and shown on Figure 4.3. Each well will be sampled and analyzed for the field and analytical parameters described in Section 4.4.2.3. Baseline sampling will include microbial analysis of two groundwater samples, one from a shallow monitoring well (MW-05A) and one from a deep monitoring well (MW-05B).

Performance sampling will include the complete monitoring well network described in Section 4.4.2.2 and shown on Figure 4.3. Each well will be sampled and analyzed for the field and analytical parameters described in Section 4.4.2.3, except that the two outer well clusters used to assess ROI (MW-04A/B and MW-08A/B) will be sampled for field parameters only. No samples will be submitted for microbial analysis during the performance monitoring.

4.4.3 SETTLEMENT MONITORING OF EXISTING BUILDINGS

Some oxidants have the potential to change the engineering properties (e.g., strength and compressibility) of soil that comes in contact with the oxidant. Where ISCO is performed in close proximity to existing buildings and structures, changes in soil properties may be accompanied by movement (settlement) of existing structures. Although this type of behavior is not expected with use of potassium permanganate or sodium persulfate, the study area is in close proximity to several existing structures. As a precautionary measure, the monitoring program for the Former Wash Racks (Building 606/626) study area will include an elevation survey of selected reference points to be established on the four corners of the existing brick chimney structure and along the west wall of Building 626. A pre-injection survey and several post-injection surveys, scheduled concurrent with other field activities, will be made to document any building movements associated with the PSTS. Field personnel will establish a temporary bench mark located away from the study area for use in the elevation survey. Elevations data will be accurate to +/- 0.02 feet.

4.5 STAGING AREA(S)

During a preliminary site visit in July 2006 attended by USACE – Kansas City District and HGL personnel, SAA personnel indicated that space for a temporary staging area was feasible pending coordination with Raytheon. Likely staging area locations include the vacant parking areas immediately east and south of Building 606. Field personnel will coordinate selection

and use of proposed staging areas with the USACE-Kansas City District Project Manager or her designee.

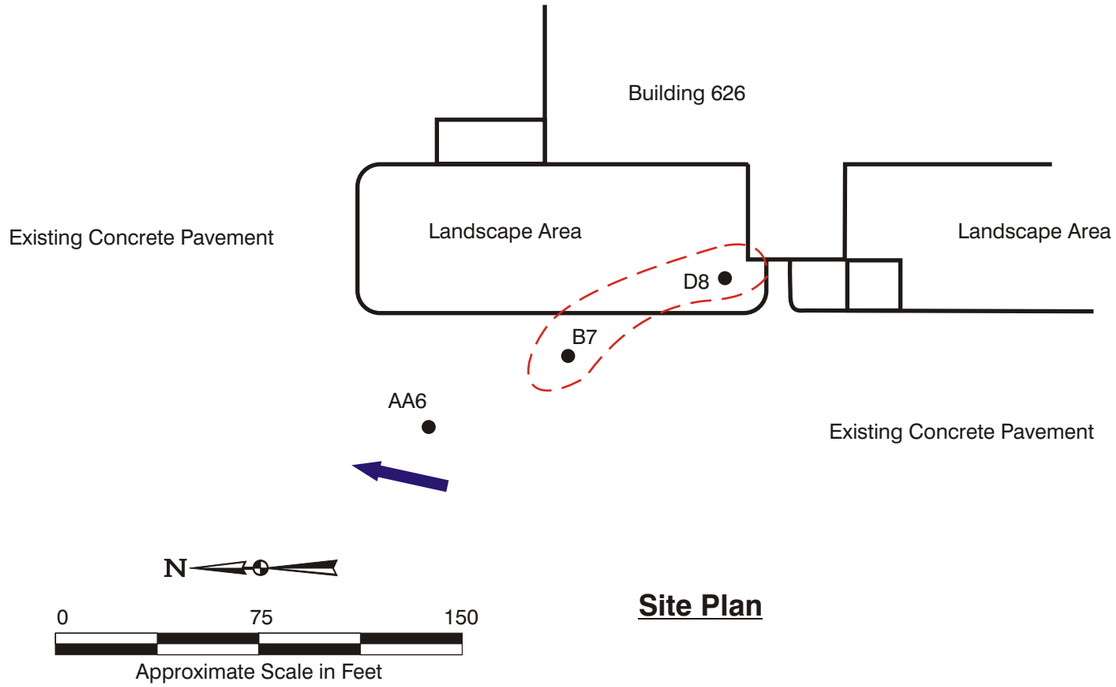
Table 4.1
Field Parameters

Field Parameters	Rationale/Comments
pH	General water quality parameter.
Temperature	General water quality parameter.
Conductance	General water quality parameter.
Turbidity	General water quality parameter.
Dissolved Oxygen (DO)	Important indicator of aquifer redox conditions. Increasing DO levels with values greater than 0.5 mg/L indicate oxidizing conditions.
Oxidation Reduction Potential (ORP)	Important indicator of aquifer redox conditions. ORP values greater than 0.0 mV are indicative of oxidizing conditions.

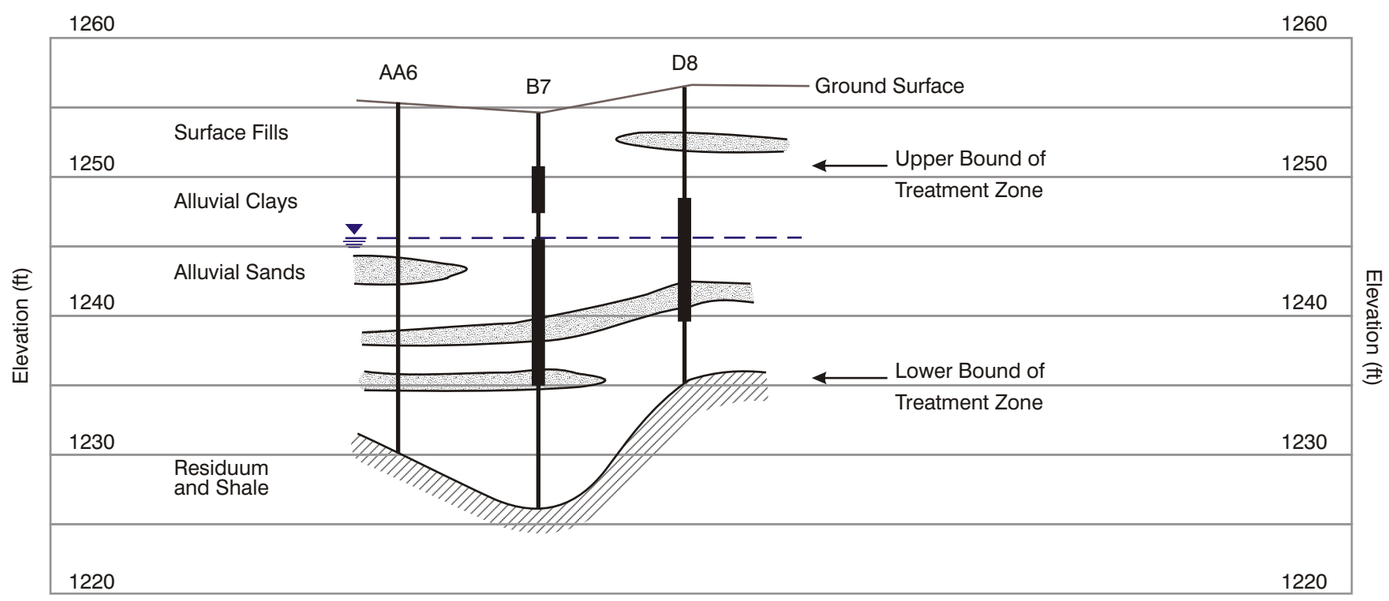
Table 4.2
Analytical Parameters

Analytical Parameters	Rationale/Comments
VOCs	TCE (parent compound) and its dechlorination products, *cis*-1,2-DCE and vinyl chloride, are the contaminants of concern; data trends for these parameters will be used to assess the effectiveness of ISCO in degrading VOCs.
TPH	This study area includes fuel related contaminants; data trends for TPH will be used to assess the effectiveness of ISCO in degrading fuel related contaminants.
Metals	Dissolved concentrations of arsenic and iron will be used as indicator metals to assess potential mobilization of metals following oxidant injection.

Figure 4.1
Site and Subsurface Conditions
Former Wash Rack Study Area



Site Plan



Subsurface Conditions

Legend

- Approximate Limits of Study Area
- AA6 — Membrane Interface Probe (MIP) Location and Designation
- Significant Response to MIP/ECD
- General Direction of Groundwater Flow
- Relatively Fine-Grained Alluvial Deposits
- Relatively Coarse-Grained Alluvial Deposits
- Residuum and Shale

Notes:

1. Subsurface soils include shallow fills associated with site development and Existing utilities (not shown in cross-section).
2. Deeper deposits at B7 (below elevation 1235) include fine and coarse-grained Soils.
3. Refer to Figure 4.2 for approximate locations of existing utilities. Existing utilities include the following:
   - Buried: gas, water storm drains
   - Overhead: telephone, electric

Filename: X:/KAN004/TO_103/DOMP/MAPS/
Site_Cond_Former_Wash_Rack.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/231/06 CV
Source: USACE Remedial
Investigation Report, 2005

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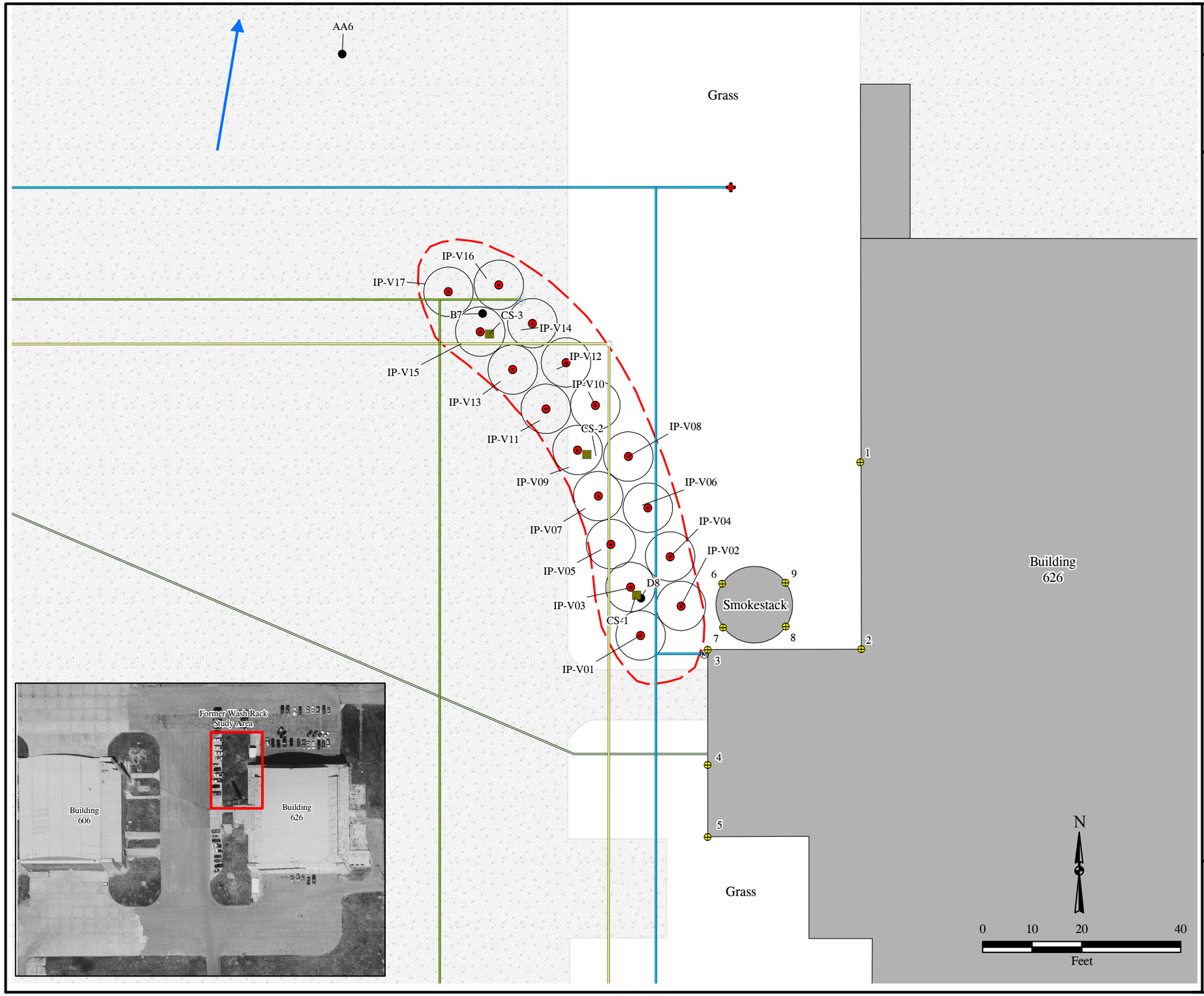
Figure 4.2
Former Wash Rack Study Area Vadose Zone Field Activities Map



Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Gas Line
- Storm Line
- Overhead Line (Power/Telephone)
- Water Line
- Groundwater Flow Direction
- Storm Drain
- Meter Location
- Fire Hydrant

Previous Activities

- Membrane Interface Probe (MIP)

Proposed Activities

- Study Area
- Potassium Permanganate Slurry Injection Point
- Elevation Monitoring Point
- Subsurface Soil Sample Location
- Substrate Radius of Influence

Filename: X:/KAN004/TO_103/DOMP/MAPS
Wash_Rack_Vadose_Zone.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/23/06 CV
Source: USACE Remedial Investigation Report, 2005

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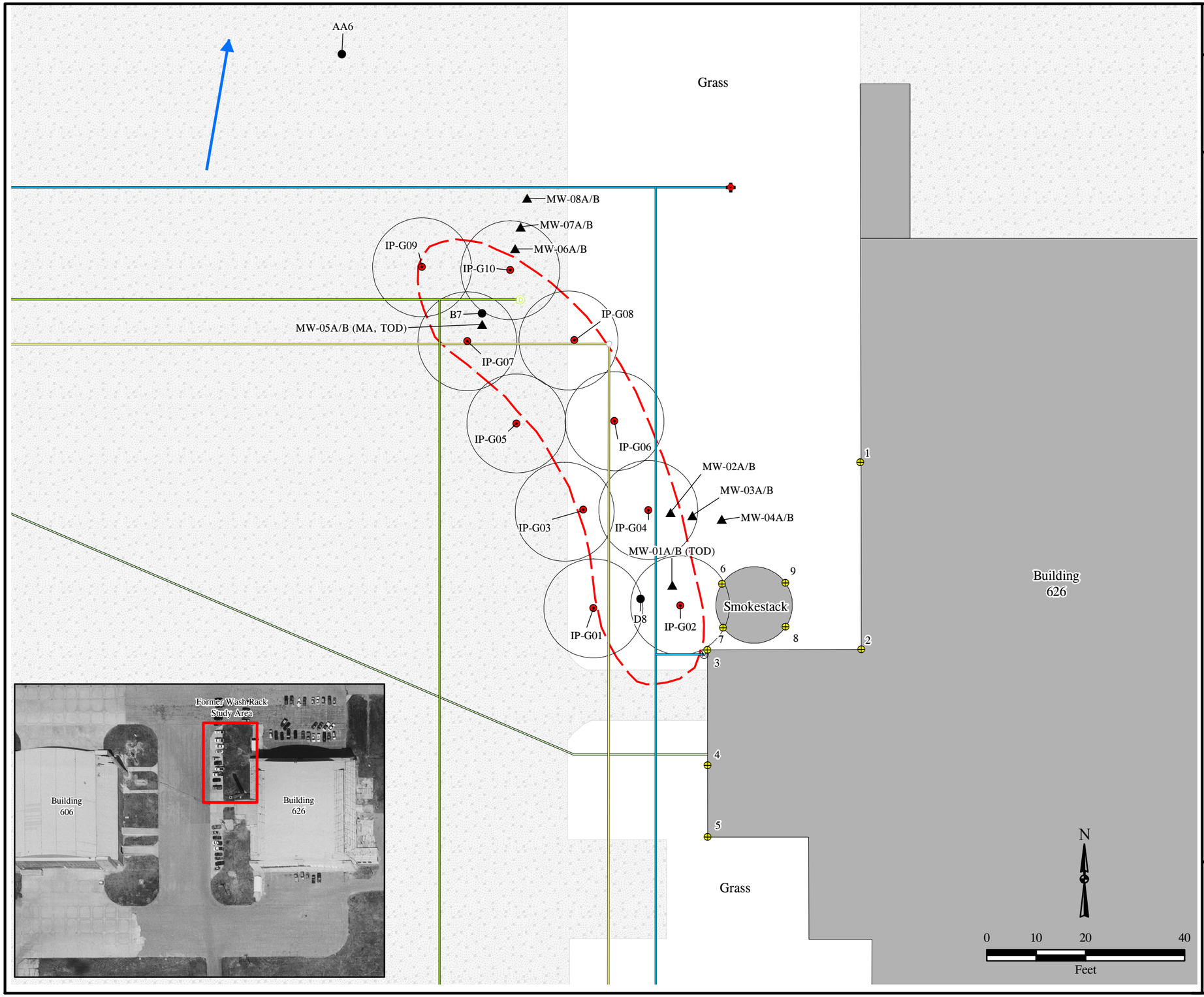

HydroGeoLogic, Inc.—Design, Operations and Monitoring Plan
Former Schilling AFB, Kansas

Figure 4.3
Former Wash Rack Study Area
Saturated Zone Field Activities Map

Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Gas Line
- Storm Line
- Overhead Line (Power/Telephone)
- Water Line
- Groundwater Flow Direction
- Storm Drain
- Meter Location
- Fire Hydrant

Previous Activities

- Membrane Interface Probe (MIP)

Proposed Activities

- Study Area
- Elevation Monitoring Point
- Substrate Radius of Influence
- Sodium Persulfate Slurry Injection Point
- Monitoring Well Cluster
  - A-Screened in Upper Alluvium
  - B-Screened in Lower Alluvium
  - MA-Baseline Groundwater Sampling Includes Microbial Analysis
  - TOD-Baseline Soil Sampling Includes Total Oxidant Demand Testing

Filename: X:/KAN004/TO_103/DOMP/MAPS Saturated_Zone_Activites_Map.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/23/06 CV
Source: USACE Remedial Investigation Report, 2005

HGL HydroGeoLogic, Inc

5.0 REPORTING

HGL will submit weekly progress reports to the USACE-Kansas city District Project Manager via electronic mail. Weekly progress reports will provide details of the work conducted during the reporting period, upcoming work and any issues and resolutions that may have occurred during the reporting period.

Upon completion of the field and laboratory studies, the field and analytical data collected during execution of the PSTS will be compiled and presented in a Treatability Study Report. The report will evaluate the data to provide conclusions and recommendation on the following:

- Effectiveness of ERD and ISCO in treating the dissolved phase chlorinated solvent contamination at the site.
- Results of the study in addressing key CERCLA criteria used in comparative analysis of remedial alternatives in the Feasibility Study (e.g., effectiveness, implementability and cost).
- Preliminary parameters (e.g., substrate loading, radius of influence) for design of full-scale implementation.

Additionally, the PSTS results will be presented to the Schilling Air Force Base Restoration Advisory Board.

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6.0 PROJECT SCHEDULE

The proposed project schedule is presented in Figure 6.1. As illustrated in Figure 6.1, the project is expected to last for 16 months, of which the field work is slated to last 10 months including time for laboratory analysis of field samples. HGL will submit weekly status reports with an updated project schedule as needed to reflect changes in work progress.

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In order to assess the effectiveness of the injection technique and ROI, the design of the monitoring network includes temporary monitoring wells distributed spatially downgradient and sidegradient to selected injection points. Differences in aquifer properties with depth have been recognized in design of the monitoring network by providing for monitoring well clusters (2 wells per cluster) screened at different depths in the targeted treatment zone.

3.4.2 Monitoring System

The monitoring well network for the Building 837 Source Area is shown in Figure 3.2. The monitoring well network will include 9 new temporary well clusters consisting of 2 wells per cluster, the existing monitoring well (99MW24), and a new temporary deeper companion well for 99MW24. The temporary wells have been distributed across the site to provide monitoring data for each treatment subarea (south subarea - substrate with BA; central subarea - substrate only; and the north subarea - substrate amended with ZVI). The locations of three monitoring wells (MW-03A/B, MW-08A/B and MW-10A/B) were selected to coincide with the locations of the previous MIP/ECD locations.

The majority of the monitoring wells will be located within 4.5 feet from the closest injection point to assure that the monitoring data is representative of the treatment zone. As shown on Figure 3.2, three of the well clusters (MW-04A/B, MW-05A/B and MW-06A/B) will be located downgradient of injection point IP-B02, and three well clusters (MW-01A/B, MW-02A/B and MW-03A/B) will be located sidegradient of injection point IP-B01. These wells will be spaced with increasing distance (4.5, 9 and 15 feet) from their companion injection point. These well clusters will provide data to assess the effectiveness of the injection technique in distributing the substrate horizontally and vertically in the aquifer.

The design of the temporary monitoring well clusters provides for 2 wells per cluster with 5 foot screen intervals within the upper and lower treatment zones. Preliminary screen intervals will be from 15 to 20 feet for the shallow wells and from 25 to 30 feet in the deeper wells. The wells will consist of 1-inch Schedule 40 PVC with pre-packed well screens. The temporary wells will be installed by EPS using direct push technology (DPT). The temporary wells will be removed from the site at the conclusion of the PSTS. The deep well locations at MW-02B, MW-05B, MW-08B, MW-09B and MW-10B will be sampled and logged to document site stratigraphy and select the final well screen intervals.

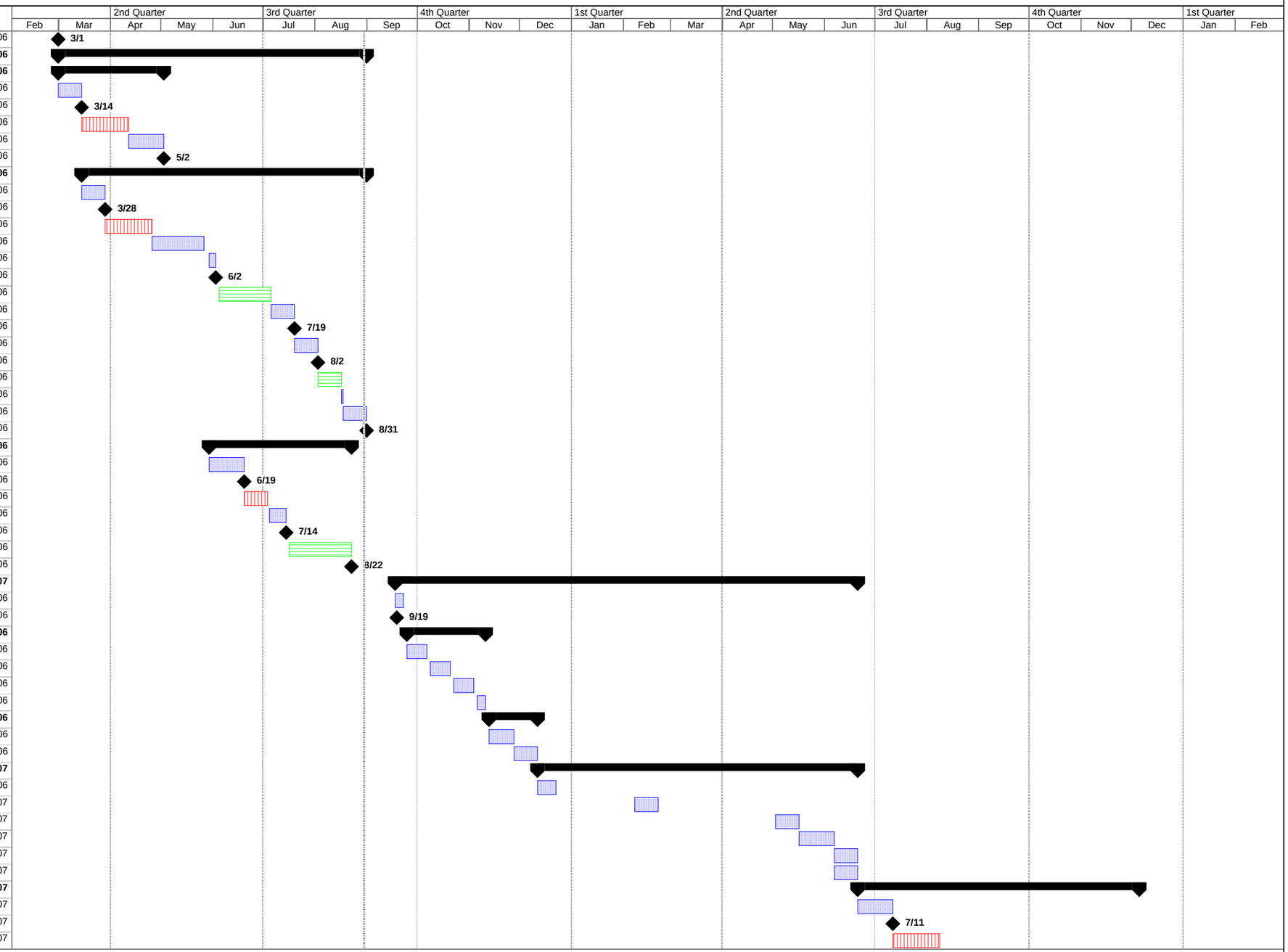
Details of the well design, installation techniques, and well development are described in the FSP. All IDW generated during the monitoring well installation activities will be managed in accordance with the FSP.

3.4.3 MONITORING PARAMETERS

The design of the monitoring system provides for collection of a suite of field and analytical parameters that inventory general water quality parameters, important redox species, and the concentrations of the contaminants of concern. The specific monitoring parameters are identified in Table 3.1.

Figure 6.1 Project Schedule
Pilot-Scale Treatability Study
Schilling AFB, Kansas

ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Wed 3/1/06	Wed 3/1/06
2	**Plans**	**130 days**	**Wed 3/1/06**	**Thu 8/31/06**
3	**Quality Conrol Plan**	**45 days**	**Wed 3/1/06**	**Tue 5/2/06**
4	Prepare Draft QCP	10 days	Wed 3/1/06	Tue 3/14/06
5	Submit Draft QCP	0 days	Tue 3/14/06	Tue 3/14/06
6	USACE Review	20 days	Wed 3/15/06	Tue 4/11/06
7	Prepare Final QCP	15 days	Wed 4/12/06	Tue 5/2/06
8	Submit Final QCP	0 days	Tue 5/2/06	Tue 5/2/06
9	**Work Plans**	**120 days**	**Wed 3/15/06**	**Thu 8/31/06**
10	Prepare Draft WP	10 days	Wed 3/15/06	Tue 3/28/06
11	Submit Draft WP	0 days	Tue 3/28/06	Tue 3/28/06
12	USACE Review	20 days	Wed 3/29/06	Tue 4/25/06
13	Comment Resolution	23 days	Wed 4/26/06	Fri 5/26/06
14	Prepare Revised Draft WP	4 days	Tue 5/30/06	Fri 6/2/06
15	Submit Revised Draft WP	0 days	Fri 6/2/06	Fri 6/2/06
16	PRP/RAB/KDHE Review	22 days	Mon 6/5/06	Wed 7/5/06
17	Prepare Responses to Comments	10 days	Thu 7/6/06	Wed 7/19/06
18	Comment Resolution Meeting	0 days	Wed 7/19/06	Wed 7/19/06
19	Prepare Draft Final WP	10 days	Thu 7/20/06	Wed 8/2/06
20	Submit Draft Final WP	0 days	Wed 8/2/06	Wed 8/2/06
21	PRP/RAB/KDHE 10 Day Backcheck	10 days	Thu 8/3/06	Wed 8/16/06
22	Prepare Responses to Comments	1 day	Thu 8/17/06	Thu 8/17/06
23	Prepare Final WP	10 days	Fri 8/18/06	Thu 8/31/06
24	Submit Final WP	0 days	Thu 8/31/06	Thu 8/31/06
25	**Permitting**	**60 days**	**Tue 5/30/06**	**Tue 8/22/06**
26	Prepare Draft Permitting Documentation	15 days	Tue 5/30/06	Mon 6/19/06
27	Submit Draft Permitting Documentation	0 days	Mon 6/19/06	Mon 6/19/06
28	USACE Review	10 days	Tue 6/20/06	Mon 7/3/06
29	Prepare Final Permitting Documentation	8 days	Wed 7/5/06	Fri 7/14/06
30	Submit Final Permitting Documentation	0 days	Fri 7/14/06	Fri 7/14/06
31	KDHE Review	27 days	Mon 7/17/06	Tue 8/22/06
32	KDHE Approval	0 days	Tue 8/22/06	Tue 8/22/06
33	**Field Activities**	**195 days**	**Mon 9/18/06**	**Wed 6/20/07**
34	Mobilization	5 days	Mon 9/18/06	Fri 9/22/06
35	Coordination Meeting with Property Owners	0 days	Tue 9/19/06	Tue 9/19/06
36	**Baseline Data/MW Installation**	**35 days**	**Mon 9/25/06**	**Fri 11/10/06**
37	Soil Sampling/Well Installation	10 days	Mon 9/25/06	Fri 10/6/06
38	Well Development	10 days	Mon 10/9/06	Fri 10/20/06
39	Baseline GW Sampling	10 days	Mon 10/23/06	Fri 11/3/06
40	Data Review for BA Determination	5 days	Mon 11/6/06	Fri 11/10/06
41	**Injection Activities**	**20 days**	**Mon 11/13/06**	**Mon 12/11/06**
42	Injection Bldg 837 (ERD)	10 days	Mon 11/13/06	Mon 11/27/06
43	Injection 606/626 (ISCO)	10 days	Tue 11/28/06	Mon 12/11/06
44	**Field Activities**	**135 days**	**Tue 12/12/06**	**Wed 6/20/07**
45	One Month	9 days	Tue 12/12/06	Fri 12/22/06
46	Three Month	10 days	Thu 2/8/07	Wed 2/21/07
47	Six Month	10 days	Thu 5/3/07	Wed 5/16/07
48	Sample Analysis	15 days	Thu 5/17/07	Wed 6/6/07
49	Data Validation	10 days	Thu 6/7/07	Wed 6/20/07
50	Data Management	10 days	Thu 6/7/07	Wed 6/20/07
51	**Treatability Study Report**	**120 days**	**Thu 6/21/07**	**Wed 12/5/07**
52	Prepare Internal Draft Report	15 days	Thu 6/21/07	Wed 7/11/07
53	Submit Internal Draft Report	0 days	Wed 7/11/07	Wed 7/11/07
54	USACE Review	20 days	Thu 7/12/07	Wed 8/8/07

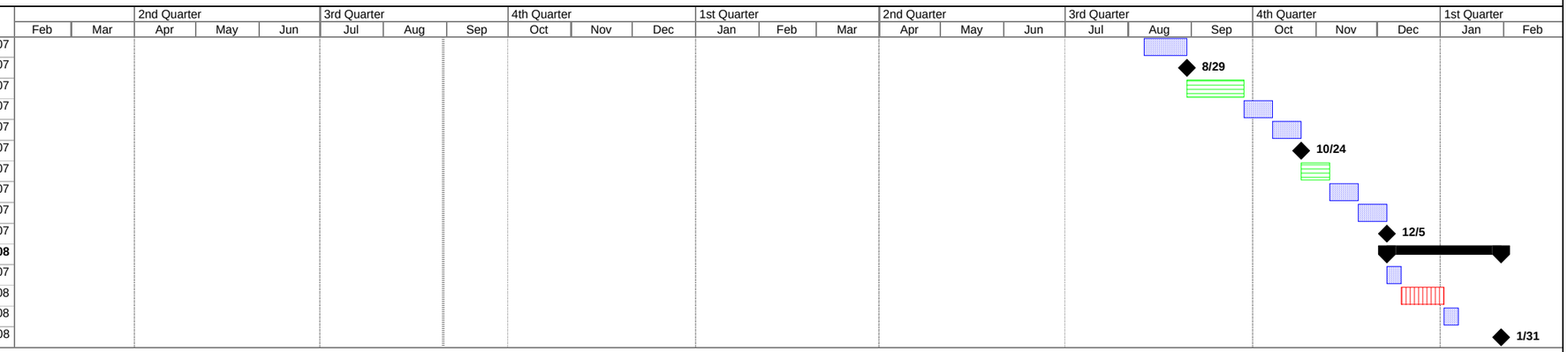


Project: SchillingAFB_schedule_0806
Date: Wed 8/30/06

Task | Milestone | Summary | USACE Review | Other Reivew

Figure 6.1 Project Schedule
Pilot-Scale Treatability Study
Schilling AFB, Kansas

ID	Task Name	Duration	Start	Finish
55	Prepare Draft Report	15 days	Thu 8/9/07	Wed 8/29/07
56	Submit Draft Report	0 days	Wed 8/29/07	Wed 8/29/07
57	PRP/RAB/KDHE Review	20 days	Thu 8/30/07	Wed 9/26/07
58	Prepare Responses to Comments	10 days	Thu 9/27/07	Wed 10/10/07
59	Prepare Draft Final Report	10 days	Thu 10/11/07	Wed 10/24/07
60	Submit Draft Final Report	0 days	Wed 10/24/07	Wed 10/24/07
61	PRP/RAB/KDHE 10 Day Backcheck	10 days	Thu 10/25/07	Wed 11/7/07
62	Prepare Responses to Comments	10 days	Thu 11/8/07	Wed 11/21/07
63	Prepare Final Report	10 days	Thu 11/22/07	Wed 12/5/07
64	Submit Final Report	0 days	Wed 12/5/07	Wed 12/5/07
65	**RAB Meeting**	**40 days**	**Thu 12/6/07**	**Thu 1/31/08**
66	Draft Presentation	5 days	Thu 12/6/07	Wed 12/12/07
67	USACE Review	15 days	Thu 12/13/07	Wed 1/2/08
68	Final Presentation	5 days	Thu 1/3/08	Wed 1/9/08
69	RAB Meeting	0 days	Thu 1/31/08	Thu 1/31/08



Project: SchillingAFB_schedule_0806
Date: Wed 8/30/06

Task | Milestone | Summary | USACE Review | Other Reivew

7.0 REFERENCES

HydroGeoLogic, Inc., (HGL), 2006, Quality Control Plan, Former Schilling Air Force Base Pilot Scale Treatability Study, Salina, Kansas, May, 2006.

U.S. Army Corps of Engineers, Kansas City District, 2005. Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Volume I, September 2005.

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FINAL
FIELD SAMPLING PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, MO 64106

Contract No. DAC41-02-D-0004
Delivery Order 0003

August 2006

FINAL
FIELD SAMPLING PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
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August 2006

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AHA	Activity Hazard Analysis
BA	Bioaugmentation
BART	Biological Activity Reaction Test
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
°C	degrees Celsius
COC	chain of custody
CQCM	Contractor Quality Control Manager
DCE	dichloroethene
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DOT	Department Of Transportation
DQCR	Daily Quality Control Report
DRO	diesel range organics
ERD	enhanced reductive dechlorination
eV	electron volts
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	gas chromatograph/mass spectrometer
g/kg	grams per kilogram
gpm	gallons per minute
HAB	heterotrophic aerobic bacteria
HGL	HydroGeoLogic, Inc.
HTW	hazardous toxic waste
IDW	investigation-derived waste
IRB	iron related bacteria
ISCO	in-situ chemical oxidation
ITR	Independent Technical Reviewer
K	conductivity
KDHE	Kansas Department of Health and Environment
KSU	Kansas State University

L/min	liters per minute
LNAPL	light non-aqueous phase liquid
μg/L	micrograms per liter
µg/kg	micrograms per kilogram
$\mu g/m^3$	micrograms per cubic meter
MIP/ECD	membrane interface probe/electron capture detector
ml/min	milliliters per minute
MS/MSD	matrix spike/matrix spike duplicate
ORP	oxidation reduction potential
PETG	polyethylene terephthalate glycol
PGM	Program Manager
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
PRG	Preliminary Remediation Goal
psi	pounds per square inch
PSTS	pilot scale treatability study
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
qPCR	quantitative polymerase chain reaction
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SAA	Salina Airport Authority
SMA	Salina Municipal Airport
SRB	sulfate reducing bacteria
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TOD	total oxidant demand
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UST	underground storage tank
VOC	volatile organic compound
ZVI	zero valent iron

FINAL
FIELD SAMPLING PLAN
PILOT-STUDY TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

1.0 INTRODUCTION

This Field Sampling Plan (FSP) describes the general field methodologies and specific field activities related to the Pilot-Scale Treatability Study (PSTS) being conducted at two areas at the former Schilling Air Force Base (AFB) in Salina, Kansas (Figure 1.1). The areas are located near Building 837 on the Kansas State University (KSU) at Salina Campus and between Buildings 606 and 626 (former Wash Racks Area). The site layout is illustrated on Figure 1.2. The site contaminants primarily consist of trichloroethene (TCE) and its degradation products *cis*-1,2-dichloroethene (DCE); *trans*-1,2-DCE; and vinyl chloride; and fuel constituents (benzene, toluene, ethylbenzne, and total xylenes [BTEX]). The work is being conducted by HydroGeoLogic, Inc. (HGL) under Delivery Order 0003 entitled "Pilot-Scale Treatability Study" issued on March 3, 2006 for the U.S. Army Corps of Engineers (USACE)-Kansas City District under DAC41-02-D-0004.

The Quality Assurance Project Plan (Appendix B) and this FSP comprise the Sampling and Analysis Plan (SAP) for the PSTS project. Information pertaining to project objectives, key personnel, and the schedule for this project can be found in the Design, Operations and Monitoring Plan (DOMP).

The preliminary screening of alternatives for the former Schilling AFB site has identified enhanced reductive dechlorination (ERD) and in-situ chemical oxidation (ISCO) as potential technologies for remediation of source areas at the site. The specific objectives of the ERD treatability study include:

- Evaluate the effectiveness of ERD in treating the dissolved phase chlorinated solvent contamination at the Building 837 source area.
- Obtain site specific performance data to assess the effectiveness of the selected substrate and method of injection.
- Develop preliminary parameters (i.e., substrate loading) and costs for detailed evaluation of this technology and design of full-scale implementation.

Similarly, the specific objectives of the ISCO treatability study include:

- Evaluate the effectiveness of ISCO in treating the chlorinated solvents and petroleum related contaminants detected in the vadose zone and groundwater at the Former Wash Rack (Buildings 606/626) study area.
- Obtain site-specific performance data to assess the effectiveness of the selected oxidant and method of injection.

- Develop preliminary parameters (i.e., oxidant loading) and costs for detailed evaluation of this technology and design of full-scale implementation.

The findings of the PSTS will be documented in a Treatability Study Report to be prepared at the conclusion of the study. Additionally, the PSTS results will be presented to the Schilling AFB Restoration Advisory Board.

1.1 REPORT ORGANIZATION

This field sampling plan is divided into six sections as summarized below.

Section 1.0 Introduction This section presents the site areas, delivery order information, contract number, and report organization. The site history, location, previous investigations, and environmental setting is described in this section.

Section 2.0 Field Methodologies This section discusses the procedures for the activities that are scheduled to be conducted at the site including: direct push technology (DPT) operations, sampling, disposal of investigation-derived waste (IDW), sampling, field measurements, equipment calibration, equipment maintenance, and surveying.

Section 3.0 Field Activities Details pertaining to stratigraphic logging, temporary monitoring well installation, sampling, and injections are described in this section.

Section 4.0 Field Documentation This section defines the information that must be recorded in the field logbook and forms that will be completed by the field team.

Section 5.0 References The references for this report are listed in this section.

1.2 BACKGROUND INFORMATION

This section provides details regarding the history of the site, current site conditions, use and occupants, and environmental setting.

1.2.1 SITE HISTORY

The Smoky Hill Army Base was built in 1942 as headquarters for the newly created Army Air Corps Unit, 20th Bomber Command, and became the first operational training base for B-29 bombers. The Base name was changed to the Smoky Hill Air Force Base in 1946 and to Schilling AFB in 1957. In 1942, the property encompassed 365 acres and housed 5,000 military employees. By 1967, the Base had expanded to 4,000 acres. The Base remained a bomber base for 5 years after World War II and was deactivated in 1949. In 1951, the Base was reopened for the Korean Conflict. Upon reactivation, several improvements to the facility were made, including a 25-mile long jet fuel pipeline that started in McPherson, Kansas, and terminated at a bulk oil storage farm on base. With the arrival of the Strategic Air Command and the 802nd Air Division at the Base in 1952, further site improvements, including the construction of a trainer building, a boiler facility, a gas distribution system, and bulk oil storage system, were completed. The Base was designated a permanent Air Force installation

in July of 1953. In 1960, the 802nd Air Division was deactivated, and the 40th Bombardment Wing was transferred to Schilling AFB. A squadron of Atlas F and Nike missiles was deployed to 12 sites around Schilling AFB and attached to Schilling AFB for support. New facilities were constructed for storage and repair of both conventional and nuclear munitions and nuclear warhead maintenance. Schilling AFB was also upgraded to receive B-52 bombers and KC-135 jet tankers. The closure of Schilling AFB was announced in 1964 and was transferred to the Salina Airport Authority (SAA) in 1966 (USACE, 2005).

1.2.2 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

The following subsections describe the previous investigations preformed at each site by study area.

1.2.2.1 Building 837 Study Area

There have been two remedial investigations at the former Schilling AFB, 1999 and 2005, respectively (B&M, 1999 and USACE, 2005). During the 1999 investigation activities, the Building 837 area was included in the sampling of Areas of Influence (AOI 99). In the 2005 investigation, the investigation activities focused on OU1 and included membrane interface probe/electron capture detector (MIP/ECD) screening at 27 locations in the Building 837 area (USACE, 2005). Seven direct push soil samples were collected at four of these locations and analyzed for VOCs, SVOCs, and metals. Groundwater samples were collected from two monitoring wells and were analyzed for SVOCs and VOCs. Direct push equipment also was used to collect 10 surface soil samples from a depth of 0 to 6 inches bgs for metals and SVOCs. Near-surface soil samples were also collected from 0.5 to 1.0 ft below ground surface (bgs) and submitted for VOC analysis. Groundwater samples were also collected in the Building 837 area. The objective of the groundwater investigation was to further define the leading edge of the VOC groundwater plume. Direct push equipment was used to collect ground water samples that were analyzed for TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE, vinyl chloride, carbon tetrachloride, and chloroform using an on-site gas chromatograph/mass spectrometer (GC/MS). Confirmation samples were collected at a rate of 10 percent of the GC/MS samples.

The Kansas Department of Health and Environment (KDHE) conducted an indoor air sampling event in the KSU College of Technology Building in 2004 (KDHE, 2004). At the KSU- Salina College of Technology, TCE was detected at 84.9 micrograms per cubic meter ($\mu g/m^3$) in Room 118 at the Tullis Building (Building 849-SA3). At the Technology Center Building (adjacent to Building 837), carbon tetrachloride was detected at 1.4 $\mu g/m^3$ in the ambient air sample, 1.5 $\mu g/m^3$ in Rooms 141B and 102, and at 7.6 $\mu g/m^3$ in the sub-slab sample in Room 141. The carbon tetrachloride detections exceed the Region 9 Preliminary Remediation Goal (PRG) of 0.13 $\mu g/m^3$. KDHE concluded that the carbon tetrachloride detections were not likely to be the result of vapor intrusion because it was also detected in the ambient air sample. The TCE, however, was attributed to possible vapor intrusion.

1.2.2.2 Former Wash Racks (Building 606/626) Study Area

This area was used as an aircraft wash area while Schilling AFB was operational. During the RI, four subsurface soil samples were collected with direct push equipment from 1 to 5 feet bgs and were analyzed for VOCs and total petroleum hydrocarbons (TPH) (USACE, 2005). A groundwater sample was obtained from one of the borings and from a temporary piezometer and were both analyzed for VOCs. One sediment sample was collected from the northwest storm water drain and was analyzed for SVOCs and inorganic constituents.

1.2.3 STUDY AREA DESCRIPTION

SAA has since used much of the property in operating the airfield, renamed as Salina Municipal Airport (SMA). The remainder of the former Schilling AFB is currently used for light-to-heavy industrial, aviation, and educational purposes. Many of these entities either lease property from SMA or have purchased their properties outright. Major landowners at the Schilling AFB include the Kansas Board of Regents KSU campus), the Salina Area Vocational Technical School, Kansas National Guard, and the Occupational Center of Central Kansas. Local industry includes Tony's Pizza, Schwan's Sales Enterprises, Raytheon (Beechcraft), Flower Aviation, and Moore's Midway Aviation.

The PSTS will be performed in two distinct areas at the former Schilling AFB: near Building 837 on the KSU campus and between Buildings 606 and 626 (former wash rack areas).

The KSU campus is an active university. Building 837 is located immediately adjacent to the campus administrative building. The area is an open grass field that lies between three active administrative and classroom buildings. There are sidewalks and utility crossings in and around the area. Care will be taken to ensure that disruptions to current operations are minimized during field activities.

The former Wash Racks (Buildings 606/626) are active facilities. The study area is a parking lot adjacent to the grassy area in and around Building 606. Numerous utilities and drainage lines exist in this area. A fuel oil underground storage tank (UST) was removed from the northwest corner of Building 606 in 1999.

1.2.4 ENVIRONMENTAL SETTING

The site location, geology, hydrogeology, groundwater chemistry, and nature and extent of contamination are described in this section.

1.2.4.1 Location

The former Schilling AFB is located in central Kansas, Saline County, just southwest of the city of Salina. At its maximum extent, the former Schilling AFB occupied all or parts of Sections 22, 27, 32, 33, and 35 in Township 14 South (T. 14 S.), Range 3 West (R. 3 W.), and Sections 2, 3, and 4 in T. 15 S., R. 3 W. The city of Salina incorporated the base into its legal boundary when it was acquired in 1966.

1.2.4.2 Soils

Two soil associations are present at the site. The central, western, and southern portions of the former Schilling AFB are within the Crete-Longford Association. This association consists of deep, nearly level to moderately sloping, moderately well-drained soils that have a silty or clayey subsoil. The eastern and northern portions of the former Schilling AFB are within the Detroit-Hord-Sutphen Association. It consists of deep, nearly level to moderately well-drained and well-drained soils that have silty or clayey subsoil; on stream terraces and floodplains (Merriam, 1957).

1.2.4.3 Geology

The local geology at the former Schilling AFB is defined by two principal regimes, the bedrock uplands, and the alluvial valley and terraces of the Smoky Hill River. The sites associated with this PSTS are located on the alluvial valley and terraces of the Smoky Hill River. These deposits consist of Pleistocene and Recent age alluvium. The alluvium is made up of stream-laid deposits of clay, silt, sand, and gravel from the Dry Creek and the Smoky Hill River Alluvium. The Dry Creek Alluvium is finer grained than the Smoky Hill River Alluvium and is mainly silt and clay with some poorly sorted clayey sand and gravel which contains fragments of shale, sandstone, and ironstone (Latta, 1949).

The upper-most bedrock unit at the sites is the Wellington Formation, which is weathered shale. The Wellington Formation acts as an aquitard and the upper portion is considered a confining unit to the underlying Wellington Aquifer. The Wellington Formation varies in color from gray to dark-gray with some reddish-brown and olive. Depth to bedrock at the Former Wash Rack (Building 606/626) area is approximately 21 to 29 feet bgs based on borings in the area. The depth to bedrock is deeper at Building 837 and is approximately 60 to 80 feet bgs based on MIP/ECD data (USACE, 2005).

1.2.4.4 Hydrogeology

The geologic regime at the former Schilling AFB is complex due to the manner in which the unconsolidated materials transition between residual uplands and alluvial valley or terrace deposits; thus, the hydrogeology is equally complex. The uppermost aquifer in the vicinity of the former Schilling AFB is the Smoky Hill River Valley alluvium. This aquifer is used for stock, domestic, irrigation, industrial, and public-supply purposes. The depth to groundwater generally ranges from 8 to 15 feet bgs. Recharge of this upper aquifer primarily occurs via infiltration of precipitation in the local area; however, a limited amount of recharge does occur via subsurface inflow from upstream alluvium. Historically, water well yields in the vicinity of the site have ranged from 50 to 1,700 gallons per minute (gpm). The higher yield wells were screened in the coarser-grained deposits, which is a relatively porous alluvium. The monitoring wells installed near the study area are typically screened in fine materials in the upper alluvium and in some instances, the upper foot of shale resulting in much lower yields.

1.2.4.5 Groundwater Chemistry

Groundwater produced from alluvial aquifers in the site area generally must be treated prior to domestic use due to excessive dissolved solids (>500 parts per million [ppm]), hardness (>200 ppm), and iron (0.1 ppm).

The Wellington Formation generally yields too little water and/or is too highly mineralized for most uses. In the zone of bedrock collapse induced by salt dissolution, prodigious volumes of water can be produced, but the water is usually saturated with sodium chloride (USACE, 2005).

1.2.4.6 Nature and Extent of Contamination

The Building 837 study area has been defined by previous site characterization activities and consists of an elongated area measuring approximately 190 feet long by 15 to 30 feet wide in overall dimensions. The depth of contamination detected in the saturated zone varies across the study area, but is generally observed within the saturated alluvial deposits extending 10 to 35 feet bgs (USACE, 2005). TCE and several of its breakdown products have been detected in monitoring well 99M24 located within the study area. Previous contaminant concentrations at this well location are summarized below:

- TCE concentrations range from 5,303 micrograms per liter (μg/L) to 79,000 μg/L
- *cis*-1,2-DCE concentrations range from 87.1 μg/L to 13,000 μg/L
- Vinyl chloride concentrations range from non-detect to 14 μg/L

Previous investigative activities at the Former Wash Racks (Buildings 606/626) study area includes direct push sampling and analysis of soils and groundwater. No monitoring wells exist in the immediate vicinity of the study area. Subsurface conditions include shallow surface fills overlying alluvial deposits, primarily silty clays with sand layers in upper alluvium, and sands with clay layers in the lower alluvium. Residuum and shale exist at depths of 21 to 29 feet bgs and groundwater occurs at 8 to 10 feet bgs (USACE, 2005). The three closest monitoring wells to this area show that bedrock is much shallower in the surrounding area (10 to 15 feet).

TCE and several of its breakdown products as well as fuel-related constituents have been detected in soil samples and monitoring wells in the surrounding area. Previous contaminant concentrations in soil and groundwater are summarized below:

- TCE concentrations range from 73.7 μg/L to 2,206 μg/L in groundwater and from 260 micrograms per kilogram (μg/kg) to 220,000 μg/kg in soil.
- *Cis*-1,2-DCE concentrations range from 3.8 μg/L to 583 μg/L in groundwater and from 75 μg/kg to 12,000 μg/kg in soil.
- Vinyl chloride concentrations range from non-detect to 1 μg/L in groundwater and from non-detect to 39 μg/kg in soil.

Filename: X:/KAN004/TO_103/MAPS Site_Location_Map.cdr
Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/09/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

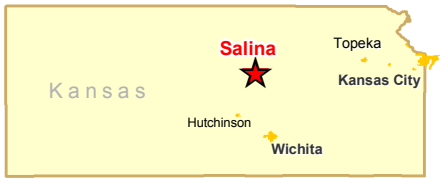


Figure 1.1
Site Location Map
Former Schilling AFB

Filename: X:/KAN004/TO_103/MAPS Site_Location_Map.cdr
Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/23/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

Legend

Study Area

Figure 1.2
Location Map of Buildings 837 and 626/606 Study Areas

2.0 FIELD METHODOLOGIES

The subsequent sections describe the field methodologies planned to be executed at the site during the PSTS. The Design, Operations, and Monitoring Plan (DOMP) provides a more extensive summary field sampling objectives.

A variety of field methods will be employed during the PSTS including the following:

- Stratigraphic Logging
- Monitoring Well Installation
- Injection
- Decontamination
- Disposal of IDW
- Site Survey
- Soil Sampling
- Groundwater Sampling
- Soil Field Measurements
- Groundwater Field Measurements
- Equipment Calibration
- Equipment Maintenance

Stratigraphic logging, prepacked monitoring well installation, and injection activities will be completed at both of the study areas during the PSTS using direct push methods.

2.1 STRATIGRAPHIC LOGGING

Subsurface soil samples will be obtained from boreholes to log the study area stratigraphy. The boreholes will be sampled continuously at 3- to 4-foot intervals utilizing a soil sampler, which will contain the samples in polyvinyl chloride (PVC), Teflon, or similar liners. All pertinent borehole information will be recorded on a hazardous and toxic waste (HTW) drilling log. A copy of a properly completed HTW drilling log and blank HTW drilling log is included in Attachment 1. Borings will be logged according to the general procedures described in USACE Engineer Manual EM 1110-1-4000 (1994) and as follows:

- A qualified experienced Kansas Licensed Geologist will prepare boring logs in the field, as borings are cored. Each log will be signed by the preparer;
- All log entries will be printed. Photo reproductions will be clear and legible;
- Borehole depth information will be from direct measurements accurate to 0.10 foot;
- Logs will be prepared on the HTRW drilling log, form NWK-55;
- All information blanks in the log heading will be completed as appropriate;
- Log scale will be 1 inch=1 foot;
- Each and every material type encountered will be described in column “c” of the log form;

- Unconsolidated materials will be described as follows:
  - Descriptive Unified Soil Classification System (USCS) classification;
  - Consistency of cohesive materials or apparent density of noncohesive materials;
  - Moisture content assessment (e.g., moist, wet, saturated, etc.);
  - Color
  - Other descriptive features (e.g., bedding characteristics, organic materials, etc.); and
  - Depositional type (e.g., alluvium, till, loess, etc.);
- Rock materials will be described in accordance with standard geologic nomenclature, including;
  - Rock type;
  - Relative hardness;
  - Density;
  - Texture;
  - Color;
  - Weathering;
  - Bedding;
  - Fractures, joints, and cavities; and
  - Other descriptive features (e.g., fossils, pits, crystals, etc.).
- Stratigraphic/lithologic changes will be identified in column "c" by a solid horizontal line at the appropriate scale depth on the log that corresponds to measured borehole depths at which changes occur, measured, and recorded to the nearest 0.1 foot. Gradational transitions, changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate depth based upon the best judgment of the logger;
- Logs will clearly show in column "f" the depth intervals from which all samples are retained;
- Logs will clearly identify the depth at which water is first encountered, the depth to water at the completion of coring, and the stabilized depth to water. The absence of water in borings will also be indicated. Stabilized water level data will include time allowed for levels to stabilize;
- Logs will show borehole and sample diameters and depths at which coring or sampling methods or equipment change;
- Logs will show total depth of penetration and sampling. The bottom of the borehole will be identified on the log by solid double lines from margin to margin with the notation "bottom of hole";
- Logs will identify any coring fluid losses, including depths at which they occur, rate of loss, and total volume lost;
- Logs will show coring fluids used, as appropriate;
- Source of makeup water;
- Core fluid additives by brand and product name, and mixture proportions; and
- Type of filter for compressed air.

- Logs will show depths and types of any temporary casing used;
- Logs will identify any intervals of hole instability;
- Intervals of lost bedrock core will be shown in column "e". Intervals of intact soil sampling attempts will also be shown in column "e", including depths from which attempts were made and the length of the sample recovered from each attempt. Bedrock coring information will also include:
  - Start and stop time of each core run;
  - Depth to top and bottom of each core run;
  - Length of core recovered from each run; and
  - Size and type of coring bit and barrel.
- Any special coring or sampling problems will be recorded on logs, including descriptions of problem resolutions; and
- Logs will include all other information relevant to a particular investigation, including but not limited to:
  - Odors;
  - Organic vapor meter measurements;
  - Any observed evidence of contamination in samples, cuttings or coring fluids.

2.2 TEMPORARY MONITORING WELLS

2.2.1 Installation

Prepacked monitoring well screens are installed by driving probe rods fitted with an expendable anchor point to a depth desired for well construction. When the final well depth is reached, a prepackaged well screen and riser pipe are lowered through the probe rods and fastened to the expendable anchor point. As the probe rods are retracted from the hole, the expendable point and prepacked well screen/riser assembly remain in place. As the probe rods are retracted to a point above the prepacked well screen, a sand barrier (similar to the filter pack material) is introduced into the annular space between the probe rod and the riser pipe. The sand barrier is used to prevent grout from entering the well screen. As the probe rods continue to be withdrawn, a bentonite sealing material and grout are placed above the sand barrier, incrementally, until the probe rods are removed and the annular space between the well riser assembly and borehole are filled. An alternative method of prepacked screen placement is to place a prefabricated well screen and riser pipe assembly into an open borehole, and subsequently backfill the hole with filter pack sand, bentonite seal, and grout, as required.

2.2.2 Well Development

After completion, the well will be developed using a peristaltic pump, inertial pump, or a bailer. During development the water quality parameters pH, temperature, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity will be monitored until they are stable. If the conditions are not stable within 1.5 hours of development time,

then the well will be considered developed. The USACE will be notified about the condition of the well during the daily reporting process.

2.2.3 Groundwater Sampling

Groundwater samples will be collected from each well using a small diameter bladder pump utilizing low-flow sampling procedures as described in Section 3.8 and Attachment 2. The VOC portion of the sample will be collected first, followed by metals. If bailing is used to purge the well, it will be performed at a very slow rate to minimize volatilization and sample turbidity.

For filtered metals sampling, a pressurized barrel filter with a 0.45-micron filter paper or an in-line 0.45 micron filter canister will be used. The filtered groundwater will be passed through the barrel filter or in-line filter and pumped directly into the appropriate sample container.

All groundwater grab samples will immediately be placed in a cooler with ice and properly preserved prior to sample shipment.

2.2.4 Abandonment

After all rounds of samples have been collected, the temporary wells will be abandoned according to the KDHE Plugging Packet guidance document. Each borehole will be plugged from the bottom of the boring to within 3 feet of the surface using a high solids bentonite slurry. The remaining 3 feet will be backfilled with native soil.

2.3 INJECTION

2.3.1 Building 837 Study Area

2.3.1.1 ABC™ Injection

The ABC™ solution is mixed and pumped using a Redox Tech™ injection trailer that will be equipped with a Sandpiper™ double diaphragm pump. The Sandpiper™ pump transfersthe ABC™ solution from the mixing tank to the injection well through a series of injection hoses and valves. The injection hoses are attached to the drill rods using a Geoprobe™ swivel coupler assembly (designed by Geoprobe™ for injecting fluids). The valves are used to shut off or restrict flow, if required. The Sandpiper™ pump is operated with an air compressor and controlled with an air regulator, which is mounted to the trailer. This allows the field crew to control the injection pressure. The mixing tank is graduated and therefore flow rates can be calculated by measuring the volume of solution over time, if required. The ABC™ injections are typically designed so that one tank of the solution is mixed for each Geoprobe™ injection point. If the volumes are small, then multiple injection wells can be addressed with a single tank. After an injection interval is completed, the casing is retracted and another interval is completed.

The ABC™ solution will be injected at the site through Geoprobe™ drill rods with a Redox Tech™ proprietary injection tool. A 6610 DT Geoprobe™ rig will be used to drive casing and the injection tool to the target depth. The ABC™ solution will then be injected at approximately 5 to 10 gpm, utilizing an injection pressure that may range from approximately 50 to 125 psi. The injection pressure will be determined in the field.

It should be noted the Geoprobe™ rig and injection tool mentioned above will be used for all injections unless otherwise described.

2.3.1.2 ABC™ and ZVI Injection

The ABC™ solution will again be mixed using the Redox Tech™ injection trailer. After the solution is mixed, the diaphragm Sandpiper™ pump transfers the solution to a ChemGrout™ CG-500HP high-pressure grout pump.

This unit has two 70-gallon mixing tanks, a 21-gallon holding hopper, and a high-pressure plunger grout pump. The double mix tank design permits continuous pumping as each mixing tank alternates feeding the pump. Each mixing tank is equipped with baffles and variable speed high-efficiency paddles that provide rapid mixing. The tank outlets are large slide gates that allow viscous grouting materials to flow quickly into the removable holding hopper. The holding hopper is connected directly to a double acting, positive displacement plunger pump.

As the ABC™ solution is pumped to the high-pressure grout pump the hoppers are filled and the paddles are rotated and the zero valent iron (ZVI) is added to the mixing solution at the proper percent by weight proportion. When the mixing is completed the solution is transferred to the holding hopper and pumped by the plunger pump to the injection hose and pumped to the desired depth.

2.3.1.3 RTB-1™ Injection (Bioaugmentation)

RTB-1™ will be delivered to the site in 10 liter sealed stainless steel cylinders. These containers will be equipped with an inlet and outlet port. The inlet port will be connected to nitrogen gas forcing the RTB-1™ solution into the injection line, ultimately evacuating the canister. The canister shall be equipped with a sight glass so the field crew can visually determine the volume of RTB-1™ injected.

The RTB-1™ will be injected simultaneously with the ABC™ solution (see Section 3.3 for details). The ABC™ solution will be mixed and injected following the procedures discussed in the ABC™ Injection section. RTB-1™ shall be introduced into the ABC™ injection hose downstream of the Sandpiper™ diaphragm pump using a wye fitting, prior to the top of the well screen or Geoprobe™ drill rods.

2.3.2 Former Wash Rack (Buildings 606/626) Study Area

2.3.2.1 Vadose Zone (Potassium Permanganate)

The potassium permanganate slurry will be injected at each target depth using a piston-feed grout pump utilizing the following steps:

- Potassium permanganate will be placed in a small hopper on the grout pump.
- Water will be slowly added to the potassium permanganate, forming a thick slurry (approximately 50 percent by volume).
- Gravity will feed the slurry into a port at the bottom of the hopper.
- The slurry will be injected through the drill rods, which is connected to the grout pump via a high pressure hose assembly.
- Once a predetermined volume of permanganate slurry has been injected, the drill rods shall be removed and the hole is filled with granular bentonite.
- A new tip will be placed on the drill rods and advanced to the next depth interval through the existing borehole. The purpose of the granular bentonite is to provide a seal around the drill pipe, and to prevent the expendable tip from falling off while the rods are advanced to the next interval.
- The entire procedure is then repeated.

One of the objectives of the study is to assess the effectiveness of the injection technique. Direct field observation of the oxidant distribution in the vadose zone is planned following completion of the initial vadose zone injections at three injection locations. The DPT equipment will be used to collect soil samples from probe locations offset from the injection points. Visual observation of purple soil staining is considered a positive indicator of the presence of the permanganate. If the results of these observations show relatively uniform distribution, the remaining injections will be completed as planned based on a radius of influence (ROI) of 5 feet. If the results show non-uniform distribution of the oxidant, the ROI may be decreased slightly in the field. With any increase in the number of injection points, the quantity of oxidant per injection point will be recalculated accordingly.

Upon completion, each boring will be sealed with bentonite slurry in accordance with abandonment procedures set forth by the State of Kansas and described in Section 2.2.4.

2.3.2.2 Saturated Zone (Sodium Persulfate)

The persuflate solution will be mixed in a 500-gallon poly tank, which is located on the Redox Tech™ injection trailer following the steps listed below:

- A predetermined mass of persuflate will be manually placed into the mixing tank.
- Water will then be added to achieve a 20 percent by weight solution.

- The solution will be mixed for a couple of minutes using an electric drill equipped with a mixing blade. Sodium persuflate is extremely soluble; therefore, it mixes easily.
- Approximately 10 gallons of 25 percent sodium hydroxide (catalyst) will be added for each 500 gallons of persuflate solution.

The sodium persulfate solution will be injected following the procedures detailed in Section 2.3.1.1 except the drill rods will be replaced with PVC injection points.

2.4 EQUIPMENT DECONTAMINATION

Decontamination of subsurface boring equipment will be performed before and after each location. At a minimum, the DPT subcontractor will utilize a high-pressure steam cleaner and wastewater collection system. Specific attention will be given to the coring rods. Equipment or supplies that cannot be effectively decontaminated (e.g., sample tubing or rope) will be disposed of after sampling. Investigation/sampling equipment will be cleaned at the site before use, between sampling locations, and before transport off site. Decontamination of field equipment will be noted in the project logbook. If it is necessary to make changes to decontamination procedures in the field, the changes will be noted in the logbook. Otherwise, a notation will be made each day that decontamination was conducted as specified in the project documents. Procedures for decontaminating investigation/sampling equipment that may be used at the study areas as follows:

Direct Push Rig and Equipment:

- High-pressure steam cleaning;
- Scrubbing with brushes if soil remains on equipment; and
- Steam rinsing.

The back end of the direct push rig, and all associated equipment (i.e., rods, cutting shoes, and drive cap) will be decontaminated before and after drilling each location. Once clean, no equipment may touch the ground before use. Equipment must be stored on the direct push rig, or on plastic sheeting.

Sampling Equipment will be decontaminated using the following procedure:

- Steam clean (DPT equipment only) or clean water rinse immediately after use;
- Detergent scrub with brushes (Alconox, Liquinox or equivalent detergent will be used if nutrients are analytes);
- Clean water rinse (with a steam cleaner for coring equipment);
- Double deionized water rinse;
- Air dry; and
- Cover (if not to be used immediately).

Submersible pumps and interior and exterior surfaces of pump hoses for all pumps used to purge groundwater wells will be decontaminated using the following procedure:

- Clean water rinse immediately after use;
- Detergent and tap water wash and flush;
- Clean water rinse and flush;
- Deionized water rinse and flush; and
- Air drying.

Equipment that cannot be adequately decontaminated will be discarded.

2.5 DISPOSAL OF INVESTIGATION-DERIVED WASTE

IDW includes disposable equipment and personal protection equipment (PPE), purge and development waters, soil obtained to define stratigraphy, and decontamination fluids. All IDW will be handled in a manner consistent with USACE and USEPA guidance for managing IDW for site inspections (see USEPA 540-G-91/009) and applicable federal and state regulations.

In general, the following procedures will be utilized to dispose of IDW unless the FSP directs otherwise:

- Resource Conservation and Recovery Act (RCRA) nonhazardous wastes (except disposable equipment and PPE) will be disposed of on site when possible if first approved by KDHE.
- When wastes cannot be pre-determined to be RCRA non-hazardous or on-site disposal is not possible, the wastes will be containerized as described below.
    - Decontamination waters will be containerized in a watertight container. After sample analysis, non-hazardous waters will be disposed of in the sanitary sewer.
    - RCRA nonhazardous and decontaminated disposable equipment and PPE will be double bagged and placed inside a dumpster for disposal at a sanitary landfill.
    - Waste acids and bases will be diluted or neutralized and flushed into a sanitary sewer.
    - IDW that is considered RCRA hazardous waste will be disposed of at an appropriate licensed hazardous waste disposal facility.

Investigation-derived soils and water will be field screened by visual inspection and with a photoionization detector (PID) to determine whether these wastes are contaminated. If samples have positive PID readings, all IDW associated from these sites will be placed in Department Of Transportation (DOT)-approved 55-gallon drums or other approved container. If clean soil cannot be placed at the well location as indicated above, they will be drummed. If potentially contaminated groundwater is identified by field screening or historical sample analysis, this water will be containerized in DOT-approved 55-gallon drums or other approved container.

All drummed cuttings and water will be transported to an area agreed upon between HGL and the SAA point of contact. The IDW will remain at this location until analytical results are received. Analytical data collected from IDW samples will be evaluated by HGL and the IDW subcontractor to determine the appropriate disposal methods.

2.6 SITE SURVEY

Surrounding structures will be surveyed at the former Wash Rack study area to define their elevations. New temporary monitoring wells also will be surveyed. The surveyed locations will be accurate to 0.1 foot and elevations will be accurate to within 0.01 foot. New temporary monitoring wells will be measured for both top of casing elevation and ground surface elevation.

2.7 SOIL SAMPLING

Soil samples collected using direct-push technology will be obtained by driving a soil-sampling device from the ground surface to the desired depth but not greater than that of the length of the sampling device. The soil sampling tool will be constructed of a steel tube, including a cutting shoe and a drive head, and lined with a plastic insert (liner) into which the soil is collected. Common liner material includes PVC, polyethylene terephthalate glycol (PETG), and Teflon. After driving the sampler to the required depth, it will be retracted from the ground. The plastic liner will then be removed from the tube and cut longitudinally to expose the soil core for logging by the site geologist and processing for chemical analysis. The interval selected for the intermediate sample will be determined by the field geologist based on screening results with a PID and visual observations of staining or other indications of contamination. These samples will be labeled, packaged and preserved according to procedures outlined in Section 2.14 and 2.15.

The sample tube will then be relined using a new liner and placed into the open borehole previously left by the sampler. Direct-push (probe) rods are then threaded to the top of the sampler and driven downward to obtain a sample from the next sampling interval. The process is repeated until the desired borehole depth is achieved.

In the event that the borehole does not remain open between sample runs, a closed-piston tip assembly will be inserted into the cutting shoe of the soil sampler. The tip will keep soil material out of the soil sampler until the desired depth of sample collection is achieved. To collect soil samples in this manner, a soil sampling tube and liner with a closed-piston top is inserted in the cutting shoe. The soil sampling tube/probe rod assembly to the desired depth. Using an extension rod lowered through the inside of the probe rods, is lowered the closed-piston tip is released and the sampler driven to depth as described above. The sampler is removed from the borehole, the soil core is retrieved, and the process is repeated until the desired borehole depth is achieved.

After the samples have been collected, the borings will be abandoned according to the KDHE Plugging Packet guidance document. Each borehole will be plugged from the bottom of the

boring to within 3 feet of the surface using a high solids bentonite slurry. The remaining 3 feet will be backfilled with native soil.

2.8 GROUNDWATER SAMPLING

2.8.1 Low-Flow Purging

Low-flow purging using a non-dedicated, variable speed bladder pump will be used during the PSTS. The objectives and methods for this procedure are included in the USEPA Guidance document titled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (USEPA, 1996) and the USACE-Kansas City District document titled *Standard Operating Procedure for Low-flow Groundwater Purging and Sampling* (USACE, 2002). The goal of installing and sampling temporary monitoring wells is to provide groundwater quality data that is representative of actual aquifer conditions with minimal alteration caused by inappropriate or variable sampling techniques. The equipment and procedure for performing low-flow groundwater sampling of the permanent wells are identified below.

- Purging will be performed using a variable speed bladder pump.
- Measure depth to water table and total depth of well with a water level indicator;
- The bladder pump intake will be located in the middle of the screened interval so that the water will be pumped directly from the formation. Field personnel may use discretion in adjusting the location of the pump intake to coincide with zones of higher permeability (if any) as indicated during well installation and development activities. Pumps or tubing should only be placed near the top of the well when light non-aqueous phase liquid (LNAPL) contaminants are suspected;
- Flow rates of 0.1 to 0.5 liters per minute (L/min) will be used for purging if possible. The well should be pumped at a rate where minimal drawdown during purging does not exceed 0.3 feet if possible and a stable water level is obtained. Water quality measurements will be used as the basis for establishing the stabilization of the well water. These well stabilization parameters will include DO, pH, specific conductivity, temperature, ORP, and turbidity. These parameters will be measured every 3 to 5 minutes until stabilization of all parameters is achieved. The purging will be considered complete after the field parameters have stabilized for three successive readings. The readings should be within ± 0.1 for pH, and $\pm 10\%$ for DO for readings above 1 mg/L; ± 0.1 mg/L below 1 mg/L, $\pm 1\%$ of full scale (instrument repeatability) or default ± 20 μmhos/cm for specific conductivity, ± 0.5 degrees Celsius (°C) for temperature, ± 10 mV for ORP, and < 50 NTUs for turbidity according the USACE protocol (USACE, 2002). All measurements will be tabulated for comparison on the sample collection field sheet. Final measurements will be recorded in the sampling log book.

- If the water level drops more that 0.3 feet during purging, water level stability has not been established. In this case either the Alternative Sustainable Recovery Well method or the Low-Recovery Well method from the USACE-Kansas City District *Standard Operating Procedure for Low-flow Groundwater Purging and Sampling* (USACE, 2002) will be used. This document is included as Attachment 2.

2.8.2 Low-Flow Collection

Low-flow sampling will be completed utilizing a bladder pump. A sampling flow rate between 0.1 and 0.5 L/min will be employed for all samples except VOC samples. VOC samples will be collected implementing a flow rate of 0.1 L/min. Samples to be analyzed for volatile or gaseous constituents will be withdrawn at flows that do not degas the samples.

Before collecting groundwater samples, the sampler shall don clean, phthalate-free protective gloves (i.e., nitrile or similar). If VOC samples are collected, hydrochloric acid will be added as a sample preservative to the VOC sample bottle before introducing the sample water. The sample will be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization. The sample vial will be filled until a meniscus is visible, and then sealed immediately. After sealing, it will be inverted and gently tapped to ensure that no air bubbles are present in the vial. If bubbles are observed, the vial may be opened and additional water carefully added so as to not overflow the container, resulting in loss of preservative. If the sample overflows, the sampler will discard that sample and recollect the sample using a new container. In areas where limestone is prevalent, some bubbling may occur as the hydrochloric acid preservative reacts with calcium carbonate. If a strong reaction occurs resulting in a large volume of bubbles, the sample will be collected in an unpreserved sample container. Unpreserved sample containers will be immediately shipped using an overnight courier to the laboratory with a notation on the chain of custody that the sample was unpreserved. The holding time for unpreserved VOC samples is 7 days (versus 14 days for preserved samples). After the containers are sealed, some sample degassing may occur, causing bubbles to form. If the bubbles are relatively small, they can be left in the container. Following collection of VOC samples, remaining water samples will be collected. The containers for the other analysis are not required to be free of headspace.

The microbial DNA samples will be collected by connecting a Microbial Insights filter to the end of the purge line. The water passed through the filter during sampling must be accurately measured to calculate microbe concentrations. The amount of sample passed through the filter will vary depending on the turbidity of the sample location. Microbial Insights recommends that sample water be passed through the filter until it clogs. If the sample location is well developed, the fines that would normally clog the filter are for the most part nonexistent; thus, a minimum of 1 to 2 liters must be passed through the filter. It should be noted, as the sample volume that is passed through the filter increases, the representativeness of that sample increases. If the sample volume passed through the filter is less than 500 milliliters, a second

filter must be collected. The volume of water passed through each filter is recorded. Both filters will be submitted for laboratory analysis as one sample.

Sampling equipment will be decontaminated in accordance with Section 2.4. The samples will be immediately placed in a sample cooler with ice, cooled, and maintained at sample temperature equal to or less than 4 °C.

2.9 SOIL FIELD MEASUREMENTS

A PID will be used to help determine the soil sample interval. The PID will utilize a lamp of equal to or greater than 10.6 electron volts (eV). The PID will display readings in ppm. The readings obtained will be recorded in the field logbook and HTW logging form.

2.10 GROUNDWATER FIELD MEASUREMENTS

The following text discusses the groundwater measurements that will be recorded during the PSTS at the study areas.

2.10.1 Water Level Measurements

Water-level measurements will be taken from selected permanent groundwater monitor wells to determine the elevation of the water table surface. Any conditions that may affect water levels will be recorded in the daily field log.

Water-level measurements will be taken with an electronic water level sounder. A water level sounder will issue an audible alert when the probe encounters the water table. The oil/water interface probe utilizes separate audible alarms when encountered LNAPL and the water table. All measuring equipment will be decontaminated according to the specifications in Section 2.4 of this plan. LNAPL and Groundwater levels will be measured to the nearest 0.01 foot.

Static water levels will be measured each time a well is sampled, and before any equipment enters the well. If the casing cap is airtight, time will be allowed prior to measurement for equilibration of pressures after the cap is removed. Measurements will be repeated until the water level has stabilized.

The depth to water will be periodically recorded during purging. If the water level drops more that 0.3 feet during purging, water level stability has not been established.

2.10.2 Discharge Measurements

Groundwater discharge measurements will be obtained during monitoring well purging. Groundwater discharges may be measured with orifice meters, containers of known volume, in-line meters, flumes, or weirs. Measurement devices will be calibrated using containers of known volume.

2.10.3 Water Quality Parameters

DO, pH, temperature, ORP and conductivity will be measured using an in-line electronic multifunction meter. This unit automatically corrects for salinity at low DO reading by estimating salinity from temperature and conductivity measurements, and then internally adjusting the DO reading.

Before use, the probes will be calibrated according to the manufacturer's specifications. The probes will be rinsed with clean water between each calibration solution. Used calibration solution is to be discarded.

After calibration, the probe is fitted into the flow-through cell provided with the instrument, using the included mounting hardware. The line from the in-well bladder pump is attached to one of the barbed hose fittings on the flow-through cell. A drain line is attached to the other fitting, with the effluent directed to a bucket. Pumping is then started. The maximum flow rate will not exceed 500 milliliters per minute (ml/min). All field measurements will be recorded and tabulated once the water level stabilizes. The probes and flow-through chamber will be thoroughly rinsed with clean water after use.

The turbidity meter is a separate meter. Before use, the turbidity meter will be calibrated according to the manufacturer's specifications. Samples for turbidity will be collected from the effluent of the hose. The turbidity meter will be rinsed with clean water between each calibration.

2.10.4 Photoionization Detector Measurements

A PID will be used to screen the monitoring well headspace for health and safety purposes. The PID will utilize a lamp of equal to or greater than 10.6 electron volts (eV). The PID will display readings in ppm. The readings obtained will be recorded in the field logbook. Further details pertaining to safety procedures are discussed in the Accident Prevention Plan (APP) (Appendix C).

2.10.5 Biological Activity Measurement

Iron related bacteria (IRB), sulfate reducing bacteria (SRB) and heterotrophic aerobic bacteria (HAB), the three most important agents involved in biofouling, can be monitored by the BART™ kit. The aforementioned bacteria can cause corrosion, clogging, or fouling of the water.

The BART™ kit does not require a microscope or incubator; however, the test must be preformed at roughly room temperature. Different microorganisms like to grow at different heights in a column of water to which nutrients have been added. The BART™ kit contains nutrients in the base of a column and a ball. The ball restricts the amount of oxygen entering the water column, so that aerobic organisms grow around the ball and anaerobic organisms grow deep down in the water column. By changing the nutrients in the base of the column,

different organisms are encouraged to grow; thus, the BART™ kit allows field team members to determine the presence and activity levels of microorganisms. The time taken for a color change to occur measures the population size and activity. The color change occurs in the BART™ tube as a result of the oxygen gradient diffusing from the bottom upward. The change of color indicates a presence of bacteria within that sample. Further interpretation of color changes and reaction times is provided with the kits.

2.11 EQUIPMENT CALIBRATION

Field equipment will be maintained and calibrated to the standards in their respective operations manuals. Equipment failures will be repaired in the field if possible; if not, the instrument will be tagged, removed from use, and returned for repair or replacement. Field equipment will be calibrated daily before the start of sampling activities. Those instruments that require recalibration when turned off will be recalibrated when turned back on. PIDs will be recalibrated throughout the day if a change in weather conditions occurs. Calibration records will be maintained on the Calibration Log (Attachment 1).

2.12 EQUIPMENT MAINTENANCE

Field equipment will be kept in a designated area in the field office when not in use and will be decontaminated prior to return to storage or rental vendor; any malfunctions will be reported to the field team leader. The field team leader will initiate actions necessary for the repair or replacement of defective equipment. Battery-powered instruments will be checked daily. Rechargeable instruments will be recharged daily.

2.13 FIELD QUALITY CONTROL SAMPLES

This section summarizes the types of field QC samples that will be collected at the study areas during the PSTS.

2.13.1 Equipment Rinsate Blanks

Equipment rinsate blank samples are prepared by pouring ASTM Type II reagent grade water into or over or pumped through a sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment rinsate blanks are used to assess the effectiveness of equipment decontamination procedures and to verify that cross-contamination between sites has not occurred. Equipment rinsate blanks will be collected immediately after the equipment has been decontaminated. One equipment blank will be collected per sampling event. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

2.13.2 Trip Blanks

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip

blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank will accompany each cooler of samples sent to the laboratory for VOCs analysis.

2.13.3 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis.

Duplicate sample results are used to assess precision of the sample collection process. Precision of samples to be analyzed for VOCs is assessed from co-located (soil) or sequentially collected (water) samples because the compositing process required to obtain uniform samples could result in loss of the compounds of interest. One duplicate sample will be collected for every tenth sample collected.

2.13.4 Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) samples are spiked with known contaminant concentrations by the laboratory to define the matrix effect. MS/MSD samples will be collected in the field by HGL and submitted to the laboratory for their use. One MS/MSD sample pair will be collected per every 20 samples.

2.14 SAMPLE LABELING

All samples will be assigned a unique sample identifier. Field personnel will generate a label for each sample container that will contain the sample identifier, date of sample collection, the sampler's initials, analytical parameters, and type of preservation used. The sampler will initial any change in the label information prepared prior to the sample collection.

A sample numbering system will be used to identify each sample collected and submitted for analysis. The purpose of the numbering system is to assist in the tracking of samples and to facilitate retrieval of analytical results. The sampling number will be used on sample labels, sample tracking forms, chain of custody (COC) forms, field logbooks, and for other applicable documentation.

The field sample numbering system will follow the general format outlined below:

XXX-AABBB-(C-C)-EEEE

XXX = Study area (e.g.- 606 and 837)

AA = Media Type
- SS = Subsurface Soil
- GW = Groundwater

BBB = Location Sample Number (Duplicate sample will be a 100 series number [i.e.- 102B])

(C-C) = Sample Interval (if applicable)

EEEE = Month and Year of Sampling (e.g.- 0206)

The QC sample numbering system will follow the general format outlined below:

MS	=	XXX-AABBB-(C-C)-EEEE-MS
MSD	=	XXX-AABBB-(C-C)-EEEE-MSD
Duplicate	=	XXX-AA1BBB-(C-C)-EEEE
Rinsate	=	XXX-AA2(F)-EEEE
Trip Blank	=	XXX-AA3(F)-EEEE

Rinsate samples will be a sequential 200 series number (i.e. -201 [day 1], -202 [day 2])

Trip blank samples will be a sequential 300 series number (i.e. -301 [day 1], -302 [day 2])

F = Sequential Number

2.15 SAMPLE PACKAGING AND SHIPPING

Preservation reagents will be added to sample containers before or immediately after collection of the sample. The samples will immediately be placed on ice and then maintained at 4 °C during transport to the laboratory.

Sample containers will be placed inside sealed plastic bags as a precaution against cross-contamination caused by leakage or breakage. Bagged sample containers will be placed in coolers supplied by the laboratory in such a manner as to eliminate the chance of breakage during shipment. Ice in plastic bags will be placed in the coolers to keep the samples at 4 °C throughout shipment.

Sample shipment will be performed in strict accordance with all applicable DOT regulations. The samples will be shipped to the laboratory by an overnight courier service, preferably Federal Express. Arrangements will be made between HGL and the contract laboratory point-of-contact for samples that are to be delivered to a laboratory on a weekend so that holding times are not compromised. All chemical analysis samples will be shipped to Severn Trent

Laboratories, Inc. in Chicago, Illinois and the microbial samples will be shipped to Microbial Insights, Inc. located in Rockford, Tennessee.

3.0 FIELD ACTIVITIES

The following text lists and subsequent sections discuss the field activities, in the general order of occurrence, that are scheduled to be completed at the study areas.

- Temporary Monitoring Well Installation
- Pre-Injection Sampling
- Injection at the Building 837 study area
- Injection at the Former Wash Rack (Building 606/626) study area
- Performance Monitoring Sampling

All activities will be performed according to the appropriate procedures in Section 2.0.

3.1 TEMPORARY MONITORING WELL INSTALLATION

Temporary monitoring wells will be installed to collect groundwater samples to provide baseline data, determine the effectiveness of the injections, and define the radius of influence. The stratigraphy will be logged at the study areas to document geologic conditions and aid with selecting the screening intervals of the prepacked monitoring wells.

3.1.1 Building 837 Study Area

A total of 19, temporary monitoring wells will be installed at this area (Figure 3.1). The temporary monitoring well network will include 10 monitoring well clusters consisting of 2 wells per cluster with 5 foot screen intervals within the upper and lower treatment zones. Preliminary well screen intervals in the upper portion of the treatment zone (designated as 'A' wells) will be from 15 to 20 feet. Preliminary well screen intervals in the deeper portion of the treatment zone (designated as 'B' wells) will be from 25 to 30 feet. Final well screen intervals will be determined in the field. It is intended that wells be screened across both the fine- and coarse-grained alluvial deposits. One of the clusters will consist of an existing shallow monitoring well (99M24) and a temporary prepacked deep monitoring well (MW-7B) installed during the PSTS. Thus, the total number of temporary monitoring wells is 19. Three of the well clusters will be located downgradient (MW-04A/B, MW-05A/B and MW-06A/B) and three well clusters will be located side gradient (MW-01A/B, MW-02A/B and MW-03A/B) to the direction of groundwater flow. These wells will be spaced with increasing distance (4.5, 9 and 15 feet) from their companion injection point (IP-B01 and IP-B02). The monitoring well network will include single well clusters in the center and northern portions of the study area to assess the effectiveness of the substrate amended with ZVI and without ZVI and bioaugmentation (BA). The single well clusters are generally located where previous MIP/ECD probes were completed. The stratigraphy will be recorded at five deep well locations (MW-02B, MW-05B, MW-08B, MW-09B and MW-10B) that will be strategically spaced across this study area. See Table 3.1 for monitoring well information and rationale.

3.1.2 Former Wash Rack (Building 606/626) Study Area

The monitoring well network at this area will include eight monitoring well clusters consisting of two wells per cluster with 5 foot screen intervals within the upper and lower treatment zones. Preliminary well screen intervals in the upper alluvium (designated as 'A' wells) will be from 10 to 15 feet. Preliminary well screen intervals in the deeper alluvium (designated as 'B' wells) will be from 15 to 20 feet. Three of the well clusters will be located downgradient (MW-06A/B. MW-07A/B and MW-08A/B) and three well clusters will be located side gradient (MW-02A/B, MW-03A/B and MW-04A/B) to the direction of groundwater flow. These well clusters will be spaced with increasing distance (4.5, 9 and 15 feet) from their companion injection point (IP-G04 or IP-G10). The other two well clusters will be located in the southern and northern portions of the study area to assess the effectiveness of ISCO at the previous MIP/ECD locations. These wells will be located 4.5 feet from their companion injection point. The deep well locations (MW-03B, MW-05B and MW-07B) at this study area will be sampled and logged as necessary to document site stratigraphy and select the final well screen intervals. See Table 3.2 for monitoring well information and rationale. The temporary monitoring well locations are displayed on Figure 3.2.

3.2 PRE-INJECTION SAMPLING

Soil and groundwater samples will be collected during the pre-injection sampling. All soil and groundwater samples will be collected according to procedures in Section 2.0.

3.2.1 Soil Sampling

Pre-Injection soil samples will be collected from both study areas.

3.2.1.1 <u>Building 837 Study Area</u>

Although ISCO is not being considered for the Building 837 study area, the field studies will include bench scale testing of soil samples to evaluate TOD. Two samples from the deep boring for MW-07B, one sample of fine-grained soil and one coarse-grained sample will be analyzed for TOD. Comparison of TOD data from the Building 837 study area and the former Wash Rack study area will provide information on the variability of TOD across both sites.

Tables 3.3 through 3.5 summarize the soil sampling rationale, number of samples to be collected, QC samples, and analysis for this study area.

3.2.1.2 <u>Former Wash Rack (Buildings 606/626) Study Area</u>

Before injection, a series of baseline soil borings will be advanced to collect samples for TOD analysis and chemical analysis of VOCs and TPH-diesel range organics (DRO).

TOD analysis will be conducted on six soil samples from two monitoring well borings (MW-01B and MW-05B). One soil sample from the vadose zone and two samples from the saturated

zone will be collected from each boring. The samples will be submitted to Redox Tech for TOD analysis. The samples are intended to be representative of the fine-grained and coarse-grained materials beneath the site to assess the variability of TOD within soil types. These TOD results for these samples will be used to finalize oxidant loading rates for injection.

The baseline contaminant concentrations (VOC and TPH-DRO) in the vadose zone will be documented at three borings located in each of the three subareas referred to as Subarea CS-1, Subarea CS-2 and Subarea CS-3 as shown on Figure 3.3. At each boring, soil samples will be collected from a shallow (5 to 6 feet bgs) and deep (7 to 8 feet bgs) interval for VOC and TPH-DRO analysis.

Tables 3.6 through 3.8 summarize the soil sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.3 displays the sampling locations.

3.2.2 Groundwater Sampling

Groundwater samples will be collected from both study areas prior to the ERD and ISCO injections.

3.2.2.1 <u>Building 837 Study Area</u>

Four bench test samples will be collected and submitted for microbial analysis before the substrate solutions are injected to determine native population. The stimulation of anaerobic dechlorination requires the presence of microorganisms (specifically dehalococcoides). As part of the planned field studies, groundwater samples will be collected and analyzed for quantitative polymerase chain reaction (qPCR), which is a Deoxyribonucleic Acid (DNA)-based approach that provides a means to obtain direct information regarding the dominant biological processes occurring within the subsurface. Groundwater samples collected from temporary monitoring wells screened in both the fine-grained and coarse-grained alluvium will be submitted to Microbial Insights for bench-scale testing to assess potential differences in the microbial populations versus soil type.

Sixteen monitoring samples (one from each well at the site except MW-01A/B and MW-06A/B) will be collected before the treatment injections are implemented to establish baseline conditions. The laboratory analyses of these samples will include: VOCs, filtered metals (manganese and iron), alkalinity, anions (chloride, nitrate, sulfate, phosphate), carbon dioxide, ethene, ethane, volatile fatty acids, and total organic carbon (TOC). Field parameters will also be collected from each well. In addition, field parameters will be collected from the outer well clusters used to assess ROI (MW-01A/B and MW-06A/B). Analytical samples will not be collected from these four wells.

Tables 3.9 through 3.11 summarize the groundwater sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.1 displays the sampling locations.

3.2.2.2 Former Wash Rack (Buildings 606/626) Study Area

Groundwater samples will be collected before injection/treatment commences to establish baseline conditions from all 16 wells installed for the study. Twelve of these wells will be analyzed for VOCs, TPH-DRO, filtered metals (iron and arsenic), and field parameters. An unfiltered arsenic sample will also be collected for a baseline comparison sample. Field parameters will be collected from the two outer well clusters used to assess ROI (MW-04A/B and MW-08A/B). Analytical samples will not be collected from these four wells. Baseline sampling will include microbial analysis of two groundwater samples, one from a shallow monitoring well (MW-05A) and one from a deep monitoring well (MW-05B).

Tables 3.12 through 3.14 summarize the groundwater sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.2 displays the sampling locations.

3.3 INJECTION AT THE BUILDING 837 STUDY AREA

The effectiveness of ERD at the Building 837 study area will be influenced by the distribution of the substrate in the subsurface environment. The site poses challenges in achieving a uniform distribution given the presence of interbedded fine and coarse grained soils whose hydrogeologic properties (e.g., conductivity) can vary over several orders of magnitude. In order to properly disperse the substrate within the designated areas, the conceptual design features 15 injection points distributed spatially across two rows to encompass the total study area. The substrate injections will be performed using DPT equipment. Injection of the substrate is planned from the groundwater surface to a depth of approximately 35 feet bgs. The injection points will be removed upon completion of the injection activities.

Assuming an ABC™ formula loading rate of 550 pounds for every 8,000 cubic feet of soil, approximately 11,000 pounds of ABC™ will be required to treat the study area at Building 837. ZVI will be mixed with the ABC™ at a 20 percent by weight solution. The addition of ZVI will occur during the injection process at six locations in the northern portion of the study area (locations 1p-Z10 to 215). The ABC™ formula will be mixed at a 15 percent solution with water in order to increase the dispersion and radial influence at each point. This results in approximately 3,600 gallons of solution.

If baseline sampling results indicate that reducing conditions exist at the site then six injection points in the southern portion of the study area will be augmented with BA (locations 1P-B01 to -B06). Approximately, 1 liter of RTB-1™ solution will be used for every 100 gallons of ABC™ solution. If baseline samples indicate that reducing conditions are not present or DNA samples do not indicate favorable population levels of bacteria then 100 gallons of ABC™ solution will be injected at the six injection locations listed above at the beginning of the Treatability Study. Approximately two weeks later (after completing the ISCO field work) RTB-1 will be injected at the same six locations. Based on the existing data two weeks should be enough time to allow reducing conditions to be achieved. The reducing conditions are

necessary to keep the bacteria in the RTB-1 alive. The RTB-1 will be mixed at a ratio of 1 L per 100 gallons of ABC™ .

The injection locations are displayed on Figure 3.1.

3.4 INJECTION AT THE FORMER WASH RACK STUDY AREA

Two different ISCO solutions (potassium permanganate and sodium persulfate) will be injected at the former Wash Rack (Buildings 606/626) study area. Potassium permanganate is scheduled to be dispersed in the vadose zone, and sodium persulfate will be introduced into the saturated zone.

3.4.1 Vadose Zone (Potassium Permanganate)

For the vadose zone, the conceptual approach provides for 17 injection points (approximately 10 foot on-center, adjusted locally for utility locations), spaced across two rows encompassing a 20-by-95 foot area.

Treatment of the unsaturated zone is estimated to require approximately 2,700 pounds of potassium permanganate assuming a total oxidant demand of 2 grams of oxidant for each kilogram of soil. The final chemical loading will be based on Total Oxidant Demand (TOD) results from the bench-scale studies. The potassium permanganate will be mixed into a slurry form (approximately 50 percent by volume with water) and injected into the vadose zone soils through the drill rods. Injections will be conducted at 2-foot intervals from 4 feet bgs to approximately 10 feet bgs (the water table). Based on 4 injections at each injection point, this will result in approximately 68 total injections with each injection introducing approximately 40 pounds of potassium permanganate slurry into the subsurface. This tight injection spacing, both vertically and horizontally, will provide a much more efficient distribution of the oxidant within the unsaturated zone than can be achieved via pumping through well screens spaced at greater distances.

Figure 3.3 illustrates the injection locations for this area.

3.4.2 Saturated Zone (Sodium Persulfate)

For the saturated zone, the conceptual approach provides for 10 injection points (approximately 20 foot on-center, adjusted locally for utility locations) spaced across two rows encompassing a 20-by-85 foot area. Similar to the vadose zone, injections in the saturated zone will be performed using direct push equipment. Injection of the sodium persulfate will begin at the groundwater surface and extend to a depth of approximately 20 feet bgs. Sodium persulfate will be injected into the soil formation through temporary injection points constructed with ¾-inch PVC schedule 40 screens and risers. Each injection point will consist of two nested wells, screened from 10 to 15 feet bgs, and 15 to 20 feet bgs. The purpose of the nested injection points is to ensure that adequate vertical distribution of the oxidant solution is achieved. The injection points will be removed upon completion of the injection activities.

Based on an areal extent of 95-by-20 foot and a target thickness of 10 ft, approximately 1,300 cubic feet of saturated aquifer will require treatment. Assuming a TOD of 2 grams per kilogram (g/kg), approximately 6,300 pounds of sodium persulfate will be needed to treat the target zone. This value accounts for both the target contaminants and the oxidant demand of the organic matter and other possible oxidant consumers that may exist within the soil. Mixed at a 20 percent by weight solution, approximately 3,800 gallons of sodium persulfate solution will be required.

The injection locations for the former Wash Rack study area are displayed on Figure 3.2.

3.5 PERFORMANCE MONITORING

Soil and groundwater samples will be collected during performance monitoring to assess the ROI and the effectiveness of the treatment.

3.5.1 Soil Sampling

3.5.1.1 Field Assessment of Oxidant Distribution

The need for field assessment of the oxidant distribution during the initial injections at the former Wash Rack (Buildings 606/626) was initially described in Section 2.3.2.1. Oxidant injection in the vadose zone will begin with IP-V05, IP-V06, and IP-V07. When these three injection points are completed, the DPT equipment will be used to sample a series of probe locations to observe the presence or absence of soil discoloration as an indicator of permanganate distribution. The first probe will be offset 2 feet from an injection point (e.g., IP-V05) and two soil samples will be collected for observation from depths of 6 feet and 8 feet. Assuming positive confirmation of permanganate distribution, the next probe shall be off-set 4 feet from the injection point and two samples will be collected for observation from depths of 6 feet and 8 feet. Assuming positive confirmation of permanganate distribution, no further probing will be required. If positive confirmation of the oxidant distribution cannot be made, two additional probes shall be sampled with off-set distances of 2 feet and 4 feet from IP-V06 (sampling depths of 6 feet and 8 feet). Based on these field observations, field personnel in consultation with USACE will make adjustments in the spacing and layout of the final injection points.

3.5.1.2 Post-Injection Soil Sampling

The monitoring program for the vadose zone at the former Wash Rack (Buildings 606/626) will focus on chemical analysis of VOCs and TPH-DRO in soils. As described previously in Section 3.2.1.2, three subareas of the study area have been designated for pre- and post-injection soil sampling. These areas are identified as Subareas CS-1, CS-2 and CS-3. Pre-injection sampling in each of these subareas will include collection of 2 samples from each subarea at depths of 6 and 8 feet using DPT equipment. The DPT sampling locations will be off-set 2.5 feet from the closest injection point in each subarea. The soil samples will be analyzed for VOCs and TPH-DRO to establish baseline contaminant concentrations prior to injection.

Following injection, post-injection soil sampling will be performed in each of the three subareas (CS-1, CS-2 and CS-3) in the same manner as the pre-injection sampling. The DPT probe locations will be off-set 2.5 feet from the closest injection point and approximately 6 inches from the pre-injection sampling location.

The post-injection sampling will be performed approximately 1 month and 3 months after injection.

Tables 3.6 through 3.8 summarize the soil sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.3 displays the sampling locations.

3.5.2 Groundwater Sampling

Groundwater samples will be collected from both study areas during the performance monitoring period of the field activities.

3.5.2.1 Building 837 Study Area

Performance groundwater samples will be collected from the Building 837 study area during this period to provide monitoring and biofouling information.

The twenty monitoring wells located within this study area will be sampled after the injections have been completed at the following intervals: 1 month, 3 months, and 6 months. Laboratory analyses of 16 of these samples will consist of VOCs, filtered metals (iron and manganese), alkalinity, anions (chloride, nitrate, sulfate, phosphate), carbon dioxide, ethene, ethane, volatile fatty acids, and TOC. Field parameters will also be collected from these wells. Field parameters will be collected from the outer well clusters used to assess ROI (MW-01A/B and MW-06A/B). Anaytical samples will not be collected from these four wells. Microbial analysis will be performed on samples collected from MW-05 A/B and MW-10 A/B during the 1-month and 6-month sampling events.

In order to assess the potential for biofouling, three groundwater samples will be collected from wells in the north, central and south areas of study area during the final round of monitoring. These samples will be analyzed on site using the Biological Activity Reaction Test (BART™) kit. The field-screening kit tests for the presence of different types of bacteria that have the potential to cause biofouling.

Tables 3.9 through 3.11 summarize the groundwater sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.1 displays the sampling locations.

3.5.2.2 Former Wash Rack (Buildings 606/626) Study Area

Groundwater samples will be collected from 16 temporary monitoring wells at 1 month, 3 months, and 6 months after the injections. Laboratory analyses for 12 of these samples will

include: VOCs, TPH-DRO and filtered metals (iron and arsenic). Field parameters will also be collected from the samples. Field parameters will be collected from the outer well clusters used to assess ROI (MW-04A/B and MW-08A/B). Analytical samples will not be collected from these four wells.

Tables 3.12 through 3.14 summarize the groundwater sampling rationale, number of samples to be collected, QC samples, and analysis for this study area. Figure 3.2 displays the sampling locations.

3.6 INVESTIGATION-DERIVED WASTE SAMPLING

All drummed cuttings and water (IDW) will be transported to an area agreed upon between HGL, the SAA point of contact. The IDW will remain at this location until analytical results are received. The contents of the drums that are suspected to be contaminated will be characterized using data generated during the various sampling events. VOC toxicity characteristic leaching procedure (TCLP), corrosivity, ignitability, and reactivity analyses will be collected if the landfill or treatment plant taking the IDW requests the analyses. Tables 3.15 and 3.16 summarize the samples that may be collected to determine disposal options for IDW generated at the Building 837 study area and Wash Rack study area, respectively. The IDW water disposal events are scheduled to be conducted at approximately 3 months (IDW removal Phase I) and 7 months (IDW removal Phase II) after the baseline sampling. Data from the IDW will be evaluated by HGL and the IDW subcontractor to determine the appropriate waste disposal.

Table 3.1
Building 837 Study Area
Monitoring Well Information and Installation Rationale

Reference Figure Number	Installation Rationale	Monitoring Well Information			
		Number of Proposed Monitoring Wells to be Installed	Boring Depth (ft bgs)	Proposed Depth of Monitoring Well (ft bgs)	Sand Monitoring Well will be Screened in
3.1	**Shallow Temporary Wells** - Installation of 9 new performance temporary monitoring wells is proposed in the area to the northeast of Building 837. Existing monitoring well 99M24 will be utilized as the tenth shallow performance well. The installation of these wells will provide sufficient data to asses the effectiveness of the substate and its amendments within the upper alluvial deposits. At each location, a shallow and a deep well will be installed together forming a well cluster.	9 performance monitoring wells Shallow Temporary Wells • MW-01A • MW-02A • MW-03A • MW-04A • MW-05A • MW-06A • MW-08A • MW-09A • MW-10A	As deep as 20 feet	Monitoring wells will be screened from 15 to 20 feet bgs. Continuous soil samples will be collected for lithology and logged at select locations.	Upper Alluvial clays and sands (predominant soil type is expected to be silty clay with sand layers)
	Deep Temporary Wells - A total of 10 peformance temporary monitoring wells in the lower alluvial deposits are proposed in the area to the northeast of Building 837. The network of wells will establish vertical control, determine groundwater gradients, and the effectiviness of the substate within the lower zone.	10 performance monitoring wells Deep Temporary Wells • MW-01B • MW-02B • MW-03B • MW-04B • MW-05B • MW-06B • MW-07B • MW-08B • MW-09B • MW-10B	As deep as 35 feet	Monitoring wells will be screened from 25 to 30 feet bgs. Continuous soil samples will be collected for lithology and logged at select locations.	Lower Alluvial sands with clay (predominant soil type is expected to be sand with clay layers)

Key:
bgs = below ground surface
ft = feet

Table 3.2
Former Wash rack (Building 606/626) Study Area
Monitoring Well Information and Installation Rationale

Reference Figure Number	Installation Rationale	Monitoring Well Information			
		Number of Proposed Monitoring Wells to be installed	Boring Depth (ft bgs)	Proposed Depth of Monitoring Well (ft bgs)	Sand Monitoring Well will be Screened in
3.2	**Shallow Temporary Wells** - Installation of 8 new performance monitoring wells is proposed in the area to the west of Building 626 and to the east of Building 606. The installation of these wells will provide sufficient data to asses the effectiveness of the oxidant and its amendments within the upper alluvial deposits. At each shallow monitoring well location, a deeper well will be installed and together will constitute a well cluster.	8 performance monitoring wells Shallow Temporary Wells • MW-01A • MW-02A • MW-03A • MW-04A • MW-05A • MW-06A • MW-07A • MW-08A	As deep as 15 feet	Monitoring wells will be screened in the upper 5 feet of the treatment zone (approximately 10 to 15 feet bgs). Continuous soil samples will be collected for lithology and logged at select locations.	Upper Alluvial clays with sand
	Deep Temporary Wells - A total of 8 performance monitoring wells in the lower alluvial deposits are proposed in the area to the west of Building 626 and to the east of Building 606. The network of three wells will establish vertical control, determine groundwater gradients, and the effectiviness of the oxidant within the lower zone.	8 performance monitoring wells Deep Temporary Wells • MW-01B • MW-02B • MW-03B • MW-04B • MW-05B • MW-06B • MW-07B • MW-08B	As deep as 20 feet	Monitoring wells will be screened in the lower portion of the treatment zone (approximately 15 to 20 feet bgs). Continuous soil samples will be collected for lithology and logged at select locations.	Lower Alluvial Sand Zone

Key:
bgs = below ground surface
ft = feet

Table 3.3
Building 837 Study Area
Soil Sampling Rationale

Reference Figure Number	Sampling Rationale	Proposed Investigations						
		Sample Type	Number of Locations	Samples Per Location	Boring Depth (ft bgs)	Sample Depth (ft bgs)	Sample Location	Analytical Test and Methods to be conducted
3.1	The field studies will include bench-scale testing of soil samples (fine and coarse-grained soil to evaluate Total Oxidant Demand (TOD). Two samples will be collected; one in the upper alluvial zone (silty clay) and a second in the lower alluvial zone (sand). Comparison of TOD data from the Building 837 Study Area and the Building 606/626 Study Area will provide information on the variability of TOD across both sites.	Subsurface Soil	1	2	As deep as 35 feet	Sample depths will range from 12 to 35 feet	Samples will be collected at MW-07B	Total Oxidant Demand (TOD)

Key:
bgs = below ground surface

Table 3.4
Building 837 Study Area
Soil Sample Analytical Summary

Sample Type/Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Subsurface Soil	Total Oxidant Demand (TOD)	none	2	0	0	0	0	0	48 hours	Ice to 4 °C	100 grams collected from soil core	2

Key:
QC = Quality Control
MS = matrix spike
MSD = matrix spike duplicate

Table 3.5
Building 837 Study Area
Soil Sample Details

Location Identification	Sample Depths	Analytical Parameters	QC Duplicates	MS/MSD	Notes
		Total Oxidant Demand (TOD)			
Baseline Sampling (prior to injection)					
TS837MW-7B (Borehole)	2 Samples; 1 collected from the upper alluvial clays and 1 collected from the lower alluvial sands (Depths range from 12 to 35 ft bgs)	X			No subsequent subsurface soil sampling is scheduled for the Building 837 Study Area.

Key:
ft = feet
bgs = below ground surface
QC = quality control
MS/MSD = matrix spike/matrix spike duplicate

Table 3.6
Former Wash rack (Building 606/626) Study Area
Soil Sampling Rationale

Reference Figure Number	Sampling Rationale	Proposed Investigations						
		Sample Type	Number of Locations	Samples Per Location	Boring Depth (ft bgs)	Sample Depth (ft bgs)	Sample Location	Analytical Test and Methods to be conducted
3.2	**Bench-Scale Study** - A series of baseline soil borings will be advanced to obtain information on site strigraphy for design of the monitoring program and to collect samples for Total Oxidant Demand (TOD). Comparison of TOD data from the former Wash Rack Study Area and the Building 837 Study Area will provide information on the variability of TOD across both sites. Samples will be collected from the vadose zone and the saturated zone of representative alluvial soil.	Subsurface Soil	2	3 (1 from the vadose zone and 2 from the saturated zone)	As deep as 20 feet	Sample depths will range from 6 to 20 feet	Samples will be collected from borings located in the northern (MW-05B) and southern (MW-01B) portion of the plume	Total Oxidant Demand (TOD)
3.3	**Confirmation Sampling Study** - Designated confirmation sampling study areas will be analyzed before injection to document pre-injection concentrations. Following injection, the designated areas will be resampled at 1 month and 3 months intervals to assess the effectiveness of the ISCO in the vadose zone	Subsurface Soil	3	2	As deep as 10 feet	Sample depths will range from 5 to 6 feet and 7 to 8 feet	Confirmation Study Areas (CS-1, CS-2, CS-3)	VOCs (SW8260B), TPH-DRO (USEPA 8015)

Key:
bgs = below ground surface
ft = feet

Building 3.7
Former Wash Rack (Building 606/626) Study Area
Soil Sample Analytical Summary

Sample Type/ Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Subsurface Soil	Total Oxidant Demand (TOD)	none	6	0	0	0	0	0	48 hous	Ice to 4°C	100 grams collected from soil core	6
	VOCs	SW8260B	6 samples per event - Baseline, 1 Month, and 3 Months	3	0	3	3	0	14 Days	Ice to 4°C	Three 5 gram EnCore Samples	81
	TPH - extractable (DRO)	USEPA 8015B	6 samples per event - Baseline, 1 Month, and 3 Months	0	0	0	0	0	14 Days	Ice to 4°C	8 ounce	18

Key:

VOCs = volatile organic compounds

TPH = total petroleum hydrocarbon

DRO = diesel range organics

USEPA = United States Environmental Protection Agency

MSD = matrix spike duplicate

MS = matrix spike

Table 3.8
Former Wash rack (Building 606/626) Study Area
Soil Sample Details

Location Identification	Analytical Parameters			QC Duplicates	MS/MSD	Notes
	Total Oxidant Demand (TOD)	VOCs	TPH-DRO			
Baseline Sampling (prior to injection)						
TS606MW-01B (borehole)	X					Collect 3 samples (1 from the vadose zone and 2 from the saturated zone)
TS606MW-05B (borehole)	X					Collect 3 samples (1 from the vadose zone and 2 from the saturated zone)
TS606CS-1		X	X	X		Collect soil samples from 5 to 6 feet and 7 to 8 feet bgs
TS606CS-2		X	X			Collect soil samples from 5 to 6 feet and 7 to 8 feet bgs
TS606CS-3		X	X		X	Collect soil samples from 5 to 6 feet and 7 to 8 feet bgs
1 Month Post Injection Sampling						
TS606CS-1		X	X	X		Samples will be collected just adjacent to the pre-injection location
TS606CS-2		X	X			Samples will be collected just adjacent to the pre-injection location
TS606CS-3		X	X		X	Samples will be collected just adjacent to the pre-injection location
3 Month Post Injection Sampling						
TS606CS-1		X	X	X		Samples will be collected just adjacent to the pre-injection location
TS606CS-2		X	X			Samples will be collected just adjacent to the pre-injection location
TS606CS-3		X	X		X	Samples will be collected just adjacent to the pre-injection location

Key:
VOCs = volatile organic compounds
TPH = total petroleum hydrocarbon
DRO = diesel range organics
QC = quality control
MS/MSD = matrix spike/matrix spike duplicate

Table 3.9
Building 837 Study Area
Groundwater Sample Rationale

Reference Figure Number	Sampling Rationale	Proposed Investigations						
		Sample Type	Number of Locations	Samples Per Location	Boring Depth (ft bgs)	Sample Depth (ft BGS)	Sample Location	Analytical Test and Methods to be conducted
3.1	Four rounds of water sampling associated with the Pilot-Scale Treatability Study will occur after all monitoring wells are installed: baseline (pre-injection), 1 month post injection, 3 months post injection, and 6 months post injection. This sampling will include a total of 20 monitoring wells (10 intermediate and 10 deep), with the baseline round of sampling occurring within 3 weeks of completion of the wells. The wells will be sampled using low-flow purging and sampling techniques.	Groundwater	16	1	NA	Sample depths will range from 15 to 20 feet (intermediate) and 25 to 30 feet (deep).	16 monitoring wells, (8 intermediate and 8 deep)	VOCs (SW8260B), Filered Metals[1] (SW6010B/6020), Alkalinity (USEPA 310.1), Sulfate, Nitrate/Nitrite, and Phosphate (USEPA 300), Ethane, Ethene, Carbon Dioxide (RSK-175), VFA, TOC (USEPA 415.1), Microbial DNA[2] (selected wells only), and Field parameters[3]
			4	1	NA	Sample depths will range from 15 to 20 feet (intermediate) and 25 to 30 feet (deep).	4 monitoring wells, (2 intermediate and 2 deep)	Field parameters[3] only

Key:
bgs = below ground surface
ft = feet
TOC = total orgainc carbon
USEPA = United States Environmental Protection Agency
VOCs = volatile organic compounds
VFA = volatile fatty acids
[1] Metal analysis includes iron and manganese
[2] DNA analysis = Dehalococcoides ethenogenes (selected wells only)
[3] Field parameters are: temperature, pH, specific conductance, oxidation reduction potential, dissolved oxygen, and turbidity

Table 3.10
Building 837 Study Area
Groundwater Sample Analytical Summary per Sampling Events

Sample Type/Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Groundwater Samples (19 1-inch performance monitoring wells and 1 2-inch existing well)	VOCs	SW8260B	16	2	2	1	1	4	14 Days	Ice to 4°C HCl to pH <2	Three 40-ml GSV	66
	Metals (iron & manganese)	6010B/6020	16	0	0	0	0	0	6 Months	Ice to 4°C $HN0_3$*	One 250-L Poly	16
	Sulfate, Nitrate, Phosphate, and Chloride	USEPA 300	16	0	0	0	0	0	48 hours	Ice to 4°C	One 500-ml Poly	16
	Alkalinity	USEPA 310.1	16	0	0	0	0	0				
	Volalite Fatty Acids (VFA)	none	16	0	0	0	0	0	14 Days	Ice to 4°C	Three 40-ml GSV	16
	Ethane / Ethene	(RSK-175)	16	0	0	0	0	0	14 Days	Ice to 4°C HCl to pH <2	Three 40-ml GSV	48
	Deoxyribonucleic acid (DNA)[1]	none	4	0	0	0	0	0	None	Ice to 4°C	One inline filter (2-liter pass thru)	12
	Carbon Dioxide	RSK 175	16	0	0	0	0	0	7 Days	Ice to 4°C	Three 40-ml GSV	16
	Total Orgainc Carbon (TOC)	EPA 415.1	16	0	0	0	0	0	28 Days	Ice to 4°C H_3SO_4	Three 40-ml GSV	16

Key:
QC = Quality Control
VOCs = Volatile Organic Compounds
MS = matrix spike
MSD = matrix spike duplicate
ml = milliliter
L = Liter
HCl = hydrochloric acid
°C = Celcius
HNO_3 = nitric acid

GSV = Glass Septum Vial
Poly = Polyethylene Bottle
[1] DNA analysis = Dehalococcoides ethenogenes
*Note: Metals samples will be filtered before preservation using a 0.45 micron filter.
Duplicate samples are collected 1 per 10 field samples
MS/MSD samples are collected 1 per 20 field samples
Rinsate samples are collected 1 per 10 field samples

Table 3.11
Building 837 Study Area
Well specific Groundwater Sampling Analytical Summary with Timeline

Well Identification	Analytical Parameters												Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	Filtered Metals[1]	Ethane/Ethene	Alkalinity	Chloride	Sulfate	Nitrate	Phosphate	VFA	CO_2	TOC	DNA				
Baseline Sampling (prior to injection)																
TS837MW-1A													X			
TS837MW-1B													X			
TS837MW-2A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-2B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-4A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-4B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-5A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-5B	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-6A													X			
TS837MW-6B													X			
99M24	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-7B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8B	X	X	X	X	X	X	X	X	X	X	X		X		X	collect MS/MSD
TS837MW-9A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-9B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-10A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-10B	X	X	X	X	X	X	X	X	X	X	X	X	X			

Table 3.11 (continued)
Building 837 Study Area
Well specific Groundwater Sampling Analytical Summary with Timeline

Well Identification	Analytical Parameters												Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	Filtered Metals[1]	Ethane/Ethene	Alkalinity	Chloride	Sulfate	Nitrate	Phosphate	VFA	CO_2	TOC	DNA				
1 Month Post Injection Sampling																
TS837MW-1A													X			
TS837MW-1B													X			
TS837MW-2A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-2B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-4A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-4B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-5A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-5B	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-6A													X			
TS837MW-6B													X			
99M24	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-7B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8B	X	X	X	X	X	X	X	X	X	X	X		X		X	collect MS/MSD
TS837MW-9A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-9B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-10A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-10B	X	X	X	X	X	X	X	X	X	X	X	X	X			

Table 3.11 (continued)
Building 837 Study Area
Well specific Groundwater Sampling Analytical Summary with Timeline

Well Identification	Analytical Parameters												Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	Filtered Metals[1]	Ethane/Ethene	Alkalinity	Chloride	Sulfate	Nitrate	Phosphate	VFA	CO_2	TOC	DNA				
3 Month Post Injection Sampling																
TS837MW-1A													X			
TS837MW-1B													X			
TS837MW-2A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-2B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-4A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-4B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-5A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-5B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-6A													X			
TS837MW-6B													X			
99M24	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-7B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8B	X	X	X	X	X	X	X	X	X	X	X		X		X	collect MS/MSD
TS837MW-9A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-9B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-10A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-10B	X	X	X	X	X	X	X	X	X	X	X		X			

Table 3.11 (continued)
Building 837 Study Area
Well specific Groundwater Sampling Analytical Summary with Timeline

Well Identification	Analytical Parameters												Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	Filtered Metals[1]	Ethane/Ethene	Alkalinity	Chloride	Sulfate	Nitrate	Phosphate	VFA	CO_2	TOC	DNA				
6 Month Post Injection Sampling																
TS837MW-1A													X			
TS837MW-2A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-2B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-3B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-4A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-4B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-5A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-5B	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-6A													X			
TS837MW-6B													X			
99M24	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-7B	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-8B	X	X	X	X	X	X	X	X	X	X	X		X		X	collect MS/MSD
TS837MW-9A	X	X	X	X	X	X	X	X	X	X	X		X			
TS837MW-9B	X	X	X	X	X	X	X	X	X	X	X		X	X		collect duplicate sample
TS837MW-10A	X	X	X	X	X	X	X	X	X	X	X	X	X			
TS837MW-10B	X	X	X	X	X	X	X	X	X	X	X	X	X			

Key:
MS/MSD = matrix spike / matrix spike duplicate
CO_2 = carbon dioxide
VOCs = volatile organic compounds
TOC = total organic carbon
VFA = volatile fatty acids
DNA = Dehalococcoides ethenogenes
QC = quality control

[1] Metals analysis includes iron and manganese
[2] Field Parameters are: pH, temperature, specific conductance, oxidation reduction potential (ORP), dissolved oxygen (DO), and turbidity.
Note: Well identifications A and B constitute a monitoring well cluster. Monitoring well idenification that end with (A) are approximately 20ft bgs and screened from 15 - 20ft bgs.
Monitoring well idenification that end with (B) are approximately 3ft bgs and screened from 25 - 30ft bgs.

Table 3.12
Former Wash Rack (Building 606/626) Study Area
Groundwater Sampling Rationale

Reference Figure Number	Sampling Rationale	Proposed Investigations						
		Sample Type	Number of Locations	Samples Per Location	Boring Depth (ft bgs)	Sample Depth (ft BGS)	Sample Location	Analytical Test and Methods to be conducted
3.2	Four rounds of water sampling associated with the Pilot-Scale Treatability Study will occur after all monitoring wells are installed: baseline (pre-injection), 1 month post injection, 3 months post injection, and 6 months post injection. This sampling will include a total of 16 performance wells (8 shallow and 8 deep), with the baseline round of sampling occurring within 3 weeks of completion of the wells. The wells will be sampled using low-flow purging and sampling techniques.	Groundwater	12	1	NA	Sample depths will range from 10 to 15 feet (shallow) and 15 to 20 feet (deep).	12 monitoring wells, (6 shallow and 6 deep)	VOCs (SW8260B), TPH-DRO (USEPA 8015B), Metals[1] (SW6010B), Microbial DNA[2] (baseline only - 2 samples), and Field parameters[3]
			4	1	NA	Sample depths will range from 10 to 15 feet (shallow) and 15 to 20 feet (deep).	4 monitoring wells, (2 shallow and 2 deep)	Field parameters[3] only

Key:
bgs = below ground surface
ft = feet
VOCs = volatile organic compounds
USEPA = United States Environmental Protection Agency
TPH = total petroleum hydrocarbons
[1]Metal analysis includes filtered iron and arsenic. An unfiltered arsenic sample will also be collected during the baseline sampling.
[2] DNA analysis = Dehalococcoides ethenogenes
[3]Field parameters are: temperature, pH, specific conductance, oxidation reduction potential, dissolved oxygen, and turbidity

Table 3.13
Former Wash Rack (Building 606/626) Study Area
Groundwater Sample Analytical Summary per Sampling Event

Sample Type/Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Groundwater Samples (16 1-inch performance monitoring wells)	VOCs	SW8260B	12	2	2	1	1	4	14 Days	Ice to 4°C HCl to pH <2	Three 40-ml GSV	54
	TPH - extractable (DRO)	USEPA 8015B	12	0	0	0	0	0	7 Days	Ice to 4°C	2 x 1 L amber glass	24
	Metals (iron & arsenic)	6010B	12	0	0	0	0	0	6 Months	Ice to 4°C $HN0_3$*	One 250-L Poly	12
	Deoxyribonucleic acid (DNA)[1]	none	2	0	0	0	0	0	None	Ice to 4°C	One inline filter (2-liter pass thru)	2

Key:

QC = Quality Control
VOCs = Volatile Organic Compounds
MS = matrix spike
MSD = matrix spike duplicate
ml = milliliter
L = Liter
HCl = hydrochloric acid
°C = Celcius
HNO_3 = nitric acid
GSV = Glass Septum Vial
Poly = Polyethylene Bottle

[1] Note: To assess the variability of biological activity across the site, two sample for DNA analysis will be collected during the baseline sampling

Duplicate samples are collected 1 per 10 field samples

MS/MSD samples are collected 1 per 20 field samples

Rinsate samples are collected 1 per 10 field samples

Table 3.14
Former Wash Rack (Building 606/626) Study Area
Well Specific Groundwater Sample Analytical Summary with Timeline

Well Identification	Analytical Parameters					Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	TPH-DRO	Filtered Metals (iron & arsenic)	Unfiltered Metals (arsenic)	DNA[1]				
Baseline Sampling (prior to injection)									
TS606MW-1A	X	X	X	X		X			
TS606MW-1B	X	X	X	X		X	X		collect duplicate sample
TS606MW-2A	X	X	X	X		X			
TS606MW-2B	X	X	X	X		X			
TS606MW-3A	X	X	X	X		X			
TS606MW-3B	X	X	X	X		X			
TS606MW-4A						X			
TS606MW-4B						X			
TS606MW-5A	X	X	X	X	X	X			
TS606MW-5B	X	X	X	X	X	X	X		collect duplicate sample
TS606MW-6A	X	X	X	X		X			
TS606MW-6B	X	X	X	X		X			
TS606MW-7A	X	X	X	X		X			
TS606MW-7B	X	X	X	X		X		X	collect MS/MSD sample
TS606MW-8A						X			
TS606MW-8B						X			
1 Month Post Injection Sampling									
TS606MW-1A	X	X	X			X			
TS606MW-1B	X	X	X			X	X		collect duplicate
TS606MW-2A	X	X	X			X			
TS606MW-2B	X	X	X			X			

Table 3.14 (continued)
Former Wash Rack (Building 606/626) Study Area
Well Specific Groundwater Sample Analytical Summary with Timeline

Well Identification	Analytical Parameters					Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	TPH-DRO	Filtered Metals (iron & arsenic)	Unfiltered Metals (arsenic)	DNA[1]				
1 Month Post Injection Sampling (continued)									
TS606MW-3A	X	X	X			X			
TS606MW-3B	X	X	X			X			
TS606MW-4A						X			
TS606MW-4B						X			
TS606MW-5A	X	X	X			X			
TS606MW-5B	X	X	X			X	X		collect duplicate sample
TS606MW-6A	X	X	X			X			
TS606MW-6B	X	X	X			X			
TS606MW-7A	X	X	X			X			
TS606MW-7B	X	X	X			X		X	collect MS/MSD sample
TS606MW-8A						X			
TS606MW-8B						X			
3 Month Post Injection Sampling									
TS606MW-1A	X	X	X			X			
TS606MW-1B	X	X	X			X	X		collect duplicate sample
TS606MW-2A	X	X	X			X			
TS606MW-2B	X	X	X			X			
TS606MW-3A	X	X	X			X			
TS606MW-3B	X	X	X			X			
TS606MW-4A						X			

Table 3.14 (continued)
Former Wash Rack (Building 606/626) Study Area
Well Specific Groundwater Sample Analytical Summary with Timeline

Well Identification	Analytical Parameters					Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	TPH-DRO	Filtered Metals (iron & arsenic)	Unfiltered Metals (arsenic)	DNA[1]				
3 Month Post Injection Sampling (continued)									
TS606MW-4B						X			
TS606MW-5A	X	X	X			X			
TS606MW-5B	X	X	X			X	X		collect duplicate
TS606MW-6A	X	X	X			X			
TS606MW-6B	X	X	X			X			
TS606MW-7A	X	X	X			X			
TS606MW-7B	X	X	X			X		X	collect MS/MSD sample
TS606MW-8A						X			
TS606MW-8B						X			
6 Month Post Injection Sampling									
TS606MW-1A	X	X	X			X			
TS606MW-1B	X	X	X			X	X		collect duplicate
TS606MW-2A	X	X	X			X			
TS606MW-2B	X	X	X			X			
TS606MW-3A	X	X	X			X			
TS606MW-3B	X	X	X			X			
TS606MW-4A						X			
TS606MW-4B						X			
TS606MW-5A	X	X	X			X			
TS606MW-5B	X	X	X			X	X		collect duplicate
TS606MW-6A	X	X	X			X			

Table 3.14 (continued)
Former Wash Rack (Building 606/626) Study Area
Well Specific Groundwater Sample Analytical Summary with Timeline

Well Identification	Analytical Parameters					Field Parameters[2]	QC Duplicates	MS/MSD	Notes
	VOCs	TPH-DRO	Filtered Metals (iron & arsenic)	Unfiltered Metals (arsenic)	DNA[1]				
TS606MW-6B	X	X	X			X			
TS606MW-7A	X	X	X			X			
TS606MW-7B	X	X	X			X		X	collect MS/MSD sample
TS606MW-8A						X			
TS606MW-8B						X			

Key:
VOCs = volatile organic compounds
TPH = toal petroleum hydrocarbon
QC = quality control
MS/MSD = matrix spike/matrix spike duplicate
[1] DNA analysis = Dehalococcoides ethenogenes
[2] Field Parameters are: pH, temperature, specific conductance, oxidation reduction potential (ORP), dissolved oxygen (DO), and turbidity.

Note: Well identification A and B constitiute a monitoring well cluster. Monitoring well idenification that end with (A) are approximately 13ft bgs and screened from 8 - 13ft bgs. Monitoring well idenification that end with (B) are approximately 20ft bgs and screened from 15 - 20ft bgs.

Table 3.15
Building 837 Study Area
Investigation Derived Waste Disposal Sampling

Sample Type /Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Subsurface Soil (IDW Phase I)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C	Three Encore Samples	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 months	Ice to 4 °C	One 8-oz Glass Jar	1
Decontamination, well development, and purge water (IDW Phase I)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C HCl	Three 40-ml GSV	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 Months	Ice to 4 °C HNO_3	One 1-L poly	1
Well Purge Water (IDW Phase II)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C HCl	Three 40-ml GSV	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 Months	Ice to 4 °C HNO_3	One 1-L poly	1

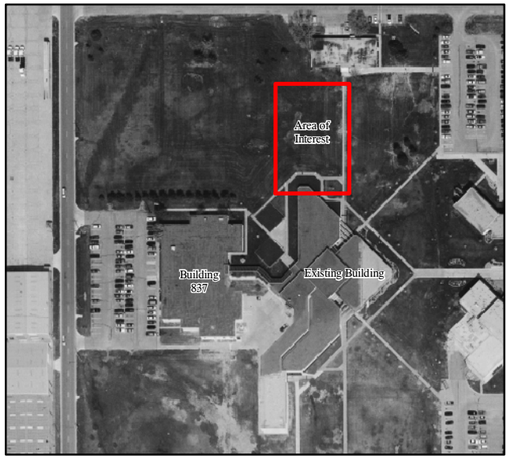
Key:
QC = quality control
MS = matrix spike
MSD = matrix spike duplicate
HCl = hydrochloric acid
GSV = glass septum vial
USEPA = United States Environmental Protection Agency
TPH = total petroleum hydrocarbon
DRO = diesel range organics
VOC = volatile organic compound
IDW = investigation-derived waste
RCRA = Resource Conservation and Recovery Act

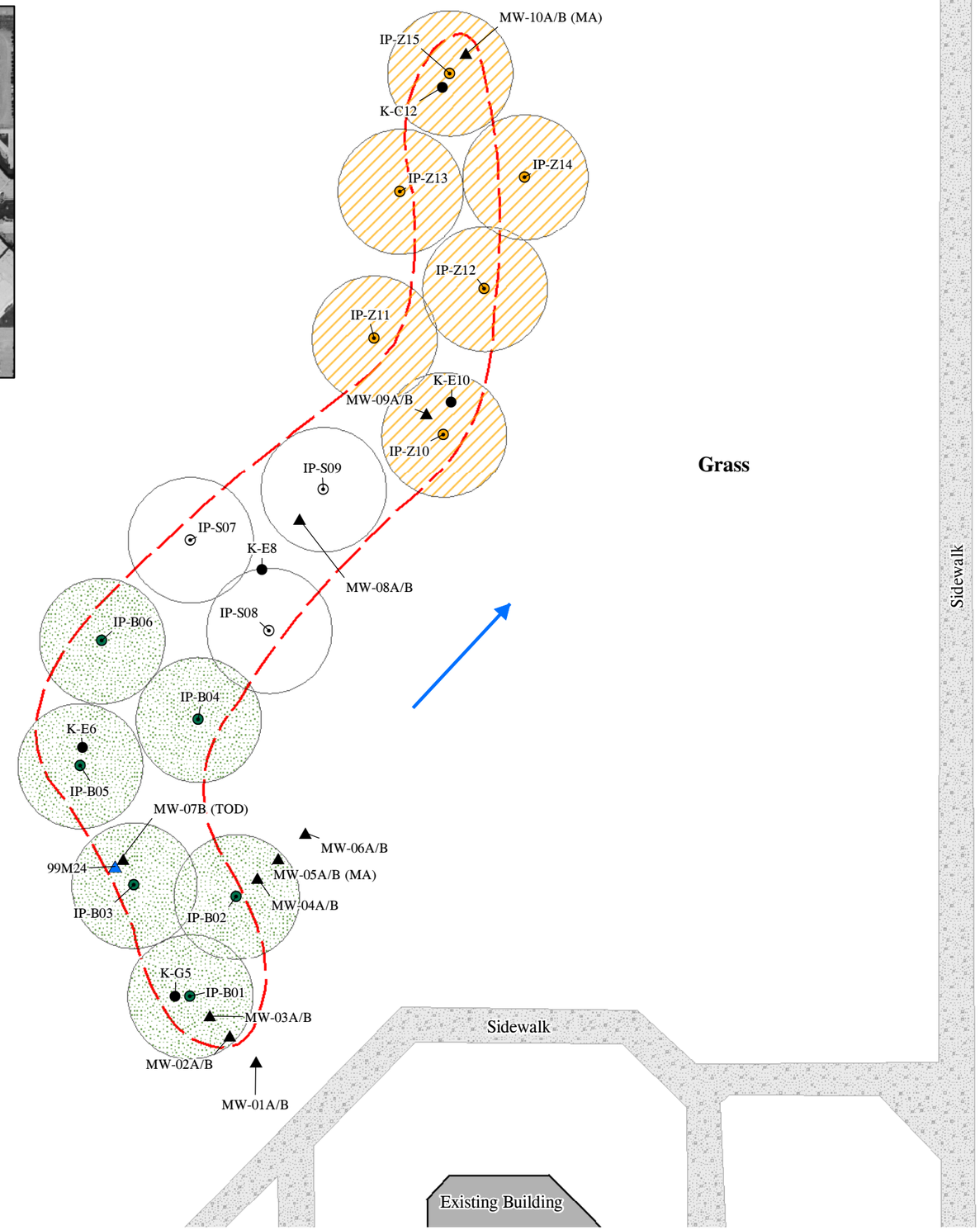
Table 3.16
Former Wash rack (Building 606/626) Study Area
Investigation derived Waste Disposal Sampling

Sample Type /Matrix	Analytical Parameter	Method Number	Number of Field Samples	Field QC Samples					Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
				Duplicates	Equipment Rinsate	MS	MSD	Trip Blanks				
Subsurface Soil (IDW Removal Phase I)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C	Three Encore Samples	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 months	Ice to 4 °C	One 8-oz Glass Jar	1
	TPH - extractable (DRO)	USEPA 8015B	1	0	0	0	0	0	14 Days	Ice to 4 °C	8 ounce jar	1
Decontamination, well development, and purge water (IDW Removal Phase I)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C HCl	Three 40-ml GSV	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 Months	Ice to 4 °C HNO_3	One 1-L poly	1
	TPH - extractable (DRO)	USEPA 8015B	1	0	0	0	0	0	7 Days	Ice to 4 °C	2 x 1-L amber glass	2
Subsurface Soil (IDW Removal Phase II)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C	Three Encore Samples	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 months	Ice to 4 °C	One 8-oz Glass Jar	1
	TPH - extractable (DRO)	USEPA 8015B	1	0	0	0	0	0	14 Days	Ice to 4 °C	8 ounce jar	1
Well Purge Water (IDW Removal Phase II)	VOCs	SW8260B	1	0	0	0	0	0	14 Days	Ice to 4 °C Cl	Three 40-ml GSV	3
	RCRA Metals (excluding mercury)	SW6010B	1	0	0	0	0	0	6 Months	Ice to 4 °C HNO_3	One 1-L poly	1
	TPH - extractable (DRO)	USEPA 8015B	1	0	0	0	0	0	7 Days	Ice to 4 °C	2 x 1-L amber glass	1

Key:
QC = quality control
MS = matrix spike
MSD = matrix spike duplicate
HCl = hydrochloric acid
GSV = glass septum vial
USEPA = United States Environmental Protection Agency
TPH = total petroleum hydrocarbon
DRO = diesel range organics
VOC = volatile organic compound
IDW = investigation-derived waste
RCRA = Resource Conservation and Recovery Act

Figure 3.1
Building 837 Study Area
Saturated Zone Field Activities Map





Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Existing Monitoring Well
- Groundwater Flow Direction

Previous Activities

- Membrane Interface Probe (MIP)

Proposed Activities

- Study Area
- Substrate Only
- Substrate and Zero Valent Iron
- Substrate with Potential Bio Augmentation Pending Biological Analysis
- Estimated Radius of Influence of 10 ft
- Monitoring Well Cluster
  A-Screened in Upper Alluvium
  B-Screened in Lower Alluvium
  MA-Baseline Groundwater Sampling
  Includes Microbial Analysis
  TOD-Baseline Soil Sampling
  Includes Total Oxidant Demand Testing

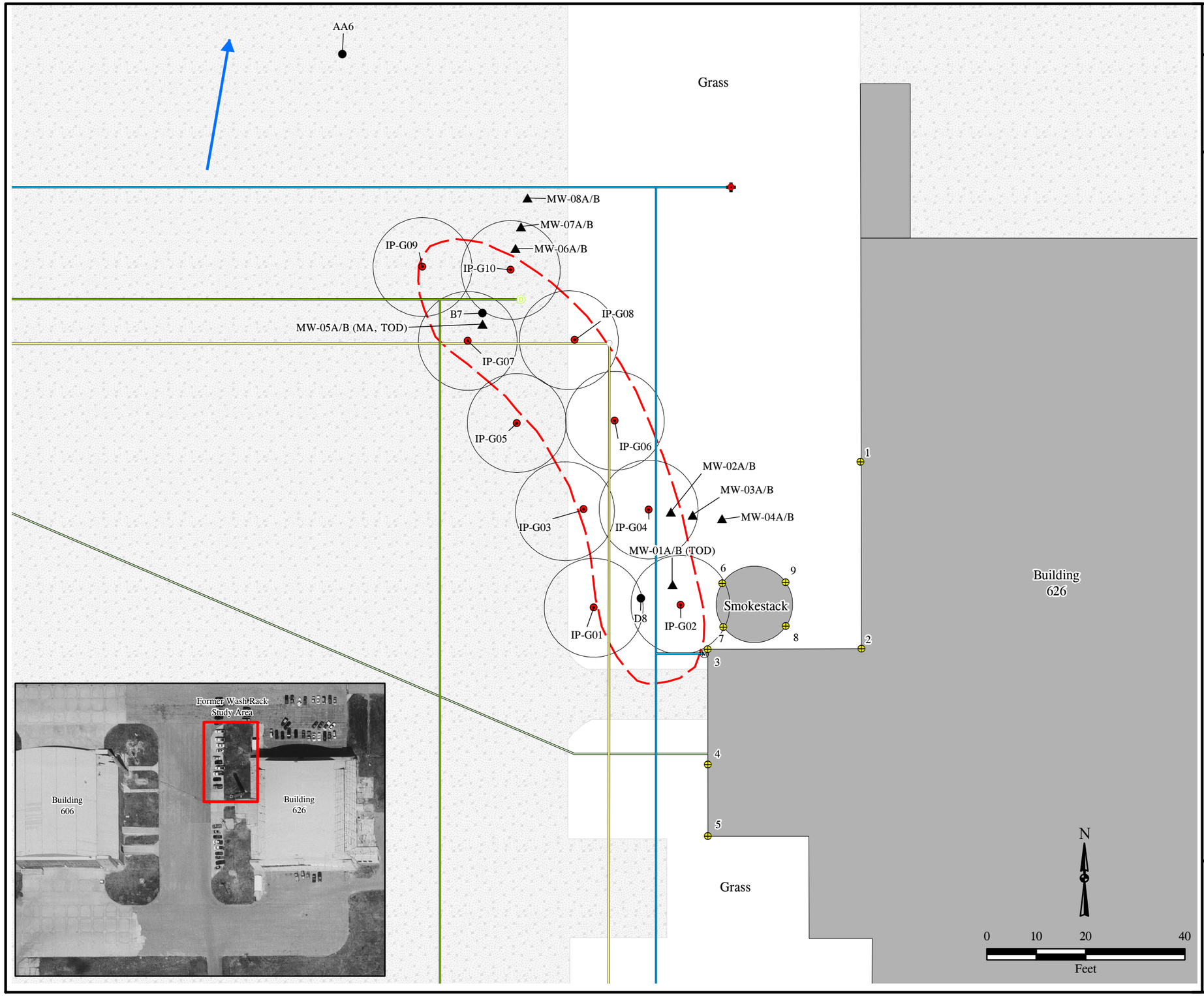
0 10 20 40
Feet

N

Filename: X:/KAN004/TO_103/FSP/MAPS Building_837_Study_Area.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 07/27/06 CV
Source: USACE Remedial Investigation Report, 2005

HGL HydroGeoLogic, Inc

Figure 3.2
Former Wash Rack Study Area
Saturated Zone Field Activities Map



Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Gas Line
- Storm Line
- Overhead Line (Power/Telephone)
- Water Line
- Groundwater Flow Direction
- Storm Drain
- Meter Location
- Fire Hydrant

Previous Activities

- Membrane Interface Probe (MIP)

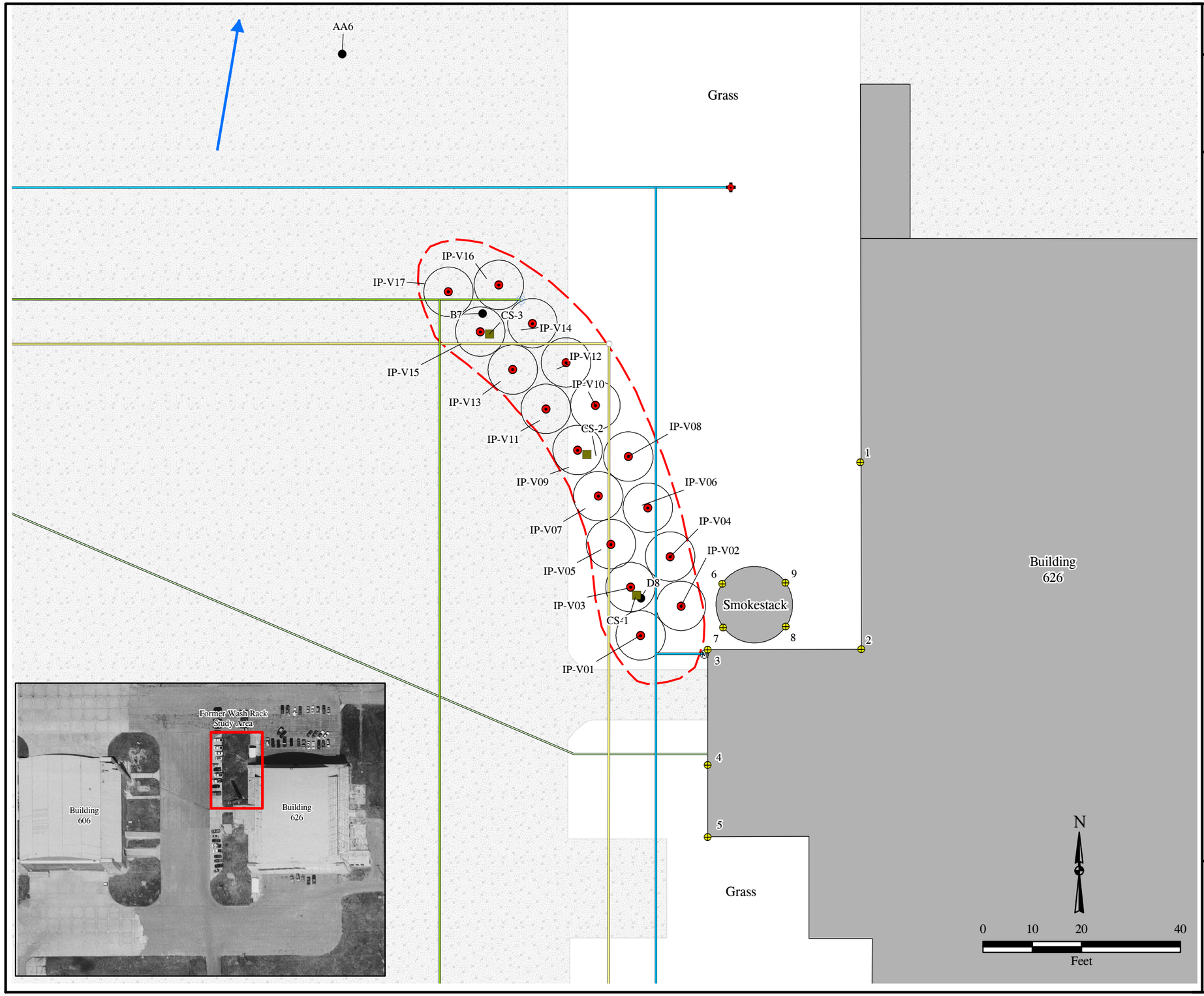
Proposed Activities

- Study Area
- Elevation Monitoring Point
- Substrate Radius of Influence
- Sodium Persulfate Slurry Injection Point
- Monitoring Well Cluster
  - A-Screened in Upper Alluvium
  - B-Screened in Lower Alluvium
  - MA-Baseline Groundwater Sampling Includes Microbial Analysis
  - TOD-Baseline Soil Sampling Includes Total Oxidant Demand Testing

Filename: X:/KAN004/TO_103/FSP/MAPS Saturated_Zone_Activites_Map.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/28/06 CV
Source: USACE Remedial Investigation Report, 2005

HGL HydroGeoLogic, Inc

Figure 3.3
Former Wash Rack Study Area Vadose Zone Field Activities Map



Legend

Existing Features

- Existing Structure
- Concrete/Paved Area
- Gas Line
- Storm Line
- Overhead Line (Power/Telephone)
- Water Line
- Groundwater Flow Direction
- Storm Drain
- Meter Location
- Fire Hydrant

Previous Activities

- Membrane Interface Probe (MIP)

Proposed Activities

- Study Area
- Potassium Permanganate Slurry Injection Point
- Elevation Monitoring Point
- Subsurface Soil Sample Location
- Substrate Radius of Influence

Filename: X:/KAN004/TO_103/FSP/MAPS Wash_Rack_Vadose_Zone.mxd
Project: KAN004-103-01-03
Created by: cvanfosson 03/14/06
Revised: 03/28/06 CV
Source: USACE Remedial Investigation Report, 2005

HGL HydroGeoLogic, Inc

4.0 FIELD DOCUMENTATION

HGL will maintain field records sufficient to recreate all sampling and measurement activities. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages or on appropriate field forms. These records will be archived in an easily accessible form and made available to the USACE upon request.

The following information will be recorded for all field activities: (1) location; (2) date and time; (3) identity of people performing activity; and (4) weather conditions. For field measurements, the numerical value and units of each measurement and the identity of and calibration results for each field instrument will also be recorded.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method; (2) the identity of each sample and depth(s), where applicable, from which it was collected; (3) the volume/quantity of each sample; (4) sample description (e.g., color, odor, clarity); (5) identification of sampling devices; and (6) identification of conditions that might affect the representativeness of a sample.

The following sections describe the field documentation procedures that will be followed as a means of recording observations and findings during the field investigation. Documentation will include field forms or field logbooks, various sample and calibration forms, site photographs, and drawings/sketches. All documentation will be completed in indelible ink and corrections will be clearly stricken out and initialed.

Copies of all applicable forms are included in Attachment 1.

4.1 FIELD LOGBOOK OR FIELD FORMS

Logbooks with sequentially numbered pages or dated daily field forms will be kept at the site during all field activities. These logs or daily field forms will be updated continually and will constitute master field investigation documents. Information to be recorded in the logs or field forms includes, but is not limited to, the following:

- Project identification;
- Field activity subject;
- General work activity, work dates, and general time of occurrence;
- Unusual events;
- Subcontractor progress or problems;
- Communication with the client or others;
- Weather conditions;
- HGL personnel, subcontractors, and visitors on site;
- Sample locations, sample number, and time of day for each sample collected for analysis;

- Record of telephone call(s) to the laboratory informing it of sample shipment or other pertinent communication;
- Accomplishment of decontamination activities;
- Accomplishment of required equipment calibrations;
- Generation and disposition of IDW and other wastes;
- Variances from project plans and procedures (details will be recorded in the log book and presented in the Field Investigation);
- Accomplishment of tailgate safety meetings;
- Review of project procedures with site personnel;
- Headspace screening and breathing zone readings;
- Photographs taken and identification numbers;
- Accomplishment of inspections.

4.2 FIELD EQUIPMENT LOG

The field equipment logbook or daily equipment calibration forms will be maintained to document the proper use, maintenance, and calibration of field testing equipment. Information to be recorded in the field equipment logbook or on the daily equipment calibration forms will include:

- Equipment calibration status;
- Equipment decontamination status;
- Equipment nonconformance;
- Equipment inspection and repair records;
- Name and signature of person making entry;
- Date of entry;
- Name of equipment and its identifying number; and
- Manufacturer, lot number, and expiration date of calibration standards;

4.3 SAMPLE COLLECTION LOGS

Various field gauging and/or sampling forms will be completed for each well gauged, purged, and sampled during the PSTS. At a minimum, the following forms will be used:

- Well Gauging Form
- Low Flow Groundwater Purge and Sample Record
- Field Sampling Report

In addition, a Waste Inventory Tracking Form will be completed, if necessary. Copies of each form are included in Attachment 1.

4.4 CHAIN OF CUSTODY RECORDS

Procedures to ensure the custody and integrity of the samples begins at the time of sampling and continues through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition

of the samples are maintained in the field and laboratory records. Sample event information should be recorded on the COC before sampling begins and as each sample is collected it must be documented on the COC.

COC records will be maintained for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession; (2) it is in their view, after being in their possession; (3) it was in their possession and they locked it up for safe keeping; or (4) it is in a designated secure area. All sample containers will be sealed in a manner that will prevent or detect tampering, if it occurs. In no instance will tape be used to seal sample containers. Attachment 1 contains a sample COC.

The following minimum information concerning samples will be documented on the COC:

- Unique sample identification
- Date and time of sample collection
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection in accordance with Section 2.14 of this plan. Samples collected in the field will be transported to the laboratory or field testing site as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples will be packed in ice to keep them cool during collection and transportation. As a general rule, storage at low temperature is the best way to preserve most samples.

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5.0 REFERENCES

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Latta, B.F., 1949. Ground-Water Conditions in the Smoky Hill Valley in Saline, Dickinson, and Geary Counties, Kansas, University of Kansas Publications, State Geological Survey of Kansas, Bulletin 84.

U.S. Army Corps of Engineers, Kansas City District, 2005. Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Volume I, September 2005.

U.S. Army Corps of Engineers, Kansas City District, 2002. Standard Operating Procedures for Low-flow Groundwater Purging and Sampling, Version 1.3, August 2002.

U.S. Environmental Protection Agency (USEPA), 1996. Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures, Offices of Solid Waste and Emergency Response, Washington, DC. EPA/540/S-95/504.

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ATTACHMENT 1

FIELD FORMS

- Calibration Log
- HTW Drilling Log
- HTW Drilling Log (Example/Completed)
- Well Construction Details Form
- Well Development Log
- Water Sample Collection Field Sheet
- Chain of Custody
- Field Sampling Report
- Waste Inventory Form

ATTACHMENT 2

USACE—KANSAS CITY DISTRICT
STANDARD OPERATING PROCEDURE
FOR LOW-FLOW PURGING AND SAMPLING

ATTACHMENT 1

FIELD FORMS

- Calibration Log
- HTW Drilling Log
- HTW Drilling Log (Example/Completed)
- Well Construction Details Form
- Well Development Log
- Water Sample Collection Field Sheet
- Chain of Custody
- Field Sampling Report
- Waste Inventory Form

CALIBRATION LOG

Project Name: _____ By: _____

Project No.: _____ Page _____ of _____

Date/Time	Instrument	STD	STD CONC ppm	Meter Reading	Comments

HTW DRILLING LOG

HOLE NO.

1 COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF SHEETS

3. PROJECT	4. LOCATION
5 NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION
	9. SURFACE ELEVATION
	10. DATE STARTED / 11. DATE COMPLETED
12 OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13 DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14 TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS 9	REMARKS h

PROJECT

HOLE NO.

FORM MRK JUN 89 55

HTW DRILLING LOG (CONT.)

HOLE NO.

PROJECT

INSPECTOR

SHEET
OF SHEETS

ELEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. I	BLOW COUNTS 9	REMARKS h

PROJECT

HOLE NO.

HTW DRILLING LOG

HOLE NO. MW-926

1 COMPANY NAME	HYDROGEOLOGIC, INC.
2. DRILLING SUBCONTRACTOR	BOART LONGYEAR
SHEET 1 OF 5 SHEETS	
3. PROJECT	FORBES S-9
4. LOCATION	HOLTON, KS
5 NAME OF DRILLER	KEN GOBELLE
6. MANUFACTURER'S DESIGNATION OF DRILL	GP24-300RS 605 PECH ROTASONIC
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	6" DRILL PIPE
8. HOLE LOCATION	SOUTH SIDE OF GULLY, EAST OF BRIDGE
9. SURFACE ELEVATION	
10. DATE STARTED	11-8-09 1600
11. DATE COMPLETED	11-9-09 1000
12 OVERBURDEN THICKNESS	35'
15. DEPTH GROUNDWATER ENCOUNTERED	27'
13 DEPTH DRILLED INTO ROCK	~~0~~
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	21', 20 MIN
14 TOTAL DEPTH OF HOLE	35'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NONE	N/A	N/A	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
NONE	N/A	N/A	N/A	N/A	N/A	95 %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
		✓		[signature]

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	~~BLOW COUNTS~~ % REC	REMARKS h
	0–1	DARK SILT LOAM (2.5Y 3/3) [OL]				70	
	1–2	CLAY, LIGHT GRAYISH BROWN (2.5Y 4/3), BLACK STAINING, MANGANESE STAINING, FEW STRAY GRAVEL (CALCITE), LOW PLASTICITY, DRY [CL]				70	

HTW DRILLING LOG (CONT.)

HOLE NO. MW-926

PROJECT FORBES S-9

INSPECTOR C. WILLIAMS/H. HAWORTH

SHEET 2 OF 5 SHEETS

ELEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. I	~~BLOW COUNTS~~ % REC	REMARKS h
		SAME AS ABOVE, MODERATE PLASTICITY, MOIST					
	6						
	7						
	8					100	
	9						
	10						
	11						
	12						
	13						
	14						

FORM MRK JUN 89 55-2

PROJECT FORBES S-9

HOLE NO. MW-926

HTW DRILLING LOG (CONT.)

HOLE NO. MW-926

PROJECT FORBES S-9

INSPECTOR C. WILLIAMS / H. HAWORTH

SHEET 3 OF 5 SHEETS

ELEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. I	~~BLOW COUNTS~~ %REC	REMARKS h
	14	SAME AS ABOVE				100	
	15						
	16						
	17	BLACK CLAY SILT (2.5Y 2.5/1), LOW PLASTICITY, DRY ROUNDED PEBBLES [ML]				90	
	18						
	19						
	20					90	
	21						
	22	NO ROUNDED PEBBLES	0.0				STOPPED FOR DAY 11/8/04 1650 BEGIN AGAIN 11/9/04 0700
	23						

FORM MRK JUN 89 55-2

PROJECT FORBES S-9

HOLE NO. MW-926

HTW DRILLING LOG (CONT.)

HOLE NO. MW-926

PROJECT FORBES S-9

INSPECTOR C. WILLIAMS / H. HAWORTH

SHEET 4 OF 5 SHEETS

ELEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. I	~~BLOW COUNTS~~ % REC	REMARKS h
		SAME AS ABOVE					
	24		0.0			100	
	25		0.0				
	26		0.0				
	27	CLAYEY SILT SEAM, SAME AS ABOVE MOIST/WET	0.0			100	
		SILTY CLAY SAME AS ABOVE, DRY					
	28		0.0				
	29	FINE SAND, DARK GRAY (5Y 4/1), MOIST, NO PLASTICITY SP	0.0				
		WET					
	30		0.0				
						100	
	31		0.0				
	32		0.0				

FORM MRK JUN 89 55-2

PROJECT FORBES S-9

HOLE NO. MW-926

HTW DRILLING LOG (CONT.)

HOLE NO. MW-926

PROJECT FORBES S-9

INSPECTOR C. WILLIAMS / H. HAWORTH

SHEET 5 OF 5 SHEETS

ELEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. I	~~BLOW COUNTS~~ % REC	REMARKS h
	32	SAME AS ABOVE	0.0				
	33		0.0				
		VERY DARK GRAY CLAYEY-SILT, CALCITE CONCRETIONS				100	
	34	ML	0.0				
	35		0.0				
	35	BOTTOM OF BORING 35FT					WELL INSTALLED AT 35', 10" 10-SLOT SCREEN FROM 25-35, FILTER SAND TO 22, FINE SAND TO 21', GROUT TO SURFACE
	36						

WELL CONSTRUCTION (FLUSHMOUNT) DETAILS FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE: _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____
CASING DIAMETER: _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE SEAL: _____
QUANTITY USED: _____

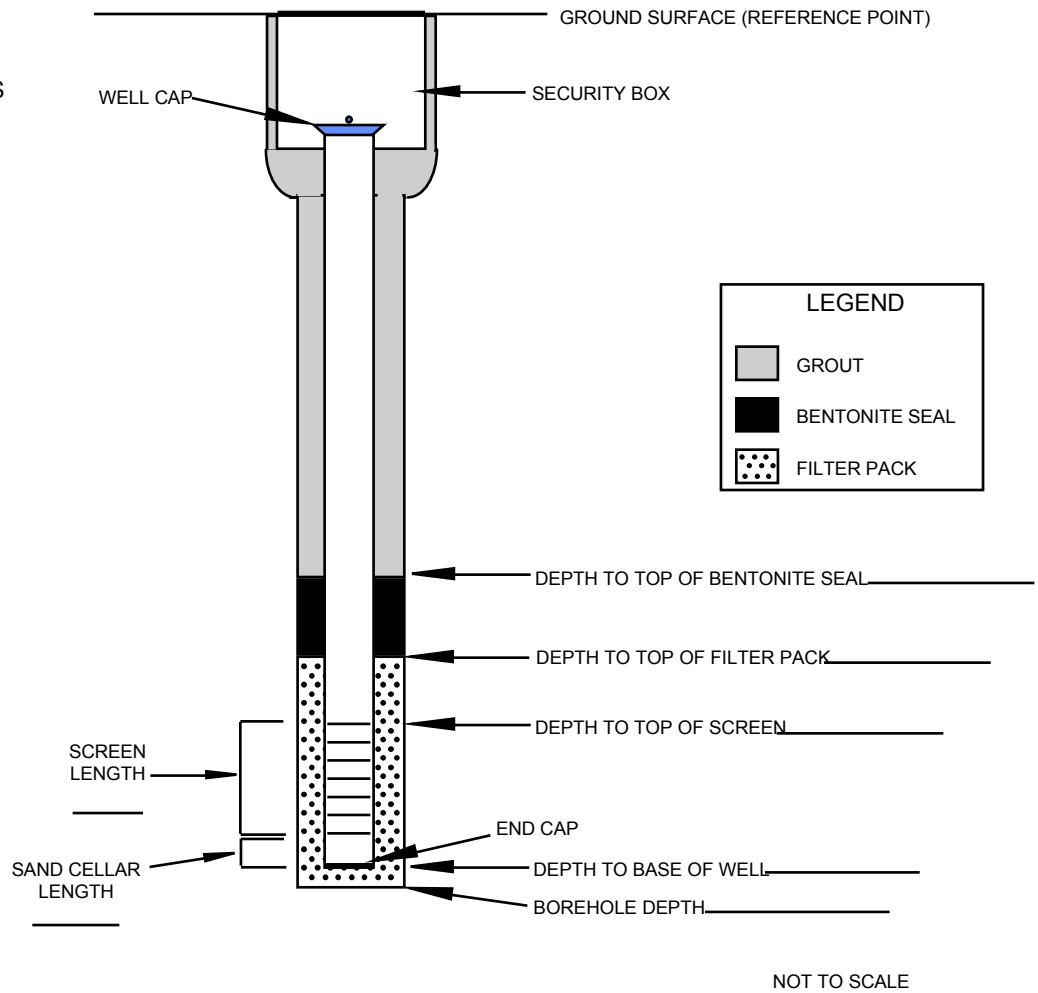
TYPE OF GROUT: _____
AMOUNT CEMENT USED: _____

DIMENSIONS OF SECURITY BOX: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

Well Development Log

Project: _____ Well No: _____
Project No: _____ Date: _____

Well Measurements

Casing I.D.: _____ inches
Well depth: _____ feet BTOC (before development) Borehole water volume: _____ gallons
Well depth: _____ feet BTOC (after development) Five (5) borehole volumes: _____ gallons
Depth to water: _____ feet BTOC

Casing Volume Information

Casing ID (inch)	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	10.0
Casing vol. (gal/ft)	0.04	0.09	0.16	0.37	0.65	1.0	1.5	2.0	2.6	4.08

Sampling Measurements

Date	Time	Water Level (feet BTOC)	Volume Removed (gallons)	pH	Sp. Cond. (μS/cm)	Temp. (celsius)	D.O. (mg/l)	ORP (mV)	Turbidity (NTU)	Comments (e.g. color, odor)

Development Method: _____

Notes: _____

_____

Equipment Identification Numbers

Water Level Indicator:

Water Quality Instrument:

WATER SAMPLE COLLECTION FIELD SHEET

GENERAL INFORMATION

SITE NAME _____ PROJECT NO. _____

SAMPLE NO. _____ WELL NO. _____

DATE/TIME COLLECTED _____ PERSONNEL _____
SAMPLE METHOD _____

SAMPLE MEDIA: **Groundwater**
SAMPLE QA SPLIT: YES **NO** SPLIT SAMPLE NO. _____
SAMPLE QC DUPLICATE: YES **NO** DUPLICATE SAMPLE NO. _____
MS/MSD REQUESTED YES **NO**

SAMPLE CONTAINERS, PRESERVATIVES, ANALYSIS

Sample Container	Preservative	Analysis Requested

WELL PURGING DATA

		Well Depth (ft. BTOC)	
Date		Depth to Water (ft. BTOC)	
Time Started		Water Column Length	
Time Completed		Volume of Water in Well (Liters)	
PID Measurements		Purge Rate (Liters/min.)	
Background		Level of Drawdown (feet)	
Breathing Zone		Amount Purged (Liters)	
Well Head			
Purge Water			

FIELD MEASUREMENTS

Time	Amount Purged (L)	pH	Temperature (Celsius)	Specific Conductance (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU's)	ORP (mV)	Water Level (ft BTOC)	Purge Rate (L/min)

FIELD EQUIPMENT AND CALIBRATION

	Model	Calibration
Water Level Probe	Slope Indicator	Checked against calibrated length
Water Quality Meter	YSI 556 Multi-parameter probe	Calibrated daily
PID Meter	Thero PID	Calibrated daily

GENERAL COMMENTS

Ferrous Iron =
Pump Placement Depth =
Well Diameter =
Screen interval =

CHAIN OF CUSTODY RECORD

HYDRO GeoLogic INC.
1155 Herndon Parkway
Suite 900
Herndon, VA 20170

Client:

Project Name/No.:

Project Manager:

Sampler:

Phone: (703) 478-5186 Fax: (703) 471-4180

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS OR SAMPLE LOCATION

APPLICABLE REGULATION

RCRA
ECRA
CERCLA
NPDES
CWA
SDWA
OTHER

Special Instructions

Possible Hazard Identification
Non-Hazard Flammable Skin Irritant Poison B Unknown

Sample Disposal
Return to Client Disposal by Lab Archive for _____ Months

Turn Around Time Required
Normal Rush

QC Level
I. II. III.

Project Specific (specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

FIELD SAMPLING REPORT

LOCATION: _____ PROJECT: _____

SITE: _____

SAMPLE INFORMATION

MATRIX _____ SAMPLE ID: _____

SAMPLING METHOD _____ DUP./REP. OF: _____

BEGINNING DEPTH _____ MATRIX SPIKE/MATRIX SPIKE DUPLICATE

END DEPTH _____ YES ( ) NO ( )

GRAB ( ) COMPOSITE ( ) DATE: _____ TIME: _____

CONTAINER		PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS
SIZE/TYPE	X				

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH _____ Temperature _____ Dissolved oxygen _____ Specific Conductivity _____

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DIRECTION _____ AMBIENT TEMP _____

SHIPMENT VIA: FED-X _____ HAND DELIVER _____ COURIER _____ OTHER _____

SHIPPED TO: _____

COMMENTS: _____

SAMPLER: _____ OBSERVER: _____

MATRIX CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
GW=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAB/WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB/WIPE	SP=SUBMERSIBLE PUMP

WASTE INVENTORY TRACKING FORM

Date: _____

Location: _____

Zone: _____ **Area:** _____

Activity:

Waste Type *	Activity generating Waste (well ID, etc.)	Estimated Volume	Field Evidence of Contamination	Type of Container	Location of Container	Waste Category**	Comments

* Waste types:

- Decontamination Fluids
- Purge Water (list by well)
- Soil
- Used PPE/Miscellaneous trash
- Other (Describe)

** Waste Category

- Class 1 non-hazardous waste
- Potentially hazardous waste (pending characterization)
- Hazardous Waste
- Municipal Trash

Form Completed By: _____ Form Reviewed By: _____

HGL HydroGeoLogic, Inc Exceeding Expectations

ATTACHMENT 2

USACE—KANSAS CITY DISTRICT
STANDARD OPERATING PROCEDURE
FOR LOW-FLOW PURGING AND SAMPLING

Standard Operating Procedure for Groundwater Low-Flow Purging

1 Purpose

The purpose of this standard operating procedure (SOP) is to provide a standardized set of procedures, decisions, and criteria for low-flow groundwater purging and sampling. This SOP will be reviewed on an annual basis by the appropriate technical disciplines and updated as appropriate. Review without revision will be indicated by changing the date in the header. Reviews with revision will be indicated by changing the version in the header and providing the date of the version.

2 Technical Background

The objective of groundwater sampling is to produce reproducible, representative, verifiable, legally defensible groundwater chemical data. Monitoring wells are purged prior to sampling because it is generally accepted that water in the well casing is not representative of formation water in the aquifer (Puls and Barcelona, 1996). Water may be chemically nonrepresentative for any or all of the following reasons (Puls and Barcelona, 1996):

- concentration gradients for dissolved oxygen (DO) and other gases with depth from the air-water interface
- concentration gradient for volatile organic compounds (VOC) with elevation from the screened interval
- leaching from and/or sorption to the casing or filter pack
- chemical changes due to reaction with clay seals and/or backfill
- surface infiltration

2.1 Historical Overview

Although it has long been agreed that subsurface disturbance and sample handling must be minimized in order to prevent sample alteration and obtain representative samples, there has been considerable disagreement as to the extent or significance of particular disturbances and the magnitude of the resultant physical and chemical changes (Puls and Powell, 1992a). Controversies regarding well purging concern the manner in which the well is purged and the required duration (Giddings, 1983; Gibs and Imbrigiotta, 1990; Puls and Powell, 1992a).

Historical well purging has included a number of common practices which may have significant negative impact on sample quality and/or have been found to be lacking in technical justification. Many of these practices are considered “industry standard” and are still used. Some have been recommended in older but still widely-used guidance documents (e.g., US EPA, 1986, 1991). These include:

- removing large or arbitrary amounts of water (e.g., 3-5 “well volumes” – may be either casing or borehole) during purging
- purging at rates in excess of natural flow through the well screen using a high-speed submersible pump or bailer
- water level drawdown is not controlled during purging
- no specific placement of the pump in the well (i.e., pump intake may be in the cased interval rather than in the screened interval)

- using different devices for purging and sampling (e.g., purging with a high-speed pump and then sampling with a bailer)
- monitoring only 3 water quality parameters
- purging "low-recharge" wells dry and sampling as soon as sufficient water volume re-enters the well

Purging a large or arbitrary number of "well volumes" (either casing or borehole) increases the pumping radius of influence within the aquifer and averages a large volume of water in the sample (Puls and Paul, 1995). Since many contaminant plumes are thin or narrow, this mixing of chemically-distinct waters can result in dilution and misleading data concerning contaminant presence and concentration gradients (Puls and Paul, 1995). High-volume purging is also time-consuming, costly, and generates unnecessarily large volumes of contaminated water which must be managed as investigation-derived waste (Puls and Barcelona, 1996; Puls and Powell, 1992a).

In order to minimize the field time and cost of standardized "well volume" purging, a high-speed pump and fast flow rates would typically be used (Puls and Paul, 1995). However, purging at rates in excess of site hydrogeologic conditions causes excessive drawdown in the well, which pulls stagnant water into the screened interval, mixes chemically-distinct waters, and causes aeration, turbulence, and redevelopment of the well (Giddings, 1983; Gilham, et. al., 1983; Puls and Powell, 1992a). The resulting artificially-induced chemical and physical changes in the groundwater include changes in redox, pH, carbonate equilibria, metal speciation, chemical precipitation, erroneously high turbidity and total metals, suspension of particles that may not be mobile in the aquifer and which may have adsorbed contaminants, order-of-magnitude errors in dissolved chemical data, and the potential for damage to the filter pack of the monitoring well (Barcelona and Helfrich, 1986; Gibs et al., 1993; Giddings, 1983; Gilham, et. al., 1983; Kaminski, 2002; Martin-Hayden et al., 1991; McCarthy and Zachara, 1989; Powell and Puls, 1993; Puls and Barcelona, 1996; Puls and Powell, 1992a,b; Puls et al., 1992; Reilly and Gibs, 1993; Robbins and Martin-Hayden, 1991; Robin and Gilham, 1987; Schmidt, 1982, Strausberg, 1983; Wilson and Rouse, 1983).

In addition to the adverse consequences of uncontrolled drawdown and high pumping rates, historical "well volume" purging typically had no requirement for pump intake placement within the well. The high-speed submersible pump would often be placed near the top of the water column (Puls and Paul, 1995), a placement that has been shown to actually increase the volume required to access formation water to values much greater than the conventional 3-5 "well volumes" (Robin and Gilham, 1987).

Various workers (e.g., Kearl et al., 1992; Powell and Puls, 1993; Robin and Gilham, 1987) have determined that groundwater flow through the screened interval of a well is laminar, with little interaction or mixing with chemically-different water in the overlying well casing unless disturbed (e.g., by insertion of sampling equipment or pumping at high rates), and therefore is representative of formation water in the surrounding aquifer. By placing the pump within the screened interval and pumping at a rate low enough to minimize or eliminate drawdown, many adverse effects on sample quality would be mitigated. Studies using a downhole camera during purging and sampling indicate that emplacement of the sampling device causes significant disturbance at the sampling point (Kearl et al., 1992; Powell and Puls, 1993). Use of different devices for purging and sampling should therefore be avoided.

Although monitoring field water quality indicator parameters for stabilization to determine when formation water is being accessed ("equilibrated ") has generally been conducted prior to groundwater sampling, historically, only three parameters (pH, temperature, and specific conductance) were usually measured. Work by various investigators beginning in the 1980s indicates that pH, temperature, and

specific conductance tend to stabilize quickly and that these parameters are insensitive in distinguishing between formation water and stagnant water (Humenick et al., 1980; Pionke and Urban, 1987; Powell and Puls, 1993; Puls and Barcelona, 1996; Puls and Powell, 1992b; Puls et al., 1991, 1992). In the early 1990s, Puls et al. (1991, 1992) determined that oxidation-reduction potential (ORP), dissolved oxygen (DO), turbidity, and contaminant concentrations are the most sensitive indicators of equilibrated conditions.

Using the volume of the sampling system (bladder pump, tubing, and flow-through cell) as a means for comparison, the earliest that a well could show stabilization of indicator parameters would be after two "system volumes" had been removed (Barcelona et al., 1994; Puls and Paul, 1995) At flow rates of 0.2 – 0.5 L/min, Puls and Paul (1995) found that the indicator parameters equilibrated at 0.7 "well volumes" (4 L) for a dedicated sampling system and 1.8 "well volumes" (10 L) for a portable system. They also determined that after removing 3 sampling system volumes at a constant flow rate, the water quality parameters were within 20% of the final equilibrated values. These findings were determined from wells which could achieve sustainable water levels.

Dewatering a well considered to be "low-recharge" is another common, historical practice that has a number of adverse hydrogeological and hydrochemical consequences. When a well is evacuated, water drains from the well filter pack, the filter pack pore spaces fill with air, which remains even after water re-enters the well, the trapped air upsets the natural gas equilibria and alters fO_2-pH conditions, and samples are not representative (Kaminski, 2002).

2.2 Low-flow Method

"Low-flow" (also called "low stress") purging and sampling addresses the various problems associated with historical well purging practices. "Low-flow" refers to the velocity at which water enters the pump intake and which is imparted to the formation water in the immediate vicinity of the well screen, not to the flow rate of water discharged at the surface (Puls and Barcelona, 1996; Puls and Paul, 1995). Low-flow purging is typically conducted at flow rates on the order of 100 – 500 mL/min (Puls and Barcelona, 1996). It should be noted that 1 L/min is the upper limit for low-flow purge rate, regardless of the transmissivity of the formation, since higher flow rates will exceed the laminar flow regime and induce turbulent flow (Puls and Barcelona, 1996).

One of the major objectives of low-flow purging is to minimize stress by pumping at a rate that does not exceed natural flow rate of groundwater within the aquifer. Water level drawdown is considered the best indicator of the stress imparted by a given flow rate in a particular hydrogeological situation (Puls and Barcelona, 1996; Puls and Paul, 1995), and is monitored frequently.

Other characteristics of the "low-flow" method include:

- Use of a variable-speed pump capable of low flow rates (100 mL/min or less is recommended for sensitive analytes such as VOC and redox-sensitive species).
- Using the same pump for both purging and sampling to minimize disturbance caused by insertion and withdrawal of sampling devices (Kearl et al., 1992).
- Isolation of water from the screened interval of the well from overlying stagnant casing water by placing the pump intake within the screened interval.
- Pumping at a rate that does not exceed natural flow rate of groundwater within the aquifer.
- Monitoring water level drawdown during purging to determine the amount of stress on the aquifer.

- Monitoring six water quality indicator parameters (dissolved oxygen (DO), turbidity, Eh (ORP), specific conductance, pH, and temperature) during purging to determine when formation water is being accessed and samples can be collected.

In addition to minimizing physical disturbance and chemical changes, low-flow purging also typically minimizes the amount of investigation-derived waste (IDW) generated during the sampling event.

3 Procedure Overview

The collection of groundwater samples from monitoring wells using the low-flow method will be accomplished in four general steps:

- Determine the sustainable purge flow rate for the well;
- Obtain stabilized water level in the well;
- Obtain stabilized water quality indicator parameters;
- Collect groundwater samples.

In order to avoid cross-contamination, monitoring wells will be purged and sampled in order so that the well having the lowest suspected contamination is sampled first, and the well having the highest suspected contamination is sampled last. (Note: It is important to "flush" the pumping system with groundwater to remove residues from the last operation, regardless of whether the pump is dedicated or portable)

3.1 Stabilization Criteria

3.1.1 Water Level

Water level will be measured to the nearest 0.01 ft. using an electronic water level indicator. Water level will be considered stable when 3 successive readings at 5-min. intervals show no change. Note: for purposes of this SOP, either stable (no change) or rising water level will be considered acceptable.

3.1.2 Water Quality Indicator Parameters

The six field indicator parameters to be monitored are: dissolved oxygen (DO), turbidity, Eh (ORP), specific conductance, pH, and temperature. Of these, DO, ORP, specific conductance, pH, and temperature are moderately to extremely sensitive to contact with atmospheric oxygen, and will be measured in-line using a flow-through cell and multimeter. Turbidity may be measured separately on a discrete sample. Indicator parameters will be monitored continuously during purging and values recorded approximately every 3-5 minutes.

3.1.2.1 DO, ORP, specific conductance, pH, and temperature

Stabilization is mathematically defined as an asymptote (i.e., the slope of a plotted curve for each parameter is no longer changing). The operational criteria for DO, ORP, specific conductance, pH, and temperature are 3 successive readings at 5-min. intervals within the following ranges:

- turbidity: < 50 NTU
- DO: ± 10% above 1 mg/L. ±0.1 mg/l below 1 mg/l

- Eh (ORP): ± 10 mV
- specific conductance: ± 1% of full scale reading (instrument repeatability) *or* default ± 20 µmhos/cm
- pH: ± 0.1 unit
- temperature: ± 0.5 °C

3.1.2.2 Turbidity

Turbidity is considered stabilized if values are less than 50 NTU for 3 successive readings at 5-min. intervals (assuming a 100 mL/min flow rate). If the other parameters stabilize, but turbidity remains >50 NTU, the field personnel should continue purging at the determined sustainable flow rate to see whether the turbidity decreases with additional pumping. If turbidity does not decrease, the designated point of contact for the PDT should be notified.

3.2 Recommended Equipment

In addition to field equipment specified in the project Field Sampling Plan (FSP), the following equipment should be available for field sampling:

- variable-speed bladder pump or submersible pump capable of low flow rates (i.e., 100 mL/min or less)
- contingency low-flow sampling device (e.g., peristaltic pump)
- project specified tubing
- Flow-through cell no larger than 500 mL equipped at a minimum with probes for DO, ORP, pH, conductivity, temperature
- Above probes must be calibratable by field personnel.
- Instrument for measurement of turbidity. Must be able to calibrate.
- Stopwatch
- 500-mL graduated cylinder
- Three or more 5-gallon buckets
- Pre-printed field forms for recording readings
- Water level measuring device
- Graph paper or field computer - for plotting readings vs. time if desired)

Backup equipment should be available as necessary.

4 Procedures for Sustainable Recovery Wells

In these procedures, a “sustainable recovery” well is defined as a well in which a sustainable water level can be obtained during pumping at any given, constant flow rate at an elevation above the pump intake such that there is sufficient volume for all required samples (including any extra volume required for quality assurance/quality control (QA/QC purposes) plus two sampling system volumes (see sec. 4.1, no. 9).

“Excessive drawdown” is defined as drawdown at any given, constant flow rate such that a stabilized water level can not be obtained at an elevation above the pump intake such that there is sufficient volume for all required samples plus two sampling system volumes.

4.1 "Standard" Sustainable Recovery Wells

In this procedure, a "standard" sustainable recovery well is defined as a well in which stabilized water level can be obtained at a pumping rate equal to or greater than 100 mL/min.

Note: The project Field Sampling Plan should be consulted for site-specific field preparatory activities which may take place at a given well prior to purging.

1. Obtain well casing and borehole diameters and filter pack percent porosity from well construction records (may be needed for calculations if the well is determined to be a low-recovery well).
2. Calibrate the electronic water quality multi-meter equipment (e.g., Horiba U22 or equivalent) as per manufacturer's instructions and record calibration data in the field logbook or on a field data form.
3. Check the function of the electronic water level meter as per the manufacturer's instructions.
4. Assemble equipment at the well and perform field preparatory activities as described in the project-specific Field Sampling Plan.
5. If using a portable pump, the following steps are applicable:
   - Measure well depth. Using the electronic water level meter, measure and document the depth of the well (to the nearest 0.01 ft) from the reference mark on the top of the inner well casing.
   - Measure water level. Using the electronic water level meter, measure and document the water level to the nearest 0.01 ft. from the reference mark on the top of the inner well casing.
   - Assemble the pump and sampling line components, taking care not to contact any of the components with potentially-contaminated media, and ensure that the discharge line is affixed such that initial discharge is captured in either a graduated 5-gallon bucket or a purge water collection/disposal drum.
   - Determine the depth of portable pump intake. Measure length of pump from intake to tubing and cable attachment. Measure length of tubing and cable needed to set pump at desired depth within the screened interval.
   - Slowly lower the pump into the well casing to the desired depth in the screened interval, taking care not to encounter the bottom of the well and cause unnecessary agitation of sediment. Affix the pump in this position by fastening the supporting cable. Record depth of pump intake from the reference mark on the top of the inner well casing.
6. If using a dedicated pump, the following steps are applicable:
   - Obtain well depth and depth of pump intake from well construction records.
   - Measure water level with pump in place. Using the electronic water level meter, measure and document the depth to water (to the nearest 0.01 ft) from the reference mark on the top of the inner well casing.
7. Determine saturated casing volume and saturated borehole volume (saturated casing volume + saturated filter pack volume) (may be needed for calculations if the well is determined to be a low-recovery well).
8. Determine the casing volume above the pump intake (may be needed for calculations if the well is determined to be a low-recovery well).
9. Determine sampling system volume (volume capacity of pump, tubing, and flow-through cell) (may be needed for calculations if the well is determined to be a low-recovery well).

10. Determine volume necessary to collect all required samples (may be needed for calculations if the well is determined to be a low-recovery well).
11. Connect the flow-through cell and multi-meter to the pump tubing.
12. If the sustainable flow rate is not known for the well, begin purging at 100 mL/min. For wells with historical sustainable flow rate data, use the historical rate.
13. Ensure that no air bubbles are entrained in the pump tubing. Raise the level of the flow-through cell above the well such that water must pump upward through the intake tubing of the cell. This will purge any bubbles through the tubing. After the cell fills with water, it may be lowered.
14. Measure and record the water level and an initial set of water quality indicator parameter measurements.
15. Determine the initial purge flow rate from the well. Using a graduated cylinder, bucket, or other suitable container of known volume and a stopwatch, time the rate of filling.
16. Determine whether the initial purge flow rate causes water level drawdown in the well. Measure and record the water level and water quality indicator parameters at 500 mL or 5-min. intervals. The water level will be considered stable if water level readings do not decrease over 3 successive measurements (it is acceptable for the water level to remain unchanged or to increase) and if the volume of water in the casing above the pump intake is equal to or greater than the volume needed for all required samples plus 2 sampling system volumes.
17. If the initial purge rate of 100 mL/min does not cause drawdown and is an appropriate rate for project analytes and purposes, document that sustainable recovery has been achieved at this rate and go to no. 25 and obtain stabilized indicator parameter readings.
18. If the initial purge rate of 100 mL/min does not cause drawdown and a higher rate is desirable for project-specific reasons, adjust the flow rate and determine whether sustainable recovery can be obtained using the higher flow rate. Record each adjustment made to the pumping rate, the water level, and the multi-meter readings measured immediately after each adjustment. The water level and water quality parameters should be measured and recorded approximately every five minutes. When sustainable recovery has been documented at the higher flow rate, go to step 21 and obtain stabilized indicator parameter readings.

    Note: Assuming a highly transmissive formation, 1 L/min is the *maximum* purge rate that will preserve laminar flow in the screened interval.
19. If the initial purge rate of 100 mL/min causes drawdown and the well is less than 25 – 30 ft. deep, the procedure may be repeated using a peristaltic pump to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min ("alternative" sustainable recovery well – sec. 4.2).
20. If the initial purge rate of 100 mL/min causes drawdown and alternative equipment with flow rates less than 100 mL/min cannot be used, go to the low-recharge procedure (sec. 4.3).
21. Once a stabilized water level has been obtained, the field indicator parameters will be monitored for stabilization. If the flow rate is equal to or greater than 100 mL/min, measure and record the water quality indicator parameters at 5- min. intervals. If the flow rate is less than 100 mL/min, measure and record the water quality indicator parameters at time intervals of 500 mL ÷ purge rate. Field indicator parameter measurements will be considered stable when 3 consecutive measurements within the following ranges are obtained:

    - turbidity: < 50 NTU

- DO: ± 10% for readings above 1 mg/L; ±0.1 mg/L below 1 mg/L
- Eh (ORP): ± 10 mV
- specific conductance: ± 1% of full scale (instrument repeatability) *or* default ± 20 μmhos/cm
- pH: ± 0.1 unit
- temperature: ± 0.5 °C

22. Once stabilized field indicator parameter measurements have been obtained, samples may be collected.

23. If the other parameters stabilize but turbidity < 50 NTU cannot be attained, the designated point of contact for the PDT should be notified.

4.2 "Alternative" Sustainable Recovery Wells

An "alternative" sustainable recovery well is defined as a well in which stabilized water level can be obtained as described in sec. 4 at a pumping rate less than 100 mL/min. using alternative equipment capable of lower flow rates (e.g., peristaltic pump, "mini" bladder pump).

1. If a purge rate of 100 mL/min causes drawdown and the well is less than 25 – 30 ft. deep, the standard sustainable recovery procedure may be repeated using a peristaltic pump to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min.

2. If a stabilized water level can be obtained at any level above the pump intake at a pumping rate less than 100 mL/min. using alternative equipment, go to sec. 4.1 step 21 and obtain stabilized indicator parameter readings. Note that for flow rates of less than 100 mL/min, parameter measurement interval is determined by 500 mL ÷ purge rate.

4.3 "Low-Recovery" Wells

A "low-recovery" well is defined as a well in which stabilized water level cannot be obtained as described in sec. 4, regardless of pumping rate or equipment type.

1. If a purge rate of 100 mL/min causes drawdown and/or alternative equipment with flow rates less than 100 mL/min cannot be used, the following procedure should be used.
2. The following information (see sec. 4.1, steps 1, 7, 8, 9) will be needed:

    - Obtain well casing and borehole diameters and filter pack percent porosity from well construction records.
    - Determine saturated borehole volume (casing volume + saturated filter pack volume).
    - Determine casing volume above the pump intake.
    - Determine sampling system volume (volume capacity of pump, tubing, and flow-through cell).
    - Determine volume necessary to collect all required samples, including QA/QC samples.

3. Determine whether the casing volume above the pump intake is sufficient for at least 2 sampling system volumes plus required samples.

4. If the casing volume above the pump intake is sufficient for at least 2 sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until 2 (or available) system volumes have been removed; collect samples; document conditions and procedures. (Note: water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.)
5. If the casing volume above the pump intake is sufficient for at least 1 sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until 1 (or available) system volumes have been removed; collect samples; document conditions and procedures. (Note: water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.)
6. If the casing volume above the pump intake is sufficient for all required samples only, determine whether it is acceptable to collect samples without purging. If this is acceptable for project purposes, collect samples at a constant flow rate without purging, document conditions and procedures.
7. If the casing volume above the pump intake is not sufficient for all required samples, determine whether samples can be prioritized and it is acceptable to collect priority samples without purging. If this is acceptable for project purposes, collect priority samples at a constant flow rate without purging, document conditions and procedures.
8. If the casing volume above the pump intake is not sufficient for all required samples, samples can not be prioritized, and/or it is not acceptable for project purposes to collect samples without purging, do not sample, document conditions.
9. If the well cannot be sampled using the low-recharge procedure:
    - Determine whether diffusion samplers or other “passive” methods are acceptable for project purposes and can be used.
    - Determine whether the well can be removed from the monitoring network.

5 Decision Trees

I. Wells with historical purge rate data:

A. Does historical purging data indicate a consistent, sustainable recovery well (i.e., stabilized water level can always be achieved) using either standard or alternative equipment?
- If yes, use historical sustainable flow rate and equipment; obtain stabilizedwater level; obtain stabilized indicator parameters; collect samples.

B. Does historical purging data indicate a well with inconsistent recovery across sampling events?
1. Determine whether sustainable flow rate can be achieved during this sampling episode using standard or alternative equipment
   - If yes, use sustainable rate and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
   - If no, use low recharge procedure.

II. Wells without historical purge rate data but with information from well development or redevelopment:

A. Does well development or redevelopment record indicate a sustainable recovery well using either standard or alternative equipment?
- If yes, determine sustainable flow rate and use sustainable rate procedure and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
- If no, use low recharge procedure.

III. Wells without either historical purge rate or well development or redevelopment data:

A. Determine whether sustainable flow rate can be achieved during this sampling episode using standard or alternative equipment
- If yes, use sustainable rate and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
- If no, use low recharge procedure.

6 References

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FINAL
QUALITY ASSURANCE PROJECT PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Contract No. DACW41-02-D-0004
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August 2006

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LIST OF ACRONYMS AND ABBREVIATIONS

AES	atomic emission spectroscopy
AFB	Air Force Base
ASTM	American Society for Testing and Materials
BA	bioaugmentation
BS	blank spike
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
CLP	Contract Laboratory Program
COC	chain-of-custody
CQCM	Contractor Quality Control Manager
1,2-DCE	1,2-dichloroethene
cis-1,2-DCE	*cis*-1, 2-dichloroethene
DO	dissolved oxygen
DOMP	Design, Operations and Monitoring Plan
DQCR	Daily Quality Control Report
DQOs	data quality objectives
DRO	diesel range organics
ERD	enhanced reductive dechlorination
eV	electron volt
FID	Flame Ionization Detect
FSP	Field Sampling Plan
GC/FID	gas chromatography/flame ionization detector
GC/MS	gas chromatography/mass spectrometry
HCl	hydrochloric acid
HDPE	high density polyethylene
HNO_3	nitric acid
HGL	HydroGeoLogic, Inc.
H_2SO_4	sulfuric acid
ICP	inductively-coupled plasma
ISCO	in-situ chemical oxidation
KDHE	Kansas Department of Health and Environment
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LIMS	laboratory information management system

LQAM	Laboratory Quality Assurance Manual
MCL	Maximum Contaminant Level
MDL	method detection limit
MEK	methyl ethyl ketone
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
μS/cm	microsiemens per centimeter
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolt
ORP	oxidation-reduction potential
PID	photoionization detector
PQL	practical quantitation limit
PSTS	pilot scale treatability study
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QCSR	Quality Control Summary Report
%R	percent recovery
%RSD	percent relative standard deviation
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SHO	Safety and Health Officer
SOP	standard operating procedure
SS	Site Supervisor
SSHP	Site Safety and Health Plan
SSHO	Site Safety and Health Officer
STL	Severn Trent Laboratories
TCE	trichloroethene
TOC	total organic carbon
TOD	total oxidant demand
TPH	total petroleum hydrocarbon
TPP	Technical Planning Process
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

VOA	volatile organic analysis
VOC	volatile organic compound
ZVI	zero valent iron

FINAL
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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is designed to provide specific guidance and quality assurance/quality control (QA/QC) requirements and evaluation criteria for the generation of environmental data of known quality for use in making site-specific decisions. HydroGeoLogic, Inc. (HGL) prepared this QAPP for the U.S. Army Corps of Engineers (USACE), Kansas City District, under Contract No. DACW41-02-D-0004, Delivery Order 0003, entitled "Pilot-Scale Treatability Study, Former Schilling Air Force Base, Salina, Kansas." This QAPP is intended to comply with the Technical Project Planning (TPP) Process (USACE, 1998); *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001); the *Department of Defense Quality Systems Manual for Environmental Laboratories* (QSM), version 3 (Department of Defense [DoD], 2006); and other applicable regulations and guidance documents.

This QAPP has been written to address the project-specific sampling, analysis, and data use requirements presented in the Performance Work Statement issued on December 23, 2005 (USACE, 2005). The work to be supported by this QAPP includes implementation of pilot-scale treatability studies (PSTSs) at two sites at the former Schilling AFB. This QAPP establishes the basic QC methodology to be applied during site activities and also presents the task-specific information necessary to conduct PSTS activities in accordance with project data quality objectives (Section 2). This QAPP, together with the Field Sampling Plan (FSP) (Appendix A), constitutes the Sampling and Analysis Plan for the work to be conducted.

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2.0 DATA QUALITY OBJECTIVES

Daily Quality Objectives (DQOs) were developed to optimize and describe the data collection objectives for two PSTSs to be conducted at the former Schilling AFB. The DQO process, as described in the U.S. Environmental Protection Agency (USEPA) document *Guidance for the Data Quality Objectives Process* (USEPA, 2000), is subdivided into seven steps:

- State the problem
- Identify the decisions
- Identify inputs to the decisions
- Define study boundaries
- Develop decision rules
- Specify limits on decision errors
- Optimize study design.

Each of the above steps is discussed in detail in the following sections.

2.1 PROBLEM STATEMENT

Two sites will be the subject of a PSTS under this project. These sites are trichloroethene (TCE) contamination of soil and groundwater near Building 837 and TCE and fuel contamination of soil and groundwater at the Former Wash Rack Area near Buildings 606 and 626. The treatment technique selected for testing at Building 837 is in-situ enhanced reductive dechlorination (ERD); the treatment technique selected for testing at the Former Wash Rack Area is in-situ chemical oxidation (ISCO). Although a different treatment method has been selected for each site, the overall objective of both PSTSs is the same: to obtain data in support of an evaluation of the remedial action cost and effectiveness of the chosen technologies when implemented on a full scale. Thus, the current problem has the following components:

1. Determine the most appropriate injection method for the treatment substrate;
2. Determine the radius of influence of the selected technology at the site;
3. Determine the potential for site conditions (e.g., biofouling, geophysical constraints) to impact the effectiveness of the selected technology; and
4. Determine the number of injection points and treatment substrate mass required to achieve significant reduction in contaminant mass.

2.2 IDENTIFY THE DECISIONS

Decisions necessary to achieve the objectives of the PSTSs are related to assessing the effectiveness of the selected treatment technologies. These objectives include determining whether the selected technologies will effectively reduce contaminant concentrations while minimizing unwanted effects (e.g., subsidence), determining the site conditions that will affect the treatment, and determining the amount of treatment substrate for full-scale site remediation. Specifically, the PSTSs must address the following questions:

1. What are the groundwater concentrations of contaminants and are the groundwater concentrations decreasing?
2. What are the groundwater and aquifer conditions relative to the stability of the contaminant plume and what trends and temporal changes in these conditions are taking place?
3. What background conditions at the site will affect the utilization of the remediation substrate?
4. Does bioaugmentation (BA) or the addition of zerovalent iron (ZVI) increase the effectiveness of the ERD treatment at Building 837?

2.3 IDENTIFY INPUTS TO THE DECISIONS

The analytical chemistry data generated during the PSTSs are the most critical inputs to all site decisions listed above. Sample results from the groundwater matrix will be used in the formulation of every decision. The information from chemical analyses will be supplemented by the data provided by real-time instruments and field tests conducted during sample collection.

An understanding of the geologic, hydrologic, and lithologic characteristics of the study areas is essential for interpreting the results of the groundwater monitoring and water level data. Geologic, lithologic, and hydrologic data from previous investigative activities at the site are available and will be used augmented by information gathered during the execution of this task order. This information will be used to support most site decisions listed above.

2.4 DEFINE STUDY BOUNDARIES

The study boundaries at Buildings 837 and 606/626 have been defined by the USACE. Figures depicting the boundaries of the study areas are presented in the FSP. The vertical treatment zones will include both the groundwater and the saturated/unsaturated interface (smear zone).

2.5 DEVELOP DECISION RULES

There are three rules regarding the application of data in reaching decisions:

1. Only analytical data that have been reviewed or validated and identified as acceptable, in accordance with this QAPP, may be used to support a decision. *Rationale*: Data of unacceptable quality may have biases or more serious issues (false positive or false negative results) that could contribute to decision errors. Project completeness goals (see Section 4.4.3) have been developed in order to ensure that the overall data set will be of sufficient quality to support project decisions.
2. Whenever duplicate samples are collected, the average concentration found in the duplicate pair will be the value used in supporting a decision. *Rationale*: The purpose of the PSTSs is to develop the most realistic evaluation of

treatment performance. Using the average concentration to support a decision is the appropriate approach; any error or bias that results from lack of field precision will be minimized by this approach.

Specific decisions will be based on the following rules.

1. *What are the groundwater concentrations of contaminants and are the groundwater concentrations decreasing?* Measurement of volatile organic compounds (VOC) (including benzene, toluene, ethylbenzene, and xylenes [BTEX]; other fuel-related VOCs; and TCE), and diesel range organics (DRO) concentrations before and at specified intervals after treatment will be used to evaluate the effectiveness of the selected technologies in reducing the concentration of site contaminants. The presence and locations of remediation indicators (e.g., total organic carbon [TOC], anions, dissolved metals) will be used to determine the factors and mechanisms affecting the reduction of fuel and TCE contamination in the groundwater. TCE degradation products (*cis*-1,2-dichloroethene [DCE], vinyl chloride, and ethene/ethane/methane) will also be used as indicators for the mechanisms affecting the reduction of TCE in the groundwater.
2. *What are the groundwater and aquifer conditions relative to the stability of the contaminant plume and what trends and temporal changes in these conditions are taking place?* Contaminant concentration data from the baseline sampling and three rounds of post-injection sampling will be used to evaluate the effectiveness of the remedial technologies. Most of the monitoring points are located within designated treatment areas where temporal changes in groundwater quality are expected to reflect changes resulting from injection of the substrate/oxidant. Likewise, measured water levels from the baseline sampling and three rounds of post-injection sampling will be examined to identify temporal changes or trends in the direction of groundwater flow and variations in saturated thickness of the aquifer. Temporal changes in the groundwater elevations could be the result of seasonal influences and/or response of the aquifer to substrate/oxidant injection. The limited historic data at the study areas and the limited sampling during the pilot study are not sufficient for rigorous statistical analysis. The evaluation of data will be based on a qualitative discussion of observed trends.
3. *What background conditions at the site will affect the utilization of the remediation substrate?* Bench-scale testing of subsurface soils will be conducted to determine the soil conditions and the potential effects on the remediation technologies. At both sites, bench-scale testing of soil samples will be performed for quantitative polymerase chain reaction (qPCR) to determine the dominant subsurface biological processes and for total oxidant demand (TOD) to establish the oxygen loading rates for persulfate injection. Note that although qPCR is only applicable to the ERD performed at Building 837 and TOD is only applicable to the ISCO performed at Buildings 606/626, bench-scale tests will be

performed at both sites for these parameters to provide additional information on site variability.

4. *Does BA or the addition of ZVI increase the effectiveness of the ERD treatment at Building 837?* The reduction in contaminant concentrations and the impact on indicator analytes in areas receiving additional treatment with BA or ZVI will be evaluated against those areas that were treated with ERD without BA or ZVI.

2.6 SPECIFY LIMITS ON DECISION ERRORS

The statements below describe the null hypotheses for the PSTSs.

- The selected technologies are effective in treating site contamination in situ and will ultimately be capable of reducing contaminant concentrations below regulatory limits.
- BA and ZVI will increase the effectiveness of the ERD at Building 837.

Decision errors may occur through two scenarios.

- A false acceptance decision error would be to conclude that the null hypothesis is true, when in fact, it is not. The consequences of this decision error would be to incur unnecessary expense to remediate contamination using methodologies that are not effective or do not provide a cost-effective benefit.
- The second type of decision error is a false rejection error. In that case, the error would be to conclude that the null hypothesis is false, when in fact, it is true. The consequences of this decision error would be to reject an effective treatment methodology and continue studying remediation scenarios. This would lead to unnecessary delay in selecting a treatment technology, expense in conducting unneeded studies, and possibly, the selection of a less effective remediation technique.

Both types of errors are limited by the decision rules. Decisions are not based on a single data point, but rather on the entire body of data available. Consequently, a large number of data errors would have to occur across several locations to bias the decision towards a false acceptance or false rejection conclusion. The probability of simultaneous occurrences of error at a large number of measuring points and over an extended period is very low.

The requirement that decisions be based only on data that have been accepted in accordance with the data review and validation process also serves to limit the occurrence of decision errors. The null hypothesis will be accepted or rejected based on a qualitative evaluation of the PSTS data sets. From the standpoint of the PSTS project objectives, there is no tolerable rate for decision errors.

2.7 OPTIMIZE THE STUDY DESIGN

Data from each phase of work under this project will be evaluated to determine whether changes in the sampling or analytical methodology are warranted. If it is decided that changes are warranted, the changes will be incorporated into this QAPP by addendum, as appropriate.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 RESPONSIBILITIES OF KEY PERSONNEL

The organizational structure and responsibilities defined below are designed to ensure adequate project control and proper QA for investigation activities. The project organizational chart, contact information, and necessary communication channels are discussed in full detail in the Quality Control Plan (QCP). Key project personnel include:

- Program Manager/Senior Technical Reviewer
- Project Manager (PM)
- Program QA Manager
- Contractor Quality Control Manager (CQCM)
- Chemical Data Management Team
- Corporate Safety and Health Officer (SHO)
- Site Supervisor (SS)/Site Safety and Health Officer (SSHO)
- Project Staff

3.1.1 Program Manager/Senior Technical Reviewer

Mr. Don Jones, P.E., has overall responsibility and accountability for management of the program and contractual activities. He will also conduct independent senior technical reviews of all product deliverables, as well as provide technical consultation during critical phases of product development. As the Program Manager (PGM) Mr. Jones possesses the authority to commit corporate resources to support program functions, and has assumed the responsibility of providing responsiveness to the USACE.

3.1.2 Project Manager

HGL's PM, Miquette Rochford, P.G, is the primary point of contact with USACE. The PM coordinates the work of HGL technical staff in the successful accomplishment of project goals and policies. The PM reviews all documents, reports, and technical memoranda prepared by HGL that are relevant to completing the PSTSs. The PM is also responsible for the project schedule.

3.1.3 Program QA Manager

HGL's Program QA Manager, Janardan Patel, PMP, is responsible for overseeing the implementation of the QCP from the corporate standpoint. He will be responsible for ensuring that the QC team is provided with the company resources necessary to maintain QC of the project. The CQCM for the project will report directly to him on matters of QC. Mr. Patel will report any QC discrepancies to the PGM, and will ensure that the appropriate corrective actions are taken.

3.1.4 Contractor QC Manager

Mr. Robert Overfelt, P.G., will serve as HGL's Contractor Quality Control Manager (CQCM). He will have the overall responsibility for the HGL QC program for the environmental restoration at the former Schilling AFB. The CQCM reports directly to the Program QA Manager. The CQCM is responsible for the development and interpretation of QC policies and procedures, and carries the requisite authority to oversee and execute QC activities at Schilling. The CQCM will also be responsible for the development and implementation of the QCP. He will provide overall direction to the program QC function, perform audits, surveillance, document reviews, and execute other QC functions as required in the QCP. A more detailed description of the responsibilities of the CQCM is presented in Section 4.2.2 of the QCP (HGL, 2006).

3.1.5 Chemical Data Management Team

The project chemical data management team will consist of the Project Chemist (Mr. Chuck Smith), Assistant Chemist (Ms. Kimberly Evers), and the Database Manager (Mr. Jeff Martin). The Project Chemist will have overall responsibility for implementing the requirements of this QAPP and for ensuring that all data obtained from project activities are capable of supporting the DQOs. The Project Chemist will serve as the chief point of contact for all issues relating to laboratory performance and will coordinate with the laboratory Project Manager to ensure that the laboratory is performing all work in accordance with the QAPP. Following the completion of data validation and data qualification in the database, the Project Chemist will produce the Quality Control Summary Report (QCSR) for the project. The Project Chemist will report directly to the CQCM. The Assistant Chemist will perform data validation and data qualification. The Database Manager will create and maintain the project database, and will ensure that the database is organized in a fashion that can be queried to support project data reporting needs. The Assistant Chemist will assist the Database Manager in ensuring that all data included in the project database are accurate, match the laboratory hardcopy data reports, and are correctly qualified. The HGL Senior Chemist (Mr. Ken Rapuano) will provide overall technical guidance to the Chemical Data Management Team on an as-needed basis, will perform senior review of all data validation reports, and will assist the Project Chemist in producing the QCSR.

3.1.6 Corporate Health and Safety Officer

Ms. Mary Ann Heaney, CIH, is HGL's Corporate SHO. Ms. Heaney is responsible for program level implementation of the Site Safety and Health Plan (SSHP).

3.1.7 Site Supervisor/Site Safety Health Officer

Mr. Chris Williams, P.G., will serve as the Site Supervisor (SS) and Site Safety and Health Officer (SSHO). The SS/SSHO reports to the PM and is responsible for field enforcement of the SSHP. The SS will inform the CIH and PM of any changes to the work plan, prior to implementation, so the Safety and Health issues introduced by those changes may be properly addressed.

In addition to field enforcement of the SSHP, the SS will be responsible for coordinating all site activities with the PM, laboratory, and on-site subcontractors. The SS will provide the necessary orientation, training, direction, and supervision to all field personnel. The SS ensures the use of calibrated measurement and equipment, as well as manages all field documentation. All sampling operations will be monitored by the SS to ensure the sampling team members adhere to the FSP.

Other responsibilities include:

- Requiring that the SSHP is read and signed by all field personnel on the project, including subcontractors,
- Contacting the CIH if changes to an Activity Hazard Analysis (AHA), or developing a new AHA as needed,
- Assuming the duties of the SHO if directed by the SHO,
- Overseeing technical execution of field sampling activities,
- Providing all required supplies, equipment, and tools prior to initiation of each task,
- Ensuring employees maintain required training and medical monitoring throughout the project, and
- Monitoring that the equipment is properly calibrated and used, and that the results are properly recorded and filed in accordance with HGL's HSP Policy 4.1.

3.1.8 Project Staff

Each project staff member will report to the PM and inform PM of completed project activities. Members of the project staff are responsible for understanding and implementing the QA/QC Program, as it applies to their assigned project activities.

3.2 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including employees and consultants, will be qualified to perform the task to which they are assigned.

Appraisal of the qualifications of technical personnel assigned to the project will be made by the PM. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether further training is required and, if required, by what method. On-the-job training is an acceptable method, provided such training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented.

All documents concerning qualification appraisal will be stored in the project files.

3.3 PROJECT LABORATORIES

The primary point of contact at project laboratories will be the laboratory Project Manager. The laboratory Project Manager will coordinate the functions of the various laboratory sections, including sample receiving, analytical groups, report preparation, database management, and QA/QC to ensure that the analytical data delivered to HGL meet the project quality objectives and meet HGL's expectations for timeliness, completeness, and cost-effectiveness. Should issues arise that cannot be resolved by the laboratory Project Manager, the laboratory Operations Manager and QA Manager will be responsible for assisting the laboratory Project Manager.

3.3.1 Environmental Laboratories

The environmental laboratory selected to perform soil and groundwater analyses is the Severn Trent Laboratories (STL) facility in University Park, Illinois (STL-Chicago). STL-Chicago has been determined to be in compliance with the DoD QSM Version 3 based on assessment of its self-declaration and supporting documentation by USACE Kansas City District. STL-Chicago will subcontract analyses for dissolved gases and carbon dioxide to the STL facility in Burlington, Vermont, and the analysis of volatile fatty acids (VFA) to the STL facility in Buffalo, New York. The environmental laboratories are required to follow the requirements of this QAPP, particularly the QC objectives specified in Section 4.

The STL-Chicago Project Manager is Ms. Linda Mackley; her telephone number is (708) 534-5200. Ms. Mackley will serve as the principal point-of-contact for all issues relating to work performed by STL-Chicago or subcontracted through STL-Chicago to STL-Burlington or STL-Buffalo.

3.3.2 Bench-Scale Laboratories

Bench-scale testing of qPCR and bacterial DNA will be performed by Microbial Insights located in Rockford, Tennessee. The Microbial Insights Project Manager is Ms. Dora Ogles; her telephone number is (865) 573-8188. Bench-scale testing of TOD will be performed by Redox Tech, LLC located in Morrisville, North Carolina The Redox Tech Project Manager is Mr. Joe Rossabi; his telephone number is (919) 460-4747. Both Microbial Insights and Redox Tech, LLC have been determined to be in compliance with the DoD QSM Version 3 based on assessment of their respective self-declaration and supporting documentation by USACE Kansas City District.

4.0 QUALITY CONTROL OBJECTIVES

4.1 GENERAL

The overall QC objective for this project is to develop and implement procedures for sampling, laboratory analyses, field measurements, and reporting that will provide data of a degree of quality consistent with its intended use. The sample set, chemical analysis results, and interpretations must be based on data that meet or exceed QC objectives established for the project. QC objectives for the field measurement systems are also an important aspect of the site investigations. The following sections discuss field and laboratory analytical measurements.

4.2 FIELD QA/QC SAMPLES

The following paragraphs describe the QA/QC samples anticipated for this project. Sample containers, preservation requirements, and holding times for all samples collected for this project are detailed in Table 4.1.

4.2.1 Blanks

Two types of field blanks, equipment (rinsate) blanks and trip blanks, will be collected in association with the PSTSs.

Rinsate blanks are prepared by pouring distilled/deionized water over or through the sample preparation/collection apparatus following decontamination procedures. The collection of rinsate blanks is not required for sampling methods using dedicated or disposable sampling devices. Rinsate blank results will be used to determine the potential for cross-contamination attributed to sampling equipment. Such information can be used to estimate measurement error associated with the field sample preparation, containers, field environment, cross-contamination, and laboratory analysis. Rinsate samples will be collected at a rate of 1 per 10 (with a maximum of one per day per matrix sampled) environmental samples collected and will be collected only for those sampling methods for which they are appropriate.

Trip blanks accompany groundwater samples taken for VOC analysis. Trip blanks consist of volatile organic analysis (VOA) vials filled with American Society for Testing and Materials (ASTM) Type II water at the laboratory. The samples will be shipped to the sampling site and sent back to the laboratory with field samples; they will not be opened in the field. One trip blank will accompany each cooler containing VOC samples. Trip blank results can be used to identify contamination associated with sample storage, shipment, and laboratory analysis.

4.2.2 Duplicates

Field duplicate samples are co-located (soil) or sequentially collected (water) samples collected and submitted for analysis in conjunction with the field samples. Field duplicates will be collected from the sampling device in a manner that minimizes loss due to volatilization (i.e.,

both sets of VOC samples will be collected first). Field duplicate samples will be submitted to the laboratory as blind QC samples (with unique sample identifiers) to ensure that they are analyzed in the same manner as all other environmental samples. Field duplicate results will provide an estimate of overall precision of sample collection, field sample preparation, and laboratory analysis (total measurement of sample variability). Field duplicate samples will be collected at a rate of 1 per 10 environmental samples.

4.2.3 Matrix Spike/Matrix Spike Duplicate Samples

Field samples will be submitted for matrix spike and matrix spike duplicate (MS/MSD) analyses. MS/MSD results will be used to assess the potential for matrix interferences to affect reported sample concentrations.

Extra sample quantity for MS/MSD analysis will be collected for VOCs, DRO, and total organic carbon (TOC) (water samples) and for VOCs, and DRO (soil samples) at a rate of 1 per 20 environmental samples. For other analyses, the standard sample size will be sufficient to allow for aliquots to be selected at the laboratory for MS/MSD analyses. MS/MSD analyses will only be requested for those matrices and analyses for which they are appropriate.

MS samples will be analyzed on a batch-specific basis for metals, alkalinity and anions. As an alternative to performing an MSD analysis, the laboratory may associate MS analyses with a laboratory duplicate (LD) to assess precision (see Section 4.3.4).

In addition to project-specific MS/MSD or MS/LD analyses, the analytical methods require the analysis of these analyses on the basis of each preparation batch (not to exceed 20 samples). For those preparation batches that do not contain a project-specific MS/MSD or MS/LD, the laboratory may report these results for non-project samples in order to fulfill batch QC requirements.

4.3 LABORATORY QA/QC SAMPLES

4.3.1 Method (Preparation) Blank

A method blank consists of analyte-free deionized water for groundwater samples and Ottawa sand for soil samples. Method blanks are carried through each step of the analytical method. The method blank data will be used to evaluate the contamination attributable to laboratory operations during the storage, preparation, and analytical processes.

4.3.2 Surrogate Spikes

Surrogates are generally specified for organic analytical methods and are usually brominated, fluorinated, or isotopically labeled compounds that are not expected to be detected in environmental media. Surrogate spikes are compounds added to every blank, sample, MS, MSD, and standard when specified in the analytical methodology. Surrogate results are used to evaluate the accuracy of the analytical measurement on a sample-specific basis. Surrogate

results are expressed as percent recovery (%R) of the surrogate spike. Outlying spike recoveries may indicate matrix interference or extraction anomalies.

4.3.3 Laboratory Control Samples

Laboratory control samples (LCS) are well-characterized, laboratory-generated samples that are used to monitor the laboratory's day-to-day performance of analytical methods. LCSs may also be referred to as laboratory blank spike (BS) analyses. LCSs will be used to monitor the precision and accuracy of the analytical process independent of matrix effects. The results of LCSs will be compared to well-defined evaluation criteria to determine whether extraction and analysis processes were performed properly on a batch-specific basis. Controlling laboratory operations with LCSs (rather than surrogates or MS/MSD) offers the advantage of being able to differentiate outlying recoveries due to systematic errors from those due to matrix effects. LCS duplicates (LCSDs) will be analyzed in association with each VOC LCS. LCSDs will be evaluated in the same manner as LCSs, and will also be used to evaluate batch precision (see Section 4.4.1).

4.3.4 Laboratory Duplicate Samples

The performance of LD analyses provides an estimate of laboratory precision and isolates the measurement of overall precision from variability caused by field conditions and sampling methodology. LD analyses will be performed in a manner and at a rate consistent with the specific analytical method being performed.

4.4 QUANTITATIVE QA/QC MEASUREMENTS

QC objectives usually are expressed in terms of accuracy, precision, completeness, representativeness, comparability, and sensitivity. The PSTS data sets will be used for qualitative evaluation of treatment effectiveness (see Section 2.6). The precision and accuracy criteria will be used only to evaluate analytical method performance and will not be used to support a statistical evaluation of decision errors. Acceptance criteria for precision, accuracy, and sensitivity are presented in Tables 4.2 through 4.10. The control limits for the QC acceptance criteria tables were derived from the acceptance criteria presented in the analytical methods. Where available, the precision and accuracy control limits presented in the method-specific tables are from the QSM Version 3 (DoD Environmental Data Quality Workshop, 2005). Control limits for DRO and general chemistry parameters are those currently established by the laboratory based on statistical evaluation of actual laboratory results. These control limits are updated at regular intervals by the laboratory; if these control limits changeover the course of this project, the laboratory's current control limits will be used to evaluate the performance of these methods. The sensitivity requirements that are presented are those RLs that are achievable by STL-Chicago under routine analytical conditions. HGL has examined these RLs and determined that they are sufficient to meet project data needs. These sensitivity requirements will be maintained throughout the PSPS in order to ensure that all data obtained over time are comparable.

Failure to meet QC objectives will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process.

4.4.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known laboratory standards and by analysis of duplicate environmental samples. Precision will be determined as relative percent difference (RPD) between duplicate sample results. The RPD is calculated by dividing the absolute value of the difference of the two results by the average of the two results and multiplying by 100.

Replicate measurements of known standard (LCS/LCSD pairs) are routinely monitored by the laboratory by comparing the RPD with established control limits. Some analytical methods do not require the generation of LCS/LCSD RPD control limits. The RPD for MS/MSD analyses will be calculated by the laboratory as part of the internal data review process.

The RPD for field duplicate samples will be calculated during the independent data review and validation process (see Sections 9.3 and 9.4). Precision criteria for field duplicate samples are the same as the precision criteria for MS/MSD analyses, as long as both duplicate results in a pair are above the RL for an analyte.

4.4.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of measurement bias. The %R achieved by analyzing known concentrations of spiking compounds will be used to evaluate analytical accuracy. %R is calculated on an analyte-specific basis by dividing the observed value by the true value and multiplying by 100.

Overall analytical accuracy is assessed on a batch-specific basis by evaluating the %R for each analyte in the LCS and LCSD against the QC limits. One known reference standard or LCS is analyzed for every batch (maximum of 20 samples). The accuracy of specific sample analyses is assessed by evaluating the %R of the surrogate spike compounds. %R QC criteria for MS/MSDs will be used to assess the potential for matrix interferences. Acceptable measurement accuracy is also dependent on the sample matrix.

The accuracy of field measurements will be assessed through the performance of pre-measurement calibrations and calibration verifications.

4.4.3 Completeness

Sampling completeness is defined as the percentage of analytical results obtained compared with the projected number of analytical results that would be obtained from all planned sample

locations. Analytical completeness is defined as the percentage of valid (non-rejected) analytical results obtained from measurement systems compared with the total number of analytical results requested.

Although the ideal of 100 percent data completeness may not be achieved, it may still be possible to make site-specific decisions. The impact of rejected or missing data on project decisions will be evaluated on a case-by-case basis. Furthermore, the auditing procedures that are in place will help in the selection of subcontract laboratories which demonstrate good quality practices. During assessment of the data, an evaluation of samples needed to make decisions with respect to project objectives will be made. An overall completeness goal of 95 percent is established for each matrix to be sampled for this project.

4.4.4 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Analyte-specific MDLs are defined as the minimum concentration of a substance that can be identified, measured and reported with a 99 percent confidence that the analyte concentration is greater than zero, and is determined for analysis of a sample in a given matrix containing the analyte. Typical laboratory reporting limits (RLs) are generally 3 to 5 times higher that the laboratory MDLs and are established by the low point of the calibration curve for each analyte. Laboratory MDLs and RLs are presented in Table 4.8 (VOCs) and Table 4.9 (DRO, metals, and general chemistry); MDLs are specific to an individual MDL study performed at an individual laboratory. The laboratory will report all detected values above the MDL; values above the MDL and less then the RL will be qualified as estimated.

The actual project laboratory MDLs and RLs may vary from those cited in Tables 4.8 and 4.9 on a sample-specific basis. Sample-specific factors that can affect MDLs and RLs for that sample include variations in subsample size, percent moisture, matrix interference, and dilutions. Most of these factors will decrease sample-specific sensitivity.

4.5 QUALITATIVE QA/QC MEASUREMENTS

4.5.1 Representativeness

Representativeness is the degree to which data accurately and precisely express a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Although representativeness is a qualitative measurement, it is evaluated through a multistep process beginning with a quantitative check of precision and accuracy data, as described in Section 4.4. Project design is one of the critical inputs that determine if the data collected are representative of the population sampled. This sampling event is not intended to provide an overall site characterization, but is instead intended to provide data from preselected locations that are likely to provide maximum coverage of the contaminated subsurface. Consequently, the DQOs for this sampling effort require that project design incorporate biased sampling.

Although the overall sampling scheme is biased, the samples from each individual point will be collected and analyzed using those protocols necessary to ensure that the data from each sampling location is representative of that location.

The act of sampling a matrix has the potential to affect the representativeness of the sampled material. Samples removed from the sampled medium are subject to changes that can lead to the loss of analytes due to exposure of the sample to light, heat, microbial action, evaporation, and oxidation. The sample container, preservation, and holding time criteria presented in Table 4.1 have been developed on a method-specific basis in order to ensure that the analysis of each sample fraction is performed on an aliquot that is representative of the originally sampled matrix. Deviations from these requirements will affect sample representativeness, and, if they are severe enough, can lead to the rejection of the affected results.

In the case of field duplicate samples, which will be collected and utilized as a means to assess field representativeness, satisfactory representativeness will first be assessed by evaluating RPDs for field duplicate samples against the precision criteria. Results for analytes not meeting these criteria will be evaluated in light of project objectives and, if professional judgment warrants, qualified as estimated in both the original and duplicate samples during the review process.

Representativeness will also be assessed using blank samples. A method blank will be analyzed with every analytical batch to determine potential contamination introduced during routine laboratory procedures. Trip blank and rinsate blank samples will be collected to assess potential contamination due to field operations. The assessment of blank samples will determine if compounds detected in the environmental samples are site-related or introduced through shipping, storage, field procedures, or laboratory procedures.

4.5.2 Comparability

Data within a sample set are comparable if collection techniques and measurement procedures, methods, and RLs are equivalent for the samples and data is of known accuracy. To control data uncertainty analytical and sample collection methods will remain consistent throughout the PSTS, and data will be evaluated with consistent criteria.

Table 4.1
Sample Containers, Preservation Requirements, and Holding Times

Parameter	Analytical Method	Sample Container	Preservation	Holding Time
		Aqueous Samples		
Volatile Organic Compounds	SW8260B	3 H 40 mL VOA vials	4 °C, HCl to pH <2	14 Days
TPH-Extractable (DRO)	SW8015B-Modified	2 x 1 L amber glass	4 °C	7 Days to extraction; 40 days from extraction to analysis
Total Organic Carbon	E415.1 or SW9060A	3 H 40 mL VOA vials	4 °C, H_2SO_4 to pH <2	28 Days
Metals	SW6010B	1 H 1 L HDPE	4 °C, HNO_3 to pH <2[1]	6 Months
Dissolved Gases	RSK-175	2 H 40 mL VOA vials	4 °C, HCl to pH <2	14 Days
Carbon dioxide	RSK-175	2 H 40 mL VOA vials	4 °C	7 Days
Sulfate, Chloride, Orthophosphate, and Nitrate/Nitrite (total)	E300 or SW9056	1 H 500 mL HDPE	4 °C	28 Days (48 hours for nitrate/nitrite and orthophosphate)
Volatile Fatty Acids	AM-20 GAX (In-house method)	2 x 40 mL VOA vials	4 °C	14 Days
Alkalinity	E310.1	1 H 500 mL HDPE	4 °C	14 Days
Microbial DNA	Proprietary method	1 x 1 L HDPE	4 °C	24 hours (to start of test)
Ferrous Iron	NA	NA (field test kit)	NA	Analyze immediately (field test)
Biological Activity Reaction Test (BART)	NA	NA (field test kit)	NA	Analyze immediately (field test)
ORP	ASTN D1498	Glass or HDPE	NA	Analyze immediately (field test)
Temperature	E170.1	Glass or HDPE	NA	Analyze immediately (field test)
Turbidity	E180.1	Glass or HDPE	NA	Analyze immediately (field test)
Dissolved Oxygen	E360.1	Glass or HDPE	NA	Analyze immediately (field test)
pH	SW9040B	Glass or HDPE	NA	Analyze immediately (field test)
Conductance	SW9050A	Glass or HDPE	NA	Analyze immediately (field test)

Table 4.1 (continued)
Sample Containers, Preservation Requirements, and Holding Times

Parameter	Analytical Method	Sample Container	Preservation	Holding Time
Soil Samples				
Volatile Organic Compounds	SW8260B	3 H EnCore® 5 g samplers	4 °C	48 hours; 14 days if frozen to –7 °C within 48 hours of collection
TPH-Extractable (DRO)	SW8015B-Modified	8 ounce jar	4 °C	14 Days to extraction; 40 days from extraction to analysis
Total Oxygen Demand	Proprietary method	100 g (glass jar or acetate-lined sleeve)[2]	4 °C	48 hours
Quantitative Polymerase Chain Reaction (qPCR)	Proprietary method	10 g (glass jar)	4 °C	24 hours (to start of test)
Investigation Derived Waste (IDW)—Water				
VOC	SW8260B	3-40 cc VOA	4 °C, HCl to pH <2	14 days
RCRA Metals	SW6010B	1 c poly	4 °C, HNO_3, pH <2	6 month
TPH-Extractable (DRO)	SW8015B-Modified	2 x 1 L amber glass	4 °C	7 Days to extraction; 40 days from extraction to analysis
Investigation Derived Waste (IDW)—Soil				
Volatile Organic Compounds	SW8260B	3 H EnCore® 5 g samplers	4 °C	48 hours; 14 days if frozen to –7 °C within 48 hours of collection
RCRA Metals	SW6010B	8 oz jar	4°C	6 month
TPH-Extractable (DRO)	SW8015B-Modified	8 ounce jar	4 °C	14 Days to extraction; 40 days from extraction to analysis

[1] If total metals analysis is required, the samples will be preserved in the field. If dissolved metals analysis is required, then the samples will be filtered in the field prior to preservation.
[2] Plus 150 mL (in glass) of associated groundwater submitted separately (if available).

HDPE = High Density Polyethylene
mL = Milliliter
°C = degrees Celsius
HCl = Hydrochloric Acid
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid.
RCRA = Resource Conservation and Recovery Act

Table 4.2
Quality Control Criteria for VOC Analyses by SW846 Method 8260B

QC Element	Frequency	Acceptance Criteria	Corrective Action
BFB Tune	Daily, prior to use	Must meet mass vs. ion abundance criteria as listed in the method	1) Evaluate System 2) Re-tune the instrument
Initial Calibration	Initially; thereafter as the continuing calibration fails	%RSD of CCCs ≥30%; RRFs for all SPCCs ≥0.300 (except chloromethane, bromoform; 1,1-DCA ≥0.100) r ≥0.995 or %RSD ≤15% for each individual analyte	1) Evaluate System 2) Recalibrate as necessary
Initial Calibration Verification	Following initial calibration	%R = 80% to 120%	1) Evaluate System 2) Recalibrate as necessary
Continuing Calibration Verification	Every 12 hours	CCCs %D ≤20%; RRFs for SPCCs ≥0.300 (except chloromethane, bromoform, 1,1-DCA ≥0.100) Target analytes: %D ≤25%	1) Evaluate System 2) Clean system 3) Reanalyze affected samples since the last in-control Continuing Calibration
Method Blank	Following CCV	Analytes < ½ RL Common lab contaminants < RL	1) Rerun. 2) Evaluate Batch. 3) Reanalyze or qualify results as necessary
LCS/LCSD	Every analytical batch (maximum of 20 samples)	See Table 4.3	1) Rerun. 2) Evaluate batch 3) Reanalyze or qualify results as necessary
MS/MSD	As indicated on chain of custody forms	See Table 4.3 (not applicable if parent sample concentration > 4x the spike level)	1) Evaluate MS/MSD to assess matrix interference 2) Evaluate batch and qualify results as necessary
Surrogate Recovery	Every sample	See Table 4.3	1) Rerun 2) Reanalyze or qualify results as necessary

% RSD = Percent Relative Standard Deviation
%R = Percent Recovery
%D = Percent Difference/Percent Drift
RL = Reporting Limit
CCC = Calibration Check Compound
SPCC = System Performance Check Compound
BFB = Bromofluorobenzene

Table 4.3
Accuracy and Precision Requirements for VOCs Analysis (Aqueous and Soils)

Analyte	Aqueous		Soil	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Dichlorodifluoromethane (Freon 12)	30-155	Lab	35-135	Lab
Chloromethane	40-125	Lab	50-130	Lab
Vinyl Chloride	50-145	Lab	60-125	Lab
Bromomethane	30-145	Lab	30-160	Lab
Chloroethane	60-135	Lab	40-155	Lab
Trichlorofluoromethane (Freon 11)	60-145	Lab	25-185	Lab
1,1-Dichloroethene	[65]-130	Lab	65-135	Lab
Carbon Disulfide	35-160	Lab	[35]-160	Lab
Acetone	40-140	Lab	20-160	Lab
Methylene Chloride	55-140	Lab	55-140	Lab
***trans*-1,2-Dichloroethene**	60-140	Lab	65-135	Lab
1,1-Dichloroethane	70-135	Lab	75-125	Lab
2,2-Dichloropropane	70-135	Lab	65-135	Lab
***cis*-1,2-Dichloroethene**	70-125	Lab	65-125	Lab
2-Butanone	30-150	Lab	30-160	Lab
Bromochloromethane	65-130	Lab	70-125	Lab
Chloroform	65-135	Lab	70-125	Lab
1,1,1-Trichloroethane	65-130	Lab	70-135	Lab
1,1-Dichloropropene	75-130	Lab	70-135	Lab
Carbon Tetrachloride	65-140	Lab	65-135	Lab
Benzene*	80-120	Lab	75-125	Lab
1,2-Dichloroethane	70-130	Lab	70-135	Lab
Trichloroethene	70-125	Lab	75-125	Lab
1,2-Dichloropropane	75-125	Lab	70-120	Lab
Dibromomethane	75-125	Lab	75-130	Lab
Bromodichloromethane	75-120	Lab	70-130	Lab
cis-1,3-Dichloropropene	70-130	Lab	70-125	Lab
4-Methyl-2-Pentanone	60-135	Lab	45-145	Lab
Toluene*	75-120	Lab	70-125	Lab
trans-1,3-Dichloropropene	55-140	Lab	65-125	Lab
1,1,2-Trichloroethane	75-125	Lab	60-125	Lab
Tetrachloroethene	45-150	Lab	65-140	Lab
1,3-Dichloropropane	75-125	Lab	75-125	Lab
2-Hexanone	55-130	Lab	45-145	Lab
Dibromochloromethane	60-135	Lab	65-130	Lab
1,2-Dibromoethane	[73]-120	Lab	70-125	Lab
Chlorobenzene	80-120	Lab	75-125	Lab
1,1,1,2-Tetrachloroethane	80-130	Lab	75-125	Lab
Ethylbenzene*	75-125	Lab	75-125	Lab

Table 4.3 (continued)
Accuracy and Precision Requirements for VOCs Analysis (Aqueous and Soil)

Analyte	Aqueous		Soil	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
meta- and *para*-Xylenes*	75-130	Lab	80-125	Lab
ortho-Xylene*	80-120	Lab	75-125	Lab
Styrene*	65-135	Lab	75-125	Lab
Bromoform	70-130	Lab	55-135	Lab
Isopropylbenzene*	75-125	Lab	[69]-[130]	Lab
Bromobenzene	75-125	Lab	65-120	Lab
1,1,2,2-Tetrachloroethane	65-130	Lab	55-130	Lab
1,2,3-Trichloropropane	75-125	Lab	65-130	Lab
n-Propylbenzene*	70-130	Lab	65-135	Lab
2-Chlorotoluene	75-125	Lab	70-130	Lab
1,3,5-Trimethylbenzene*	75-130	Lab	65-135	Lab
4-Chlorotoluene	75-130	Lab	75-125	Lab
tert-Butylbenzene*	70-130	Lab	65-130	Lab
1,2,4-Trimethylbenzene*	75-130	Lab	65-135	Lab
sec-Butylbenzene*	70-125	Lab	65-130	Lab
1,3-Dichlorobenzene	75-125	Lab	70-125	Lab
p-Isopropyltoluene*	75-130	Lab	75-135	Lab
1,4-Dichlorobenzene	75-125	Lab	70-125	Lab
n-Butylbenzene*	70-135	Lab	65-140	Lab
1,2-Dichlorobenzene	70-120	Lab	75-120	Lab
1,2-Dibromo-3-chloropropane	50-130	Lab	40-135	Lab
1,2,4-Trichlorobenzene	65-135	Lab	65-130	Lab
Hexachlorobutadiene	50-140	Lab	55-140	Lab
Naphthalene*	55-140	Lab	40-125	Lab
1,2,3-Trichlorobenzene	55-140	Lab	60-135	Lab
Surrogates:				
1,2-Dichloroethane-*d4*	70-120	NA	55-145 (Lab)	NA
4-Bromofluorobenzene	75-120	NA	[79]-120	NA
Dibromofluoromethane	85-115	NA	63-146 (Lab)	NA
Toluene-*d8*	85-120	NA	[78]-115	NA

Control limits from the DoD QSM, Appendix D; control limits in [brackets] are laboratory-specific deviations from the QSM.
Chemical names in **bold** are contaminants of concern for Building 837 and Buildings 606/626 PSTSs
Chemical names denoted with a * are contaminants of concern for the Building 606/626 PSTS
Key:
%R = Percent Recovery RPD = Relative Percent Difference
Lab = Control limits are not established by the DoD QSM and the laboratory's internally derived control limits will be acceptable.

Table 4.4
Quality Control Criteria for DRO Analyses by Modified SW846 Method 8015B

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration	Initially; thereafter as the continuing calibration fails	r $\geq$0.995 or %RSD $\leq$20% for each individual analyte	1) Evaluate System 2) Recalibrate as necessary
Initial Calibration Verification	Following initial calibration	%D $\leq$15%	1) Evaluate System 2) Recalibrate as necessary
Continuing Calibration Verification	Every 12 hours	%D $\leq$15%	1) Evaluate System 2) Clean system 3) Recalibrate as necessary 4) Reanalyze affected samples since the last in-control Continuing Calibration
Retention Time Windows	During initial and continuing calibration verification	Within 3σ of RT established in initial calibration for surrogates and for the following compounds: 2-methlypentane and 1,2,4-trimethylbenzene DRO: C_{10} and C_{28} alkanes	1) Evaluate System 2) Recalibrate as necessary
Method Blank	One per analytical batch	Analytes < ½ RL	1) Rerun. 2) Evaluate Batch. 3) Reanalyze or qualify results as necessary
LCS/LCSD	Every analytical batch (maximum of 20 samples)	%R = within laboratory control limits	1) Rerun. 2) Evaluate batch 3) Reanalyze or qualify results as necessary
MS/MSD	As indicated on chain of custody forms	%R = within laboratory control limits (not applicable if parent sample concentration > 4x the spike level)	1) Evaluate MS/MSD to assess matrix interference 2) Evaluate batch and qualify results as necessary
Surrogate Recovery	Every sample	%R = within laboratory control limits	1) Rerun 2) Reanalyze or qualify results as necessary

% RSD = Percent Relative Standard Deviation
%D = Percent Difference

Table 4.5
Quality Control Criteria for Metals Analyses by SW-846 Method 6010B

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration	Daily	Check Standard at RL: %D ≤20% Alternative Evaluation: r ≥0.995	1) Evaluate system 2) Recalibrate
Initial Calibration Verification (ICV)	Following initial calibration	% R = 90% to 110%	1) Evaluate system 2) Recalibrate as necessary
Initial Calibration Blank (ICB)	Following initial calibration verification	Analytes <RL	1) Rerun 2) Clean system 3) Qualify results as appropriate
Interference Check Sample (ICS)	Beginning of analytical sequence	% R = 80% to 120%	1) Evaluate system 2) Recalibrate
Continuing Calibration Verification (CCV)	Every 10 samples and at the end of analytical sequence	% R = 90% to 110%	1) Evaluate system 2) Repeat calibration check (ICV/CCV) 3) Recalibrate as necessary 4) Reanalyze affected samples
Continuing Calibration Blank (CCB)	Following CCV	Analytes <RL	1) Rerun 2) Clean system 3) Reanalyze affected samples or qualify results as appropriate
Method Blank (MB)	Every analytical batch (maximum of 20 samples)	Analytes <RL	1) Rerun 2) Evaluate batch 3) Re-digest affected samples or qualify results as appropriate
Laboratory Control Sample (LCS)	Every analytical batch (maximum of 20 samples)	%R = 80% to 120%	1) Rerun for affected analytes 2) Evaluate batch 3) Re-digest affected samples or qualify results as appropriate
Matrix Spike (MS)	Every analytical batch (maximum of 20 samples)	%R = 75% to 125% (not applicable if parent sample concentration > 4x the spike level)	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate
Laboratory Duplicate	Every analytical batch (maximum of 20 samples)	RPD ≤25%	1) Rerun; if still out, perform post-digestion spike 2) Evaluate batch 3) Qualify sample results as appropriate
Post Digestion Spike	Every analytical batch of 20 samples, only if MS analysis fails	%R = 75% to 125%	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate
Serial Dilution	Every analytical batch (maximum of 20 samples)	%D ≤10% for analytes present >50 x MDL	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate

Table 4.6
Quality Control Criteria for Wet Chemistry Analyses[1]

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration	Daily	Check Standard at RL: %RSD ≤method criteria Alternative Evaluation: r ≥0.995	1) Evaluate system 2) Recalibrate
Initial Calibration Verification (ICV)	Following initial calibration	%R within method control limits	1) Evaluate system 2) Recalibrate as necessary
Initial Calibration Blank (ICB)	Following initial calibration verification	Analytes <RL	1) Rerun 2) Clean system 3) Qualify results as appropriate
Continuing Calibration Verification (CCV)	Every 10 samples and at the end of analytical sequence	%R = within method control limits	1) Evaluate system 2) Repeat calibration check (ICV/CCV) 3) Recalibrate as necessary 4) Reanalyze affected samples
Continuing Calibration Blank (CCB)	Following CCV	Analytes <RL	1) Rerun 2) Clean system 3) Reanalyze affected samples or qualify results as appropriate
Method Blank (MB)	Every analytical batch (maximum of 20 samples)	Analytes <RL	1) Rerun 2) Evaluate batch 3) Reprepare affected samples or qualify results as appropriate
Laboratory Control Sample (LCS)	Every analytical batch (maximum of 20 samples)	%R = within laboratory control limits	1) Rerun for affected analytes 2) Evaluate batch 3) Reprepare affected samples or qualify results as appropriate
Matrix Spike (MS)	Every analytical batch (maximum of 20 samples)	%R = within laboratory control limits (not applicable if parent sample concentration > 4x the spike level)	1) Rerun MS 2) Evaluate batch 3) Qualify sample results as appropriate
Laboratory Duplicate	Every analytical batch (maximum of 20 samples)	RPD ≤ laboratory control limits	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate

[1] Analyses include total organic carbon, nitrate/nitrite (total), orthophosphate, sulfate, chloride, dissolved gases (methane, ethane, and ethene), carbon dioxide, alkalinity, volatile fatty acids, and total oxygen demand. Note that not all QC elements are applicable to all the listed methods.

Table 4.7
Quality Control Criteria for Microbial Analyses

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Assay Calibration (standard curve)	Once per assay	Standard curve $r^2 \geq 0.95$	Rerun or optimize assay
Continuing Calibration Verification (CCV)	Primary – every 4 months Secondary – every plate (assay)	Standard curve $r^2 \geq 0.95$ CT value within 2 units of same point on standard curve	Rerun assay/check reagents
Laboratory Duplicate	All field samples	CT value within 2 units of parent sample	Rerun assay
Field Duplicate	As requested on chains of custody	CT value within 4 units of parent sample	None
Assay Negative Control (Blank)	Once per analytical assay (plate)	Values for positive samples are set above any fluorescence for the negative control	Rerun or optimize assay
DNA Extraction Negative Control	1 per analytical batch	CT $\leq$ assay negative control	Rerun assay or re-extract samples
Positive Control	Once per analytical assay (plate)	CT value within 2 units of parent sample	Rerun assay/check reagents

Source: Microbial Insights internal method QC documentation

Table 4.8
Method Sensitivity Requirements for VOCs

Analyte	Aqueous		Soil	
	Reporting Limit (μg/L)	MCL[1] (μg/L)	Reporting Limit (μg/kg)	PRG[2] (μg/kg)
Dichlorodifluoromethane (Freon 12)	1.0	NA	5	310000
Chloromethane	1.0	NA	5	160000
Vinyl Chloride	1.0	2	5	750
Bromomethane	1.8	NA	10	13000
Chloroethane	1.0	NA	10	6500
Trichlorofluoromethane (Freon 11)	1.0	NA	5	2000000
1,1-Dichloroethene	1.0	7	5	410000
Carbon Disulfide	5.0	NA	5	720000
Acetone	5.0	NA	10	54000000
Methylene Chloride	1.0	NA	5	21000
trans-1,2-Dichloroethene	1.0	100	5	230000
1,1-Dichloroethane	1.0	NA	5	1700000
2,2-Dichloropropane	1.0	NA	5	NA
cis-1,2-Dichloroethene	1.0	70	5	150000
2-Butanone	5.0	NA	10	110000000
Bromochloromethane	1.0	NA	5	NA
Chloroform	1.0	80	5	470
1,1,1-Trichloroethane	1.0	200	5	1200000
1,1-Dichloropropene	1.2	NA	5	NA
Carbon Tetrachloride	1.1	5	5	550
Benzene	1.0	5	5	1400
1,2-Dichloroethane	1.0	5	5	600
Trichloroethene	1.0	5	5	110
1,2-Dichloropropane	1.0	5	5	740
Dibromomethane	1.0	NA	5	NA
Bromodichloromethane	1.0	80	5	1800
cis-1,3-Dichloropropene	1.0	NA	5	NA
4-Methyl-2-Pentanone	5.0	NA	5	47000000
Toluene	1.0	1000	6	520000
trans-1,3-Dichloropropene	1.0	NA	5	NA
1,1,2-Trichloroethane	1.0	5	5	1600
Tetrachloroethene	1.0	5	5	1300
1,3-Dichloropropane	1.0	NA	5	360000
2-Hexanone	5.0	NA	5	NA
Dibromochloromethane	1.0	80	5	2600
1,2-Dibromoethane	1.0	NA	5	73
Chlorobenzene	1.0	NA	5	5300000
1,1,1,2-Tetrachloroethane	1.0	NA	5	7300
Ethylbenzene	1.0	700	5	400000

Table 4.8
Method Sensitivity Requirements for VOCs (continued)

Analyte	Aqueous		Soil	
	Reporting Limit (μg/L)	MCL[1] (μg/L)	Reporting Limit (μg/kg)	PRG[2] (μg/kg)
meta- and *para*-Xylene	2.0	10000*	10	420000*
ortho-Xylene	1.0	10000*	5	420000*
Styrene	1.0	100	5	1700000
Bromoform	1.0	80	5	220000
Isopropylbenzene	1.0	NA	5	2000000
Bromobenzene	1.0	NA	5	92000
1,1,2,2-Tetrachloroethane	1.1	NA	5	930
1,2,3-Trichloropropane	1.1	NA	5	76
n-Propylbenzene	1.0	NA	5	240000
2-Chlorotoluene	1.0	NA	5	560000
1,3,5-Trimethylbenzene	1.0	NA	5	70000
4-Chlorotoluene	1.0	NA	5	NA
tert-Butylbenzene	1.0	NA	5	390000
1,2,4-Trimethylbenzene	1.0	NA	5	170000
sec-Butylbenzene	1.0	NA	5	220000
1,3-Dichlorobenzene	1.0	NA	5	600000
p-Isopropyltoluene	1.0	NA	5	NA
1,4-Dichlorobenzene	1.0	75	5	7900
n-Butylbenzene	1.1	NA	5	240000
1,2-Dichlorobenzene	1.0	NA	5	600000
1,2-Dibromo-3-chloropropane	1.3	NA	5	2000
1,2,4-Trichlorobenzene	1.1	70	5	220000
Hexachlorobutadiene	1.1	NA	10	22000
Naphthalene	1.2	NA	5	190000
1,2,3-Trichlorobenzene	1.3	NA	5	NA

μg/kg = micrograms per kilogram
μg/L = micrograms per Liter
MCL = maximum contamination level
PRG = preliminary remediation goal
NA = not available
*Note: The MCL and PRG is for total xylenes.
[1] Ref: United States Environmental Protection Agency (USEPA), Region 9, October 2002, EPA Region 9 Preliminary Goals (PRGs) Table.
[2] Ref: United States Environmental Protection Agency (USEPA), 2002, EPA National Primary Drinking Water Standards Table.

Table 4.9
Method Sensitivity Requirements for DRO, Metals, and General Chemistry Parameters

Analyte	Aqueous		Soil	
	Reporting Limit	Units	Reporting Limit	Units
Petroleum Hydrocarbons by Method SW8015B				
DRO	0.125	mg/L	6.0	mg/kg
Metals by Method SW6010B				
Iron	0.11	mg/L	NA	
Manganese	0.010	mg/L	NA	
Anions by Method E300 (or SW9056)				
Chloride	0.2	mg/L	NA	
Nitrate/Nitrite	0.1	mg/L	NA	
Orthophosphate	0.2	mg/L	NA	
Sulfate	0.24	mg/L	NA	
TOC by Method E415.1 (or SW9060A)				
TOC	1.1	mg/L	NA	
Alkalinity by E310.1				
Alkalinity	5	mg/L	NA	
Dissolved Gases and Carbon Dioxide by RSK-175				
Ethane	4	μg/L	NA	
Ethene	3	μg/L	NA	
Methane	2	μg/L	NA	
Carbon dioxide	350	μg/L	NA	
Volatile Fatty Acids (Laboratory SOP)				
Pyruvic acid	1	mg/L	NA	
Lactic acid	1	mg/L	NA	
Acetic acid	1	mg/L	NA	
Propionic acid	1	mg/L	NA	
Butyric acid	1	mg/L	NA	
Bench-Scale Total Oxygen Demand				
Total Oxygen Demand	NA		100	mg/kg
Microbiology				
qPCR	NA		500	cells/g
Dehalococcoides	500	cells/mL	NA	

μg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
μg/L = micrograms per liter
mg/L = milligrams per liter

Table 4.10
Accuracy and Precision Requirements for DRO, Metals, and General Chemistry Parameters

Analyte	Aqueous		Soil	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Petroleum Hydrocarbons by Method SW8015B				
DRO	64-100	20	62-120	30
Metals by Method SW6010B				
Iron	80-120 (LCS) 75-125 (MS)	20	NA	
Manganese	80-120 (LCS) 75-125 (MS)	20	NA	
Anions by Method E300 (or SW9056)				
Chloride	80-120 (LCS) 75-125 (MS)	20	NA	
Nitrate/Nitrite	80-120 (LCS) 75-125 (MS)	20	NA	
Orthophosphate	80-120 (LCS) 75-125 (MS)	20	NA	
Sulfate	80-120 (LCS) 75-125 (MS)	20	NA	
TOC by Method E415.1 (or SW9060A)				
TOC	80-120 (LCS) 75-125 (MS)	20	NA	
Alkalinity by E310.1				
Alkalinity	80-120	20	NA	
Dissolved Gases and Carbon Dioxide by RSK-175				
Ethane	70-130	30	NA	
Ethene	70-130	30	NA	
Methane	70-130	30	NA	
Carbon dioxide	NA	NA	NA	
Volatile Fatty Acids (Laboratory SOP)				
Pyruvic acid	80-120	20	NA	
Lactic acid	80-120	20	NA	
Acetic acid	80-120	20	NA	
Propionic acid	80-120	20	NA	
Butyric acid	80-120	20	NA	
Bench-Scale Total Oxygen Demand				
Total Oxygen Demand	NA		97-103	NA
Microbiology				
qPCR	NA		NA	Table 4.7
Dehalococcoides	NA	Table 4.7	NA	

5.0 SAMPLING AND FIELD PROCEDURES

5.1 GENERAL

The attainment of high quality data that are legally defensible and from which sound decisions can be made involves many critical steps. The first of these steps is sample collection. Proper sampling activities provide representative samples upon which subsequent evaluations and decisions may be based. Therefore, the proper performance of sampling procedures, including proper QC procedures, is critical to the achievement of project objectives.

5.2 QUALIFICATIONS OF SAMPLING PERSONNEL

The personnel responsible for sampling and other field activities will have adequate experience to perform the tasks assigned to them. All field personnel will read and familiarize themselves with all pertinent documents, including this QAPP. Field personnel will be cognizant of the importance and level of QC that must be maintained in order to produce the most representative samples. Loss of volatiles is of particular concern for this project and particular care will be employed during sampling for VOCs analyses. The generation of acceptable data hinges on the proper collection of samples; therefore, sampling activities will be appropriately monitored by the SS throughout the site investigation activities.

5.3 SAMPLE COLLECTION

Collection of all samples will follow standard USEPA and USACE protocols. Detailed procedures for the collection of samples are provided in the FSP (Appendix B).

5.3.1 Collection of Quality Control Samples

Field operations will include the collection of several types of QC samples. These samples will include field duplicate samples, MS/MSD samples, and rinsate blanks.

Wherever historical results are available, field duplicate samples will be collected at locations where reportable concentrations of analytes are expected. In order to minimize the effects of high analyte concentrations, MS/MSD samples will be collected from locations that are expected to exhibit low to non-detect concentrations of analytes. For field duplicate samples, fractions for the same analytical parameters will always be collected consecutively. The field duplicate samples will be submitted as laboratory blind samples by assigning a unique sample identifier. Duplicate and MS/MSD samples will be used to assess accuracy and precision as discussed in Section 4.4.

Rinsate blanks will be collected when the sampling equipment is decontaminated and reused in the field. Analyte-free water will be poured over or pumped through the equipment and the water will be collected in sample containers. Rinsate blanks provide a qualitative assessment to determine if the decontamination procedure has been adequately performed. Rinsate blanks will only be analyzed for VOCs, and DRO.

A source water sample may be collected and analyzed prior to field activities to determine if potable water used during decontamination is free of contamination. If collected, the source water will be analyzed for VOCs, and DRO only.

5.4 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

The general requirements for sampling containers, preservation, and holding times are provided in Table 4.1.

5.5 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Following sample collection, each sample cooler will be packed with cushioning packing material and sufficient double-bagged wet ice to ensure that an internal ambient temperature of 4 °C ± 2 °C is maintained from the field to the laboratory. In addition, each sample cooler will contain an associated chain-of-custody (COC) form. After sample coolers have been sealed with packing tape, signed and dated custody seals will be placed across the front and back cooler openings and secured with clear tape. A broken seal upon arrival at the laboratory will indicate that the cooler was compromised during shipment.

6.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Verifiable sample COCs will be an integral part of all field and laboratory operations. Traceable steps will be taken in the field and laboratory to document that all samples have been properly acquired, preserved, and identified. The FSP provides details related to carrying out verifiable field documentation.

STL Chicago's laboratory COC forms, procedures for sample storage and dispersal for analysis, and associated documentation are from the Standard Operating Procedure (SOP) *Sample Receipt and Handling* (USR-001).

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7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 GENERAL

All field and laboratory instrumentation will be calibrated prior to and during continued use. The calibration and maintenance history of the project-specific field and laboratory instrumentation is an important aspect of the project's overall QC program. Consequently, all initial and continuing calibration procedures will be implemented and overseen by trained personnel following the manufacturer's instructions and EPA specifications. This will ensure that the equipment is functioning within the tolerances established by the manufacturer and the EPA method-specific analytical requirements.

7.2 FIELD INSTRUMENTS AND EQUIPMENT

Field instrumentation will be calibrated and maintained per manufacturers' operating instructions. The calibration and general maintenance of field instrumentation will be the responsibility of the SS and SSHO. All documentation pertaining to the calibration and maintenance of field equipment will be maintained in an active field logbook. Entries made into the logbook regarding the status of any field equipment will contain, but are not necessarily limited to, the following information:

- Date and time of calibration or maintenance
- Name of person conducting calibration or maintenance
- Type of equipment being serviced and identification number (such as the serial number)
- Reference standard used for calibration (such as pH of buffer solutions)
- Calibration or maintenance procedure used
- Other pertinent information.

Equipment that fails calibration or becomes otherwise inoperable during the field investigation will be removed from service and segregated to prevent inadvertent use. Such equipment will be properly tagged to indicate that it should not be used until the problem can be corrected. Equipment requiring repair or recalibration must be approved for use by the SS or SSHO before being placed back into service. Equipment that cannot be repaired or recalibrated will be replaced.

7.2.1 Photoionization Detectors

A photoionization detector equipped with a 10.6 electron volt (eV) lamp will be used to perform health and safety air monitoring and for screening samples. The photoionization detector (PID) will be calibrated daily while in the field. Measurements of background VOCs will be documented, the calibration gas concentration will be measured, the reading documented, and the instrument will be adjusted for proper calibration. The final reading will

also be documented. Calibration protocols and measurement will be documented in the field logbook.

7.2.2 Water Quality Probe

Water quality parameters will be measured as part of the data required to determine aquifer conditions at the site. The water quality parameters to be measured include: pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, specific conductance, and turbidity. The water quality probes will be calibrated before use, and at a minimum of once every week after that. The calibration process for water quality probes will follow the manufacturer's recommendations.

To ensure that the water quality probes are operating within criteria, a check solution will be analyzed daily. The check solutions will include standards for specific conductance, ORP, and pH. The temperature probe will be pre-calibrated by the equipment distributor and will not be calibrated in the field. The DO probe will be calibrated daily by inputting the ambient barometric pressure into the probe. The turbidity meter will be calibrated according to manufacturer specifications. If the results do not meet the precision criteria shown below, the probe will be recalibrated.

Parameter	Precision [1]
Specific Conductance	± 50 μS/cm
Oxidation/Reduction Potential	± 50 mV
pH	± 0.1 standard units

μS/cm = microsiemens per centimeter

[1] Precision criteria as established in Wiedemeier et al., 1996.

7.2.3 Ferrous Iron

In addition to the water quality parameters identified above, ferrous iron (Fe^{+2}) will be determined in the field using Hach test kits. Ferrous iron analysis will be completed immediately after sample collection activities.

Ferrous iron will be determined using the 1,10-phenanthroline method (Hach Method 8146), which employs a DR/700 colorimeter (module 50.01). The initial calibration utilizes the analysis of a blank sample to zero the instrument per the manufacturer's recommendation. In addition, a check standard will be analyzed once at the beginning of each sampling round to ensure the instrument is operating within criteria. If the check sample results do not meet the manufacturer's specifications, the instrument will be recalibrated per the manufacturer's recommendation.

7.3 LABORATORY INSTRUMENTATION

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the required sensitivity to meet project-specific DQOs.

Calibration acceptance criteria for VOCs, TPH, metals, general chemistry parameters, and DNA are presented in Tables 4.2, 4.4, 4.5, 4.6, and 4.7, respectively. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method in accordance with the EPA SW-846 (3rd Edition) or other appropriate methodology. Laboratory instrument calibration policies are presented in Section 5.4.3 and Table 10 of the STL LQM.

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8.0 ANALYTICAL PROCEDURES

8.1 FIELD PROCEDURES

Field analytical procedures will be performed as described in the FSP.

8.2 LABORATORY PROCEDURES

The following paragraphs summarize the methodology to be followed for analytical methods, sample preparation, sample tracking, and documentation controls.

8.2.1 Volatile Organic Compounds

VOCs include halogenated organic chemicals, non-halogenated organic chemicals, and aromatic organic chemicals. The first two classes generally contain compounds associated with solvents, such as TCE, methyl ethyl ketone (MEK), and acetone. The third class includes compounds associated with fuels, such as BTEX.

The VOCs analysis method for water and soil samples, SW-846 Method 8260B, employs gas chromatography/mass spectrometry (GC/MS) for separation and detection of target compounds. Samples are introduced into the GC/MS system by purge-and-trap Method 5030 (aqueous samples) or by closed-system purge-and-trap Method 5035 (soil samples). The power of GC/MS lies in the capacity for positive identification of relatively low detection limits. This methodology is also indicated where its capability for tentative identification of unlisted compounds is desired. QC criteria for the evaluation of VOC analyses are listed in Tables 4.2 and 4.3. RLs for Method 8260B are presented in Table 4.8.

8.2.2 Total Petroleum Hydrocarbons

Volatile petroleum hydrocarbon components, such as gasoline and other low molecular weight petroleum products, are analyzed by the direct purge and trap technique described in Method SW5030B followed by a modified approach to Method SW8015B. Extractable petroleum hydrocarbon components, such as jet fuel, kerosene, diesel, motor oil, and other high molecular weight extractable petroleum products, are extracted by methods 3510C or 3520C prior to analysis. A flame ionization detecter (FID) is used to detect and quantify the hydrocarbon components in a sample.

Identification and quantitation of petroleum hydrocarbon components require more analytical judgment than other GC methods. The chromatograms for this method generally consist of groups of peaks that fall within specific retention time range based on number of carbon atoms in the associated molecule. Standard fuel components are used to calibrate the instruments. The total petroleum hydrocarbons concentrations are reported based on quantitation of the total area count for (C_6-C_{10}) or DRO (C_{10}-C_{28}). The instrument retention time window is set such that the window encompasses only the C_6 through C_{28} range of organics. QC criteria for the evaluation of DRO analyses are listed in Table 4.4. RLs for DRO are provided in Table 4.9.

8.2.3 Metals

SW-846 Method 6010B is utilized to determine concentrations of metals by inductively-coupled plasma (ICP) atomic emission spectroscopy (AES). ICP-AES provides for the detection of a wide range of metals in a relatively quick time of analysis. Prior to analysis, aqueous samples are digested by Methods 3005, 3010, or 3015, and soil samples are digested by methods 3050 or 3051. Project groundwater metals analyses will be performed for dissolved metals during all four sampling events. Additionally, non filtered arsenic will be collected for the baseline sampling only. For those sample fractions that require analysis for total metals, the samples will be preserved in the field with nitric acid. Dissolved metals samples will be filtered in the field prior to preservation. QC criteria for the evaluation of metals analyses are listed in Table 4.5. RLs for metals are provided in Table 4.9.

8.2.4 Dissolved Gases (Methane, Ethane, and Ethene) and Carbon Dioxide

Dissolved gases (methane, ethane, and ethene) and carbon dioxide will be analyzed using Method RSK-175 (Robert S. Kerr Environmental Research Laboratory Method 175). This method was originally designed for the analyses of air samples. Through a modification of the sample preparation methods, groundwater samples will be analyzed. Surrogate compounds are not included during analysis. Analysis is performed by a gas chromatograph equipped with a flame ionization detector (GC/FID). QC elements and corrective actions applicable to this method are presented in Table 4.6. RLs for these analyses are provided in Table 4.9.

8.2.5 Water Quality/Bioremediation Parameters

Various parameters are analyzed for the purposes of assessing groundwater quality and bioremediation. The parameters to be analyzed are listed below:

- Nitrate/nitrite, sulfate, chloride, and orthophosphate by EPA Method 300.0 (or SW9056);
- Alkalinity by EPA Method 310.1;
- Dissolved metals (EPA Method 3005);
- Total organic carbon by EPA Method 415.1 (or SW9060A);
- Volatile fatty acids by laboratory-specific SOP; and
- DNA (using in-house methods following Laboratory SOP).

EPA method 300.0 is a method that uses ion chromatography to separate dissolved anions, which are then detected by a conductivity detector. Alkalinity is determined using titration. Total organic carbon is measured by converting all the organic carbon in a sample to carbon dioxide (CO_2). The CO_2 formed can be measured directly by an infrared detector or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 is directly proportional to the concentration of carbonaceous material in the sample.

Because these are water quality-related analyses, the laboratory's internal QC limits will be employed for evaluation of the data. These limits are based on statistical evaluation of actual

laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these methods are not presented in this document. QC elements and corrective actions applicable to these methods are presented in Table 4.6.

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9.0 DATA REDUCTION, VALIDATION, AND REPORTING

9.1 GENERAL

The analytical data generated by the laboratory will be checked for accuracy, precision, representativeness, comparability, completeness, and sensitivity. The data validation process for this project will consist of data generation, reduction, and three levels of review. The levels of review will include a 100 percent review by the analyst, a 100 percent verification review by a technically qualified supervisor or data review specialist, and a final administrative review.

9.2 ANALYTICAL LABORATORY DATA REVIEW AND REPORTING

The analytical laboratory Data Reviewer who has the initial responsibility for the correctness and completeness of the data will conduct the first level of review, which may contain multiple sublevels of all project related data. All data are generated and reduced following protocols specified in EPA SW-846, 3rd Edition, Final Update III, and the LQM. Data reduction, QA review, and reporting by the laboratory will be completed as follows:

- Raw data produced by the analyst are processed and reviewed for attainment of QC criteria as outlined in the LQM and/or established EPA methods and for overall reasonableness.
- After entry into the Laboratory Information Management System (LIMS), a computerized report is generated and sent to the laboratory Data Reviewer.
- The Data Reviewer will decide whether any sample reanalysis is required.
- Upon acceptance of the preliminary reports by the Data Reviewer, final reports will be generated.

The laboratory Data Reviewer will evaluate the quality of the work based on an established set of laboratory guidelines. This person will review the data package to ensure that:

- Sample preparation information is correct and complete
- Analysis information is correct and complete
- The appropriate standard operating procedures (SOPs) have been followed
- Analytical results are correct and complete
- QC samples are within established control limits
- Special sample preparation and analytical requirements have been met.

Documentation is complete when all anomalies in the preparation and analysis have been documented.

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory QA Director. The laboratory Program Administrator (PA) is responsible for assessing data quality and advising the laboratory Project Manager of any data

that were rated "preliminary" or "unacceptable", or other notations that would caution the data user of possible unreliability.

The laboratory will prepare and retain full analytical and QC documentation. Such retained documentation will not be hard (paper) copy, but will be on other storage media (e.g., magnetic tape). STL's document custody and records retention policies are presented in Section 4.12 and Tables 4, 5, and 6 of STL Chicago's LQM.

The contents of the laboratory data package will include both general information and method-specific information. Each sample delivery group (SDG) data report should comprise three parts: 1) analytical results for all environmental and field QC samples; 2) summary forms for QC measures such as surrogate and spike sample recoveries, and LCS results; and 3) supporting documentation and raw data that will substantiate the summarized data and also allow for verification and recalculation of all summarized data. General information required as part of each SDG would include the following items:

- Chain-of-Custody
- Cooler Receipt Form
- Complete list of samples in the SDG including QC samples and their relationship to the other samples in the SDG
- Cross reference of laboratory ID to field ID
- SDG narrative describing in detail any problems encountered in processing and analyses of the samples or a statement that QC criteria were met if no problems were encountered.

9.3 DATA REVIEW

The second level of review, which contains multiple sublevels, will be performed by the HGL Project Chemist, whose function is to provide an independent review of the data package. One hundred percent of the data will undergo a review which is conducted to ensure that:

- Data provided in the laboratory deliverable are scientifically sound, appropriate to the method, and completely documented
- QC samples are within established guidelines
- Documentation is complete and correct (all anomalies in the preparation and analysis have been documented; noncompliance forms, if required, are complete; holding times are documented)
- The data are ready for incorporation into the final report
- The data package is complete and ready for data archive.

The second level review will include the elements described below.

9.3.1 Review of VOCs and DRO Analyses (Aqueous and Soil)

VOCs and DRO analytical data will undergo evaluation of:

- Holding times
- Blank results
- Surrogate recoveries
- LCS/LCSD results
- MS/MSD results
- Field duplicate samples
- Laboratory case narrative
- Completeness of the data package.

9.3.2 Review of Metals Analyses

Metals analytical data will undergo evaluation of:

- Holding times
- Blank results
- LCS results
- MS results
- Laboratory duplicate results
- Field duplicate samples
- Serial dilution results
- Post-digest spike results (if applicable)
- Laboratory case narrative
- Completeness of the data package.

9.3.3 Review of General Chemistry Analytical Data

Other analytical data will undergo, where applicable, evaluation of:

- Holding times
- Blank contamination
- Spike recoveries (LCS, MS/MSD)
- Duplicate analysis precision (field duplicate samples, laboratory duplicate analyses, LCSDs, and MSDs)
- Laboratory case narrative
- Completeness of the data package.

The data review steps will be documented by the Project Chemist in a data review report.

9.4 DATA VALIDATION

Ten percent of the VOCs and DRO analytical data will undergo full data validation. The full validation of the analytical data includes review of all parameters identified above and the additional parameters listed below:

- Sample data including quantitation reports, chromatographs, and compound identification
- Sample run, preparation, and batch log sheets (including digestion/extraction data)
- GC/MS instrument performance check (tuning) data including mass spectra and mass listing (VOCs only)
- Retention time windows (DRO)
- Moisture content of soil samples
- Initial and continuing calibration data including quantitation reports and chromatograms
- Blank data including quantitation reports and chromatograms
- Surrogate spike data including quantitation reports and chromatograms
- MS/MSD data on specified samples including summary forms listing recoveries, RPD, and spike levels; quantitation reports; and chromatograms
- LCS data including quantitation reports and chromatograms
- Internal standard data including quantitation reports and chromatograms (VOCs only)
- Sample result recalculation.

The data validation steps will be documented by the Project Chemist in a data validation report.

The information generated by the analyses performed for metals and general chemistry parameters do not directly affect the decision rules and are not critical inputs into the DQOs. Consequently, the results for these analyses will not be submitted for third party validation.

9.5 DATA REVIEW/VALIDATION METHODOLOGY

The Project Chemist will identify any out-of-control data points and data omissions and interact with the laboratory to correct data deficiencies. Analytical results will be reviewed using the QC criteria established in this document, following the guidance of the applicable portions of the *Kansas City District Data Quality Guidance (DQE),* August 18, 2003, (USACE-Kansas City, 2003).

Based on the project DQOs, the following modifications to the data evaluation guidance will apply:

- Exceedence of holding times by less than a factor of 2 will result in qualification of J (detections) or UJ (non-detections), not R, only if the laboratory contacts the HGL Project Chemist immediately the discrepancy is noted and direction is given to continue with the analysis.
- Non-detected results will not be qualified on the basis of poor precision (exception: poor precision between results in a duplicate pair) or high bias (high LCS/LCSD, MS/MSD, or surrogate recovery) alone.

- Random marginal exceedences (RMEs) will be evaluated in accordance with Appendix D of the QSM (VOCs only).
- Discrepancies in initial calibration, continuing calibration, LCS results, or blank results that affect the chemicals identified as contaminants of concern in Table 4.3 will require corrective action (unless that discrepancy meets the criteria for an RME) even if no qualification will be required.
- Corrective action will not be required on the basis of MS/MSD discrepancies alone unless an error in the preparation or analytical process is identified as the source of the discrepancy.

Decisions to repeat sample collection and analysis may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. Note that the CLP validation guidelines were written to apply to CLP analytical methods. Where the control criteria for the specific methods conflict with the CLP criteria (e.g., calibration for VOCs), the method criteria will be used to evaluate the data. In such cases, data failing method QC criteria will be qualified using the analogous procedures from the CLP guidelines.

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10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 GENERAL

Performance and systems audits may be conducted to verify documentation and implementation of the QC program, assess the effectiveness of the QAPP, identify any deviations from the QC program, and verify correction of identified deficiencies. The CQCM will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

10.2 PERFORMANCE AUDITS

The Program QA Manager will evaluate the need for performance audits with due consideration given to the recommendations of the PM. Performance audits are utilized to quantitatively assess the accuracy of measurement data through the use of performance evaluation and blind check samples. The performance audit, if conducted, will be conducted by the CQCM or designee. Any performance audits of the project laboratory will be performed in accordance with the procedures outlined in this section.

10.3 SYSTEM AUDITS

If determined to be necessary, a system audit on fieldwork performance will be conducted by the CQCM during project field activities. The SS is responsible for supervising and checking that samples are collected and handled in accordance with the approved project plans and that documentation of work is adequate and complete. The PM is responsible for overseeing that the project performance satisfies the QC objectives as set forth in the QAPP. Reports and technical correspondence will be peer reviewed by an assigned qualified individual, otherwise external to the project, before being finalized.

The laboratory will regularly conduct the following internal audits:

- Monthly project review of 10 percent of all projects, to be conducted by the QA department
- Quarterly audits conducted by Divisional QA Director
- Special audits by the QA Director or corporate management when a problem is suspected or identified
- Yearly audits conducted by the laboratory Corporate QA Officer.

10.4 AUDIT PROCEDURES

If it is determined to be necessary, audits of field or laboratory operations will be conducted to document compliance with this QAPP. Any internal or external audits that are performed will be conducted in accordance with the following procedure.

10.4.1 Audit Notification

The Project Manager and, if appropriate, the corresponding manager of the audited entity (e.g., SS, Laboratory Supervisor) will be notified by the CQCM of an audit at a reasonable time before the audit is performed. This notification will be in writing and will include information such as the general scope and schedule of the audit and the name of the audit team leader.

10.4.2 Pre-audit Conference

A pre-audit conference will be conducted at the audit site with the appropriate manager or designated representative (e.g., SS, Laboratory Supervisor). The purpose of the conference will be to confirm the audit scope, present the audit plan, discuss the audit sequence, and plan for the post-audit conference.

10.4.3 Audit

The audit is then implemented by the audit team. Checklists prepared by the audit team and approved by the CQCM will be sufficiently detailed to document major audit components. Selected elements of the QAPP will be audited to the depth necessary to evaluate the effectiveness of implementation. Conditions requiring immediate corrective action will be reported immediately to the CQCM.

10.4.4 Post-audit Conference

At the conclusion of the audit, a post-audit conference will be held with the SS or Laboratory Supervisor, or their designated representative, to present audit findings and clarify any misunderstandings. Audit findings will be concisely stated by the audit team leader on a list of findings. The findings will be acknowledged by signature of the Project Manager or designated representative upon completion of the post-audit conferences.

10.4.5 Audit Report

An audit report will be prepared by the audit team leader and signed by the CQCM. The report will include the following:

- Description of the audit scope
- Identification of the audit team
- Persons contacted during pre-audit, audit, and post-audit activities
- A summary of audit results, including an evaluation statement regarding the effectiveness of the QAPP elements which were audited
- Details of findings and program deficiencies
- Recommendations for correcting the findings to the CQCM, with a copy to the Project Manager and others as appropriate.

10.4.6 Audit Responses

The Project Manager or designated representative will respond to the audit report within five days of receipt. The response will clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

10.4.7 Follow-Up Action

Follow-up action will be performed by the CQCM or designated representative to:

- Evaluate the adequacy of the Project Manager's response
- Assess that corrective action is identified and scheduled for each finding
- Confirm that corrective action is accomplished as scheduled.

Follow-up action may be accomplished through written communications, the performance of a Follow-On audit, or other appropriate means. When all corrective actions have been verified, a memo will be sent to the Project Manager signifying the satisfactory close-out of the audit, with copies to the Responsible Professional and others as appropriate.

10.4.8 Audit Records

Original records generated for all audits will be retained within the central project files. Records will include audit reports, written replies, the record of completion of corrective actions, and documents associated with the conduct of audits which support audit findings and corrective actions as appropriate.

10.5 LABORATORY AUDIT PARTICIPATION

STL-Chicago participates in internal and external audit and performance evaluation processes. STL-Chicago's internal and external audit policies are presented in Sections 4.13 and 4.14 of the LQM, respectively, and Table 7 of that document.

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11.0 PREVENTIVE MAINTENANCE

11.1 GENERAL

To ensure that analytical data generated for the activities conducted at the Schilling AFB sitare reliable, all equipment and instruments will have an established routine maintenance schedule in addition to a calibration schedule. Preventive maintenance will be performed and documented by qualified project personnel.

11.2 FIELD INSTRUMENTS

All field instrumentation, sampling equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications and established field practice. All maintenance will be performed by qualified project personnel and will be documented by the appointed equipment manager or his designee under the direction of the equipment manager.

The SS and SSHO will review calibration and maintenance records on a regular basis to ensure that required maintenance is occurring. These activities will be recorded in the field logbook to document that established calibration and maintenance procedures have been followed. Field instruments will be checked and calibrated prior to their use on site, and batteries will be charged and checked daily where applicable.

11.3 LABORATORY INSTRUMENTS

The laboratory is responsible for the maintenance of laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with manufacturer's recommendations, the laboratory's SOPs, and good laboratory practices. Section 5.4 and Table 10 of the STL Chicago's LQM describe STL's instrument maintenance policies.

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be performed by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory will have multiple instruments to serve as backup to minimize the potential for down time. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records on a regular basis to ensure that required maintenance is occurring.

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12.0 CORRECTIVE ACTION

The ultimate responsibility for maintaining quality throughout project sampling and analytical activities rests with the PM. Responsibility for the routine operation of the QA process falls upon the SS, the Project Chemist, the CQCM, and the laboratory Project Manager.

Any and all deviations from established QC procedures will be promptly identified and controlled. No additional work which is dependent on the nonconforming activity will be performed until the identified nonconformance is corrected.

12.1 FIELD CORRECTIVE ACTION

The SS will review the procedures being implemented in the field for consistency with the established protocols. Activities such as sample collection, preservation, and labeling will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, the deviations will be field documented and reported to the CQCM. Corrective actions will be defined by the SS and PM and documented as appropriate. Upon implementation of the corrective action, the SS will provide the Project Chemist with a written memorandum documenting field implementation. The memorandum will become part of the project file.

12.2 LABORATORY CORRECTIVE ACTION

The laboratory department supervisors will review the data generated to ensure that all QC samples have been analyzed as specified in the protocol. MS/MSD results and laboratory QC data will be evaluated using the accuracy and precision QC criteria listed in the Tables in Section 4. Data generated with LCSs that do not fall within control limits are considered suspect, and the analyses are repeated. If this is not possible, results are qualified.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptance windows for precision and accuracy established for LCSs
- Blanks contain contaminants at concentrations above the levels specified in the tables in Section 4 for any target analyte
- Undesirable trends are detected in MS/MSD recoveries or RPD between MS/MSDs or laboratory duplicates
- There are unusual changes in instrument sensitivity
- Deficiencies are detected by the laboratory Corporate QA Director during internal or external audits, or from the results of performance evaluation samples.

If any discrepancies in analytical methodologies, QC sample results, or method performance are identified by the bench analyst, corrective actions will be implemented immediately at the bench level by the analyst. The analyst will review the preparation or extraction procedure for

possible errors, check the instrument calibration, spike and calibration mixes, instrument sensitivity, and other relevant information. The analyst will immediately notify his/her supervisor of the problem that has been identified and the investigation that is being conducted. If the problem persists or cannot be identified, the matter will be referred to the laboratory supervisor and PA for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the laboratory PA and the CQCM is provided a corrective action memorandum for inclusion into the project file if data are affected.

Corrective action may include, but will not be limited to:

- Re-extracting and reanalyzing suspect samples
- Re-collecting and analyzing new samples
- Evaluating and amending sampling or analytical procedures
- Accepting data with an acknowledged level of uncertainty
- Recalibrating analytical instruments and reanalyzing affected samples.

Data deemed unacceptable following the implementation of the required corrective action measures will not be accepted by the PM, and follow-up corrective actions will be implemented. Details of laboratory corrective actions are provided in Sections 4.9 and 4.10 of STL Chicago's LQM.

13.0 RECORDKEEPING

Bound logbooks will be utilized for all recordkeeping purposes both in the field and laboratory. The use of bound books will result in a chronological sequence of data insertion. To facilitate data validation and to enable project personnel to accurately recreate the sequence of field events, the time of all recorded entries must be noted in the logbook, and all logbook entries must be signed and dated by the person making the entry. All entries must be recorded in ink. Correction to entries shall be made by drawing a line through the incorrect entry, recording the correct information, and initialing and dating the corrected entry. If computerized information is utilized, a hard copy that has been permanently affixed to the logbook will be acceptable as an original record of sampling and laboratory logging.

Logbooks containing information specific to the project will be forwarded to USACE at the end of the project. Should the need for corporate controlled logbooks arise, copies of all relevant logbook pages shall be submitted.

13.1 PROJECT FILES

Documents used or generated during the course of the project will be accounted for and become a part of the project files upon completion of the task. Complete project file records will be maintained in HGL's Lenexa, Kansas, office for a minimum of three years past work completion and will be updated by the Project Administrator under direction by the PM. Project records included in the file may include, but are not limited to the following:

- Sample identification documents and field logbooks
- COC records
- Inventory of investigation-derived wastes
- Project deliverables (such as test plans, operations manuals, design drawings, and specifications)
- Analytical logbooks, laboratory data, calculations, graphs, control charts, field logs (to include instrument identification numbers, calibration, and measurements), and software
- Reports and correspondence material
- Records of deviation from the Design, Operations and Monitoring Plan (DOMP), FSP, and QAPP
- Photographs.

When an error is made on a primary document, corrections are made by drawing a single line through the error and entering the correct information. The correction must also be initialed and dated. If appropriate, a brief explanation may be provided explaining the reason the correction was made. The marked copies of checked material shall be retained for future reference. Notes, calculations, and other information marked on documents assist in follow-up design and aid in rechecking portions of documents.

13.2 FIELD LOGBOOKS

Logbooks for sampling and field investigation purposes must meet the requirement procedures provided in the FSP. They must be bound and entries recorded in waterproof ink. The logbook must contain sufficient information to distinguish samples from each other.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The SS will report to the PM on a daily basis regarding progress of the fieldwork and QC issues associated with the field activities. Details will be provided in a Daily Quality Control Report (DQCR). Laboratory policies on QA reports to management are presented in Section 4.15 of the STL LQM.

The project laboratories maintain detailed procedures for laboratory recordkeeping in order to support the validity of all analytical work (see Section 6). Each SDG report submitted to the Project Chemist will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were within the established control limits on all samples. The laboratory PA will provide the Project Chemist and the CQCM with QA reports of their external and internal audits on request (see Section 10.5).

After receipt of all the analytical data, the Project Chemist will submit a QA report to the CQCM and PM describing the accuracy and precision of the data collected. If necessary, verbal reports will be made based on the data reports and other information reported orally to the Project Chemist by the contract laboratory. If any problems are encountered, the laboratory PA will issue a written report to the Project Chemist who will immediately report the problem(s) to the CQCM and the PM.

After the fieldwork has been completed and the final analyses are completed and checked, a final quality control summary report (QCSR) will be prepared by the Project Chemist. The report will summarize the quality assurance and audit information, indicating any corrective actions taken and the overall results of all QC activities. The Project Chemist, in coordination with the contract laboratory's QA Director or their qualified designee, will prepare this final summary and submit this to the CQCM for review.

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FINAL
ACCIDENT PREVENTION PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Contract No. DACW41-02-D-0004
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Prepared for

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LIST OF ACRONYMS, ABBREVIATIONS AND SYMBOLS

AFB	Air Force Base
AHA	activity hazard analysis
APP	Accident Prevention Plan
APR	Air purifying respirator
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CO	Contracting Officer
COR	Contracting Officer's Representative
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CSHM	Corporate Safety and Health Manager
DOT	Department of Transportation
EMR	experience modification rate
EMS	emergency medical services
ERD	Enhanced reductive dechlorination
ERP	Emergency Response Plan
EZ	exclusion zone
HAZWOPER	Hazardous Waste Operations and Emergency Response
HGL	HydroGeoLogic, Inc.
HTW	hazardous toxic waste
ISCO	in-situ chemical oxidation
KSU	Kansas State University
MSDS	material safety data sheet
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
OSIC	On-Scene-Incident-Commander
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
PSTS	Pilot-scale treatability study
PWS	performance work statement
PVC	polyvinyl chloride

LIST OF ACRONYMS, ABBREVIATIONS AND SYMBOLS (Continued)

SAA	Salina Airport Authority
SM	Site Manager
SMA	Salina Municipal Airport
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
WOHA	Washington Occupational Health Associates

ACCIDENT PREVENTION PLAN ACKNOWLEDGMENT

I have read, understand and agree to abide by the provisions as detailed in this Accident Prevention Plan and Site Specific Safety and Health Plan prepared by HGL. Failure to comply with these provisions may lead to disciplinary action and/or my dismissal from the work site, termination of employment or, for subcontractors, termination of the work contract.

Printed Name	**Company**	**Signature**	**Date**

ACCIDENT PREVENTION PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

1.0 SIGNATURE SHEET

PROJECT:	U.S. Army Corps of Engineers
PROJECT NUMBER:	Contract Number DACW41-02-D-0004 Delivery Order Number 0003
PROJECT MANAGER:	Miquette Rochford, P.G. HydroGeoLogic, Inc.
PLAN PREPARED BY:	Hillary Haworth HydroGeoLogic, Inc.
PLAN REVIEWED/REVISED BY:	Mary Ann Heaney, CIH, CSP HydroGeoLogic, Inc.
PREPARATION DATE:	July 2006

APPROVED BY:

Mary Ann Heaney, CIH, CSP — 8/21/06 Date
HydroGeoLogic, Inc.
Certified Industrial Hygienist

Miquette Rochford — 8/25/06 Date
Miquette Rochford, PG.
HydroGeoLogic, Inc.
Project Manager

FINAL
ACCIDENT PREVENTION PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

1.1 BACKGROUND INFORMATION

This Accident Prevention Plan (APP) has been prepared for the pilot-scale treatability study (PSTS) to be performed at the former Schilling Air Force Base (AFB), Salina, Kansas. The purpose of this APP is to establish the site-specific safety and health procedures, practices, and equipment to be implemented to protect field personnel from potential hazards associated with project site activities. The APP assigns responsibilities, establishes general procedures, and provides contingency plans for situations that may arise during treatability study process. This APP will interface with HydroGeoLogic, Inc.'s (HGL) Corporate Safety and Health Program and is intended to be implemented in concert with the site-specific Health and Safety Plan included as Attachment 1. The resumes of key personnel that will be involved in the execution of this delivery order are included as Attachment 2.

Contractor:

HydroGeoLogic, Inc. (Kansas Office)
8245 Nieman Road, Suite 101
Lenexa, Kansas
Phone: 913-317-8860

HydroGeoLogic, Inc. (Corporate Office)
1155 Herndon Parkway, Suite 900
Herndon, Virginia 20170
Phone: 703-478-5186

Contract Number: DACW41-02-D-0004
Delivery Order Number 0003

Project name: Pilot-Scale Treatability Study, Former Schilling Air Force Base, Salina, Kansas.
Agency: U.S. Army Corps of Engineers (USACE), Kansas City District

1.1.1 Project Description and Description of Work

Schilling AFB is located in central Kansas, Saline County, just southwest of the city of Salina (Figure 1.1). At its maximum use, the former Schilling AFB occupied all or parts of Sections 22, 27, 32, 33, and 35 in Township 14 South (T. 14 S.), Range 3 West (R. 3 W.), and Sections 2, 3, and 4 in T. 15 S., R. 3 W. The city of Salina incorporated the former Schilling AFB into its legal boundary when it was acquired in 1966 (USACE, 2005).

The Smoky Hill Army Base was built in 1942 as headquarters for the newly created Army Air Corps Unit, 20th Bomber Command, and became the first operational training base for B-29 bombers. The Base name was changed to the Smoky Hill Air Force Base in 1946 and to Schilling AFB in 1957. In 1942, the property encompassed 365 acres and housed 5,000 military employees. By 1967, the Base had expanded to 4,000 acres. The Base remained active for 5 years after World War II and was deactivated in 1949. In 1951, the Base was reopened for the Korean Conflict. Upon reactivation, several improvements to the facility were made, including a 25-mile long jet fuel pipeline that started in McPherson, KS, and terminated at a bulk oil storage farm on base. With the arrival of the Strategic Air Command and the 802nd Air Division at the Base in 1952, further site improvements, including the construction of a trainer building, a boiler facility, a gas distribution system, and bulk oil storage system, were completed. The Base was designated a permanent Air Force installation in July of 1953. In 1960, the 802nd Air Division was deactivated, and the 40th Bombardment Wing was transferred to Schilling Air Force Base. A squadron of Atlas F and Nike missiles was deployed to 12 sites around Schilling AFB and attached to Schilling AFB for support. New facilities were constructed for storage and repair of both conventional and nuclear munitions and nuclear warhead maintenance. Schilling AFB was also upgraded to receive B-52 bombers and KC-135 jet tankers. Schilling AFB was closed in 1964 and was transferred to the Salina Airport Authority (SAA) in 1966 (USACE, 2005).

SAA has since used much of the property in operating the airfield, renamed as Salina Municipal Airport (SMA). The remainder of the former Schilling AFB is currently used for light-to-heavy industrial, aviation, and educational purposes. Major landowners at the former Schilling AFB include the Kansas Board of Regents, the Salina Area Vocational Technical School, Kansas National Guard, and the Occupational Center of Central Kansas. Local industry includes Tony's Pizza, Schwan's Sales Enterprises, Raytheon (Beechcraft), Flower Aviation, and Moore's Midway Aviation. Many of these entities either lease property from SMA or have purchased their properties outright.

The PSTS will be performed in two distinct locations: near Building 837 on the Kansas State University (KSU) campus and between Buildings 606 and 626 (former wash racks), (Figures 1.2 and 1.3 of Attachment 1, respectively).

Building 837 is located immediately adjacent to the campus administrative building. The area is an open grass field that lies between three active administrative and classroom buildings. There are sidewalks and utility crossings in and around the area. Care will be taken to ensure that disruptions to current operations are minimized during field activities.

The former wash racks (Buildings 606 and 626) are active facilities. The pilot study area is currently used as a parking lot and a grassy area in and around Building 606. The area can be fenced off and utilized in coordination with the current building operators. There are numerous utilities and drainage lines in the area. A fuel oil underground storage tank (UST) was removed from the northwest corner of Building 606 in 1999.

1.1.2 Contractor Accident Experience

The following is a summary of HGL's experience modification rate (EMR) for the year 2005. A copy of the latest Occupational Safety and Health Administration (OSHA) Form 300 and OSHA Form 300A are provided in Attachment 3.

- EMR = 0.80/1.25
- Total employee hours worked = 318,450/38,828
- OSHA Total Recordable Incident Rate = 1,1
- Lost Workday Incident Rate = 0,0
- Fatalities = 0,0

One of the keys to improving HGL's safety performance is ongoing reinforcement of the following safety issues and responsibilities:

- At risk behaviors by employees are not acceptable (e.g., failure to use assigned personal protective equipment [PPE], excessive speed while driving, not following established safety procedures) and must be addressed by their supervisors. An emphasis on behavior-based safety is critical to our safety performance.
- Safety planning should be part of all field projects (health and safety plans for Hazardous Waste Operations and Emergency Response [HAZWOPER] work, safe work plans for non-HAZWOPER work).
- Project Managers must be responsible for communicating safety expectations to their project team.
- HGL must continue to emphasize compliance with HGL's Health and Safety Training Program.

1.1.3 Phases of Work and Associated Hazardous Activities Requiring Activity Hazard Analysis

Two work phases are described below. These phases will be conducted at two distinct study areas at the site concurrently. Under each phase of work, there are inherently hazardous activities that have been analyzed to identify controls that will be implemented to protect the safety and health of all personnel entering the project site.

1.1.3.1 <u>Phase I Activities</u>

Phase I entails mobilization of personnel and equipment, and initial site training. Hazardous activities requiring activity hazard analysis (AHA) for this phase of work are:

- Hazards associated with vehicle travel to and from the project site;
- Hazards associated with site setup activities (field trailer, facilities, equipment preparation);
- Biological hazards, such as insects, ticks, mosquitoes, spiders, or other wildlife;

- Slips, trips, and falls associated with ground cover, irregular terrain or debris; and
- Heat or cold stress as environmentally dictated.

1.1.3.2 Phase II Activities

Phase II will involve field activities to support the evaluation of enhanced reductive dechlorination (ERD) as a treatment for dissolved phase chlorinated solvent contamination at Building 837, and in-situ chemical oxidation (ISCO) as a treatment of chlorinated solvents and petroleum related contaminants at the Building 606/626 source area.

Hazardous activities requiring AHA for this phase of work are:

- Hazards associated with drilling/direct-push technology;
- Hazards associated with well installation;
- Hazards associated with groundwater sampling;
- Hazards associated with soil sampling;
- Hazards associated with oversight of chemical/substrate injection into groundwater;
- Hazards associated with decontamination of equipment;
- Hazards associated with disposal of investigation derived waste;
- Biological hazards, such as insects, mosquitoes, spiders, snakes or other wildlife;
- Slips, trips and falls associated with ground cover, irregular terrain or debris;
- Heat or cold stress as environmentally dictated;

Phase II field activities hazards and initial PPE levels are summarized in Table 1.1. Action levels and monitoring frequency for Phase II activities are presented in Tables 8.1 and 8.2 of the SSHP included as Attachment 1.

1.2 SAFETY AND HEALTH POLICY STATEMENT

The purpose of this Safety and Health Policy Statement is to establish HGL's commitment to employee Health and Safety as an integral part of business conduct.

It is HGL's intent to protect and promote the health and well being of our employees by providing a safe and healthy work environment at the HGL office and project sites. The Corporate Health and Safety Manager is responsible for establishing a health and safety program that implements HGL Health and Safety Policy. The manager provides consultation to line management and conducts on-site health and safety audits to evaluate the safety of working environments and the use of effective health and safety procedures. To support the Corporate Health and Safety Manager, each office shall designate a safety officer. The safety officer is responsible for implementing and coordinating HGL Health and Safety Policy and related procedures in their office. Project managers and supervisory personnel are responsible for the actions of those they supervise, for maintaining healthy and safe working conditions in

their areas of responsibility, and for strictly enforcing all authorized health and safety rules and regulations. All employees are expected to comply with these rules and regulations. The Executive Officers of HGL consider personnel health and safety to be of primary importance in our offices and field operations. All employees are expected to cooperate in making HGL's Health and Safety Program fully effective.

1.3 RESPONSIBILITIES AND LINES OF AUTHORITY

1.3.1 Identification and Accountability of Personnel Responsible for Safety at Corporate Level

All personnel are responsible for continuous adherence to this APP and safety and health procedures during the performance of their work. No person may work in a manner that conflicts with the intent of, or the inherent safety and environmental precautions expressed in, these procedures. After due warnings, HGL will dismiss from the site any person who violates safety procedures. HGL employees are subject to progressive discipline and may be terminated for continued violations. All on-site personnel will be trained in accordance with this document. Corporate resumes are presented in Attachment 2. The following subsections describe management personnel and their job duties, including any duties that relate to safety and health. Responsible management personnel are identified in Table 1.2.

1.3.1.1 Project Manager

The Project Manager's (PM) responsibilities include:

- Ensuring conformance with HGL corporate and USACE policies and procedures;
- Coordinating the project with USACE personnel;
- Ensuring the project has the necessary resources to operate safely;
- Ensuring that the project personnel satisfy HGL and USACE Safety and Health requirements;
- Ensuring that project personnel implement the project APP; and
- Ensuring that project personnel have the appropriate regard for safe job performance.

1.3.1.2 Corporate Safety and Health Manager

The Corporate Safety and Health Manager's (CSHM) responsibilities include:

- Developing and coordinating the APP;
- Recommending changes to the APP if warranted by changed conditions;
- General Safety and Health Program administration;
- Determining the level of personnel protection required;
- Confirming each HGL team member's suitability for work based on physicians' recommendations;

- Conducting field safety and health audits to ensure conformance with the SSHP and HGL policies;
- Certifying that all workers have proper training as per 29 Code of Federal Regulations (CFR) 1910.120(e);
- Updating equipment or procedures based on information obtained during site operations;
- Investigating significant accidents and illnesses, and implementing corrective action plans;
- Establishing air-monitoring parameters based on expected contaminants;
- Establishing employee exposure monitoring notification programs;
- Stopping any operation that threatens the health or safety of the team or surrounding population; and
- Upgrading or downgrading levels of protection based on site observations or monitoring results.

1.3.1.3 Project Engineer

The Project Engineer provides technical, analytical, and report writing support to ensure the technical quality of deliverables to USACE-Kansas City District.

1.3.1.4 Certified Industrial Hygienist

The Certified Industrial Hygienist's (CIH) responsibilities include:

- Overseeing the development and coordination of the APP as required;
- Making changes to the APP if warranted by changed conditions;
- Administering and enforcing the General Health and Safety Program;
- Determining the level of personnel protection required;
- Investigating significant accidents and illnesses and implementing corrective action plans;
- Establishing air-monitoring parameters based on expected contaminants;
- Establishing employee exposure monitoring notification programs;
- Developing site-specific employee/community emergency response plans based on expected hazards;
- Stopping any operation that threatens the health or safety of the team or surrounding population; and
- Upgrading or downgrading levels of protection based on site observations or monitoring results.

1.3.2 Responsibilities at Project Level

All personnel involved in field activities are responsible for adherence to this APP during the performance of their work. The following subsections describe on-site personnel responsibilities.

1.3.2.1 Site Manager

All field activities will be conducted under the supervision of the HGL Site Manager (SM). The SM will oversee normal and emergency work, and will perform any necessary emergency notification. The SM will be responsible for:

- Authorizing stop work as related to safety and health issues;
- Supervising all site activities;
- Implementing the APP;
- Coordinating with the Site Safety and Health Officer (SSHO) on safety related matters;
- Investigating accidents, incidents, and near misses;
- Determining evacuation routes;
- Establishing work zones and exclusion zones;
- Presenting daily safety meetings to field crew;
- Maintaining logs and records in the field; and
- Implementing changes to the APP as directed by the CIH.

1.3.2.2 Site Safety and Health Officer

All site activities will be conducted under the supervision of the HGL SSHO. The SSHO will act as safety oversight for normal and emergency work, and will perform any necessary emergency notification as the On-Scene Incident Commander (OSIC). The SSHO is also responsible for:

- Authorizing stop work as related to safety and health issues;
- Implementing the APP;
- Enforcing all provisions of the APP;
- Determining evacuation routes;
- Enforcing the use of the “buddy” system;
- Establishing work zones and exclusion zones;
- Investigating accidents, incidents, and near misses;
- Presenting daily safety meetings;
- Presenting training requirements to site personnel and visitors;
- Maintaining safety logs and records in the field;
- Implementing changes to the APP as directed by the CSHM or CIH;
- Administering and enforcing the General Health and Safety Program;
- Enforcing the level of personnel protection required;
- Investigating work-related accidents and illnesses, and implementing corrective action plans;
- Establishing air-monitoring parameters based on expected contaminants;
- Establishing employee exposure monitoring notification programs;
- Stopping any operation that threatens the health or safety of the team or surrounding population; and
- Upgrading levels of protection based on site observations or monitoring results.

1.3.3 Lines of Authority

Table 1.2 and Figure 1.3 contain the project personnel, their involvement on the project, the organization these individuals represent, and contact information.

1.4 SUBCONTRACTORS AND SUPPLIERS

1.4.1 Identification of Subcontractors

The following subcontractors will perform the work described for HGL at the site:

- Environmental Priority Service Inc. - Will provide all personnel, equipment, and supplies to provide DPT drilling to support soil sampling, well installation and related IDW disposal.
- Redox Tech – Will provide all personnel, equipment, and supplies to drill borings and inject ERD and ISCO compounds for this study.

1.4.2 Measures of Controlling and Coordinating Subcontractors

Before subcontract work is performed, HGL will negotiate and prepare subcontracts that will detail all necessary and appropriate terms and conditions, and will include the PWS. Once the subcontract is executed, HGL will perform periodic reviews to ensure that contractual requirements and milestones are met. These reviews will cover contractual progress, technical progress, and cost and schedule status. HGL technical staff will review data generated by the subcontractor as part of subcontract deliverables.

1.4.3 Safety Responsibilities of Subcontractors

All subcontractors will receive training on hazard recognition and safety precautions prior to commencing activities at the site. All subcontractors will be given a daily safety briefing and will be supervised while on site. All subcontractor personnel will acknowledge by signature that they have read, understood, and will abide by the APP and SSHP for this project, and must abide by the guidance given by the Site Manager and SSHO at all times. Any deviations from the site plans could be used as the basis for termination of the subcontract agreement.

1.5 TRAINING

Personnel who participate in field activities associated with this project are subject to the training requirements presented in this APP.

1.5.1 List of Subjects to be Discussed in the Safety Indoctrination

The following subjects will be discussed with site personnel:

- Known site contaminants;
- Performance Work Statement (PWS);
- Sequence of work events;

- Equipment used;
- Who implements directives;
- Required PPE;
- Proper lifting techniques;
- Site communication;
- Chemical, physical, and biological hazards that may be encountered;
- Access, egress, and evacuation routes;
- Safe work practices;
- Emergency Response Plan (ERP);
- Emergency notifications;
- Directions to the hospital;
- Medical evacuation procedures; and
- Communications.

1.5.2 List of Mandatory Training and Certifications Applicable to this Project

Site personnel must have met the following training and certification.

- 40-hour HAZWOPER training in accordance with 29 CFR 1910.120 (e);
- 8-hour annual refresher training in accordance with 29 CFR 1910.120 (e);
- Three days of field experience under the direct supervision of a trained, experienced supervisor in accordance with 29 CFR 1910.120 (e);
- First Aid/cardiopulmonary resuscitation (CPR) (minimum of two personnel on site);
- 8-hour Supervisory Personnel Training in accordance with 29 CFR 1910.120 (e), for Site Manager and SSHO;
- 10-hour OSHA Construction Safety class (for Site Manager) in accordance with EM 385-1-1, Subsection 01.A.17;
- Respiratory Protection Training and fit testing (as required); and
- Annual physicals with medical clearance in accordance with 29 CFR 1910.120 (f).

All current certifications will be maintained on site for the duration of the project. Individuals without proper training records will not be permitted to work on site.

1.5.3 Requirements for Emergency Response Planning

Prior to commencement of the project, all site personnel will review and discuss the posted emergency telephone numbers, location of spill kit materials (as applicable), directions to the hospital, the location of all site fire extinguishers, proper use of fire extinguishers, the location of first aid kits, and the persons certified in first aid and cardiopulmonary resuscitation (CPR).

1.5.4 Fire Prevention

Smoking and lighters are prohibited in the exclusion zone or work zone. A cigarette butt receptacle will be provided in the support zone. No cigarette butts are to be discarded on the

ground. No smoking is allowed except in approved, designated locations that have fire extinguishers. The SM will review fire prevention procedures with all site personnel prior to commencement of field work.

During dry weather, the potential for fire exists in any grassy perimeter regions of the site. Sparks from operating equipment, or even contact with hot catalytic converters, can cause dry vegetation to catch fire. Vehicles and equipment will not be left idling or parked in or around areas where catalytic converters may cause a fire. Equipment and vehicles should stay on cleared areas or on roadways wherever practicable. Drivers are responsible for inspecting under and around their parked or stopped vehicles to insure the vehicle will not contribute to a fire. All vehicles will carry a fire extinguisher. Open flames and hot work are prohibited.

1.5.5 Emergency Telephone Numbers

The Emergency Points of Contact sheet (Attachment 4) will be posted on site next to the directions to the local hospital. Emergency points of contact and the telephone numbers for emergency services are shown in Table 1.2.

1.5.6 Safety Meetings and Training

1.5.6.1 Requirements for Supervisory and Employee Safety Meetings

The SSHO will conduct a general meeting at the beginning of each workday. Corporate Management will review the general Safety and Health Program and other issues as required.

1.5.6.1.1 Daily Safety Meetings

The Site Manager or SSHO will conduct a Safety Briefing (tailgate meeting) at the beginning of each workday, or whenever conditions or tasks change. All site personnel will attend these briefings. These briefings will be used as an opportunity to address site-specific safety issues, to refresh workers on specific procedures, and to address new hazards and controls. The topics discussed at the safety meeting will include:

- Safety and Health considerations for the day's/week's activities;
- Communications plan;
- Rally points and safe areas;
- Hospital and evacuation routes;
- Emergency equipment;
- Environmental conditions encountered; and
- New operations or activities.

Attendance records and meeting notes will be maintained with the project files. All HGL employees and visitors at the site who may be exposed to safety or health hazards will receive site-specific training before they are permitted to engage in site operations. Personnel will not be permitted to participate in or supervise site activities until they have been trained to the level required by their specific job function and responsibility.

1.5.6.1.2 Site-Specific Training and Pre-entry Briefing

On-site personnel will receive site-specific safety training. Signatures of those attending and the type of briefing conducted will be entered in the field logbook before site access will be granted. Two versions of this training will be used:

- The site worker version will contain full information on site hazards, hazard controls, and emergency procedures; and
- An abbreviated version will be used for visitors who will be on-site for a short time and who will be observers only, and are under safety escort at all times.

Signatures of those attending and the type of briefing conducted will be entered in the field logbook before site access will be granted.

1.5.6.1.3 Site Workers Basic Safety Briefing

The SSHO will conduct a basic safety briefing for all site workers at the beginning of work and whenever new employees arrive at the job site once the job has commenced. Attendance records and meeting notes will be maintained with the project files. Following is a general list of the topics that will be discussed:

- Names and titles of key personnel responsible for site safety and health, and other hazards present at the site;
- Pertinent components of the SSHP;
- General site safety;
- Hazards and symptoms of chemical contaminant exposure (as applicable);
- Routes of exposure from on-site contaminants (as applicable);
- Physical hazards (slips, trips, and falls; noise; heat stress; cold stress, etc.);
- Biological hazards;
- Location and availability of written hazard communication program;
- Site and activity PPE (including purpose; donning and doffing procedures; and proper use);
- Work practices by which employees can minimize risks for hazards;
- Safe use of engineering controls and equipment use;
- Site control measures;
- Traffic control plan;
- Reporting requirements for spills, and emergencies;
- Personnel decontamination procedures (as applicable);
- Contingency plans (communications, phone numbers, emergency exits, assembly points, etc.);
- Rally points and safe areas;
- Hospital and evacuation routes;
- Worker Right to Know/Hazard Communication;
- Locations and use of emergency equipment (fire extinguishers, spill kits, first aid kits, etc.); and

- Equipment safety.

1.5.7 Training Documentation

Certificates of completion of off-site training courses and daily safety briefing logs will be maintained on site for the duration of the project. Individuals without proper records of their required training will not be permitted on site.

1.6 SAFETY AND HEALTH INSPECTIONS

General safety and health inspections are described throughout this APP. HGL site personnel will conduct safety inspections on a daily basis (or more frequently if conditions warrant).

The Site Manager will be responsible for daily safety inspections. Training and qualifications of the Site Manager are provided in Attachment 2. A Safety Inspection Form will be used to record safety deficiencies, actions taken, and final results. This form will document that any safety deficiencies have been corrected after they have been identified. Deficiencies will be identified and posted using this form. The date when the deficiencies are rectified will be recorded. A record of the safety inspection checklist will be maintained in the project file.

1.6.1 Safety and Health Inspections

The Site Manager will be responsible for daily inspections of the project when present. The CSHM may make random inspections as warranted.

1.6.2 External Inspections

External inspections are not anticipated for this project.

1.7 SAFETY AND HEALTH EXPECTATIONS, INCENTIVE PROGRAMS, COMPLIANCE, AND ACCOUNTABILITY

1.7.1 HGL's Corporate Safety Program

HGL's corporate safety program is designed to provide the safety training and tools required to ensure that HGL is providing the safest work environment for its employees, other project personnel, and the general population in areas adjacent to our project sites.

The HGL CSHM and CIH have reviewed the project PWS and, based on this review, have developed this APP designed to protect health and safety during the project. As part of the job requirements employees are required:

- Read and follow the APP; and
- Attend health and safety training and briefings to make them more informed and aware of potential hazards that exist at the site.

1.7.2 HGL Safety Incentive Program

HGL builds an information database for each project it undertakes, which includes safety data noting the rate and occurrence of accidents and injuries. Incentives such as monetary bonuses and additional training courses are provided as rewards for superior employee performance, and for compliance with the project APP, SSHP and corporate safety and health policies.

1.7.3 Safety Program Noncompliance Policies and Procedures

HGL management takes employee safety requirement noncompliance seriously. Personnel not following procedures are warned and counseled in the proper safety procedures. If the problem persists personnel are again counseled and notations are made in their permanent record. Continued noncompliance will lead to termination. On HGL job sites, visitors are briefed about site safety requirements and are provided with the appropriate level of PPE. If visitors refuse to follow these procedures, they will be escorted from the site.

1.7.4 HGL's Written Procedures for Holding Managers and Supervisors Accountable for Safety

Managers and supervisors are made responsible for enforcing safety and health as part of their job descriptions. They are ultimately responsible for protecting the welfare of the employees, as well as minimizing the potential liability associated with on-the-job accidents.

1.8 ACCIDENT REPORTING

This section provides the requirements for implementing the accident reporting and record keeping provisions of EM 385-1-1 (01.D.01 to .05), as well as the HGL Safety and Health Program Manual Section 1.5: ACCIDENT/INCIDENT INVESTIGATION POLICY. HGL's Project Manager (PM) and CSHM will be notified immediately of any accidents.

All lost time injuries and property damage accidents in which the property damage exceeds $2,000 will be reported to the USACE within 24 hours of the accident/incident, using ENG Form 3394. A copy of the First Report-of-Injury will also be provided to the USACE Contracting Officer's Representative (COR). The Site Manager or SSHO will investigate all accidents.

All workers receiving medical treatment from a physician will obtain a release from the physician on the date of treatment stating one of the following: 1) the employee is not fit for duty; 2) the employee is fit for restricted duty; or 3) the employee is fit for duty. A copy of the release will be attached to the accident report (ENG Form 3394) and submitted to the USACE COR.

The following signature chain will be used on the ENG Form 3394; the name of the individual will be typed or printed legibly after each signature:

- Item 15c. Injured employee's supervisor;
- Item 16. HGL corporate management;
- Item 17. USACE-Kansas City District designated individual;
- Item 18. USACE-Kansas City District designated individual;
- Item 19. USACE-Kansas City District designated individual.

The Site Manager will document and review with the CSHM and CIH the potential exposure data versus the man-hours worked per day to evaluate the association of exposure to site accidents or injury. The exposure data will be reported monthly as part of the Monthly Status Report when field work is being conducted.

1.8.1 Exposure Data

Any person(s) who become ill or injured during work activities must immediately inform the SSHO, regardless of the severity of the illness or injury. The victim(s) will be decontaminated if the injury occurred in a containment area. In the event that the medical emergency is severe, the SSHO will order a cessation of work and notify off-site emergency personnel. All personnel at the work site will use the buddy system, staying within sight of their partner. If a partner becomes incapacitated or severely ill, an ambulance will be called. In the event that a cessation of work is ordered, all personnel should:

- Assist the SSHO or Site Manager, if required, in decontaminating the victim and/or administering first aid;
- Leave the contaminated area and undergo decontamination prior to entering the worker rest area; and
- Assist emergency response personnel when requested.

1.8.2 Accident Investigations Reports and Logs

In the event of an accident that results in a lost workday or $2,000 or more in property damage, an ENG Form 3394 will be completed and submitted within 24 hours.

USACE requirements are seven days for class D and C, and 25 days for class B and A accidents (reference OM 385-1-1, 1Nov02, App. B). The most current OSHA 300 form will be posted on site and is presented in Attachment 3

1.8.3 Immediate Notification of Major Accidents

HGL Safety & Health Program Manual Section 3.5: REGULATORY AGENCY REPORTING FOR WORK-RELATED SERIOUS INJURIES/ILLNESSES will be followed in the event of a serious injury or illness. Should an accident occur resulting in a fatality, $100,000 or more in property damage, three or more persons being hospitalized, or possible adverse publicity to the USACE, the Site Manager will make immediate notification to the USACE PM. The Site Manager will complete an ENG Form 3394 and forward it to the Contracting Officer (CO) or authorized representative within five working days after the incident.

1.9 MEDICAL SUPPORT

A minimum of two site personnel will have been trained in CPR and First Aid and have current American Red Cross certification cards. These individuals will be on site throughout the project.

The HGL Occupational Physician will be available to provide patient-specific information in case medical treatment is needed. Anish Ranpuria of Washington Occupational Health Associates (WOHA), can be reached at telephone number 202-463-6698.

For injuries or illnesses requiring Emergency Medical Services (EMS), notification via phone (Table 1.4) will activate EMS. Emergency response personnel will determine the best course of treatment and the medical treatment facility where this will occur. Emergencies will be handled through the 911 Emergency System; personnel will be transported to the Salina Regional Health Center or other medical treatment facility as determined by EMS personnel.

1.9.1 Route to Hospital

A map showing the route from the project site to the local hospital, and emergency telephone numbers are presented in Attachment 4. Contact information and directions from the site to the local hospital are included below.

Hospital Information:

Name:	Salina Regional Health Center
Telephone Number:	(785) 452-7000
Address:	400 S. Santa Fe, Salina, Kansas 66436
Distance from Site to Hospital:	5 miles

Route to Hospital:

- Exit site, From intersection of Centennial Rd and West Magnolia Rd;
- Head East on W. Magnolia Rd (1.2 mi)
- Turn Left (North) onto S. 9th Street (1.1 mi).;
- Turn Left (North) onto S. Santa Fe Ave (1.4 mi)
- Follow signs to emergency room, hospital is located at 400 S. Santa Fe.

1.10 PERSONAL PROTECTIVE EQUIPMENT

This section presents the PPE levels that may be required for HAZWOPER activities the project, and the procedures to be followed to assure its proper use, selection, and maintenance.

1.10.1 Types of Equipment

Requirements for task and activity-specific levels of protective clothing are presented on the AHAs located in the SSHP (Attachment 1) of this APP. Personnel performing site tasks shall use the appropriate level and type of PPE specified in this plan for each individual task. This APP makes provisions for use of the following levels of PPE, in accordance with the hazards and contamination levels anticipated for each task or operation: Level A, Level B, Level C, and Level D. The following sections describe the PPE requirements for activities and locations on the site.

1.10.1.1 Level A Protection

Level A Protection is not required.

1.10.1.2 Level B Protection

Level B Protection is not required.

1.10.1.3 Level C Protection

It is possible that intrusive activities which include activities such as drilling, well installation and soil sampling will need to be conducted with level C protection. Upgrade to Level C protection will be based on the results of continuous 4-gas meter readings or photoionization detector (PID) readings. Action levels are presented in Table 8.1 of Attachment 1. The SSHO may increase the level of protection due to field conditions, but may not decrease the level of protection without approval of corporate safety management. The following equipment will be used for Level C protection:

- Full-face air purifying respirator (APR);
- Combination filter/cartridge providing protection against organics and particulates:
  - Organic vapors
  - Particulates;
- Steel-toed work boots or steel-toed polyvinyl chloride (PVC) boots;
- Tyvek (or equivalent materials) coveralls with hoods and elastic wrists and ankles – if low toxicity, solid contaminants will be encountered;
- Chemical resistant coveralls (Saranex) – if moist contaminants or liquids encountered;
- Latex or Nitrile gloves (inner) and Nitrile gloves (outer)- if liquids encountered;
- Hearing protection (if necessary);

- Hard-hat (if overhead hazards are present);
- Safety glasses;
- Splash shield (if necessary);
- PPE for work where contact with poison oak is a potential shall consist of Tyvek coveralls with hoods, elastic wrists, and elastic ankles. Nitrile gloves shall be worn, all glove/coverall interfaces shall be taped securely;
- Where contact with heavy brush that may puncture or tear the Tyvek, Saranex coveralls shall be worn;
- High visibility vest when working around vehicle traffic or mobile equipment.

1.10.1.4 Level D Protection

The minimum level of protection that will be required of project personnel and visitors at the site will be Level D. The SSHO may increase the level of protection due to changing requirements, but may not decrease the level of protection without approval of corporate safety management. The following equipment will be used for Level D protection:

- Coveralls or other suitable fieldwork clothing;
- Work boots, minimal metal content - without steel toes during magnetometer operations;
- Work boots with safety toe when conducting operations which pose a compression hazard;
- Safety glasses or goggles as needed;
- Hardhat if overhead hazard or heavy equipment is encountered or operated;
- Leather work gloves; and
- Hearing protection-earplugs and/or earmuffs as needed.

Should personnel encounter an unusual odor, discolored soil, or an unknown item that may be hazardous toxic waste (HTW), they will immediately notify their supervisor and will evacuate the site upwind of the suspected item. The SSHO will notify the Site Manager and corporate safety management of the actions taken.

1.10.2 Proper PPE Selection, Use, and Maintenance

This section provides guidance for proper selection, use and maintenance of PPE.

1.10.2.1 Proper PPE Selection

Selection of PPE will be done after a thorough and initial evaluation of the hazards involved at the site during each phase of the operation, and when conditions change. Additionally, continuous monitoring as outlined in Table 8.2 of Attachment 1 will guide proper PPE selection. All persons entering the site area will put on the required PPE according to established procedures in this plan.

Hazard and risk assessment will be conducted throughout the project by the CSHM in conjunction with the SSHO. Changes in specific PPE, levels of PPE, or respiratory protection

may be made in accordance with information obtained from actual implementation of site activities and data derived from the other sources. As a general rule, levels of PPE will need to be reassessed if any of the following circumstances occur:

- Appearance of previously unidentified or anticipated chemicals, conditions, or task hazards;
- Ambient weather conditions change that impact the use of assigned PPE; and
- A new task is introduced, or a previously assigned and evaluated task is expanded in scope.

Specific levels of protection will be changed whenever site conditions change. The decision to change levels of protection will be made by the CSHM with input from the PM and the CIH. If the need arises to protect health and safety, the SSHO can upgrade protection levels without input from the CSHM or CIH. Levels of protection will not be downgraded without prior approval from the CSHM.

1.10.2.2 PPE Use

All HGL, contractor, or subcontractor site personnel will be given initial PPE-specific training. This training will be given by the SSHO or Site Manager before personnel participate in site operations where PPE is required. All personnel receiving PPE training will be required to demonstrate an understanding of the training topics and the ability to correctly use the PPE prior to starting work on the project. This will be accomplished through the SSHO supervising and visually inspecting each individuals' ability to properly don and use the PPE.

Upon completion of the training and after each employee has successfully demonstrated the proper use of PPE, the SSHO or Site Manager will complete the Certification of PPE Training form (Figure 1.3).

1.10.2.3 PPE Maintenance

Maintenance of PPE can vary greatly, depending on the complexity of the PPE and the intricacy of the repair involved. The SSHO will become familiar with the manufacturer's recommended maintenance and, when possible, repair defective PPE. If unable or unauthorized to conduct the repair, the SSHO will return the item to the manufacturer for repair or to procure a replacement.

The SSHO will be responsible for ensuring that PPE is in good, clean, working order prior to issuing the PPE the first time. Once issued, site personnel will ensure that re-usable PPE articles are maintained in a clean, sanitary fashion. During the work task, buddy teams should periodically inspect each other's PPE for evidence of chemical attack, such as discoloration, swelling, stiffening, or softening. For items used inside an exclusion zone (EZ), site personnel will follow the requirements of the Site-Specific Decontamination Plan, and ensure that the PPE is properly decontaminated before removing the item from the EZ or contamination reduction zone (CRZ).

1.10.3 PPE Program Effectiveness

Based on the inhalation hazard and potential chemical exposures at this site, Level D PPE is considered adequate for non-intrusive work that is to be accomplished. The potential for upgrade to Level C PPE is possible based on site monitoring results during intrusive work.

If work tasks are added to the PWS after approval of this APP, the SSHO shall identify and assess the task hazards and relay that information to the CSHM and CIH. The CSHM will prepare an amendment to the APP and submit the amendment for USACE-Kansas City District approval. The amendment will be added to the APP upon USACE-Kansas City District approval.

The SSHO will ensure PPE use complies with all applicable OSHA, USACE, and HGL requirements.

It is the responsibility of each employee to report to work wearing proper attire and to assemble the necessary PPE before initiating donning procedures. Figure 1.3 shows the Certificate of PPE Training.

1.11 PLANS AND PROGRAMS, AND GENERAL SAFETY PRECAUTIONS

The following plans have been identified as applicable to this project.

1.11.1 Layout Plans

Project site layout plans will be provided in the site-specific briefing and will include: temporary site facilities, location of toilets, equipment storage, planned parking areas, fencing, public traffic routes, airport restricted areas, access and egress to the work site, and rally points. See USACE EM 385-1-1 Section 04.A.01.

1.11.2 Emergency Response Plan

Before the start of this project, all personnel will review the ERP. The plan will be tested for effectiveness during the course of the project. The ERP will include: escape routes, critical operations, rescue/medical duties, emergency reporting, and emergency contacts. Emergency alert systems shall be developed, tested, and used to alert persons during emergency situations. Emergency phone numbers shall be conspicuously posted. See USACE EM 385-1-1 Section 01.E.01 to .06.

1.11.2.1 <u>Procedures and Test</u>

During the project the ERP may be tested with an emergency drill, walk through of emergency response procedures, or additional training to review procedures. See USACE EM 385-1-1 Section 01.E.01.

1.11.2.2 Spill Plans

HGL will conduct cleanup operations in the event of a spill of hazardous material (i.e. fuel or oil from field operations). The SSHO will manage the collection of the spilled material with absorbent pads and containerize the pads or materials within Department of Transportation (DOT)-approved drums for disposal as potential contaminated hazardous waste. A complete spill kit will be maintained on-site when spills are a potential hazard. See USACE EM 385-1-1 Section 01.E.01, 06.A.02.

1.11.2.3 Firefighting Plan

In the event of a fire or explosion, the SSHO or Site Manager will notify the police, fire department, and ambulance service; contact the USACE COR and the HGL PM; and escort the response personnel to the location of the fire or explosion. The SSHO will determine the extent of the fire; coordinate and manage fire suppression efforts until the fire department arrives; use available on-site fire extinguishers on incipient stage fires only, and provide emergency first aid as needed. Site personnel will not fight fires containing explosives. The responding fire department personnel will be informed of the nature of the fire and whether explosives are present. See USACE EM 385-1-1 Section 09.A.01

1.11.2.4 Posting of Emergency Telephone Numbers

Emergency response telephone numbers (Table 1.4) will be posted in the site trailer and provided for each team vehicle.

1.11.2.5 Wild Land Fire Prevention Plan

Wild land fires will be responded to as indicated in Section 1.5.4 Fire Prevention and Section 1.11.2.3 Firefighting Plan. See USACE EM 385-1-1 Section 09.K.01.

1.11.2.6 Man Overboard/Abandon Ship

Not applicable. Waterborne activities are not within the PWS for this project.

1.11.3 Hazard Communication Program

A Hazard Communication Program will be implemented to provide information about manufactured hazardous substances, including chemical hazards and the control of those hazards. The written Hazard Communication Program includes information on container labeling, the use of material safety data sheets (MSDS), and personnel training. Hazardous waste substances are excluded from this program. The following policies and regulations shall be followed: HGL Safety and Health Program Manual Section 5.1 – Hazard Communication; USACE EM 385-1-1 Section 01.B.06 Hazard Communication; and 29 CFR 1910.1200 and 1926.59. Site-specific MSDS are provided in Attachment 1.

The SSHO must ensure that project personnel can immediately obtain the required information about chemicals of concern during an emergency.

1.11.4 Respiratory Protection Plan

Respiratory hazards are not anticipated for this project, however based on site conditions, upgrade to full face respirators may be necessary. Respirators will be issued to employees based on fit testing results in accordance with HGL's respiratory protection program detailed in Policy 9.1 and in Section 5.2 of Attachment 1. Enrollment in a medical monitoring program will be required before using respirators. Respirators will be stored in a clean, dry manner in a tight closing snap lid container. Cartridges will be provided to employees during the project to prevent outdated cartridges being used. Through the buddy system, employees will monitor cartridges for color changes indicating breakthrough.

1.11.5 Health Hazard Control Plan

Hazard evaluation is provided in Section 2.0 of the SSHP.

1.11.6 Lead Abatement Plan

Not applicable. Lead hazards are not anticipated for this project.

1.11.7 Asbestos Abatement Plan

Not applicable. Asbestos hazards are not anticipated for this project.

1.11.8 Abrasive Blasting Plan

Not applicable. Abrasive hazards are not anticipated for this project.

1.11.9 Confined Space Entry

Not applicable. Confined space hazards are not anticipated for this project. However, where there is the potential for buildup of vapors, permit-required confined space entry procedures will be followed. See USACE EM 385-1-1 Section 06.I.

1.11.10 Hazardous Energy Control Plan

Not applicable. Hazardous energy locations are not anticipated for this project.

1.11.11 Critical Lift Procedures

Not applicable. Critical lifts are not anticipated for this project.

1.11.12 Contingency Plan for Severe Weather

Routinely monitoring weather conditions and reports may help reduce the impact of severe weather and natural disasters. Weather conditions will be a part of the daily briefing. It may be necessary to halt certain hazardous operations or stop work altogether to allow the situation to pass. The SSHO must decide what operations, if any, are safe to perform based on existing and anticipated conditions.

The best protection against most severe weather episodes and natural disasters is to avoid them. This means seeking shelter before the storm hits. See USACE EM-385 Section 06.J.

1.11.12.1 Safe Locations During Severe Weather and Locations to Avoid

No place is absolutely safe from severe weather; however, some places are safer than others.

- Large enclosed structures (substantially constructed buildings) tend to be much safer than smaller or open structures;
- The risk for lightning injury depends on whether the structure incorporates lightning protection, the construction materials used, and the size of the structure; and
- In general, fully enclosed metal vehicles such as cars, trucks, buses, vans, etc. with the windows rolled up provide good shelter from many weather conditions.

AVOID being in or near:

- High places and open fields, isolated trees, rain or picnic shelters, communications towers, electrical equipment, pipes, flagpoles, light poles, bleachers (metal or wood), metal fences, or water (lakes, streams, rivers, etc.).

When inside a building AVOID:

- Use of the telephone, washing your hands, or any contact with conductive surfaces with exposure to the outside (such as a metal door or window frame, electrical wiring, telephone wiring, cable TV wiring, plumbing, etc.) if lightning is a factor.

1.11.12.2 Safety Guidelines for Individuals

Identify and seek shelter that is appropriate for the type of severe weather encountered. Proper shelter will always include a sound structure and that provides protection from the elements.

When available, monitor weather conditions broadcast on weather warning devices such as National Oceanic and Atmospheric Administration (NOAA) weather radios or credible weather detection systems. However, do not let this information override common sense and direct observation of weather conditions in the area.

1.11.13 Access and Haul Road Plan

Not applicable. Access and haul roads are not within the PWS for this project.

1.11.14 Demolition Plan

Not applicable. Demolition is not within the PWS for this project.

1.11.15 Emergency Rescue Plan

An Emergency Rescue Plan is not required for this project. Local Emergency Rescue capabilities will be utilized through the 911 system.

1.11.16 Underground Construction Fire Prevention and Protection Plan

Not applicable. Underground activities are not within the PWS for this project.

1.11.17 Compressed Air Plan

Not applicable. Compressed air activities are not within the PWS for this project.

1.11.18 Form and Shoring Erection and Removal Plan

Not applicable. Form and shoring activities are not within the PWS for this project.

1.11.19 Jacking Plan, Slab Plan

Not applicable. Jacking and slab activities are not within the PWS for this project.

1.11.20 Blasting Plan

Not applicable. Blasting activities are not within the PWS for this project.

1.11.21 Diving Plan

Not applicable. Diving activities are not within the PWS for this project.

1.11.22 Plan for Prevention of Alcohol and Drug Abuse

The HGL substance abuse prevention program is attached as Attachment 5. All project personnel will be asked to read and abide by this plan. The policy will be posted at the job site.

1.11.23 Fall Protection Plan

Not applicable. Height activities are not within the PWS for this project.

1.11.24 Steel Erection Plan

Not applicable. Steel erection activities are not within the PWS for this project.

1.11.25 Night Operations Lighting Plan

Not applicable. Night operations are not within the PWS for this project. Activities will be performed during daylight hours only.

1.11.26 Site Sanitation Plan

The following sanitation provisions will be established and maintained for the duration of this project. See USACE EM 385-1-1 Section 02.

- Drinking water
- An adequate supply of cool water will be supplied and kept in water coolers in the support zone on site. The water cooler will be kept closed.

- Toilet Facilities
- HGL will provide access to plumbed toilet facilities or a portable sanitary facility on the site; hand-washing stations will be made available.

- Waste Disposal
- A trash receptacle will be provided in the support zone for the disposal of rubbish and other non-hazardous waste materials.

1.11.27 Fire Prevention Plan

A copy of the site-specific Fire Prevention Plan will be posted on site and implemented. See USACE EM 385-1-1 Section 09.A.01.

Major work place fire hazards:

- Brush and range fires
- Flammable and combustible liquids
- Electrical fires
- Waste materials, combustible waste

Potential ignition sources:

- Matches, lighters, sparks, and open flames
- Heat or sparks from vehicle engine or exhaust
- Electrical overload or malfunction
- Lightning
- Smoking
- Static discharge
- Internal combustion

Types of fire suppression equipment:

- Water
- Fire extinguishers (ABC dry chemical)

Responsibilities and housekeeping:

- All site workers are responsible for fire prevention
- A good housekeeping program must be implemented

- Waste material must be removed daily

1.12 CONTRACTOR INFORMATION

This section provides information on how HGL will meet the requirements of the applicable sections of this APP.

1.12.1 Excavations

Excavation activities and not anticipated during this project.

1.12.2 Medical and First Aid Requirements

Before commencing site work, arrangements will be made for medical facilities and personnel to provide prompt attention to medical emergencies and occupational safety and health matters. The emergency communications plan, transportation options, directions, and maps to the nearest medical facilities will be posted in the site trailers and in each site vehicle. At a minimum, at least two on-site employees shall be qualified to administer first aid and CPR.

The site manager vehicle will be designated as the primary emergency support vehicle. All site vehicles will carry first aid kits, eye wash kits and fire extinguishers.

1.12.3 Sanitation

HGL shall establish and maintain basic sanitation provisions for employees at all places of employment as specified below:

- An adequate supply of cool drinking water;
- Access to indoor sanitary facilities or approved portable toilet systems;
- Washing facilities, located next to toilet facilities; and
- Waste disposal receptacles.

HGL employees will keep the work and support areas neat and orderly and free of trash and debris. An area will be established where personnel can take a break. The area will be clearly marked or identified.

All refuse will be deposited into designated containers while on site. It is the responsibility of the SSHO to insure that the site is kept clean.

1.12.4 PPE

Based on hazard evaluations, HGL has selected Level D PPE and the base level of protection. If site conditions warrant upgrade, Level C PPE will be employed. The minimum attire for fieldwork shall be short-sleeved shirts, long pants, leather steel-toed work shoes. Field attire will be suitable for current weather conditions.

Additional PPE will be required as indicated below:

- Orange or day-glow vest – required during field activities
- Gloves – required when working with hand tools or when the threat of a hand injury exists
- Steel-toed or safety boots
- Eye protection or safety glasses – required when potential eye injury exists
- Hearing protection – required whenever sound-pressure levels exceed 85 decibels
- Head protection or hard-hat – required when head injury or overhead hazards exist

1.12.5 Fire Prevention

A written fire prevention plan will be provided and posted at the project site. It will include emergency contact information, a list of major workplace fire hazards, potential ignition sources, types of fire suppression equipment available to control a fire, and responsibilities and good housekeeping procedures and considerations.

Fire prevention training and awareness will provided during the site specific brief and during daily tailgate safety briefings

1.12.6 Public Safety Requirements

Public safety notifications will be made before fieldwork begins. Site access will be limited, exclusion zones will be maintained, required danger, caution and warning signs will be posted as required and hazardous work activities will cease if necessary to ensure public safety.

1.13 SITE-SPECIFIC HAZARDS AND CONTROL

Section 2.2 of the SSHP in Attachment 2 outlines the general hazards and safe work practices that will be followed by all site personnel to eliminate or reduce the risk of exposure to the anticipated site hazards. These controls are presented as a guide for site personnel, and do not cover all compliance issues.

Prior to injection activities the Salina Fire Department and SAA fire officials will be contacted to provide information on the chemicals that will be used on site.

Table 1.1
Hazard List
Activity/Level of Protection

Task	Activity	Initial Levels of PPE
1	Mobilization	D
2	Drilling/Direct-push Technology	D-C
3	Well Installation	D-C
4	Groundwater Sampling	D
5	Soil Sampling	D-C
6	Oversight of Chemical/Substrate Injection System	D
7	Decontamination of Equipment	D
8	Disposal of Investigation Derived Waste	D
9	Demobilization	D

Note:
As site activities progress, levels of PPE are subject to change or to modification. Upgrading of PPE can occur when action levels are exceeded or whenever the need arises to protect the safety and health of site personnel. Levels of PPE will not be downgraded without prior approval from the CIH.

Table 1.2
Line of Authority, Emergency Points of Contact, and Emergency Services Telephone Numbers

Emergency Phone Numbers

Fire Department, Salina Fire Department	
Emergency	911
Non-Emergency	(785) 826-7340
Emergency Medical Care – Salina Ambulance	
Emergency	911
Non-Emergency	(785) 826-7340
Police, Salina Police Department	
Emergency	911
Non-Emergency	(785) 826-7210
Salina Regional Health Center	
400 S. Santa Fe Salina, Kansas 66436	(785) 452-7000
Kansas Poison Control	(800) 222-1222
National Response Center	
Environmental Emergencies	(800) 424-8802

Project Contacts

HGL Contacts:

Project Manager:	Miquette Rochford	(970) 243-3893
Site Supervisor:	Chris Williams	Site phone TBD
Corporate Safety and Health Manager and Certified Industrial Hygienist:	Mary Ann Heaney	(303) 665-8528
Certified Industrial Hygienist:	Colby Smith	(303-691-1978

USACE CENWK Point of Contact

U.S. Army Corps of Engineers, Kansas City 601 East 12th Street, Room 610 Kansas City, Missouri 64106	Robyn Kiefer	(816) 389-3615

Directions to the Nearest Medical Facility

- Exit site, From intersection of Centennial Rd and West Magnolia Rd;
- Head East on W. Magnolia Rd (1.2 mi)
- Turn Left (North) onto S. 9th Street (1.1 mi).;
- Turn Left (North) onto S. Santa Fe Ave (1.4 mi)
- Follow signs to emergency room, hospital is located at 400 S. Santa Fe.

Filename: X:/KAN004/TO_103/MAPS Site_Location_Map.cdr
Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/09/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

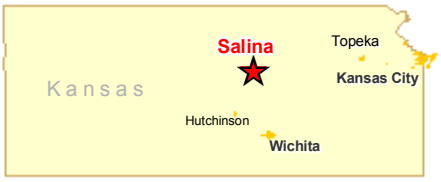
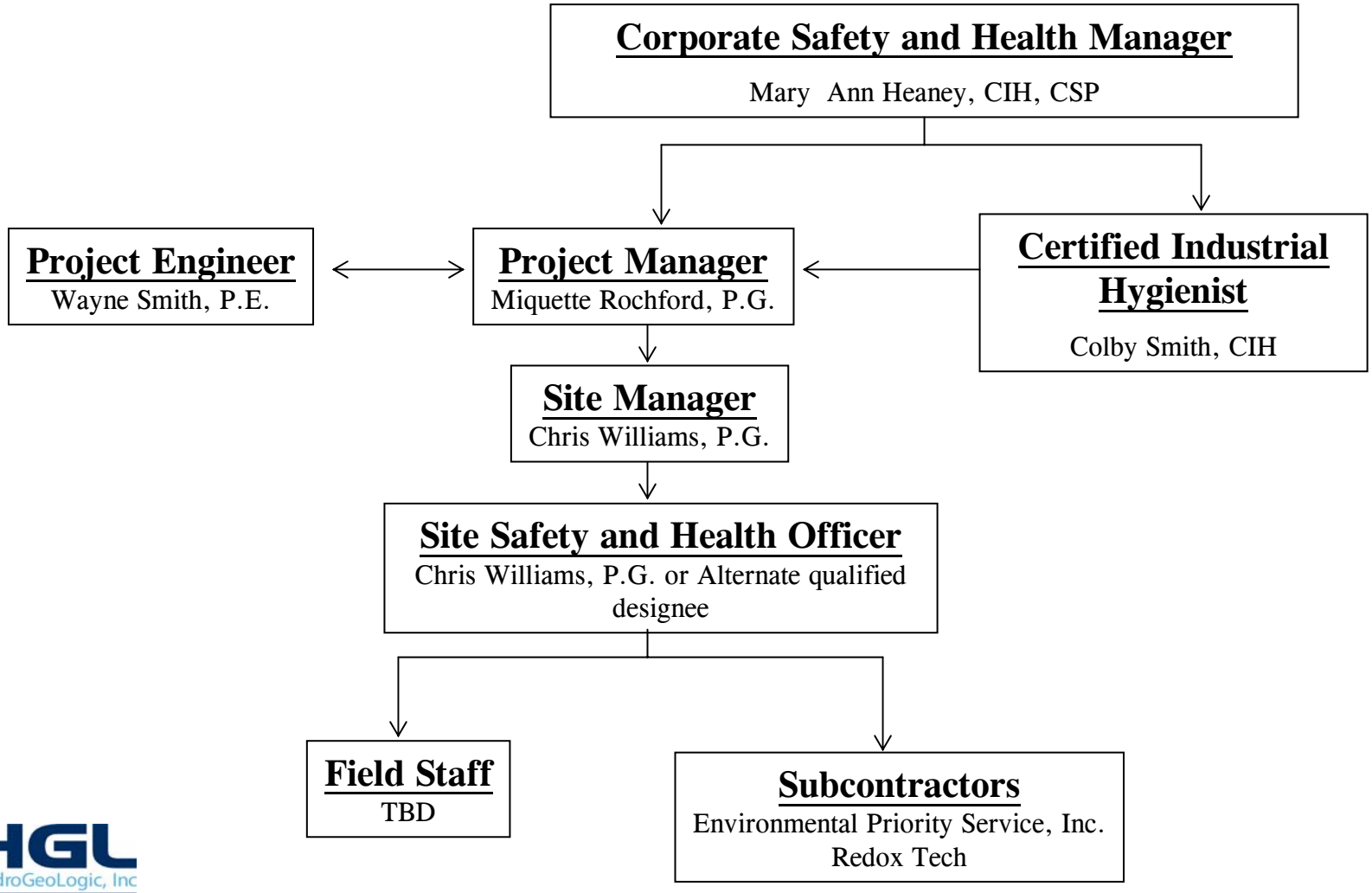


Figure 1.1
Site Location Map
Former Schilling AFB

Figure 1.2
Organization Chart



HGL HydroGeoLogic, Inc

Figure 1.3
Certificate of PPE Training

CERTIFICATION OF PERSONAL PROTECTIVE EQUIPMENT (PPE) TRAINING

SITE INFORMATION	
Site Name:	
Location:	Instructor(s):
Date of Classroom Instruction:	Date of Demonstration:

PPE TRAINING COURSE ATTENDANTS

The following personnel have attended the site PPE training course, and demonstrated, through use, an understanding of the donning/doffing procedures, inspection, cleaning, maintenance, storage, limitations, and proper disposal of the PPE listed on this certificate. These personnel are now qualified to use the site- and task-specific PPE, as required by the Site Safety and Health Plan (SSHP).

Name	Organization	Name	Organization

TYPES AND LEVELS OF PPE ADDRESSED DURING TRAINING

Trainer's Initials	Personal Protective Equipment Reviewed	Trainer's Initials	Personal Protective Equipment Reviewed

CERTIFICATION

I, the undersigned, do hereby certify that the above listed personnel have received the requisite training and successfully demonstrated their ability to use the PPE listed above, in accordance with the HGL PPE Program.

Name (printed):	Signature:	Date:

2.0 REFERENCES

U.S. Army Corps of Engineers, Kansas City District, 2005. Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Volume 1, September 2005

U.S. Army Corps of Engineers, 2003. EM385-1-1, Safety and Health Requirements Manual, November 2003

Attachment 1

Site Safety and Health Plan

FINAL
SITE SAFETY AND HEALTH PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Contract No. DACW41-02-D-0004
Delivery Order 0003

August 2006

FINAL
SITE SAFETY AND HEALTH PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Prepared for

U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, MO 64106

Prepared by

HydroGeoLogic, Inc.
8245 Nieman Road, Suite 101
Lenexa, KS 66214

August 2006

SITE SAFETY AND HEALTH PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

PROJECT:	U.S. Army Corps of Engineers
PROJECT NUMBER:	Contract No. DACW41-02-D-0004 Delivery Order No. 0003
PROJECT MANAGER:	Miquette Rochford, P.G.
PLAN PREPARED BY:	Andrea Fletcher
PREPARATION DATE:	July 2006

APPROVED BY:

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Mary Ann Heaney, CIH — Date
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Certified Industrial Hygienist

Miquette Rochford — 8/25/06
Miquette Rochford, P.G. — Date
HydroGeoLogic, Inc.
Project Manager

Hillary Haworth — 8/28/06
Hillary Haworth — Date
HydroGeoLogic, Inc.
Regional Office Health and Safety Coordinator

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ACRONYMS, ABBREVIATIONS AND SYMBOLS

ABC	Anaerobic BioChem
ACGIH	American Conference of Governmental Industrial Hygienists
AFB	Air Force Base
AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
APR	air-purifying respirator
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COC	contaminant of concern
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CSP	Certified Safety Professional
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	*cis*- 1,2-dichloroethene
dBA	decibels on an A-weighted scale
DPT	direct push technology
ERD	enhanced reductive dechlorination
EZ	exclusion zone
°F	degrees Fahrenheit
HGL	HydroGeoLogic, Inc.
HSP	Health and Safety Program
ISCO	in-situ chemical oxidation
IDW	investigation-derived waste
IIPP	Injury and Illness Prevention Plan
KDHE	Kansas Department of Health and Environment
KDHR	Kansas Department of Human Resources
KSU	Kansas State University
kW	kilowatt
LEL	lower explosive limit

MCL	Maximum Contaminant Level
μg/L	micrograms per Liter
mph	miles per hour
MSDS	Material Safety Data Sheet
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PID	photo ionization detector
PSTS	Pilot-Scale Treatability Study
PM	Project Manager
PPE	personal protective equipment
PVC	polyvinyl chloride
RTB-1	NI DHE microbial consortium
ROI	radius of influence
SAA	Salina Airport Authority
SMA	Salina Municipal Airport
SHO	Safety and Health Officer
SPF	sun protection factor
SRE	Site Reconnaissance Evaluation
SS	Site Supervisor
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
TCE	trichloroethene
TLV	threshold limit value
TSM	Tailgate Safety Meeting
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
WBGT	wet bulb globe temperature
WNV	West Nile Virus
ZVI	zero valent iron

SITE SAFETY AND HEALTH PLAN ACKNOWLEDGMENT

I understand and agree to abide by the provisions as detailed in this Site Safety and Health Plan. Failure to comply with these provisions may lead to disciplinary action that may include dismissal from the work site, termination of employment or, for subcontractors, termination of the work contract.

Printed Name	Company	Signature	Date

DISCLAIMER

The enclosed Site Safety and Health Plan has been designed for the methods presently contemplated by HydroGeoLogic, Inc. (HGL) for execution of the proposed work. Therefore, the Site Safety and Health Plan may not be appropriate if the work is not performed by or using the methods presently contemplated by HGL.

In addition, as the work is performed, conditions different from those anticipated may be encountered and the Site Safety and Health Plan may have to be modified. Therefore, HGL makes no representations or warranties as to the adequacy of the Site Safety and Health Plan, except for warranties specifically stated in the Site Safety and Health Plan itself.

FINAL
SITE SAFETY AND HEALTH PLAN
PILOT-SCALE TREATABILITY STUDY
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

1.0 INTRODUCTION

1.1 OBJECTIVE

The objective of this Site Safety and Health Plan (SSHP) is to ensure safe working conditions during the Pilot-Scale Treatability Study (PSTS) activities at the former Schilling Air Force Base (AFB) in Salina, Kansas. The procedures outlined have been established based on a preliminary analysis of potential hazards at the site.

This document, in combination with HydroGeoLogic, Inc.'s (HGL) Corporate Health and Safety Program (HSP) Manual, describes the safety and health requirements and procedures to be used while conducting field work. HGL and its subcontractors will comply with applicable Occupational Safety and Health Administration (OSHA) regulation (29 Code of Federal Regulation [CFR] 1910 and 1926) (OSHA, 2004) and the U.S. Army Corps of Engineers (USACE) "Safety and Health Requirements Manual, EM385-1-1" (USACE, 2003).

1.2 HISTORY AND FACILITY DESCRIPTION

Schilling AFB is located in central Kansas, Saline County, just southwest of the city of Salina (Figure 1.1). At its maximum use, the former Schilling AFB occupied all or parts of Sections 22, 27, 32, 33, and 35 in Township 14 South (T. 14 S.), Range 3 West (R. 3 W.), and Sections 2, 3, and 4 in T. 15 S., R. 3 W. The city of Salina incorporated the former Schilling AFB into its legal boundary when it was acquired in 1966 (USACE, 2005).

The Smoky Hill Army Base was built in 1942 as headquarters for the newly created Army Air Corps Unit, 20th Bomber Command, and became the first operational training base for B-29 bombers. The Base name was changed to the Smoky Hill Air Force Base in 1946 and to Schilling AFB in 1957. In 1942, the property encompassed 365 acres and housed 5,000 military employees. By 1967, the Base had expanded to 4,000 acres. The Base remained active for 5 years after World War II and was deactivated in 1949. In 1951, the Base was reopened for the Korean Conflict. Upon reactivation, several improvements to the facility were made, including a 25-mile long jet fuel pipeline that started in McPherson, KS, and terminated at a bulk oil storage farm on base. With the arrival of the Strategic Air Command and the 802nd Air Division at the Base in 1952, further site improvements, including the construction of a trainer building, a boiler facility, a gas distribution system, and bulk oil storage system, were completed. The Base was designated a permanent Air Force installation in July of 1953. In 1960, the 802nd Air Division was deactivated, and the 40th Bombardment Wing was transferred to Schilling Air Force Base. A squadron of Atlas F and Nike missiles was deployed to 12 sites around Schilling AFB and attached

to Schilling AFB for support. New facilities were constructed for storage and repair of both conventional and nuclear munitions and nuclear warhead maintenance. Schilling AFB was also upgraded to receive B-52 bombers and KC-135 jet tankers. Schilling AFB was closed in 1964 and was transferred to the Salina Airport Authority (SAA) in 1966 (USACE, 2005).

SAA has since used much of the property in operating the airfield, renamed as Salina Municipal Airport (SMA). The remainder of the former Schilling AFB is currently used for light-to-heavy industrial, aviation, and educational purposes. Major landowners at the former Schilling AFB include the Kansas Board of Regents, the Salina Area Vocational Technical School, Kansas National Guard, and the Occupational Center of Central Kansas. Local industry includes Tony's Pizza, Schwan's Sales Enterprises, Raytheon (Beechcraft), Flower Aviation, and Moore's Midway Aviation. Many of these entities either lease property from SMA or have purchased their properties outright.

The PSTS will be performed in two distinct locations: near Building 837 on the Kansas State University (KSU) campus and between Buildings 606 and 626 (former wash racks), (Figures 1.2 and 1.3, respectively).

Building 837 is located immediately adjacent to the campus administrative building. The area requiring treatment in this study area is shown in Figure 2.3. The area is an open grass field that lies between three active administrative and classroom buildings. There are sidewalks and utility crossings in and around the area. Care will be taken to ensure that disruptions to current operations are minimized during field activities.

The former wash racks (Buildings 606 and 626) are active facilities. The pilot study area is currently used as a parking lot and a grassy area in and around Building 606. The area can be fenced off and utilized in coordination with the current building operators. There are numerous utilities and drainage lines in the area. A fuel oil underground storage tank (UST) was removed from the northwest corner of Building 606 in 1999.

1.3 POLICY STATEMENT

It is the policy of HGL to provide a safe and healthful work environment for all employees and subcontractors. HGL considers no phase of operation or administration to be of greater importance than injury or illness prevention. Safety takes precedence over expediency or shortcuts, and every reasonable step will be taken to reduce the possibility of injury, illness, or accident.

This SSHP describes the procedures that must be followed during field work associated with activities at the former Schilling AFB. Operational changes that could affect the health or safety of personnel, the community, or the environment will not be made without the prior approval of HGL's Project Manager (PM), and Certified Industrial Hygienist (CIH).

The provisions of this SSHP are mandatory for all HGL personnel performing the work described in this document.

All HGL subcontractors performing work on this project are required to have their own SSHP in place that meets or exceeds the requirements of this document. This document will be submitted to HGL health and safety staff for review prior to work activities. HGLs SSHP takes precedence over the subcontractors and should be viewed as the primary SSHP. Each subcontractor must complete all work in accordance with their SSHP and HGLs SSHP. The subcontractor shall also provide all personal protective equipment (PPE) used by their employees and furnish documentation of all required training.

HGL requires all visitors to the work site to abide by the requirements of this SSHP. The CIH will provide written addenda to this SSHP when changes are warranted. No changes to this SSHP will be implemented without prior approval of HGL's CIH or other authorized representative.

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Project: KAN004-103-01-02
Created by: cvanfosson 03/09/06
Revised: 03/09/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

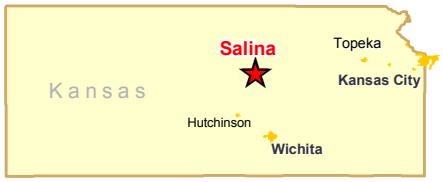
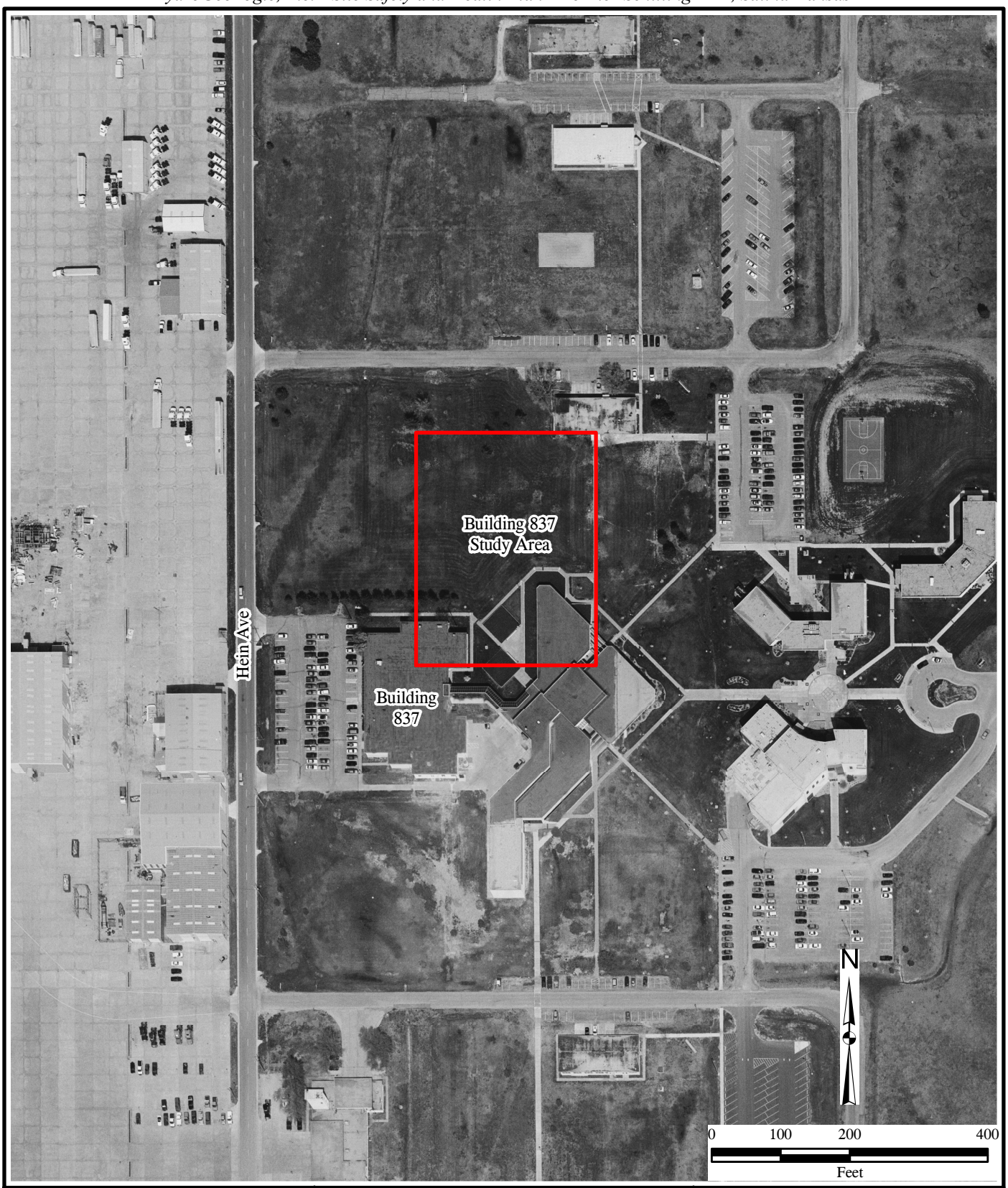


Figure 1.1
Site Location Map
Former Schilling AFB



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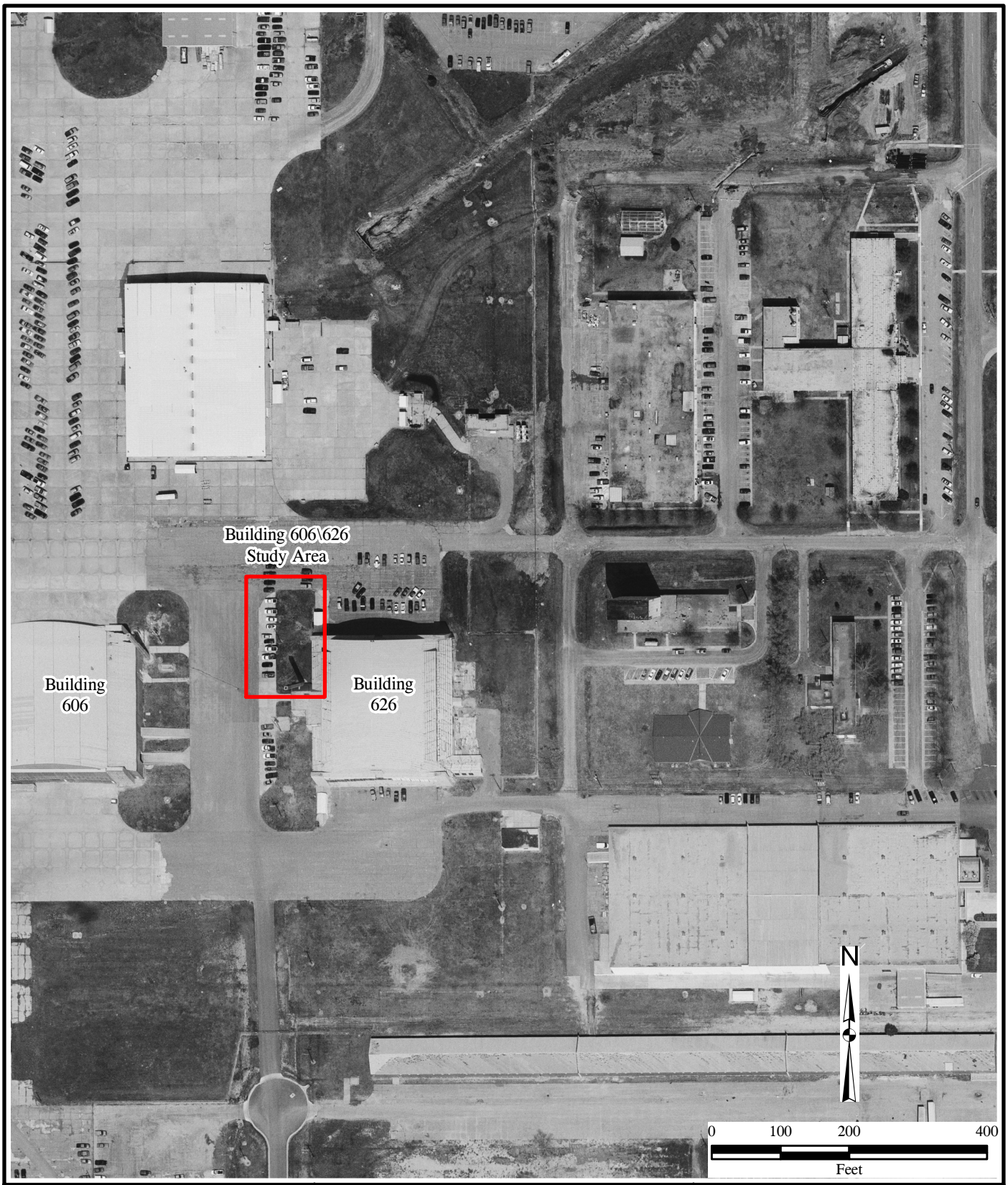
Created by: cvanfosson 03/10/06
Revised: 03/10/06 CV
Source: City of Salina, Public Access Mapping

Legend

Study Area

Figure 1.2
Building 837
Site Map



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Revised: 03/10/06 CV
Source: City of Salina, Public Access Mapping

HGL HydroGeoLogic, Inc

Legend

Study Area

Figure 1.3
Building 606/626
Site Map

2.0 PERSONNEL, ORGANIZATION AND RESPONSIBILITIES

2.1 PERSONNEL AND ORGANIZATION

One to four workers will be involved in the project at any given time.

Key Personnel include:

- PM – Miquette Rochford
- Site Supervisor (SS)/Site Safety and Health Officer (SSHO) – Chris Williams
- Safety and Health Officer (SHO)/CIH – Mary Ann Heaney

2.2 RESPONSIBILITIES

2.2.1 All Personnel

Each person is responsible for his/her own safety and health, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to the SS. All persons onsite are responsible for continuous adherence to SSHP procedures during the performance of any project work. In no case may work be performed in a manner which conflicts with the intent of, or the inherent safety precautions expressed in this SSHP.

All HGL and subcontractor personnel are required to read and acknowledge their understanding of this SSHP and cooperate with project management in ensuring a safe and healthful work site.

2.2.2 Project Manager

The PM has overall responsibility for the safety and health of all personnel on the project. The PM's responsibility with regard to safety and health is to maintain company policy and resolve safety and health issues.

The PM is responsible for:

- Scheduling field support in coordination with field operations;
- Ensuring that all subcontractors have submitted the health and safety documents required by this plan;
- Ensuring that all provisions of the SSHP are followed and contacting the CIH for any variances or modifications needed;
- Notifying the CIH when field work lasts more than six months so that the SSHP can be reviewed and updated as needed;
- Auditing the project at least annually in accordance with HSP Policy 1.6;
- Following up to ensure correction of any reported or observed safety hazard;
- Reporting all near-miss, injury, illness and vehicle accident incidents to the SS and Corporate Safety and Health Manager within 24 hours and ensuring that an Accident Investigation Form is initiated in accordance with HSP Policy 1.5; and,

- Immediately notifying the CIH upon receiving notice of any regulatory agency inspection; and
- Ensuring that copies of the following records are retained in the project files:
  - Pertinent Safety and Health correspondence
  - Air monitoring records
  - Incident reports
  - Documentation of audits and corrective actions
  - Air monitoring equipment calibration records

2.2.3 Site Supervisor/Site Safety and Health Officer

The SS reports to the PM and is responsible for field enforcement of the SSHP. The SS will serve as the SSHO for this project. The SS is responsible for informing the CIH and the PM of any changes to the work plan, prior to implementation, so that Safety and Health issues introduced by those changes may be properly addressed.

Other responsibilities include:

- Requiring that the SSHP is read and signed by all field personnel on the project, including subcontractors;
- Informing the PM and the CIH of significant changes in either the environment or work procedures which may require modification of the SSHP;
- Directing work so as to ensure personnel safety and protection of property and the environment;
- Taking steps immediately to correct any hazards disclosed by project workers or the SS;
- Conducting daily inspections to ensure adherence to this plan;
- Contacting the CIH if changes to an Activity Hazard Analysis (AHA), or developing a new AHA as needed;
- Providing all required supplies, equipment and tools prior to initiation of each task;
- Ensuring that employees maintain the required training and medical monitoring throughout the project;
- Determining that monitoring equipment is properly calibrated and used, and that results are properly recorded and filed in accordance with HSP Policy 4.1;
- Enduring that employee exposure monitoring is conducted;
- Requiring that tailgate safety meetings (TSMs), as defined in HSP Policy 2.1, are conducted daily, and the Tailgate Training Acknowledgement Form is signed by all field workers;
- Verifying and posting routes to capable medical facilities and emergency telephone numbers (including poison control facilities), and arranging emergency transportation to medical facilities;
- Immediately notifying the PM of any illnesses, accidents, injuries, or near-misses related to the project, and submitting appropriate documentation to the CIH within 24 hours;
- Establishing appropriate site control zones;

- Ensuring that copies of the following records are retained in the project files:
  - Pertinent Safety and Health correspondence
  - Air monitoring records
  - Incident reports
  - Documentation of audits and corrective actions
  - Air monitoring equipment calibration records; and,
- Maintaining a file of Material Safety Data Sheets (MSDS) for materials used on site.

2.2.4 Safety and Health Officer/Certified Industrial Hygienist

The CIH is responsible for oversight of the safety and health program. The CIH is responsible for the preparation and modification of this SSHP and will approve all changes and updates as warranted by altered site conditions. The CIH will advise the PM on safety and health issues that may have an impact on project operations. In addition, the CIH is responsible for:

- Providing technical assistance to the PM and the SS;
- Review applicable Safety and Health correspondence, air sampling records, documentation of audits and corrective actions;
- Review applicable subcontractor health and safety plans, programs and related training, air sampling results and other industrial hygiene methodologies;
- Investigating significant accidents, illnesses and near-misses.
- Recommending corrective actions as appropriate;
- Reviewing all Accident Investigation Reports; and,
- Providing support for evaluation of contractors regarding Safety and Health issues.

2.3 SUBCONTRACTOR MANAGEMENT AND PERSONNEL

Subcontractor management is responsible for the compliance of their personnel with HGL's SSHP, as well as their own SSHP. Since subcontractors are hired for their specific expertise, they must assume primary responsibility for the safety and health of their personnel. However, HGL is still responsible for the actions of the subcontractors which is why subcontractors must ultimately abide by HGL's SSHP.

The subcontractor's Field Supervisor or Crew Leader will be responsible for performing a weekly safety inspection of their operations. A copy of this inspection must be submitted to the SS each week.

Subcontractors must also:

- Comply with applicable OSHA regulations (29 Code of Federal Regulations [CFR] 1910 and 1926).
- Perform all work in accordance with this SSHP and the Subcontractors own SSHP.
- Provide documentation for each on-site worker of successful completion of 40 hours training per 29 CFR 1910.120, 1926.65. This must be received prior to the employee starting work on the site.

- Provide documentation, as needed, of medical approval to perform hazardous waste work prior to the worker arriving on site.
- Provide all PPE required for this project.
- Report all unsafe conditions, faulty equipment, incidents, and close calls, immediately to the SS.
- Provide proof of additional training prior to performing tasks requiring such training (e.g., forklift operation, respirator use, fall protection, excavation and trenching).
- Provide awareness level training to affected HGL workers regarding any material, equipment or operation that may pose a hazard to the HGL employees.
- Keep a copy of their company SSHP on site or at a nearby office at all times (per HGL HSP Policy 12.1: Subcontractors' Health and Safety Requirements);
- Conduct any required industrial hygiene monitoring for their workers and provide results and information to HGL corporate health and safety staff; and,
- Ensure that field supervisor/crew leader performs weekly safety inspections of their operations and provides results to the crew leader.

2.4 ON-SITE PERSONNEL AND VISITORS

No visitor will be allowed within the work zones without authorization from the PM and the SS. Visitors requesting authorization to enter the contamination reduction zone (CRZ) or exclusion zone (EZ) must meet the requirements for appropriate medical exams and training. On-site client personnel also will be held to these requirements. See HGL HSP Policy 1.2: Visitor Safety.

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3.0 HAZARD ANALYSIS AND RISK ASSESSMENT

3.1 SCOPE OF WORK

Work under this project may include the following activities:

1) Mobilization
2) Direct-push technology (DPT) drilling
3) DPT well installation
4) Groundwater sampling
5) Soil sampling
6) Oversight of groundwater injection treatment systems
7) Decontamination of equipment
8) Disposition of investigation derived waste (IDW)
9) Demobilization

3.2 ACTIVITY HAZARD ANALYSIS

An AHA identifies potential safety, health, and environmental hazards associated with specific tasks. Exhibit 1 contains an AHA for each major task associated with this project as identified in Section 3.1. The AHAs identify the specific activities for each task and the potential hazards associated with each of those tasks: chemical, biological, physical, and environmental.

The SS will continually review activities and work sites and identify hazards that are not addressed with an AHA. Changing conditions and potential new hazards will be discussed with the PM and the CIH. The SS will keep supervisors for subcontractors informed of changing conditions and nay new requirements for working safely.

Changes to an AHA may be originated by the SS, but must be approved by the CIH and PM.

3.2.1 Chemical Hazards

Potential chemical hazards include those substances discovered as contaminants at the site as well as materials and substances brought on-site and used during the project.

Based on site history and previous investigations, the primary contaminants that may be encountered during this project include those in the contaminated groundwater and soil. The ten chemical compounds identified as contaminants of concern (COCs) are:

- Benzene
- 1,1-Dichloroethene (DCE)
- *cis*-1,2-DCE
- 1,2-Dichloropropane
- Ethyl benzene
- bis-(2-ethylhexyl)Phthalate

- Trichloroethene (TCE)
- Toluene
- Vinyl chloride (VC)
- Xylene

Additional substances that may be brought on site include: compressed welding gases, compressed gases for instrument calibration, and small amounts of gasoline or diesel fuel, sample containers with hydrochloric acid, bentonite, neat cement, and regular concrete. Material Safety Data Sheets (MSDSs) will be provided on-site for each potentially hazardous material (other than waste) before being brought on-site. See Exhibit 2 for the MSDSs associated with the site. Table 3.1 details the Physical and Chemical Properties and Potential Health Hazards of Hazardous Materials associated with the site. Table 3.2 presents the Exposure Guidelines for Significant Site Hazardous Materials.

During the PSTS, chemicals will be injected into the subsurface using a DPT rig. The chemicals that will be injected are: Anaerobic Biochem (ABC), Zero Valent Iron (ZVI), NI DHE Microbial consortium (RTB-1), Potassium Permanganate, and Sodium Persulfate. MSDS for each of these chemicals are included in Exhibit 2.

3.2.2 Physical Hazards

3.2.2.1 General Physical Hazards

Physical hazards include those posed by equipment and tools as well as those created by employees' activities or the environment. The general physical hazards that may be encountered on this site include: slips, trips and falls, caught in or between machinery, contact with electrical current, falls from elevated surfaces, lifting, contact with traffic, contact with mobile equipment, lacerations from hand tools, fires, noise, and heat stress.

3.2.2.2 Confined Space Entry

No confined space entry is anticipated for this project; therefore, confined space entry is not addressed in this SSHP.

3.2.3 Biological Hazards

Because field work will be conducted outdoors, multiple biological hazards may be encountered – particularly when working in the more remote areas of the site.

Poisonous or stinging insects, spiders and/or reptiles may be a concern for project personnel during sampling and other site activities. Disease vectors, such as ticks and mosquitoes, may also be present. Bird excrement and rodent droppings may also pose hazards to workers.

Thorny plants or other noxious flora may be present, and can cause severe skin irritation on contact. Plants posing hazards in the area include poison ivy/oak, thistles and other thorny plants.

3.2.3.1 Spiders, Stinging Insects, Centipedes, and Scorpions

Spiders in the U.S. are generally harmless, with two notable exceptions: the black widow spider and the brown recluse or violin spider. These spiders generally inhabit places that are dark and protected, such as woodpiles, barns, stables, garages, homes, outdoor sanitation facilities, and walls made of rock.

Biting and stinging insects, such as ants, centipedes and scorpions, are very common. Most of these insects live in easily recognizable nests, but many are encountered far from their nest.

Biting and stinging insects and related animals can usually be avoided if proper precautions are taken. Care should be taken when entering little-used structures (sheds, utility buildings) and when opening monitoring well covers.

3.2.3.2 Snakes

There are various types of poisonous snakes indigenous to the Midwestern U.S. The degree of toxicity resulting from poisonous reptile bites depends on the potency of the venom, the amount of venom injected, and the size of the person bitten.

The most effective way to prevent poisonous reptile bites is to avoid reptiles in the first place. Personnel should avoid walking at night or in high grass and underbrush. Visual inspection of work areas should be performed prior to activities taking place. The use of high topped leather boots and long pants will be required, as more than half of all snake bites are on the lower part of the leg. No attempt at killing reptiles should be made; many people are bitten in such a manner.

3.2.3.3 Flying Insects

Flying insects such as mosquitoes, wasps, hornets, and bees may be encountered while site activities occur. Table 3.3 discusses problems associated with Flying Insects.

3.2.3.4 West Nile Virus

West Nile virus (WNV) has emerged in recent years in temperate regions of North America. Generally, WNV is spread by the bite of an infected mosquito. Mosquitoes are WNV carriers that become infected when they feed on infected birds. Infected mosquitoes can then spread WNV to humans and other animals when they bite.

3.2.3.5 Ticks

Ticks are vectors of many different diseases including Rocky Mountain spotted fever, Q Fever, Tularemia, Colorado Tick Fever, and Lyme disease.

3.2.3.6 Chiggers

Chiggers are common in grassy areas especially near low, wet spots, ponds and steam banks, and in forest underbrush. Chiggers move to constricted areas on the body, such as waistbands and sock tops before feeding. Feeding chiggers inject a salivary fluid that dissolves the host's cells; the liquefied tissue is then ingested by the chigger. Small red welts appear soon after, which itch severely.

3.2.3.7 Bird Excrement and Debris

Accumulation of bird excrement and debris (feathers, nest material, etc.) can pose a biological threat to site workers and visitors. There is a group of pulmonary disease and disorders which result from exposure to infected bird droppings.

3.2.3.8 Hantavirus

Rodents, such as deer mice, can potentially carry Hantavirus. Deer mice usually live at higher elevations, such as mesas, and therefore should not be located at the former Schilling AFB. However, the Center for Disease Control (CDC) believes that other rodents also have the potential to carry the virus, so precautions must be taken when dealing with any species of rodent. It is not easy to distinguish whether a rodent carries the Hantavirus by observation.

Hantavirus can be transferred to humans, primarily from breathing infected rodent excreta particles that have become airborne, or by ingesting excreta particles that have clung to hands or clothing. It can also be contacted from rodent bites or transferred through broken skin.

3.2.4 Plants and Vegetation

Areas in which individuals may work can contain poison oak, poison ivy, poison sumac, thistles, thorned trees (i.e. Hawthorne), or noxious weeds.

The greatest hazard may be from poison oak or poison ivy. Either one may grow as a vine but usually is a shrub. An allergic contact dermatitis can be caused by contact with the plant's oil called urushiol. Urushiol is found in the sap and is colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems, and leaves. After exposure to air, urushiol turns brownish-black. Damaged leaves look like they have spots of black enamel paint making it easier to recognize and identify the plant. Contact with urushiol can occur in three ways:

- Direct contact — touching the sap of the toxic plant.
- Indirect contact — touching something on which urushiol is present. The oil can stick to clothing, shoes, vehicles, tires, tools, or to any objects that have come into contact with it.
- Airborne contact — burning poison plants puts urushiol particles into the air.

Secondary transfer can occur long after primary contact: e.g. a person can come in contact with the sap if leaning against a vehicle that has brushed against the plants or by picking up a tool which has lain on the ground against a bush.

Only one nanogram (billionth of a gram) is needed to cause a rash. Urushiol oil can to stay active on any surface including dead plants for up to five years.

3.3 STANDARD OPERATING PROCEDURES, ENGINEERING CONTROLS AND WORK PRACTICES

Attempts have been made to develop a plan that provides for the maximum health and safety of site personnel, the community, and the environment. However, because of the nature of the work to be performed, potential hazards can be created during the project. These hazards will be eliminated or reduced through the use of engineering controls, administrative controls, and/or use of PPE.

General work practices and procedures that will be followed on this project are identified in the following sections. Additional controls may be identified in the AHAs.

3.3.1 Compressed Gas Cylinder Handling

Damage to compressed gas cylinders can result in the release of toxic substances. Damaged cylinders may also rupture causing rocket-like activity. At a minimum, the following procedures for managing compressed gasses include:

- Cylinders are to be stored only in designated areas and segregated by type of gas. Full cylinders shall be stored separately from empty cylinders. Cylinders shall be stored and utilized in an upright position, and secured to prevent falling.
- Cylinder caps will be in place at all times during storage and transport.
- Cylinders, hoses and valves shall be inspected before to use.
- Cylinders that show any signs of damage, including rust, corrosion, deep dents or unusual sounds, shall not be used.
- Cylinders will be secured to hand trucks or vehicles during transport.

3.3.2 Vehicle Traffic

HSP Policies 13.1 – 13.3 describe procedures for operation of motor vehicles (HGL, 2006). Operations within the former Schilling AFB will be affected by maintenance and personal motor vehicle traffic. Working in such areas presents a risk of being struck by a vehicle. Collisions between vehicles are also possible.

Unless otherwise marked, speeds should be held to 15 miles per hour (mph) or less. Care should be taken to ensure that vehicles, equipment and materials are placed in a manner that keeps obstruction of traffic to a minimum. Workers on foot should not walk on active roadways. If work in active traffic areas is required, workers will wear bright green safety vests, and the work

zone will be marked with barricades, cones or tape to warn traffic. In the event a vehicular accident occurs, a Vehicle Accident Report will be computed by the SS (Exhibit 3).

3.3.3 Drilling Hazards

The drilling subcontractor has been attained for their expertise in such drilling projects. HGL staff will serve as oversight of their activities and will not perform drilling activities themselves. HGL guidelines, policies and AHA's associated with drilling rig operations are in addition to the subcontractors own guidelines and SOP's or whichever is more stringent.

Prior to the start of work, the drilling subcontractor will inspect all drilling equipment in the presence of the PM or SSHO. In addition to verifying that all drilling equipment is in good condition, the lead driller shall demonstrate that all safety interlock switches on the drilling equipment operate correctly. Drilling equipment inspections must be conducted at least weekly and documented. The drilling subcontractor shall provide documentation of rig operators training prior to drilling activities. Drilling equipment inspections will be conducted at least weekly.

All persons involved in drilling activities will be fully trained in the operation of the particular drilling rig being used. HGL's Activity Hazard Analysis for Drilling, included in Exhibit 1, will be complied with at all times.

Operators must be aware of the potential for contact with overhead power lines. If drilling is required closer than 20 feet to overhead lines, then Table 3.3 and the CIH must be consulted. Additionally, underground utilities may be present. The local utility companies will be contacted either by calling them directly or by calling a one-call service prior to drilling, an Underground/Overhead Utility Checklist Form will be completed by the SS (Exhibit 3). Equipment will be oriented to minimize the potential for contact with all utility lines. Drilling rigs must maintain at least a 20-foot clearance from the overhead lines at all times. Table 3.4 describes the minimum clearance distances to be used from energized overhead electric lines.

Before the start of work, the drilling subcontractor will inspect all drilling equipment in the presence of the SS. In addition to verifying that all drilling equipment is in good condition, the lead driller shall demonstrate that all safety interlock switches on the drilling equipment operate correctly. Drilling equipment inspections will be conducted at least weekly.

General rules associated with drilling rig operations are as follows:

- Drilling personnel shall be aware of the potential for contact with poison oak/ivy as they position rigs, drill through plant roots, and clean and maintain equipment that may have contacted roots, leaves or branches.
- Drilling must cease immediately if combustible gas concentrations exceeding 10 percent of the lower explosive limit (LEL) are detected at the borehole;
- Rigging equipment for material handling will be checked prior to each shift and as often as necessary to ensure it is safe. Defective rigging shall be removed from service immediately;

- The area around the derrick ladder must be kept clear to provide unimpeded access to the ladder;
- The work area around the borehole shall be kept free of obstructions, and free of undue accumulation of oil, water, ice or circulating fluids;
- No drilling will occur during impending electrical storms or tornados, or when rain, ice, or wind conditions create undue potential hazards;
- All well or borehole locations will be inspected by the drill crew to ensure that a stable surface exists;
- The drilling rig will be properly blocked and leveled before raising the mast;
- The drilling rig shall not be driven or moved until after the mast has been lowered;
- The work area shall be demarcated using traffic cones, barricades or the like;
- The leveling jacks shall not be raised until the derrick is lowered; and
- When drilling activities are to be conducted in contaminated soil or associated with contaminated groundwater, monitoring shall be conducted to assess worker exposure as well as effectiveness of control measures..

3.3.4 Excavation Procedures

No excavation activities will occur during the course of this project; therefore, excavation procedures are not address in this SSHP.

3.3.5 Mobile Equipment

Mobile equipment that may be used during the project includes, drill rigs, forklifts, and compactors.

Vehicles will use designated roads as much as possible. All drivers of vehicles and equipment will be aware of the potential to become stuck in the areas where drilling may occur. Four wheel drive vehicles will be used whenever possible and towing straps shall be kept on site.

General safety precautions for operating heavy equipment include:

- Only qualified operators shall operate heavy equipment.
- Before use, all mobile equipment will be inspected. This inspection will be documented.
- Whenever the operator leaves their position, the equipment will be shut off, unless the equipment must be running to perform required maintenance or safety inspections.
- Blades and buckets will be lowered during transport and whenever the operator leaves the machine.
- Mobile equipment will have a backup alarm.
- Personnel will ensure that they have acknowledged visual contact with the operator before moving within the swing radius or path of equipment.
- The rated lifting capacity will be posted on the equipment.
- Equipment will not be used to elevate or transport employees unless specifically designed to do so.

- Employees are never permitted under loads.
- Operators will look in the direction of travel and must not operate until all persons are clear.

Prior to use of heavy equipment, a Safety Inspection Checklist for Heavy Equipment Form will be completed by the SS (Exhibit 3).

3.3.6 Cranes

Use of cranes during this project is not anticipated; therefore, crane operating procedures are not discussed.

3.3.7 Pressure Washing

Pressure washing will likely be used for equipment decontamination activities. Care must be taken because of the significant hazard of cutting and injecting water into the body. The requirements of HSP Policy 6.6 will be observed during pressure washing (HGL, 2006).

Basic safety requirements include:

- Use of proper PPE is mandatory. At a minimum, safety glasses, a face shield, and leg/metatarsal guards will be worn.
- Proper pressure will be verified before use of any washer.
- All connections and fittings will be inspected prior to use.
- No part of an individual's body will be subjected to pressure washing.

3.3.8 Lockout/Tagout/Tryout

Whenever employees or subcontractors are working on equipment or in areas where the activation of the equipment might endanger the worker's safety, lockout and tagout procedures in accordance with HSP Policy 6.3 are required (HGL, 2006). Subcontractors shall follow their own lockout/tagout procedures in addition to the HGL policies, or whichever is more stringent. General Lockout/Tagout/Tryout Requirements include:

- Locks and tags are to be used when a machine, equipment or piping system is capable of being locked out.
- Authorized padlocks will be assigned to each Authorized Employee by the PM. Each lock will be individually keyed and the SS shall maintain the master keys.
- Where multiple items must be locked out, a group lock box will be used.
- Where multiple locks must be placed on an item, a multiple lock hasp will be used.
- The SS is responsible for informing and coordinating the lockout/tagout procedure with all individuals and organizations that could be affected by the lockout. This will be documented on the Daily Logs (included in Exhibit 3).
- Subcontractors shall use HGL lockout/tagout procedure. Their own procedure may be used only after it has been reviewed and approved by the CIH.

3.3.9 Hand Tools

Use of hand tools may expose workers to cuts, lacerations or puncture wounds if adequate hand protection is not worn or tools are improperly used or stored. Damaged hand tools may also expose employees to injuries from shattered tools and flying debris.

The following safe work practices apply to the use of hand tools:

- Only use a tool for its designed use.
- Do not use damaged tools.
- Inspect tools to eliminate defective ones.
- Do not carry sharp tools in pockets.
- Wood handles must be sound and securely wedged or fastened to the tool.
- Safety glasses must always be worn during use of hand tools.

3.3.10 Power Tools

The power tools that may be present on site present many potential hazards, including shock and electrocution, injuries from accidental activation and injuries from using damaged or malfunctioning equipment.

When using power tools, the following precautions will be followed:

- Power tools will be inspected and their operation tested before being placed in service.
- Eye protection (safety glasses or goggles) will be worn whenever operating power tools. Hearing protection must be worn if the sound level produced is greater than 85 Decibels on an A-weighted scale (dBA).
- Power tools will be grounded or of the double-insulated type.
- Power tools will not be used in wet locations unless designed for such use.
- All power tools will be protected by a Ground Fault Circuit Interrupter.
- Extension cords will be visually inspected each time they are used. Cords exhibiting damage or excessive wear will not be used. Cords will be disconnected from the power source before coiling for storage.
- Extension cords used with portable electric tools shall be of three-wire type and rated for heavy duty or extra-heavy duty use. The gauge will be sufficient for the current ("amperage") drawn by the power tool and for the length of the extension cord.
- The shortest possible extension cords will be used to perform the job. Combinations of extension cords exceeding 150 feet in total length are prohibited.

3.3.11 Hot Work

"Hot work" means any activity that involves open flame or has the potential to generate sparks or embers. Such activities include use of cutting torches, metal cutting saws, abrasive grinding of metals, welding, brazing and soldering. None of these activities are expected during this project.

3.3.12 Noise

Equipment used on the project may generate loud noise. Exposures to sound levels above 85 decibels on an A-weighted scale (dBA) can impair hearing. In addition to damaging hearing, noise can hinder voice communication and increase the potential for fatigue, thereby increasing the risk of accidents.

All on-site HGL and subcontractor personnel shall wear hearing protection, with a Noise Reduction Rating of at least 25, when noise levels exceed 85 dBA (or wherever voices must be raised in order to be understood at arms length). The SS will perform sound level monitoring or noise dosimetry on operations that require hearing protection.

Whenever possible, equipment that does not generate excessive noise levels will be selected for this project. If the use of noisy equipment is unavoidable, wherever possible, barriers or increased distance will be used to minimize worker exposure to noise.

Based on previous noise dosimetry and sound level monitoring by the HGL CIH, hearing protection shall be required within 20 feet of drilling operations. HGL HSP Policy 10.1: Hearing Conservation Program shall be followed.

3.3.13 Heat Related Illness and Injury

The area's climate is characterized by warm, wet summers and cold, dry winters. Average daily ambient air temperatures typically range from 39 to 93 degrees Fahrenheit (° F), but temperatures in the minus 10s and low 110s have occurred (The Weather Channel, 2006).

Heat related illnesses range from transient heat fatigue to heat stroke and death. Heat related concerns are caused by a number of interacting factors that include environmental conditions, clothing, work load, and tolerance of the individual worker. Factors that influence an individual's tolerance for heat include physical fitness, diet, and alcohol/caffeine/drug use, sleeping habits, acclimation, genetics, medical condition, age and weight.

Heat related illness and injury may occur at any temperature, not just at elevated temperatures. Be aware of the following situations:

- In cold conditions which warrant the use of heavy PPE or winter clothing, heat related illness and injury may occur during heavy exertion (i.e., shoveling, digging, moving heavy items, and other manual labor).
- Working in highly humid conditions while ambient temperatures are lower than one would expect to be of concern (e.g., 80ºF, 90% humidity).
- Use of multiple levels of PPE (e.g., Tyvek layer below Saranex layer) can greatly increase the potential for heat related illness.
- Confined spaces where airflow is little and temperatures and humidity levels are elevated.

The following measures will be taken in preventing heat stress:

- Employees shall be acclimated to their working conditions over a 5-day period as needed or required by the CIH. The CIH shall help implement an acclimatization schedule.
- Site workers will be encouraged to drink plenty of water throughout the day - at least 16 ounces of water before going on-site regardless if they are thirsty or not.
- On-site drinking water will be kept cool to encourage personnel to drink frequently.
- Where practical, shade shall be provided in the work area.
- Workers will be instructed to limit their intake of alcohol (at least 24 hours before shift; no alcohol within 12 hours of shift) and caffeine during hot weather, as both inhibit the body's ability to handle heat by causing dehydration.
- Following HGL HSP Policy 3.7: Working in Hot Environments (HGL, 2006).

3.3.14 Sunburn

Operations will require HGL and subcontractor employees to work outside during daylight hours, typically seven to nine hours per day. Under these conditions, workers are at risk for developing sunburn on unprotected skin.

Sunscreen products with sun protection factor (SPF) ratings of 15 or higher will be available to project personnel. Fair-skinned persons may require SPF ratings of 30 or more for adequate protection. Areas or primary concern include; nose, cheeks, ears and the back of the neck. Sunscreen will be applied as necessary and reapplied after each break.

3.3.15 Cold Stress

While cold stress is unlikely to be encountered at this site, the cold stress section will be included because temperatures on occasion have dropped near or below 32 °F during the fall, winter and early spring.

In the event that the weather becomes unusually cold (temperatures below 40 °F), especially under windy, rainy or freezing precipitation conditions, the following measures must be implemented:

- Work/rest schedules will be adjusted by the PM/SSHO to account for the acclimatization of workers upon first encountering cold stress conditions. The CIH will review such schedules prior to implementation.
- Be aware of heavy exertion and manual labor while wearing winter clothing or heavy PPE during cold conditions. This combination may lead to heat related illness and injury despite the ambient temperatures.
- Workers must be provided with warm clothing, such as mittens, heavy socks, etc., as requested. Protective clothing, such as Tyvek or other disposable coveralls, may be used to shield employees from the wind.
- Additionally, the following shall be issued as requested:
  - Insulated suits, such as whole body thermal underwear
  - Wool socks or polypropylene socks to keep moisture off the feet
  - Insulated gloves
  - Insulated boots

  - Insulated head cover such as hard hat, winter liner, or knit cap
  - Insulated jacket, with wind and water resistant outer layer.
- At air temperatures below 40 °F, the following work practices will be implemented:
  - If the clothing of a site worker might become wet on the job site, the outer layer of clothing must be water impermeable.
  - If a worker's clothing becomes wet in any way, the worker must change into dry clothing immediately.
  - Workers may be provided with a warm (65 °F or above) break area.
  - Hot liquids such as soups or warm, sweet drinks should be consumed.
  - Workers should dress in layers, with thinner, lighter clothing worn next to the body.

3.3.16 Fire

During dry weather, the potential for fire exists in any unpaved grassy perimeter regions of the site. Sparks from operating equipment, or even contact with hot catalytic converters can cause ignition.

Smoking or open flames are prohibited except in designated smoking areas. Vehicles and equipment will not be left idling or parked in or around areas where catalytic converters may cause a fire. Equipment and vehicles should stay on the paved areas.

Small quantities of flammable liquids may be stored in work areas, or carried in vehicles, providing those materials will be used that day and will be contained in a safety can or other approved container. Any flammable wastes will be stored or disposed of in metal containers, clearly marked as containing flammable materials. Storage of combustible materials, in work areas, will be kept to a minimum.

In order to provide fire protection, HGL will provide and maintain portable fire extinguishers as listed in Table 3.5.

3.3.17 Unexploded Ordnance

Unexploded ordnance is not expected at this site. However, because it is a former Department of Defense facility there is a potential for it to be present at the site – particularly when excavating or drilling. Therefore, the utmost care will be taken when performing these activities.

If unexploded ordinance is suspected, all activities will cease immediately, the area cleared, and the USACE Project Manager contacted (see Emergency Contacts).

3.3.18 Electrical Power

Electric power used during this project must include proper grounding and shall be protected by a ground fault circuit interrupter. All power circuits (except portable generators supplying multi-conductor cord of appropriate size and type) shall be installed by a qualified electrician.

Applicable OSHA standards for electrical power, 29 CFR 1926 Subpart K, will apply (OSHA, 2004).

3.3.19 Portable Electric Equipment

Various types of portable electric equipment (including portable generators, ground fault circuit interrupters and flexible cords) may be used during the course of the project. To minimize electric shock hazards, the following rules apply to these pieces of equipment.

- All portable and vehicle-mounted generators will be grounded, except under the following conditions: The non-current-carrying metal parts of equipment located on the vehicle and the equipment grounding conductor terminals of the receptacles are bonded to the generator or vehicle frame, and the generator supplies only equipment located on the vehicle or the generator and/or cord - and plug - connected equipment through receptacles mounted on the vehicle or on the generator, and the frame of a vehicle-mounted generator is bonded to the vehicle frame, or the generator is single-phase, portable or vehicle-mounted, rated not more than five kilowatts (kW), and the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces.
- Ground fault circuit interrupters will be used on all flexible cords or extension cords used at the project site. In each case, the ground fault interrupter will be placed as close to the power source as feasible.
- Flexible cords and cables will be protected from accidental damage. Sharp corners and projections will be avoided. When passing through doorways or other pinch points, protection will be provided to avoid damage. Flexible cords used will be of three-wire type and rated for hard or extra-hard use.

3.3.20 Dust

Drilling activities can create airborne dust. Excessive dust can limit visibility, cause irritation to workers and create airborne chemical contamination. Airborne chemical contamination can spread the overall extent of contamination and put nearby unprotected personnel at risk of exposure.

Project personnel will take all reasonable precautions to minimize the generation of dust at the worksite. Where dust generation is significant, the CIH will be contacted to establish an air monitoring program and dust reduction measures shall be implemented.

General approaches to minimize dust include:

- Using water or manufactured dust suppressants that are environmentally acceptable.
- Use of wet methods for equipment decontamination purposes.
- Compressed air, heavy brushing and brooms will not be used for decontamination purposes.

3.3.21 Slip, Trip and Fall Hazards

Poor housekeeping may result in slip, trip and fall hazards. Some activities involve working on wet polyethylene sheeting. This can increase the chances of slip, trip, and fall injuries.

To minimize hazards, the following measures will be taken:

- Work areas will be inspected daily for adequate housekeeping.
- All stairways, passageways, gangways, and access ways will be kept free of materials, supplies, and obstructions at all times.
  - Tools, materials, and equipment subject to displacement or falling will be secured.
  - Personnel will avoid walking on polyethylene sheeting whenever possible.

3.3.22 Potable Water

The following rules apply for all field operations:

- An adequate supply of potable water shall be provided;
- Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap;
- Portable containers used to dispense drinking water will not be taken in the EZ. Employees will exit the EZ and undergo decontamination before drinking;
- All containers used for drinking water shall be clearly marked and not used for any other purpose;
- Disposable cups or personal, marked, insulated drink containers will be supplied. If disposable cups are used, both a sanitary container for unused cups and a receptacle for disposing of used cups shall be provided; and
- Non-potable water vessels and outlets shall be identified to clearly indicate that the water is unsafe and is not to be used for drinking or washing.

3.3.23 Chemical Injection Hazards

There are several general hazards that employees on site should be aware of as well as chemical hazards associated with the materials being used for the injection. There is the potential for electrical shock, cross-contamination and contact with potentially contaminated materials, chemical exposure to injection materials, and excessive heat produced by the mixing of injection materials. Several steps can be taken to ensure that these things do not occur. Proper protective clothing and equipment will be worn by employees in the injection area and all will follow proper decontamination procedures. Prior to handling any of the chemicals involved in the process, all employees will review the MSDS' for potential hazards. All containers will be labeled and only essential personnel with be allowed in the work area. A complete listing of the hazards can be found in Exhibit 1: Oversight of Groundwater Injection Systems AHA.

The chemicals used in the injection have some specific hazards that will be listed here. For further information, refer to Exhibit 2 for the individual MSDS. Klozur is a trademark mixture that is

also known as sodium persulfate. As an airborne dust it may be irritating to the eyes, nose, lungs, throat and skin. High levels of persulfate dust may cause difficulty breathing in sensitive populations. Potassium permanganate is damaging to eye tissue on contact. At room temperature it may be irritating to the skin and will leave brown stains. Airborne concentrations may cause damage to the respiratory tract and ingestion may cause severe burns to the mucous membranes of the mouth, throat, esophagus and stomach. RTB-1 does not have specific health hazard data since it has not been determined. Based on information from similar materials, ingestion may result in abdominal discomfort including nausea, vomiting, cramps, diarrhea and fever. Inhalation may cause breathing difficulties in sensitive populations. ABC may cause irritated skin and if inhaled lightheadness.

Table 3.1
Physical and Chemical Properties and Potential Health Hazards of Hazardous Materials

Contaminant (Synonym)	Physical Description	Chemical & Physical Properties	Incompatibilities	Target Organs	Symptoms of Exposure
ABC (Anaerobic Biochem)	Light yellow to colorless liquid, slight to mild characteristic odor	BP: > 100 °C VP: 2.7 mbar Sol: Soluble FP: 61 °C LEL: 1.5% UEL: 11.4% IP: NA	Above 61 °C will hydrolyze in presence of water, acids and bases	Eyes, skin	Red irritated skin, irritated respiratory system, may degrease skin
Benzene	Colorless to light-yellow liquid with an aromatic odor.	BP: 176°F VP: 75 mmHg Sol: 0.07% FP: 12% LEL: 1.2% UEL: 7.8% IP: 9.24 eV	Strong oxidizers, many fluorides & perchlorates, nitric acid	Eyes, skin, respiratory system, blood, central nervous system, bone marrow	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; potential occupational carcinogen.
1,1-Dichloroethene (1,1-DCE)	Colorless liquid or gas (above 89º)with a mild, sweet chloroform-like odor.	BP: 89ºF VP: 1 mmHg Sol: 0.009% FP: 127 ºF LEL: 0.8% UEL: 11.0% IP: 8.20eV	Aluminum, sunlight, air, copper, heat	Eyes, skin, respiratory system, CNS, liver, kidneys	Irritated eyes, skin, throat, nausea, dizziness, headache, liver and kidney dysfunction
cis-1,2 Dichloroethene (*cis*-1,2-DCE) (properties are for 1,2-dichloroethene since the properties are not listed for the isomers)	Colorless liquid (usually a mixture of the *cis* and *trans* isomers) with a slightly acrid, chloroform-like odor.	BP: 118-140 °F VP: 182 mmHg Sol: 0.4% FP: 36-39°F LEL: 5.6% UEL: 12.8% IP: 9.65 eV	Strong oxidizers, strong alkalis, potassium hydroxide, copper.	Eyes, respiratory system, central nervous system.	Irritation to eyes, respiratory system; central nervous system depressant.
1,2-Dichloropropane	Colorless liquid with a chloroform-like odor	BP: 206 °F VP: 40 mmHg Sol: 0.3% FP: 60 °F LEL: 3.4% UEL: 14.5% IP: 10.87 eV	Strong oxidizers, strong acids, active metals	Eyes, skin, respiratory system, liver, kidneys, CNS	Irritated eyes, skin, respiratory system; drowsiness, light-headed, liver and kidney damage.

Table 3.1 (continued)
Physical and Chemical Properties and Potential Health Hazards of Hazardous Materials

Contaminant (Synonym)	Physical Description	Chemical & Physical Properties	Incompatibilities	Target Organs	Symptoms of Exposure
Ethyl Benzene	Colorless liquid with an aromatic odor.	BP: 277°F VP: 7 mmHg Sol: 0.01% FP: 55°F LEL: 0.8% UEL: 6.7% IP: 8.76eV	Strong oxidizers.	Eyes, skin, respiratory system, central nervous system.	Irritation of eyes, skin, mucous membrane; head; dermatitis; narcosis, coma.
Hydrochloric Acid (Sample Preservative)	Colorless to slightly yellow gas with a pungent, irritating odor. [Note: Shipped as a liquefied compressed gas.]	BP: -121°F VP: 40.5 atm Sol: 67% FP: NA LEL: NA UEL: NA IP: 12.74 eV	Hydroxides, amines, alkalis, copper, brass, zinc [Note: Hydrochloric acid is highly corrosive to most metals.]	Eyes, skin, respiratory system	Irritation nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema
Klozur™ (Sodium Persulfate)	White odorless crystals	BP: NA VP: NA Sol: 73% at 25 °C FP: NA LEL: NA UEL: NA IP: NA	Acids, alkalis, halides, combustible materials, most metals, oxidizable materials, oxidizers, reducing agents, cleaners, organic or carbon containing compounds	Eyes, respiratory system	Irritated eyes, nose, lungs, throat and skin, difficulty breathing
Nitric Acid (Sample Preservative)	Colorless to yellowish liquid with a suffocating, acrid odor	BP: 252 °F VP: 48mmHg Sol: Infinitely FP: NA LEL: NA UEL: NA IP: 14.5 eV	Strong bases; metallic powders; carbides; hydrogen sulfide; turpentine; combustible organics	Eyes, skin, respiratory system, lungs, teeth, gastrointestinal tract	Breathing difficulties, coughing, choking, irritation of the nose and throat; skin erythema (skin redness); lung damage
bis-(2-ethylhexyl) Phthalate	Colorless, oily liquid with a slight odor	BP: 727 °F VP: <0.01 mmHg Sol: 0.00003% FP: 420°F LEL: 0.3% at 474°F UEL: ? IP: ?	Nitrates, strong oxidizers, acids and alkalis	Eyes, respiratory system, CNS, liver, reproductive system, GI tract	Irritated eyes and mucus membranes

Table 3.1 (continued)
Physical and Chemical Properties and Potential Health Hazards of Hazardous Materials

Contaminant (Synonym)	Physical Description	Chemical & Physical Properties	Incompatibilities	Target Organs	Symptoms of Exposure
RTB-1	Murky yellow water with a musty odor	BP: 100 °C VP: 24 mmHg Sol: Soluble FP: NA LEL: NA UEL: NA IP: NA	Water-reactive materials	Stomach, respiratory system	Abdominal discomfort including nausea, vomiting, cramps, diarrhea and fever
Potassium Permanganate	Dark purple solid with a metallic luster, odorless	BP: NA VP: NA Sol: 6% FP: Decomposes LEL: NA UEL: NA IP: NA	Peroxides, formaldehyde, anti-freeze, hydraulic fluids and all combustible organic or readily oxidizable inorganic materials including metal powders with hydrochloric acid, toxic chlorine gas is release	Eyes, skin, respiratory system	Severe burns to the eyes, skin irritation, damage to the respiratory tract, sever burns to the mucous membranes of the mouth, throat, esophagus and stomach
Sulfuric Acid	Colorless to dark-brown, oily odorless liquid	BP: 554 °F VP: 0.001 mmHg Sol: Miscible FP: NA LEL: NA UEL: NA IP: ?	Organic materials, chlorates, carbides, fulminates, water, powdered metals	Eyes, skin, respiratory system, teeth	Irritated eyes, skin, nose, throat; pulmonary edema, bronchitis, dental erosion
Trichloroethene (TCE)	Colorless liquid (unless dyed blue) with a chloroform-like odor.	BP: 189 °F VP: 58 mmHg Sol: 0.1% FP: Unknown LEL: (77°F): 8% UEL: (77°F): 10.5% IP: 9.45 eV	Strong caustics & alkalis; chemically-active metals (such as barium, lithium, sodium, magnesium, titanium & beryllium)	Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system	Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; potential occupational carcinogen.
Toluene	Colorless liquid with a sweet pungent benzene-like odor	BP: 232 °F VP: 21 mmHg Sol: 0.07% FP: 40 °F LEL: 1.1% UEL: 7.1% IP 8.82 eV	Strong oxidizers	Eyes, skin, respiratory system, CNS, liver, kidneys	Irritated eyes, nose; fatigue, weakness, confusion, dizziness, headache

Table 3.1 (continued)
Physical and Chemical Properties and Potential Health Hazards of Hazardous Materials

Contaminant (Synonym)	Physical Description	Chemical & Physical Properties	Incompatibilities	Target Organs	Symptoms of Exposure
Vinyl Chloride	Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations.	BP: 7°F VP: 3.3 atmospheres Sol: At 77°F: 0/1% FP: NA LEL: 3.6% UEL: 33.0% IP: 9.99eV	Copper, oxidizers, aluminum, peroxides, iron, steel (Polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol. Attacks iron and steel in presence of moisture).	Liver, central nervous system, blood, repertory system, lymphatic system (liver cancer).	Weak; abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; it is a carcinogen.
m-Xylene	Colorless liquid with an aromatic odor	BP: 282 °F VP: 9 mmHg Sol: Slight FP: 82 °F LEL: 1.1% UEL: 7.0% IP 8.56	Strong oxidizers and acids	Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys	Irritated eyes, skin, nose, throat; dizziness, drowsiness, staggering gait, nausea, vomiting
o-Xylene	Colorless liquid with an aromatic odor	BP: 292 °F VP: 7 mmHg Sol: 0.02% FP: 90°F LEL: 0.9% UEL: 6.7% IP 8.56	Strong oxidizers and acids	Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys	Irritated eyes, skin, nose, throat; dizziness, drowsiness, staggering gait, nausea, vomiting
p-Xylene	Colorless liquid with an aromatic odor	BP: 281 °F VP: 9 mmHg Sol: 0.02% FP: 81 °F LEL: 1.1% UEL: 7.0% IP 8.44	Strong oxidizers and acids	Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys	Irritated eyes, skin, nose, throat; dizziness, drowsiness, staggering gait, nausea, vomiting

BP	=	Boiling Point	mmHg	=	millimeters of mercury	%	=	Percent
VP	=	Vapor Pressure	IP	=	Ionization Potential	FP	=	Flash Point
Sol	=	Solubility	NA	=	Not Applicable	eV	=	Electrovolt
LEL	=	Lower Explosive Limit	°F	=	Degrees Fahrenheit	UEL	=	Upper Explosive Limit

Compressed welding gases, compressed gases for instrument calibration, small amounts of gasoline or diesel, sample containers with hydrochloric acid, bentonite, neat cement, and regular concrete.

Reference: NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1997.

Table 3.2
Exposure Guidelines For Significant
Site Hazardous Materials

CONTAMINANT	ACGIH LIMITS		IDLH
	8-HR TWA	15-MIN STEL/CEILING	
ABC	None	None	None
Benzene	0.5 ppm	2.5 ppm	Ca (500 ppm)
1,1-Dichloroethene	5 ppm	None	Ca (ND)
cis-1,2 Dichloroethene*	200 ppm	None	1000 ppm
1,2-Dichloropropane	75 ppm	110 ppm	Ca (400 ppm)
Ethylbenzene	100 ppm	125 ppm	800 ppm (10% LEL)
Hydrochloric Acid	None	C 2 ppm	50 ppm
Klozur™	0.1 mg/m^3	None	None
bis-(2-ethylhexyl) Phthalate	5 mg/m^3	None	Ca(5000 mg/m^3)
Potassium Permanganate	0.2 mg/m^3	None	None
RTB-1	None	None	None
Trichloroethene (TCE)	50 ppm	100 ppm	Ca (1000 ppm)
Toluene	50 ppm	None	500 ppm
Vinyl Chloride	1 ppm	None	Ca (ND)
Xylene, m-, o-, p-	100 ppm	150 ppm	900 ppm

Notes:

ACGIH	American Conference of Governmental Industrial Hygienists
C	Ceiling concentration which is not to be exceeded at any point in the work shift
Ca	carcinogen
HR	Hour
IDLH	Immediately Dangerous to Life and Health
LEL	Lower Explosive Limit
MIN	Minute
mg/m^3	milligrams per cubic meter
ND	not determined
ppm	parts per million
STEL	Short-term exposure limit
TLV	Threshold limit value
TWA	Time-weighted average
*	Properties are for 1,2-dichloroethene since the properties are not listed for the isomers

Table 3.3
Flying Insects

Organism	Description	Habitat	Problem	Severity	Protection
Hornet	One inch long with some body hair. Abdomen is mostly black.	Round, paper-like nest hanging from trees, shrubs, or under eaves of buildings.	One nest may contain up to 100,000 hornets which will attack in force at the slightest provocation.	Severe pain, allergic reactions similar to bees.	Do not come near or disturb nest. If a hornet investigates you, do not move.
Mosquito	Small, dark, fragile body with transparent wings. From 1/8 to 1/4 inch long.	Where water is available for breeding.	Bites and sucks blood. Itching and swelling result.	Can transmit encephalitis and other diseases. Scratching causes secondary infections.	Use plenty of insect repellant and wear gloves.
Wasp	Very thin waist. Color can be black, yellow or orange with stripes.	Underground nest. Paper-like honeycomb nest in abandoned buildings hollow trees, etc.	Stings. Some species will attack if you get too close to the nest.	Severe pain, allergic reactions similar to bees. Can be fatal.	Avoid Nest. Do not swat at them.
Bee	Generally has yellow and black stripes and two pair of wings.	Hollow logs, underground nests, old buildings,	Stings when annoyed. Leaves venom sac in victim.	If person is allergic, nausea, shock, constriction of the airway can result. Death may result.	Be careful and watch where you walk. Cover exposed skin. Avoid areas where bees are swarming. Avoid wearing sweet fragrances and bright clothing. Move slowly or stand still when bees are swarming about you.

Table 3.4
Minimum Clearance from Energized Overhead Electric Lines

Nominal System Voltage	Minimum Required Clearance
0 - 50 kV	10 feet
51 - 100 kV	12 feet
101 - 200 kV	15 feet
201 - 300 kV	20 feet
301 – 500 kV	25 feet Consult CIH
>501 kV	Consult CIH

kV = kilovolts

NOTE: Whenever equipment operations must be performed closer than 20 feet from overhead power lines, the CIH must be notified. When clearance to proceed is received from the CIH, the electric utility company must be contacted to turn the power off or physically insulate (protect) the lines if the operation must be performed closer to the power line than is allowed by the setbacks presented in this table.

Table 3.5
Fire Extinguisher Requirements

AREA	RATING	LOCATION
Flammable liquids 5 gal or more used on worksite (not integral fuel tanks of motor vehicles)	2A: 20B: C	Within 50 feet
Flammable liquids stored outside	2A: 20B: C	At least 25 feet but not more than 50 feet from storage area
Other storage areas	2A: 20B: C	Near exit no more than 50 feet unobstructed travel to extinguisher from anywhere in storage area
Vehicle and heavy equipment	2A: 20B: C	Mounted in or on vehicle/equipment
Trailers/offices	2A: 20B: C	Mounted near exit not more than 50 feet of unobstructed travel from anywhere in trailer/office
Hot work activities, any welding	2A: 20B: C	Within 50 feet

Note: These extinguisher ratings are the minimum acceptable for each listed application. Extinguishers with higher ratings may be substituted. For applications not listed, contact the CIH for guidance.

All extinguishers must be "multipurpose" dry chemical extinguishers. 2A: 20B: C (5 lb.) extinguishers are acceptable for offices, vehicles, and other locations where moderate amounts of flammable materials are present. Extinguishers rated 4A: 60B: C (5 lb.) must be used at locations where greater amounts of flammable materials are present; e.g. fueling areas, storage areas.

4.0 BUDDY SYSTEM

During hazardous waste operations project staffing shall meet the intent of the "buddy system." At least two persons are required to be at the work area when work that might result in worker contamination or injury is conducted in the EZ. When only one person is needed on site, they should call in to the office at predetermined times in order to verify they are well.

The responsibility of the buddy is to:

- Provide assistance if needed
- Maintain line of sight contact or verbal contact with workers in the EZ
- Observe for signs of chemical or physical trauma or heat/cold stress such as:
  - Changes in complexion and skin discoloration
  - Changes in coordination or demeanor
  - Excessive saliva and pupillary response
  - Changes in speech pattern
- Periodically verify the integrity of all protective clothing
- Notify the SS if emergency help is needed.

When work is performed in the EZ by a worker wearing Level D PPE, the SS may act as the buddy of that worker. Work in Level C PPE shall not be performed if there is no qualified employee other than the SS on-site.

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5.0 PERSONAL PROTECTIVE EQUIPMENT

5.1 LEVELS OF PROTECTION

The EPA's terminology for PPE is used on this project (Levels D, C, B, and A). The level of protection for each task has been assigned in accordance with Table 5.1. For this project, Level D and C are anticipated. If PPE is torn, ripped or damaged during work, the employee shall stop work and take action to replace or repair the PPE prior to commencing work activites. If monitoring result indicate the need, an upgrade to Level C will be made.

5.1.1 Modified Level D Protection

Modified Level D PPE at a minimum shall consist of:

- Standard work uniform or coveralls
- Steel-toed high-topped work boots
- Safety glasses
- Hard-hat
- Nitrile gloves
- Hearing protection (if necessary)
- Splash shield (if necessary)
- Leather palm gloves (if necessary)
- Chemical resistant gloves
- High visibility vest when working around vehicle traffic or mobile equipment.

5.1.2 Level C Protection

Level C PPE at a minimum shall consist of:

- Full-face air-purifying respirator (APR), full-face is required if eye irritation is encountered
- Combination filter/cartridge providing protection against organics and particulates:
  - organic vapors
  - particulates
- Steel-toed work boots or steel-toed polyvinyl chloride (PVC) boots (if liquids encountered)
- Tyvek (or equivalent materials) coveralls with hoods and elastic wrists and ankles - if low toxicity, solid contaminants will be encountered
- Chemical resistant coveralls (Saranex) – if moist contaminants or liquids encountered
- Latex or Nitrile gloves (inner) and Nitrile gloves (outer) - if liquids encountered
- Hearing protection (if necessary)
- Hard-hat
- Safety glasses (if needed)

- Splash shield (if necessary).
- PPE for work where contact with poison oak is a potential shall consist of Tyvek coveralls with hoods, elastic wrists, and elastic ankles. Nitrile gloves shall be worn also and all glove/coverall interfaces taped securely.
- Where contact with heavy brush that may puncture or tear the Tyvek, Saranex coveralls shall be worn.
- High visibility vest when working around vehicle traffic or mobile equipment.

5.2 RESPIRATORY PROTECTION

Although it is not anticipated that contaminant concentrations will warrant the use of respirators, respiratory protective equipment shall be National Institute of Occupational Safety and Health (NIOSH) approved and respirator use shall conform to American National Standards Institute (ANSI) Z88.2, OSHA 29 CFR 1926.103, and 29 CFR 1910.134 requirements (OSHA, 2004). Section 9.1 of the HGL HSP further defines the respiratory protection program that details the selection, use, inspection, cleaning, maintenance, storage, and fit testing of respiratory protective equipment. This procedure complies with the requirements contained within 29 CFR 1926.103 and will be maintained in the SS's site office along with the rest of HGL HSP Manual.

- All site personnel will have a separate assigned respirator face piece.
- Only properly cleaned, maintained, NIOSH-approved respirators are to be used on this site.
- Changes to respirator makes, models, filters and cartridges shall be specified by the CIH as needed.
- All site personnel will be clean-shaven in facial areas that touch the sealing surface of the respirator.
- Respirators will be regularly inspected. A positive and negative pressure test will be performed before each use.

All personnel performing on-site activities and using an APR (including visitors) must have successfully passed a respirator fit test in accordance with OSHA 29 CFR 1926.103 within the last 12 months. Documentation of fit testing is the responsibility of each employer.

The level of respiratory protection selected will be based upon real-time air monitoring of the work environment and an assessment by the CIH or SS of the potential for skin contact with contaminated materials. The PPE selection for each activity is presented in Table 5.1.

5.3 PERSONAL PROTECTIVE EQUIPMENT FOR VISITORS

An adequate supply of hard hats, safety glasses and other basic PPE shall be maintained on-site for use by government personnel and other visitors, except other government contractors who must supply all of their own PPE. Visitors are not to be supplied with chemical protective clothing without prior approval by the CIH and documentation of proper training. Respirators will not be issued to non-HGL personnel.

Table 5.1
Activity/Level of Protection

Task	Activity	Initial Levels of PPE
1	Mobilization	D
2	Drilling/Direct-push Technology	D-C
3	Well Installation	D-C
4	Groundwater Sampling	D
5	Soil Sampling	D-C
6	Oversight of Groundwater Injection System	D
7	Decontamination of Equipment	D
8	Disposal of Investigation Derived Waste	D
9	Demobilization	D

Note:
As site activities progress, levels of PPE are subject to change or to modification. Upgrading of PPE can occur when action levels are exceeded or whenever the need arises to protect the safety and health of site personnel. Levels of PPE will not be downgraded without prior approval from the CIH.

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6.0 SITE CONTROL

The project area will be divided into three work zones: EZ, CRZ, and a support zone. The SS and CIH shall together be responsible for designation of the work zones based upon the exposure to contaminated materials or anticipated hazards associated with the work.

The EZ will include any area where chemical contamination may be encountered and will be marked with barrier tape or other means to warn personnel of the hazards. The EZ will be large enough to prevent contamination from leaving the marked area.

Immediately adjacent to the EZ, a CRZ with a decontamination area for equipment and personnel will be established. This area will also be delineated with traffic cones and/or barrier tape. The CRZ will be large enough to provide a safety zone to prevent the movement of contaminants from the EZ into the support zone.

The remainder of the HGL project area will be designated as the support zone. No special markings or warning labels are required for this area.

Only personnel who have completed the appropriate training, have a current medical clearance for hazardous waste operations, and are wearing the proper PPE shall be allowed within the EZ or CRZ.

6.1 HAZARD BRIEFING

No person will be allowed on the site during site operations without first being given a site hazard briefing. In general, the briefing will consist of a review of the TSM Form (Exhibit 3). All persons on the site, including visitors, must sign the Site Safety Briefing Form (Exhibit 3). TSMs shall be held daily, involving all personnel on-site. It is the responsibility of the SSHO to perform the TSM. In the event an employee or visitor enters the site midday, the SSHO will repeat the daily TSM before the employee or visitor is allowed access to the site or begins work.

6.2 DOCUMENTATION OF CERTIFICATION

All HGL employees, subcontractor personnel, and visitors must provide appropriate training and medical documentation to the SS prior to the start of field work. This documentation will be maintained at the project home office at the close of the project.

6.3 EMERGENCY ENTRY AND EXIT

The EZ, CRZ, evacuation routes, and emergency equipment locations will be included on a site map before on-site activities commence. During an emergency, the evacuation routes noted on the site map will be followed. If conditions such as wind direction or physical hazards do not allow access to the designated evacuation routes, personnel will evacuate by the safest route available

and decontaminate to the greatest extent possible. Additional emergency procedures can be found in Section 12.0 of this SSHP.

7.0 DECONTAMINATION

In general, everything that enters an EZ at a site must either be decontaminated or properly discarded upon exit from an EZ. All personnel must enter and exit an EZ through a CRZ. Contaminated equipment will be decontaminated and then inspected by the SS before it is moved from the EZ to the support zone. This inspection will be noted in the daily log.

7.1 PROCEDURES FOR EQUIPMENT DECONTAMINATION

Any item or vehicles taken into an EZ must be assumed to be contaminated and must be carefully inspected and/or decontaminated before leaving that particular EZ. A visual inspection of the frame and tires of all vehicles and equipment leaving an EZ will be completed. In order for a vehicle or equipment to pass inspection, it must be in a broom-clean condition, water washed, and free of loose dirt or sludge material on tailgates, axles, wheels, bucket, etc. Care must be taken when removing dry materials from equipment to prevent potential particulate exposures. Wet methods (i.e., using a hand held spray bottle with water) should be sued while chiseling off dried-on materials. A steam pressure washer will be on site so that any vehicles or equipment can be steam cleaned if the CIH or SS deem necessary. All pressure washing activities will be conducted in accordance with HGL's HSP Policy 6.6 and Section 3.3.7 of this SSHP (HGL, 2006).

The equipment decontamination area will be used to remove soil from all equipment leaving the work area. Decontamination procedures will consist of washing equipment to remove mud and/or dirt. A special "clean area" will be utilized by personnel who must come in contact with equipment during vehicle maintenance and repair. All equipment requiring maintenance or repair will be staged in a CRZ before servicing. All non-disposable sampling equipment, such as split spoons and other drilling equipment will be decontaminated first with an Alconox (or similar solution) then a double water rinse (potable water followed by deionized water). The Alconox solution and water will be disposed of with all other fluid IDW.

7.2 PERSONNEL DECONTAMINATION

Personnel decontamination facilities will be established on site by HGL to ensure that personnel maintain a high degree of personal hygiene and minimize the possibility of exposure to chemical hazards. All personnel exiting the EZ will pass through the decontamination area to remove any contamination. Standard dry decontamination procedures are as follows:

Place all disposable PPE in a garbage bag as removed in the following order:

- Brush off work boots, remove disposable overboots or booties
- Remove gloves
- Remove safety glasses
- Remove Tyvek or cloth coverall, if used
- Remove respirator, if used
- Remove inner gloves.

- Wash hands and face before eating, drinking, or smoking (break/end of shift).

Standard wet decontamination procedures are as follows:

- Step into first washtub and wash boots and outer gloves with soap solution and scrub brush.
- Step into second washtub and rinse boots and outer gloves with clean water and scrub brush.
- Remove outer gloves and dispose in the proper receptacle.
- Remove outer coveralls and dispose in the proper receptacle.
- Remove boots and place in boot rack.
- Remove respirator, place in container to be cleaned.
- Remove inner gloves and dispose in proper receptacle.
- Wash hands and face before eating, drinking, or smoking (break/end of shift).

Personnel are required to wash hands, face, and other exposed skin areas before leaving the CRZ for breaks or lunch. With the exception of work within the support zone, no disposable work clothing, shoes, or boots will be worn or carried out of the CRZ. Boots and respirators will be decontaminated before being taken into the support zone.

When working in areas with the potential for contact with poison oak/ivy, extreme care must be used when removing PPE in order to prevent contact with the outer surfaces of coveralls, gloves, boots, etc.

Personnel who have contacted poison oak/ivy should also wash hands, arms and face in cold water using Technu's Oak & Ivy Cleanser. Technu's Oak & Ivy Cleanser is a soap specially designed to break down the resins that bind poison oak/ivy to the skin. The resins remain active for long periods of time and cannot be removed with normal soap and water after 30 minutes. Since poison oak/ivy is a contact allergen, washing the body and clothes as soon as possible after contact with the plant can prevent skin reaction.

The SS will be responsible for assessing the effectiveness and selection of decontamination procedures (e.g., dry versus wet). Should the SS deem the decontamination procedures herein to be ineffective, the SS shall consult the CIH for guidance.

8.0 SITE MONITORING

This section will be modified to appropriately address all site-specific contaminants and other hazards that can be quantitatively monitored.

8.1 AIR MONITORING

Air monitoring is essential to ensure that all field personnel are adequately protected from airborne contaminants. Whenever work is performed that might generate gases, vapors, dusts, fumes, mists or other airborne hazardous materials, air monitoring will be conducted.

Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs) refer to airborne concentrations of substances that represent conditions that nearly all employees may be repeatedly exposed to 8 hours per day, 5 days per week. It is HGL's policy to use the stricter of these two exposure standards, generally the American Conference of Governmental Industrial Hygienists (ACGIH) TLVs. However, whenever applicable, even stricter guidelines may be utilized. Exposure limits for constituents of concern are provided in Table 3.2.

- A photoionization detector (PID) with a 10.6 eV lamp will be used to measure gases and organic vapors in the work area.
- Combustible gas and oxygen detection instruments will be used in the work area if flammable contaminants are anticipated.
- Colorimetric detector tubes will be used if necessary to detect the presence of vapor contaminants. For this project, TCE will be used as an indicator of the presence of the other contaminants. Specific monitoring for additional vapor contaminants will be at the direction of the SS or CIH.
- A direct reading particulate monitor shall be used when dust generation is possible.
- All air monitoring results will be documented in project logs.
- Monitoring and equipment calibrations will be performed only by HGL employees qualified by education and training to do so.

Air monitoring will be used to determine the effectiveness of engineering controls in keeping the readings below the action levels specified in Table 8.1. It will facilitate proper selection of PPE, and evaluate the need for more aggressive control methods. For this project, due to it being detected in previous surveys in the greatest concentration, TCE will be used as the "marker" chemical in monitoring.

Instruments will be used to determine real-time concentrations. In addition, employees will conduct routine visual monitoring. Monitoring will utilize instruments in the immediate area of activities to provide monitoring data representative of worst-case exposure conditions.

A summary of the air monitoring requirements for each activity is identified in Table 8.2. The air monitoring program may be modified as conditions dictate. For example, during later project phases, the frequency of air monitoring may be reduced, as appropriate, if monitoring data

accumulated during earlier project phases during worst-case conditions indicate no significant air quality problems. Changes in monitoring frequencies will be approved by the CIH.

The CIH will determine the need for and will conduct integrated personal exposure monitoring.

8.1.1 Locations to be Monitored

All personal, integrated air monitoring samples and direct reading instrumentation readings taken for the purpose of determining appropriate Safety and Health precautions shall be collected or taken in the approximate breathing zone of site personnel. Additional sample locations should include those that are worst case: (i.e. likely to contain the highest concentrations), and at the perimeter of the work area – particularly the downwind direction. Locations to be monitored are detailed in Table 8.2.

8.1.2 Frequency

Background concentrations will be identified before startup of any equipment, sampling, trenching, or backfilling. Breathing zone air monitoring must then be conducted periodically throughout the day while work is being performed in the EZ regardless of the level of protection being worn.

Frequency requirements for air monitoring are found in Table 8.2. At a minimum, monitoring every 30 minutes is required during active excavation of contaminated soils, drilling, and trenching. The SS may reduce the frequency of the monitoring only after receiving approval from the CIH. All readings must be documented even if contaminant concentrations are "non-detectable"

8.1.3 Monitoring Equipment Maintenance and Calibration

All air monitoring equipment (e.g., photoionization detectors, colorimetric pumps, etc.) will be maintained in accordance with the specific manufacturer instructions. Calibration will occur before and after each use. Calibration gases used for the PID and combustible gas detector will have properties similar to the contaminants anticipated. The PID will be calibrated with a gas that has an ionization potential similar to the primary contaminant of concern. The combustible gas detector will be calibrated with hexane.

All personal sampling pumps shall be calibrated in accordance with OSHA sampling protocols and NIOSH methods for the analyte of interest.

Calibration will be done in a clean environment similar to the actual work environment in terms of temperature, pressure, humidity, and background noise. Before actual use, each instrument will be allowed sufficient time to warm up and will be zeroed as applicable. All air monitoring equipment calibrations and maintenance activities shall be documented on the HGL Daily Log or equivalent. (Photoionization detector calibration log included in Exhibit 3)

When applicable, only manufacturer-trained and/or authorized personnel will be allowed to perform instrument repairs or preventive maintenance.

8.2 NOISE MONITORING

High noise levels are considered to be those that make normal conversation difficult to understand at arm's length. The SS is to contact the CIH if this situation is routinely present.

8.3 HEAT STRESS

When workers are in modified Level D PPE, heat stress monitoring shall be initiated whenever ambient temperatures on site exceed 85°F. When workers are in Level C or Level D PPE, physiological monitoring will begin at 75°F. These benchmarks are not to preclude heat stress monitoring at lower temperatures if workers exhibit signs of heat stress.

At the discretion of the CIH, additional environmental and/or physiological monitoring will be carried out. Environmental monitoring shall consist of the determination of wet bulb globe temperature (WBGT) at hourly intervals. Physiologic monitoring may consist of pulse rate and/or body temperature determinations. Refer to Section 3.3.13 of this SSHP.

8.4 SAFETY REVIEWS

Job site safety reviews (inspections and audits) shall be conducted by all levels of project management. Specifically the following reviews shall be performed.

- The SS shall inspect the jobsite at least daily. Findings shall be documented on the Daily Safety Observation Log (Exhibit 3) and communicated to the project workers, the PM and CIH.
- The PM shall conduct an on-site safety audit at least annually. Findings shall be documented on Field Safety and Health Audit Checklist (Exhibit B, HSP Policy 1.6) and copied to the SS and the CIH. Whenever possible, the SS or the CIH shall be included in these audits.
- The CIH or designated representative may conduct unannounced job site safety audits at any time. Findings will be documented on Field Safety and Health Audit Checklist and copied to the PM and Corporate Safety and Health Manager.

Table 8.1
Action Levels

When in Level D PPE

Analyte	Action Level[1]	Required Action[2]
Dust	≥ 6 mg/m^3 above background	Upgrade to Level C Initiate dust suppression
Unknown VOCs	> 100 ppm above background	Use detector tubes for Benzene and TCE
	> 125 ppm < 300 ppm	Upgrade to Level C
TCE	> 100 ppm above background in breathing zone	Upgrade to Level C; contact CIH[3]
Benzene	> 2.5 ppm above background in breathing zone	Upgrade to Level C; contact CIH[3]
O_2 (Intrusive work only)	≥ 23.5% or ≤ 20%	Stop work; determine cause[3]; contact CIH[3]
LEL (Intrusive work only)	> 10% of LEL	Stop work; determine cause[3]; contact CIH[3]

When in Level C PPE

Analyte	Action Level[1]	Required Action[2]
Dust	> 6 mg/m^3 above background in the breathing zone	Continue work in Level C; initiate dust suppression[3]
Unknown VOCs	> 100 ppm above background in breathing zone	Use detector tubes for TCE, Benzene
TCE	> 200 ppm above background in breathing zone	Stop work, contact CIH[3]
Benzene	> 5 ppm above background in breathing zone	Stop work, contact CIH[3]
O_2 (Intrusive work only)	≥ 23.5% or ≤ 20%	Stop work; determine cause[3]; contact CIH[3]
LEL (Intrusive work only)	> 10% of LEL	Stop work; determine cause[3]; contact CIH[3]

[1] Five excursions above the action level in any 15 minute period or a sustained reading in excess of the action levels for 5 minutes will trigger a response.
[2] Frequency of air monitoring may be adjusted by the CIH after sufficient characterization of site contaminants has been completed, tasks are modified or site controls have proven effective.
[3] Contact with the CIH must be made before continuance of work. The CIH may then initiate integrated air sampling along with additional engineering controls.

No one is permitted to downgrade levels of PPE without authorization from the CIH.

Table 8.2
Air Monitoring Frequency and Location

Work Activity	Instrument	Frequency	Location
Task 1			
Mobilization		No Monitoring Required	N/A
Task 2			
Drilling/Direct-push Technology	Four Gas Meter PID	Initially, then at least every 30 minutes if: 1. contaminant detected; or 2. moist/discolored/odorous soil present.	Breathing Zone, worst case, perimeter, down wind, bore hole.
Task 3			
Well Installation	Four Gas Meter PID	Initially, then at least every 30 minutes if: 1. contaminant detected; or, 2. moist/discolored/odorous soil present.	Breathing Zone, worst case, perimeter, down wind, bore hole.
Task 4			
Groundwater Sampling	Four Gas Meter PID	Initially, then at each sample location if contaminant detected.	Breathing Zone, worst case, perimeter, down wind.
Task 5			
Soil Sampling	Four Gas Meter PID	Initially, then at each sample location if moist/discolored/odorous soil are present.	Breathing Zone, worst case.
Task 6			
Oversight of Groundwater Well Injection Treatment System	Four Gas Meter PID	Initially, then at each sample location if contaminant detected.	Breathing Zone, worst case, injection point.
Task 7			
Decontamination of Equipment	PID	Initially, then at least every 30 minutes if discolored/odorous residue present.	Breathing Zone, worst case, perimeter, down wind.
Task 8			
Disposal of Investigation Derived Waste	PID	Initially, then at least every 30 minutes if contaminant detected.	Breathing Zone, worst case, perimeter, down wind.
Task 9			
Demobilization		No Monitoring Required	N/A

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9.0 EMPLOYEE TRAINING

9.1 GENERAL

All personnel entering the EZ or CRZ shall have completed the hazardous waste operations-related training, as required by 29 CFR 1910.120/1926.65 (OSHA, 2004). Personnel shall have completed an 8-hour refresher course within the past 12 months if appropriate. The PM, CIH, and the SS must have completed an additional 8 hours of supervisory Safety and Health training.

With the exception of subcontractor personnel and visitors who will be working only in the support zone, subcontractor personnel must meet the above training requirements.

Subcontractors must provide certificates of training for the project file for all employees assigned to the project, if they will be working in either the EZ or CRZ. Training certificates for both subcontractor and HGL personnel shall be maintained on-site.

Before the start of the project, all personnel will participate in an initial TSM. During the initial TSM, the SSHP will be discussed. The SS will ensure that the anticipated site hazards are summarized and explained to all personnel, and that those personnel are aware of the precautions they must take to minimize their exposure to those hazards. TSMs will be held at the start of each work shift. All new employees must attend the meeting and be familiar with this SSHP. If employees or visitors are required to enter the project site, the TSM will be repeated before they are allowed access or to start work.

Attendance records, meeting notes and Site Safety Briefing Forms shall be maintained by the SS with the project file.

9.2 SITE-SPECIFIC AND ACTIVITY SPECIFIC TRAINING

Activity specific training such as Permit-Required Confined Space Entry, Excavation and Trenching Competent Person, Forklift Operation, Lockout/Tagout, etc. shall be completed before performing the task that requires such training.

9.3 FIRST AID AND CARDIOPULMONARY RESUSCITATION

At least two employees current in first aid/cardiopulmonary resuscitation (CPR) certification will be assigned to the project and at least one of these will be on the site whenever operations are ongoing. Personnel trained in first aid shall also be trained in bloodborne pathogens hazards and precautions as described in Section 11.0 of this SSHP. HGL HSP Policy 2.4: First Aid/CPR shall be followed.

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10.0 MEDICAL SURVEILLANCE PROGRAM

HGL enforces a medical surveillance program for all employees that may be exposed to hazardous substances while performing job activities. The medical surveillance program is described by HSP Policy 3.1.

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11.0 BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN

HGL workers may serve as voluntary first aid and CPR care providers. At all times, at least one person on site will be adequately trained in the requirements of the Bloodborne Pathogens Standard as listed in 29 CFR 1910.1030 (OSHA, 2004) and HGL HSP Section 3.7 (HGL, 2006), and in the contents of this plan.

Universal precautions shall be implemented whenever a foreseeable potential for contact with blood or bodily fluids exists.

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12.0 EMERGENCY RESPONSE PLAN AND CONTINGENCY PROCEDURES

Site personnel must be prepared to respond and act quickly in the event of an emergency or accidental contaminant release. Emergency preparedness and response procedures will aid in protecting site workers and the surrounding environment. Preplanning measures to avoid personal injury or exposure will include employee training, fire and explosion prevention and protection, chemical spill and discharge prevention and protection, and safe work practices.

12.1 LIST OF EMERGENCY CONTACTS AND NOTIFICATION

The SS will be notified immediately in the event of an emergency. The SS will immediately evaluate the incident and, if necessary, notify the appropriate emergency support services and the client.

If not previously notified, the PM, client site representative, and designated environmental contact will be advised of the situation. Telephone numbers for emergency contact personnel are listed in Table 12.1. The list will be maintained with current contacts, and telephone numbers will be posted along with other emergency phone numbers at all telephone locations at the site.

The information provided to the notified person should include the nature of the incident and the exact location and suspected contaminants or material involved. Information regarding the incident that should be reported to the emergency operator includes the following:

- Name and telephone number of the individual reporting the incident
- Location and type of incident
- Nature of the incident (fire, explosion, spill, or release) and substances involved
- Number and nature of medical injuries
- Movement or direction of spill/vapor/smoke
- Response actions currently in progress
- Estimate of quantity of any released materials
- Status of incident
- Other pertinent information.

Once the urgency of the emergency incident has been resolved, a complete incident report will be completed by the SS and provided via the PM to the client representative.

12.2 MEDICAL EMERGENCY RESPONSE

Minor injuries will be treated on site by qualified first-aid/CPR providers. Adequate first aid kits are required to be kept in all onsite work related vehicles along with a proper eyewash kit. If additional treatment beyond first aid is required, the injured personnel will be transported to the Salina Regional Health Center that can provide 24-hour emergency medical care.

All employee injuries must be promptly reported to the SS who is to contact the PM. See Section 12.1 of this SSHP for details.

Transportation routes and maps will be posted in the project office and in each site vehicle prior to the initiation of on-site activities. See Figure 12.1 for a Hospital Route Map.

12.3 FIRE CONTROL

All onsite work related vehicles are required to be equipped with a 2A: 20B: C rated multipurpose dry chemical extinguisher. In addition, the following measures will be implemented during site field activities to minimize the risk of fire and/or explosion:

- Smoking is permitted on site only in the designated smoking area.
- Flammable liquids will be stored only in approved containers.
- Work areas will be cleared of excess vegetation and obstructions whenever practical.
- Vehicles with catalytic converters shall not be parked atop vegetation.
- All oxidizers will be stored away from incompatible materials based on the MSDS and the manufactures instructions.
- If oxidizers should ignite, extinguish with water. Do not use carbon dioxide or other gas filled fire extinguishers. See MSDS and manufacturers instructions.

Any location specific guidelines established by the Salina Fire Department will be strictly enforced. Any fire, no matter how small, must be reported to the Salina Fire Department.

12.4 SPILLS OR LEAKS

HGL will maintain the following equipment and materials on site for use during spill response activities:

- Absorbent pads
- Granular absorbent material (noncombustible)
- Polyethylene sheeting
- 55-gallon drums
- Shovels and assorted hand tools.
- Spills or leaks of oxidizers will be cleaned up immediately and disposed of according to MSDS and manufactures instructions

If a hazardous waste spill or material release to the air, soil, or water at the site is observed, HGL will immediately notify the client site representative and the Salina Fire Department. An assessment will be made of the magnitude and potential impact of the release.

If it is safe to do so, site personnel will attempt to locate the source of the release, prevent further release, and contain the spilled and/or affected materials.

12.5 SAFETY SIGNALS

While working on-site, the following hand signals will be used for communication when necessary.

Hand Signal	Meaning
Arms crossed overhead	Shut-off equipment
Both hands around waist	Leave area immediately
Wave hands over head	Need assistance
Thumbs up	Okay, I am all right, I understand
Thumbs down	No, negative

Vehicle or portable air horns will be used for alarm signals as follows:

- One long blast: Emergency evacuation of the site

12.6 SITE EVACUATION PROCEDURES

The authority to order personnel to evacuate the area rests with the SS. In the event that site evacuation is required, a continuous, uninterrupted air horn will be sounded for approximately ten seconds. Air horns will be located in the work area or a vehicle horn will be used. Radio communication, if appropriate, will also be used to keep continuous communication between the site and the main office.

Personnel working in the EZ or CRZ will immediately make their way to the assembly point for a head count. Depending on the severity of the event and allowable time, personnel exiting the EZ and CRZ may be instructed to forgo or modify decontamination procedures.

Personnel in the support zone will immediately report to the assembly point for a head count and further instructions. The SS will remain in contact to ensure that evacuation procedures are properly executed. If the assembly point is accessible, personnel will evacuate to an upwind location and conduct a head count. The assembly point and any alternate assembly points will be identified each day during the TSM.

Situations requiring evacuation may include unusually severe weather conditions, fires, or significant chemical spills or releases. In the event of project evacuation, the client site representative, the Salina Fire Department, and the Salina Police Department will be notified immediately. A site emergency map that delineates evacuation routes, emergency air horn locations, first-aid kit locations, muster point, and site contamination control zone perimeters will be developed once an on site evaluation of conditions and topography is complete and discussed each day during the TSM.

12.7 ADVERSE WEATHER CONDITIONS/NATURAL DISASTERS

Adverse weather and natural disasters can take many forms. Thunder and lightning storms, hail, high winds, and tornados are a few examples. Sudden changes in the weather, extreme weather conditions, and natural disasters can create a number of subsequent hazards. Natural disasters can create many secondary hazards such as release of hazardous materials to the environment, structure failure and fires.

Routinely monitoring weather conditions and reports may help reduce the impact of severe weather and natural disasters. It may be necessary to halt certain hazardous operations or stop work altogether to allow the situation to pass. The SSHO must decide what operations, if any, are safe to perform based on existing and anticipated conditions.

The best protection against most severe weather episodes and natural disasters is to avoid them. This means seeking shelter before the storm hits. Stay away from pipes and electrical equipment, including telephones, should lightning be a threat and watch for damage caused by lightning strikes nearby.

12.7.1 Tornados

The following general guidelines will be adhered to in the event of a tornado:

- If indoors – seek shelter in the lowest level of the building, such as a basement or cellar. If the building is not equipped with a basement, move to a small room in the center of the structure, such as an interior hallway or bathroom. The more walls between you and the outside, the better.
- If outside, move to the nearest shelter or building for protection. If there is no structure near by, lie down in a low area with your hands covering the back of your head and neck; keep alert for flash floods.
- If driving – never try to outrun a tornado. If you see a funnel cloud or hear a tornado warning issued on the radio or by siren, get out of your vehicle and seek a safe shelter.

12.7.2 Thunderstorms

The following general guidelines will be adhered to in the event of a thunderstorm:

- If lightning is observed, but thunder is not heard continue to sample, but monitor weather conditions.
- If lightning is observed and thunder is heard stop work and take shelter.
- Start work after at least 15 minutes have passed since lighting has been observed and thunder is heard.

Table 12.1
Emergency Telephone Numbers, Contacts, and Directions to Nearest Medical Facility

Emergency Phone Numbers

Fire Department, Salina Fire Department	
Emergency	911
Non-Emergency	(785) 826-7340
Emergency Medical Care – Salina Ambulance	
Emergency	911
Non-Emergency	(785) 826-7340
Police, Salina Police Department	
Emergency	911
Non-Emergency	(785) 826-7210
Salina Regional Health Center	
400 S Santa Fe Salina, Kansas 66436	(785) 452-7000
Kansas Poison Control	(800) 222-1222
National Response Center	
Environmental Emergencies	(800) 424-8802

Project Contacts

HGL Contacts:		
Project Manager:	Miquette Rochford	(970) 243-3893
Site Supervisor:	Chris Williams	Site phone TBD
Certified Industrial Hygienist (CIH):	Mary Ann Heaney	(303) 665-8528
USACE CENWK Point of Contact		
U.S. Army Corps of Engineers, Kansas City 601 East 12th Street, Room 610 Kansas City, Missouri 64106	Robyn Kiefer	(816) 389-3615

Directions to the Nearest Medical Facility

- Exit site, From intersection of Centennial Rd and West Magnolia Rd;
- Head East on W. Magnolia Rd (1.2 mi)
- Turn Left (North) onto S. 9th Street (1.1 mi).;
- Turn Left (North) onto S. Santa Fe Ave (1.4 mi)
- Follow signs to emergency room, hospital is located at 400 S. Santa Fe.

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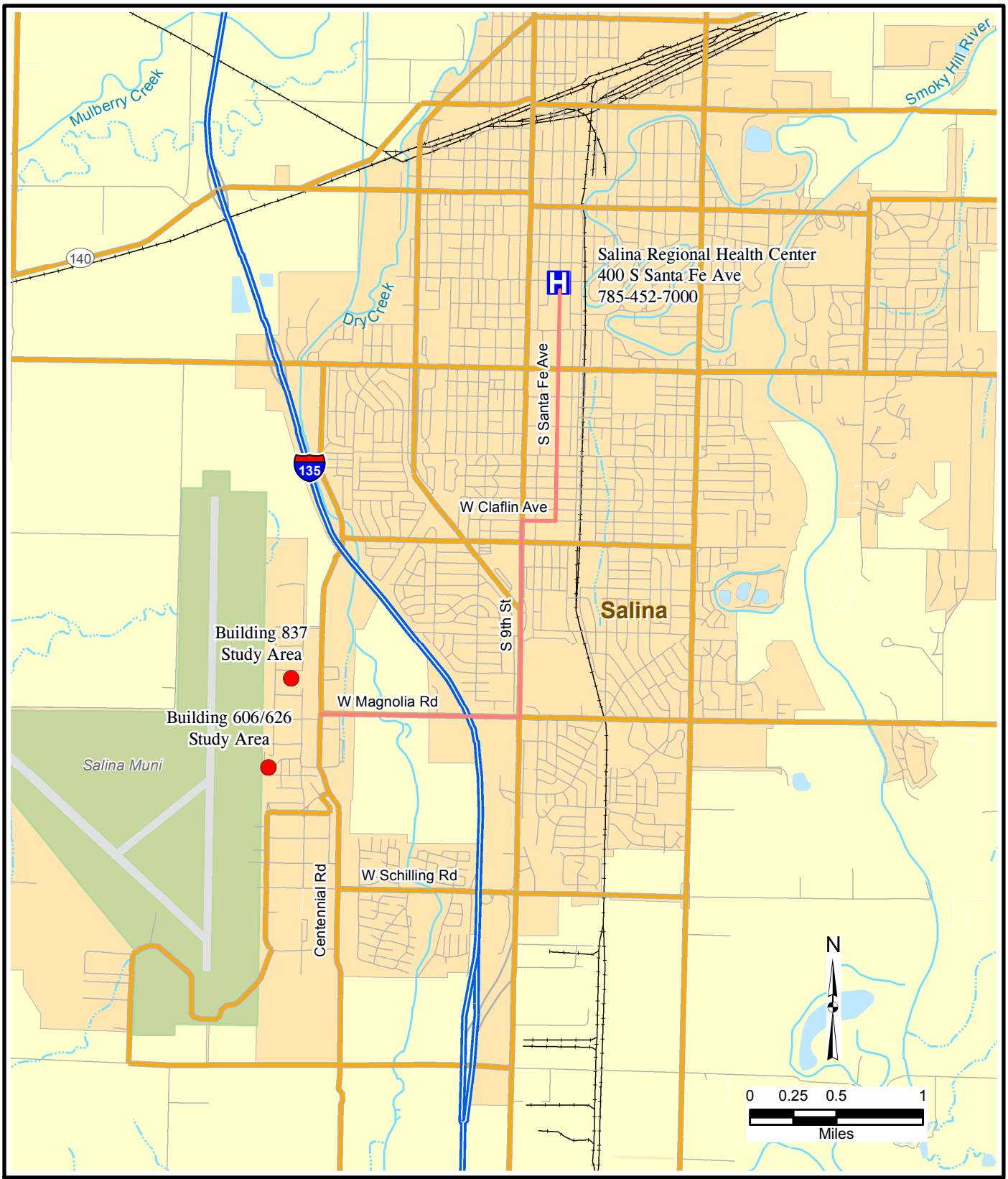

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Project: KAN004-103-01-04
Created by: cvanfosson 03/10/06
Revised: 03/17/06 CV
Source: ESRI StreetMap USA

HGL HydroGeoLogic, Inc

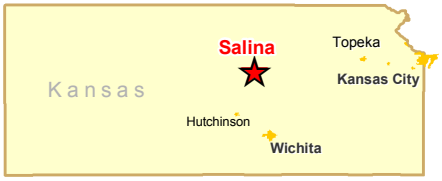

Figure 12.1
Hospital Route Map

13.0 SAFETY INSPECTIONS

The HGL accident prevention program is centered on the following key procedures:

- Project reporting, investigation, and review of all near misses, incidents, and accidents.
- Management reviews of all incident/accident reports, corrective action, and project safety concerns.
- Review of project, operations, and construction activities by safety and health professionals.

Safety reviews and inspections are conducted by all tiers of the management structure and are documented. A list of all corrective action items is required to be maintained showing the corrective action, responsible person, and the date action is to be completed. Follow-up inspections are conducted by Safety and Health personnel to ensure that corrective actions or measures have been implemented. Safety Inspection Reports are included in Exhibit 3.

The SS will inspect the site weekly and interview one or two site workers regarding areas of safety concerns or ideas for safety improvement. The SS will inspect site conditions and activities daily to identify changing conditions or potential hazards. Identified safety and occupational health deficiencies and suggested corrective measures will be brought to the attention of the PM. Safety review inspections will be recorded and filed for reference by the PM. Also, follow HGL HSP Policy 1.6: Regulatory Agency Inspections.

ACCIDENT REPORTING AND INVESTIGATION

All project personnel are required to report all near misses, injuries, illnesses, and accidents to their immediate supervisor. The SS will immediately arrange appropriate medical care as required. Once immediate medical care for the injured personnel has been accomplished, the SS will complete and submit the appropriate report forms within 24 hours. The appropriate form(s) to be completed may include:

- HGL Incident Report/Analysis (Exhibit 3)

Identified safety and occupational health deficiencies and corrective measures will be documented and filed on site for reference by the client or designated representative.

All close calls, injuries, illnesses, and accidents will be investigated by on site management personnel. The SS will investigate the conditions that led to the accident. They will document how the accident occurred and identify unsafe acts or conditions that occurred or existed at the time of the accident. Corrective actions will be determined and implemented to prevent recurrence of the accident, and responsibility for implementation of corrective actions will be assigned.

The investigation will be started immediately, and all information will be collected as soon as possible after the occurrence. The final report and required forms will be submitted to the PM for signature and forwarding to the Client and other appropriate personnel.

Any safety and occupational health deficiencies, accidents, injuries, illnesses and/or close calls will be directed to the CIH for review as soon as possible.

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14.0 REFERENCES

American Conference of Governmental Industrial Hygienists, 2004. TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.

HydroGeoLogic, Inc., 2006. Corporate Health and Safety Manual.

National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1997.

Occupational Safety and Health Administration (OSHA) regulations, 2004. 29 Code of Federal Regulations (CFR) Part 1910-Occupational Safety and Health Standards and Part 126-Safety and Health Regulations for Construction, http://cfr.law.cornell.edu/cfr/.

The Weather Channel, 2006. Monthly Average Temperatures for Salina, KS. Cited on weather.com.

U.S. Army Corps of Engineers, 2003. Safety and Health Requirements Manual (EM385-1-1).

U.S. Army Corps of Engineers (USACE) – Kansas City District, 2005, Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas, September, 2005.

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EXHIBIT 1

ACTIVITY HAZARD ANALYSIS FORMS

This exhibit is reserved for activity hazard analysis forms which set forth the tasks, hazards and control measures to provide safe work practices for operations at the project site.

NOTE: EACH ACTIVITY MUST BE REANALYZED FOR EACH DELIVERY ORDER

- Mobilization
- Drilling/Direct-push technology
- Well Installation
- Groundwater Sampling
- Soil Sampling
- Oversight of Groundwater Injection Treatment Systems
- Decontamination of Equipment
- Disposition of Investigation Derived Waste
- Demobilization
- Redox Tech
    - Direct Push Technology
    - Oxidizer Injection
    - ABC+ Injection

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Mobilization

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Installation of office and support structures	Slip, trip and fall hazards	Determine best access route before transporting equipment.
		Good Housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, ensure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 lbs. Require assistance or mechanical equipment; size-up the lift.
	Falling objects	Hardhat, stay alert and clear of materials suspended overhead, steel-toed boots.
	Flying debris, dirt, dust, etc.,	Use safety glasses/goggles. Ensure that the eye wash station is in good working order.
	Noise	Hearing protection is mandatory above 85 dBA.
	Pinch points	Keep hands and feet clear of moving/suspended materials and equipment.
		Stay alert at all times.
		Beware of contact points.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible and maintained in a fully charged and operable condition.
		Fire lanes providing access to all areas shall be established and maintained free of obstruction (the minimum space between one-story non-fire-resistant buildings shall be 20 feet). Initial survey of the suitability and effectiveness of fire prevention and protection measures and facilities at each installation shall be made by competent persons.
		Fuel will be transported and stored in approved containers.
	Vehicle traffic	Pay attention at all times.
		Wear high visibility clothing.
		Make sure that operators of vehicles know that you are near their equipment.

ACTIVITY: Mobilization

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Installation of office support structures (continued)	Vehicle traffic (continued)	A spotter will aid in the backing of all vehicles with poor rear visibility.
		Work area will be barricaded/demarcated.
	Contact with utilities	Above and underground utilities shall be located. A qualified person shall install required utilities in compliance with national, state, and local codes.
	Cut hazards	Wear adequate hand protection.
	Biological hazards	Inspect work area carefully and avoid placing hands or feet into concealed areas.
		Be alert for bees, spiders, ticks and snakes.
	Hazardous plants (poison oak, sumac, ivy), insects, snakes, etc.	Remove vegetation, identify hazardous plants, insects, etc.
	Flood potentials	Check meteorology/climatology of the area. Look for any history of flooding.
	Toilets	Chemical toilets provided in accordance with the SSHP.
	Heat Stress	Refer to the appropriate section of the SSHP.
	High winds	Mobile/portable facilities shall be anchored to withstand high winds.
	Hazard communication	Label all containers as to contents (fuel cans, etc.).
		Obtain Material Safety Data Sheets for materials brought on site.
	Contact with potentially contaminated materials	No exclusion zone activities are associated with this task.
	Strains and sprains	Use the proper tool for the job being performed.
Mobilization of trailers	Driving over soft ground	Make initial visual check. Level ground and spread gravel if needed.
		Apply gravel if needed to prevent mud or standing water. Loader (if used for spreading of grading) must meet all safety requirements.

ACTIVITY: Mobilization

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Mobilization of trailers (continued)	Level/Blocking trailer, driving stakes (stabilization) anchoring	Use caution when jacking and placing blocks or cribbing. If ground is soft, add stone to secure footing.
	Setting steps in place	Steps must be OSHA-approved (with proper handrails, mid-rail, steps, with a platform in front of the door. Refer to USACE 385-1-1 Section 21.E 02, 05, 07, 08).
	Electric shock	Lighting for work and means of egress; electrical hookup to trailers to be made by qualified electrician, GFCIs required on all circuits.
	Ventilation	Trailer ventilation shall not bring in exhaust from vehicles, etc.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools PPE Heavy Equipment Vendor trucks	Pre/post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazard communication

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Drilling / DPT

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Drilling/boring	Slip, trip, and fall hazards	Good housekeeping, keep work area picked up and as clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
	Strains and sprains, heavy lifting	Use proper lifting techniques, lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Hardhat, stay alert and clear of materials suspended overhead, steel-toed boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that the eye wash station is in good working order.
	Noise	Noise levels above 85 dBA mandates hearing protection.
	Pinch points	Keep feet and hands clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Contact with overhead power lines	Minimum overhead clearance shall be in accordance with Table 3.4.
	Fire	The drill rig or boring rig will be equipped with at least one dry chemical fire extinguisher having a minimum UL rating of 1A5BC.
	Underground utilities	All underground utilities will be located prior to excavating.
	Open excavations	HydroGeoLogic, Inc. Corporate HSP Procedure 6. 4 “Barricading for Work Site Protection” will be adhered to at all times.
	Cuts	Wear adequate hand protection.
	Traffic	Work area will be barricaded off.
		Personnel will wear high visibility vests for high visibility.
	Driving over soft ground	Make initial visual check.
		Apply gravel if needed to prevent mud or standing water.
		Level ground with loader and spread gravel is necessary.
	Contact with poison oak	Conduct visual inspection prior to work.

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Drilling/boring (continued)	Contact with poison oak (continued)	Wear PPE.
		Decon with soap if needed.
	Contact with contaminated materials	Personnel will wear appropriate PPE for the operation. This may include chemical resistant gloves, boot covers, splash suit.
	Contact with drilling equipment	Before any machinery or mechanized equipment is placed into service, it shall be inspected and tested by a competent mechanic and certified to be in safe operating condition.
		Equipment shall be inspected before being placed into service and at the beginning of each shift.
		Preventive maintenance procedures recommended by the manufacturer shall be followed.
		A lockout-tagout procedure shall be used for equipment found to be faulty or undergoing maintenance.
		Only qualified personnel shall operate machinery and mechanized equipment.
		Machinery or equipment requiring an operator shall not be permitted to run unattended.
		Machinery or equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.
		All machinery or equipment will be shut down and positive means taken to prevent its operation while repairs or manual lubrications are being done.
		All repairs on machinery or equipment will be made at a location that provides protection from traffic for repairpersons.
		Maintain eye contact with drill operator when entering zone of operation.
		Establish work zone around drill rig.
		All mobile equipment shall be equipped with a back-up alarm.

ACTIVITY: Drilling / DPT

Reviewed By: Mary Ann Heaney

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools Pipe Heavy equipment	Pre-post maintenance Visual prior to use Client required form	Tailgate safety meetings Site specific orientation Hazardous waste operations

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Well Installation

Analyzed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment	Slip, trip, and fall hazards	Determine best access route before transporting equipment.
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, insure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Stay alert and clear of materials suspended overhead. Wear hardhat and steel toes boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that the eye wash station is in good working order.
		Noise Sound levels above 85 dBA mandates hearing protection.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
		All flammable liquids will be transported in UL/FM approved containers and sources of ignition will be prohibited.
	Contact with moving equipment/vehicles	Work areas will be barricaded/demarcated.
		Equipment will be laid out in an area free of traffic flow.
		Wear high visibility clothing.
	Bees, spiders and snakes	Inspect work area carefully and avoid placing hands and feet into concealed areas.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Well Installation

Analyzed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment (continued)	Cuts	Wear adequate hand protection. Use care when handling glassware.
	Chemical exposure	Initial real time air monitoring will take place.
		Label all containers as to contents and disposes of properly.
		Obtain Material Safety Data Sheets for solvents, etc. that are being used.
Well installation	Open excavations	HydroGeoLogic Inc Health and Safety Program Procedure 6.4 "Barricading for Work Site Protection" will be adhered to at all times.
	Noise	Noise levels above 85 dBA mandates hearing protection.
	Drilling equipment operations	Refer to Activity Hazard Analysis for Drilling.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools Pipe Heavy equipment	Pre-post maintenance Visual prior to use Client required form	Tailgate safety meetings Site specific orientation Hazardous waste operations Hazard communication

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Groundwater Sampling

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment	Slip, trip, and fall hazards	Determine best access route before transporting equipment.
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, insure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Stay alert and clear of materials suspended overhead. Wear hard hat and steel toes boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that eye wash is in good working order.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
		All flammable liquids will be transported in UL/FM approved containers and sources of ignition will be prohibited.
	Contact with moving equipment/vehicles	Work area will be barricaded/demarcated.
		Equipment will be laid out in a area free of traffic flow.
	Bees, spiders and snakes	Inspect work area carefully and avoid placing hands and feet into concealed areas.
	Cut hazards	Wear adequate hand protection. Use care when handling glassware.
	Chemical exposure	Initial real time air monitoring will take place.
		Proper use of PPE.
		Label all containers as to contents and disposes of properly.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment (continued)	Chemical exposure (continued)	Obtain Material Safety Data Sheets for solvents, etc. that are being used.
	Noise	Sound levels above 85 dBA mandates hearing protection.
Sample collection	Electrical shock	All electrical circuits will be de-energized and locked out.
	Bees spiders and snakes	Inspect work areas carefully and avoid placing hands and feet into concealed areas.
	Cross-contamination and contact with potentially contaminated materials	Sampling technicians will wear proper protective clothing and equipment to safeguard against potential contamination.
		Only essential personnel will be in the work area.
		Initial real-time air monitoring will take place before and during sampling activities.
		All personnel will follow good hygiene practices.
		Proper decontamination procedures will be followed.
		All liquids and materials used for decontamination will be contained and disposed of in accordance with Federal, State and Local regulations.
	Cut hazards	Use care when handling glassware.
		Wear adequate hand protection.
	Chemical exposure	Label all containers as to contents.
		Proper use of PPE.
	Strains/sprains	Use the proper tool for the job being performed.
		Get assistance if needed.
		Avoid twisting/turning while pulling tools, grates, manway covers, etc.
	Spills/residual materials	Absorbent materials and containers will be kept available where leaks or spills may occur.

ACTIVITY: Groundwater Sampling **Reviewed By: Mary Ann Heaney**

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
Sample collection (continued)	Lighting	Adequate lighting will be provided to insure a safe work environment.
	Unattended worker	"Buddy System" – Visual contact will be maintained with the sampling technician during sampling activities.
Equipment decontamination	Chemical exposure	Maintain MSDS for all chemicals such as methanol or hexane and follow protection procedures.
Moving and shipping collected samples	Heavy lifting	Use proper lifting techniques. Lifts of greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times
	Cut hazards	Wear adequate hand protection. Use care when handling glassware.
	Chemical exposure	Label all containers as to contents and associated hazards.

Equipment To Be Used	Inspection Requirements	Training Requirements
Hand tools PPE Sampling equipment	Pre-post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazardous waste operations Hazard communication

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Soil Sampling

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment	Slip, trip, and fall hazards	Determine best access route before transporting equipment.
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, insure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Stay alert and clear of materials suspended overhead. Wear hardhat and steel toes boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that the eye wash station is in good working order.
		Noise Sound levels above 85 dBA mandates hearing protection.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
		All flammable liquids will be transported in UL/FM approved containers and sources of ignition will be prohibited.
	Contact with moving equipment/vehicles	Work areas will be barricaded/demarcated.
		Equipment will be laid out in an area free of traffic flow.
		Wear high visibility clothing.
	Bees, spiders and snakes	Inspect work area carefully and avoid placing hands and feet into concealed areas.
	Cuts	Wear adequate hand protection. Use care when handling glassware.

ACTIVITY: Soil Sampling

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment (continued)	Chemical exposure	Initial real time air monitoring will take place.
		Label all containers as to contents and disposes of properly.
		Obtain Material Safety Data Sheets for solvents, etc. that are being used.
		Proper use of PPE.
	Noise	Sound levels above 85 dBA mandates hearing protection.
Sample collection	Electrical shock	All non-essential electrical circuits will be de-energized and locked out.
	Bees, spiders and snakes	Inspect work areas carefully and avoid placing hands and feet into concealed areas.
	Cross-contamination and contact with potentially contaminated materials	Sampling technicians will wear appropriate PPE in accordance with the SSHP.
		Only essential personnel will be in the work area.
		Initial real-time air monitoring will take place before and during sampling activities.
		All personnel will follow good hygiene practices.
		Proper decontamination procedures will be followed.
		All liquids and materials used for decontamination will be contained and disposed of in accordance with Federal, State and Local regulations.
	Cut hazards	Use care when handling glassware.
		Wear adequate hand protection.
	Chemical exposure	Label all containers as to contents.
	Strains/sprains	Use the proper tool for the job being performed.
		Get assistance if needed.
		Avoid twisting/turning while pulling tools, grates, manway covers, etc.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Soil Sampling

Reviewed By: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Sample collection (continued)	Spills/residual materials	Absorbent materials and containers will be kept available where leaks or spills may occur.
	Lighting	Adequate lighting will be provided to insure a safe work environment.
	Unattended worker	"Buddy System" – Visual contact will be maintained with the sampling technician during sampling activities.
Equipment decontamination	Chemical exposure	Maintain MSDS for all chemicals such as methanol or hexane and follow protection procedures.
Moving and shipping collected samples	Heavy lifting	Use proper lifting techniques. Lifts of greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Cut hazards	Wear adequate hand protection. Use care when handling glassware.
	Chemical exposure	Label all containers as to contents and associated hazards.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools PPE Sampling equipment	Pre-post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazardous waste operations Hazard communication

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Oversight of Groundwater Injection Systems **Reviewed By: Colby H. Smith**

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging Equipment	Slip, trip, and fall hazards	Determine best access route before transporting equipment.
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, insure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 50 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Stay alert and clear of materials suspended overhead. Wear hard hat and steel toed-boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that eye wash is in good working order.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
		All flammable liquids will be transported in UL/FM approved containers and sources of ignition will be prohibited.
	Contact with moving equipment/vehicles	Work area will be barricaded/demarcated.
		Equipment will be laid out in an area free of traffic flow.
		A spotter shall be used as needed
	Bees, spiders and snakes	Inspect work area carefully and avoid placing hands and feet into concealed areas.
	Contact with poison oak/ivy	Conduct visual inspection prior to work.
	Cut hazards	Wear adequate hand protection. Use care when handling glassware.
	Chemical exposure	Label all containers as to contents and dispose of properly.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
		Proper use of PPE.
Staging Equipment (continued)	Chemical exposure (continued)	Obtain Material Safety Data Sheets for solvents, etc. that are being used.
	Noise	Sound levels above 85 dBA mandates hearing protection.
Chemical Injection	Electrical shock	All electrical circuits will be de-energized and locked out.
		HGL H&S Policy 6.3 (Lockout Tagout Procedures and Requirements) shall be followed
	Bees spiders and snakes	Inspect work areas carefully and avoid placing hands and feet into concealed areas.
	Contact with poison oak/ivy	Conduct visual inspection prior to work.
	Cross-contamination and contact with potentially contaminated materials Chemical exposure to injection material Heat produced by mixing of injection materials	Field technicians will wear proper protective clothing, chemical resistant gloves and equipment to safeguard against potential contamination.
		Only essential personnel will be in the work area.
		All personnel will follow good hygiene practices.
		Proper decontamination procedures will be followed.
		All liquids and materials used for decontamination will be contained and disposed of in accordance with Federal, State and Local regulations.
		Manufacturer's recommendations and directions shall be followed to eliminate adverse chemical reactions
	Cut hazards	Use care when handling glassware.
		Wear adequate hand protection.
	Chemical exposure	Prior to handling, review MSDSs for potential hazards associated with chemicals to be injected.
		Label all containers as to contents following HAZCOMM requirments

ACTIVITY: Oversight of Groundwater Injection Systems **Reviewed By: Colby H. Smith**

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
		Proper use of PPE.
	Strains/sprains	Use the proper tool for the job being performed.
		Get assistance if needed.
		Avoid twisting/turning while pulling tools, grates, manway covers, etc.
		Use alternative mechanical means when removing heavy objects
		Ensure work area is level and free of trip hazards; maintain proper housekeeping in work area
	Spills/residual materials	Absorbent materials and containers will be kept available where leaks or spills may occur.
Chemical Injection (continued)	Lighting	Adequate lighting will be provided to insure a safe work environment.
	Unattended worker	"Buddy System" Section 4.0 of SSHP – Visual contact will be maintained with the sampling technician during sampling activities.
Equipment decontamination	Chemical exposure	Maintain MSDS for all chemicals such as methanol or hexane and follow protection procedures.
		Use wet methods for equipment decontamination

Equipment To Be Used	Inspection Requirements	Training Requirements
Hand tools PPE Injection equipment	Pre-post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazardous waste operations Hazard communication

ACTIVITY HAZARD ANALYSIS
FOR OXIDIZER (SODIUM PERSULFATE AND POTASSIUM PERMANGANATE) INJECTION

Principal Steps	Potential Hazards	Recommended Controls
• Add appropriate amount of water to be mixed with chemical oxidizer • Mix chemical oxidizer with water • Attach injection hose to injection point • Inject oxidizer • Decontaminate equipment	• Fueling generator (if required) • Compressed air • Hydraulic line breakage • High-speed machinery • Flying debris • Biological hazards • Chemical exposure during leaks or filling system • Reactive chemicals (oxidizers) • Slip/trip hazard • Underground utilities • Noise	• Fueling and fuel storage will be in area free of vegetation and debris with proper signage • Use of insect repellant • Properly maintain equipment in working order • Buddy system • Keep tools and equipment off the ground • Modified Level D PPE (hearing protection, safety glasses, splash shields, hearing protection, tyvek suit, boot covers) • Utility locates prior to commencing work
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
• High-pressure injector • Air compressor	• All safety guards on the equipment will remain in place • Lockout/tag out Standard Operating Procedures will be followed when servicing equipment. • Site inspections will be made to identify and mark slip-trip, biological, and other hazards, which may be found at the site • Site inspection for underground utilities	• Minimum of 40-hour Hazardous Waste Operations and Emergency Response and site-specific hazard communication training • All site personnel will be trained in the safe use of specific equipment and in personal protective equipment required to perform their job • Only trained and qualified personnel will operate the injection unit and handle oxidizing material

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Decontamination of Equipment

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Movement to DECON area	Noise	Noise levels above 85 dBA mandates hearing protection.
	Contact with heavy equipment	A lockout-tagout procedure shall be used for equipment found to be faulty or undergoing maintenance.
		Only designated personnel shall operate machinery and mechanized equipment.
		Getting off or on any equipment while it is in motion is prohibited.
		Machinery or equipment requiring an operator shall not be permitted to run unattended.
		Machinery or equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.
		All machinery or equipment will be shut down and positive means taken to prevent its operation while decontamination is being done.
		Bulldozer and scraper blades, end-loader buckets, and similar equipment will be either fully lowered or blocked when being repaired or when not in use.
		All mobile equipment shall be equipped with a back-up alarm.
	Contact with potentially contaminated materials	Real time air monitoring will take place. Proper personal protective clothing and equipment will be utilized.
		Good housekeeping will be stressed to safe guard against cross contamination of surrounding areas and eliminate safety hazards.
		All site personnel will practice good personal hygiene.
		The work area will be demarcated. All unnecessary personnel will be kept out of the work area and in an upwind location.
		Refer to SSHSP for chemical hazard discussion.
		Wear proper PPE.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Decontamination of Equipment

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Movement to DECON area	Strains and sprains, heavy lifting	Good housekeeping, keep work area picked up and as clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Use proper lifting techniques, lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Cut hazards/Cuts	Keep feet and hands clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
		Wear adequate hand protection.
		Work area will be barricaded off to prevent entry by unauthorized individuals.
		Leg and metatarsal guards shall be worn.
		All connections shall be inspected prior to use of pressure equipment.
		Verification of the proper pressure shall be made prior to use of the equipment.
		LO/TO shall be used is work on the system must be performed.
Pressure Washing	Eye Injuries	Safety glasses or goggles AND a face shield shall be worn.
	Burns	Rain suits or suits of equivalent material shall be worn to prevent direct contact with hot water.
		Decontamination or washing of PPE while on a person is prohibited.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIRMENTS
Hand tools PPE Heavy equipment Dump Trucks	Pre-post maintenance Visual prior to use Client required form	Tailgate Safety Meeting Site specific orientation Hazardous waste operation

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Disposition of Investigation Derived Waste

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment	Slip, trip, and fall hazards	Determine best access route before transporting equipment
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip and fall hazards.
		Look before you step, insure safe and secure footing.
	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Falling objects	Stay alert and clear of materials suspended overhead. Wear hardhat and steel toes boots.
	Flying debris, dirt, dust, etc.	Use safety glasses/goggles. Ensure that the eye wash station is in good working order.
		Noise Sound levels above 85 dBA mandates hearing protection.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
		All flammable liquids will be transported in UL/FM approved containers and sources of ignition will be prohibited.
	Contact with moving equipment/vehicles	Work areas will be barricaded/demarcated.
		Equipment will be laid out in an area free of traffic flow.
	Bees, spiders and snakes	Inspect work area carefully and avoid placing hands and feet into concealed areas.
	Cuts	Wear adequate hand protection. Use care when handling glassware.

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Staging equipment (continued)	Chemical exposure	Initial real time air monitoring will take place.
		Wear appropriate PPE.
	Hazard communication	Label all containers as to contents and disposes of properly.
		Obtain Material Safety Data Sheets for solvents, etc. that are being used.
	Noise	Sound levels above 85 dBA mandates hearing protection.
Sample collection	Electrical shock	All non-essential electrical circuits will be de-energized and locked out.
	Bees, spiders and snakes	Inspect work areas carefully and avoid placing hands and feet into concealed areas.
	Cross-contamination and contact with potentially contaminated materials	Sampling technicians will wear appropriate PPE in accordance with the SSHP.
		Only essential personnel will be in the work area.
		Initial real-time air monitoring will take place before and during sampling activities
		All personnel will follow good hygiene practices.
		Proper decontamination procedures will be followed.
		All liquids and materials used for decontamination will be contained and disposed of in accordance with Federal, State and Local regulations.
	Cuts	Use care when handling glassware.
		Wear adequate hand protection.
	Chemical Exposure	Label all containers as to contents.
		Wear PPE.
	Strains/sprains	Use the proper tool for the job being performed.
		Get assistance if needed.

ACTIVITY: Disposition of Investigation Derived Waste

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Sample collection (continued)	Strains/sprains (continued)	Avoid twisting/turning while pulling tools, grates, manway covers, etc.
	Spills/residual materials	Absorbent materials and containers will be kept available where leaks or spills may occur.
	Lighting	Adequate lighting will be provided to insure a safe work environment.
	Unattended worker	"Buddy System" – Visual contact will be maintained with the sampling technician during sampling activities.
Equipment decontamination	Chemical exposure	Maintain MSDS for all chemicals such as methanol or hexane and follow protection procedures.
Moving and shipping collected samples	Heavy lifting	Use proper lifting techniques. Lifts of greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Pinch points	Keep hands, fingers, and feet clear of moving/suspended materials and equipment.
		Beware of contact points.
		Stay alert at all times.
	Cut hazards	Wear adequate hand protection. Use care when handling glassware.
	Hazard communication	Label all containers as to contents and associated hazards.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools PPE Sampling equipment	Pre-post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazardous waste operations Hazard communication

ACTIVITY HAZARD ANALYSIS

Activity: Demobilization

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Removal of office and support structures	Heavy lifting	Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size up the lift.
	Noise	Hearing protection is mandatory above 85 dBA.
	Falling Objects	Hardhat, stay alert and clear of materials suspended overhead, Steel toed boots required.
	Flying debris, dirt, dust etc.	Safety glasses/eye wash.
	Pinch points	Keep hands and feet clear of moving/suspended materials and equipment.
		Stay alert at all times.
		Beware of contact points.
	Fire	Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
	Vehicle traffic	Pay attention at all times. Wear high visibility vest.
		Make sure that operators of vehicles know that you are near their equipment.
		A spotter will aid in the backing of all vehicles with poor rear visibility.
	Contact with utilities	Above and underground utilities shall be located. A qualified person shall install required utilities in compliance with national state, and local codes.
	Slip, trip, and fall hazards	Determine best access route before transporting equipment.
		Good housekeeping, keep work area picked up and clean as feasible. Continually inspect the work area for slip, trip, and fall hazards.
		Look before you step, ensure safe and secure footing.
	Cut hazards	Wear adequate hand protection.
	Biological hazards	Inspect work area carefully and avoid placing hands or feet into concealed areas.
		Be alert for bees, spiders, ticks, and snakes.

Activity: Demobilization

Reviewed by: Mary Ann Heaney

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Removal of office and support structures (Continued)	Contact with poison oak.	Conduct visual inspection prior to work.
		Wear PPE.
		Decon with soap if needed.
	Toilets (sanitary)	Chemical toilets provided in accordance with this SSHP.
	Heat stress	Refer to Section 4.0 of the SSHP
	Fuel	Fuel will be transported and stored in approved containers.
	Contact with moving equipment/vehicles	Work area will be barricaded/demarcated.
	Contact with potentially contaminated materials	No Exclusion Zone activities are associated with this task.
	Strains and sprains	Use the proper tool for the job being performed.
		Get assistance if needed.
		Avoid twisting/tuning while pulling on tools, materials, etc.
	Unattended worker	"Buddy System" visual contact will be maintained between personnel performing site activities.
Demobilization of trailers	Driving over soft ground	Make initial visual check. Level ground with loader and spread gravel.
		Apply gravel if needed to prevent mud or standing water. Loader (if used for spreading or grading) must meet all safety requirements.
	Removing/Blocking trailer, stakes and anchoring	Use caution when jacking and removing blocks or cribbing. If ground is soft, add stone to secure footing.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools PPE Heavy equipment Vendor trucks	Pre-post maintenance Visual prior to use	Tailgate Safety Meeting Site specific orientation Hazard communication

REDOX TECH
ACTIVITY HAZARD ANALYSIS
FOR DIRECT PUSH TECHNOLOGY

Job Step	Potential Hazard	Controls
Forms/Permits	Unknown client-specific hazards.	• Well installation or abandonment notification. • Dig/drill clearance obtained. • Class V Injection Permit (if required)
Pre-Work Activities	Striking underground utilities	• Underground utility surveying and marking will be conducted by HGL • Daily briefing.
Pre-Work Activities	Striking overhead utilities	• Locate and take appropriate precautions with required distances from power lines. • Lower mast and secure during travel.
Site Setup	Physical environmental hazards	• Use of appropriate personal protective equipment where required. Safety boots, hard hats, safety glasses and hearing protection are mandatory. Respirators when chemical hazards exist. No loose-fitting clothing, rings, watches, etc.; long hair to be restrained close to the head.
Site Setup	Dermal or inhalation exposure to contaminants	• Investigate history of area; determine nature and degree of contaminants that could be present. • Conduct air monitoring for potential hazardous atmospheres as described in the project's written safety plan (if required). • Use respirators and other PPE as prescribed in the project's written safety plan.
Site Setup	Fire	• No smoking around the drill rig.
Site Setup	Struck by vehicles	• Follow traffic control plan. • Wear high-visibility warning vests if required.
Site Setup	Drill rig travel	• Ensure stable ground and adequate footing for machinery. Adequate ground preparation to support loads. • Drill rig travel will be conducted with mast secured in its lowered position. • Tools and equipment secured prior to rig movement. • Only personnel seated in cab are to ride on the rig vehicle.

Job Step	Potential Hazard	Controls
		• Ensure clearance of overhead power lines. • Use alarm or spotter when reversing rig.
Drilling Activities	Rotating machinery parts of drill rig	• Daily inspection of drill rig & equipment. • Ensure appropriate guards are installed or suitable barriers to forewarn personnel of dangers. • Personnel clear during set up and clear of rotating parts. • Loose clothing, long hair, and jewelry to be safely secured. • Kill switch installed, clearly identified and operational. • Rig placed in neutral when operator not at controls. • Pressurized lines and hoses secured from whipping hazards.
Drilling Activities	Falls while performing maintenance on mast	• Use fall protection whenever working over 6 feet. • Only trained workers may use fall protection.
Drilling Activities	Hoisting operations	• Ensure all personnel are clear of operation to a suitable safe distance.
Drilling Activities	Overturning of drill rig	• Establish drill pad if necessary. • Drill rig level and stabilized.
Drilling Activities	Damage underground utilities	• Exposed underground utility lines supported. • Daily briefing.
Drilling Activities	Striking hazardous materials	• Implement suitable safety procedures for the nature of the hazard . • Smoking prohibited around drilling area. • Use of PPE as required. • Daily briefing.
Drilling Activities	Failure of drill rig components	• Defective components repaired prior to return to service. • Lockout/tagout procedures used prior to maintenance. • Good housekeeping on and about the rig.
Drilling Activities	Driving equipment into excavation	• Warning/identification system used to remind equipment operators of injection points.
Drilling Activities	Weather	• Drill rig not to be operated in severe inclement weather such as lightning storms, high winds, or severe rain. Mast to be lowered in these conditions.

Job Step	Potential Hazard	Controls
Drilling Activities	Exposure to dust	• Fugitive dust suppressed.
Drilling Activities	Exposure to airborne contaminants	• Potential hazardous atmospheres tested prior to entry. • Air monitoring conducted per project's written safety plan for hazardous atmospheres. • Rescue equipment provided where potential for hazardous atmospheres exists. • Ventilation used to control hazardous atmospheres and air tested frequently. • Appropriate respiratory protection used when ventilation does not adequately control hazards.
Drilling Activities	Improper disposal of waste	• Waste disposed of according to project's written safety plan and regulations.

REDOX TECH
ACTIVITY HAZARD ANALYSIS
FOR OXIDIZER (SODIUM PERSULFATE AND POTASSIUM PERMANGANATE) INJECTION

Principal Steps	Potential Hazards	Recommended Controls
• Add appropriate amount of water to be mixed with chemical oxidizer • Mix chemical oxidizer with water • Attach injection hose to injection point • Inject oxidizer • Decontaminate equipment	• Fueling generator (if required) • Compressed air • Hydraulic line breakage • High-speed machinery • Flying debris • Biological hazards • Chemical exposure during leaks or filling system • Reactive chemicals (oxidizers) • Slip/trip hazard • Underground utilities • Noise	• Fueling and fuel storage will be in area free of vegetation and debris with proper signage • Use of insect repellant • Properly maintain equipment in working order • Buddy system • Keep tools and equipment off the ground • Modified Level D PPE (hearing protection, safety glasses, splash shields, hearing protection, tyvek suit, boot covers) • Utility locates prior to commencing work
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
• High-pressure injector • Air compressor	• All safety guards on the equipment will remain in place • Lockout/tag out Standard Operating Procedures will be followed when servicing equipment. • Site inspections will be made to identify and mark slip-trip, biological, and other hazards, which may be found at the site • Site inspection for underground utilities	• Minimum of 40-hour Hazardous Waste Operations and Emergency Response and site-specific hazard communication training • All site personnel will be trained in the safe use of specific equipment and in personal protective equipment required to perform their job • Only trained and qualified personnel will operate the injection unit and handle oxidizing material

REDOX TECH
ACTIVITY HAZARD ANALYSIS
FOR ABC+ INJECTION

Principal Steps	Potential Hazards	Recommended Controls
• Add appropriate amount of water and ZVI to be mixed with ABC • Mix chemicals with water • Attach injection hose to injection point • Inject ABC+ • Decontaminate equipment	• Fueling generator (if required) • Compressed air • Hydraulic line breakage • High-speed machinery • Flying debris • Biological hazards • Chemical exposure during leaks or filling system • Exposure to ZVI dust • Slip/trip hazard • Underground utilities • Noise	• Fueling and fuel storage will be in area free of vegetation and debris with proper signage • Use of insect repellant • Properly maintain equipment in working order • Buddy system • Keep tools and equipment off the ground • Modified Level D PPE (hearing protection, safety glasses, splash shields, hearing protection, tyvek suit, boot covers) • Utility locates prior to commencing work
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
• High-pressure injector • Air compressor • Grout Pump	• All safety guards on the equipment will remain in place • Lockout/tag out Standard Operating Procedures will be followed when servicing equipment. • Site inspections will be made to identify and mark slip-trip, biological, and other hazards, which may be found at the site • Site inspection for underground utilities	• Minimum of 40-hour Hazardous Waste Operations and Emergency Response and site-specific hazard communication training • All site personnel will be trained in the safe use of specific equipment and in personal protective equipment required to perform their job • Only trained and qualified personnel will operate the injection or grout unit and handle chemicals

EXHIBIT 2

MATERIAL SAFETY DATA SHEETS

This exhibit is reserved for Material Safety Data Sheets which include the following:

- ABC
- Benzene
- 1,1-Dichloroethene (DCE)
- *cis*-1,2-DCE
- 1,2-Dichloropropane
- Ethyl benzene
- Hydrochloric Acid (Sample Preservative)
- Klozur™
- Nitric Acid (Sample Preservative)
- bis-(2-ethylhexyl)Phthalate
- Potassium Permanganate
- RTB-1
- Trichloroethene (TCE)
- Toluene
- Vinyl chloride (VC)
- Xylene
- ZVI

Anaerobic Biochem (ABC)

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910 1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(as Used on Label and List)*
ABC (Anaerobic BioChem)

Note: Blank spaces are not permitted. If any item is not applicable or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's name REDOX TECH, LLC	Emergency Telephone Number 866-460-0330
Address *(Number, Street, City, State and ZIP Code)* 1006A Morrisville Parkway, Morrisville, NC 27560	Telephone Number for Information 919-460-0330
	Date Prepared MAY 2004
	Signature of Preparer *(optional)*

Section II—Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Mixture of :				
Lactate salts	NA	NA	(0 to 60%)	
Lactic acid esters	NA	NA	(0 to 98.5%)	
Phosphate buffer	NA	NA	(0 to 0.1%)	
Ferrous Iron	NA	NA	(0 to 0.1%)	
Fatty Acids	NA	NA	(0 to 5%)	

Section III—Physical/Chemical Characteristics

Boiling Point	> 100 C	Specific Gravity (H_20 = 1)	1.04
Vapor Pressure (mm Hg) Lactic acid esters	2.7 mbar. 20 ^oC	pH	6.0 to 8.0
Vapor Density (AIR = 1) Lactic acid esters	3.8	Evaporation Rate (Butyl Acetate = 1)	No information

Solubility in Water: Fully soluble and miscible

Appearance and Odor: Light yellow to colorless liquid, slight to mild, characteristic odor

Section IV—Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Lactic acid esters: 61 ^oC (ISO 2719, closed cup)	Lactic acid esters:	1.5% (100 ^oC)	11.4% (100 ^oC)

Extinguishing Media: Water spray, carbon dioxide, dry powder, AFFF, foam

Special Fire Fighting Procedures

Standard procedures for chemical fires

Unusual Fire and Explosion Hazards

Thermal decomposition can release irritating gases and vapors

Section V—Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	Temperatures above 61 °C. Will hydrolyze in presence of water, acids and bases

Incompatibility *(Materials to Avoid)* Strong oxidants

Hazardous Decomposition or Byproducts no known

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	

Section VI—Health Hazard Data

Route(s) of Entry Inhalation? Yes, esters only Skin? Yes Ingestion? Yes

Health Hazards *(Acute and Chronic)* Acid esters: Risk of irritation to eyes. Irritating to respiratory system. May degrease skin.

Carcinogenicity None NTP? No IARC Monographs? No OSHA Regulated? No

Signs and Symptoms of Exposure Red irritated skin. May cause light-headedness when used in poorly ventilated area without proper vapor mask..

Medical Conditions Generally Aggravated by Exposure Persons susceptible or sensitive to eye and respiratory irritation

Emergency and First Aid Procedures Inhalation: Move to fresh air; Skin: Wash skin immediately with water. Eyes: Flush with water for at least 15 minutes, consult physician; Ingestion: Drink water and consult physician.

Section VII—Precautions for Safe Handling and Use

Use safety glasses and latex or nitrile gloves. Work in well ventilated area.

Waste Disposal Method ABC can be disposed as waste water or landfilled when in compliance with local regulations

Precautions to Be Taken in Handling and Storing May be F lammable - Do not store near ignition sources or at elevated temperatures.

Avoid long storage times, will break down to innocuous products

Other Precautions Wear PPE when handling and keep containers tightly closed when stored.

Section VII—Control Measures

Respiratory Protection *(Specify Type)* If ventilation inadequate or in confined space, use respirator with filter (DIN 141)

Ventilation	Local Exhaust	Special
	Acid esters have low vapor pressure (2.7 mbar at 20 °C) Standard HVAC conditions typically adequate	Ensure fumes can not reach ignition source
	Mechanical *(General)* Floor or stand fans	Other

Protective Gloves PVA, nitrile or latex Eye Protection Safety glasses with side shields

Other Protective Clothing or Equipment

Work/Hygienic Practices Do not eat, drink or smoke while handling. Remove/wash contaminated clothing before reuse.

Benzene

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: BENZENE

TRADE NAMES/SYNONYMS:
MTG MSDS 107; BENZOL; CYCLOHEXATRIENE; BENZOLE; PHENE; PYROBENZOL; PYROBENZOLE; CARBON OIL; COAL TAR NAPHTHA; PHENYL HYDRIDE; BENZOLENE; BICARBURET OF HYDROGEN; COAL NAPHTHA; MOTOR BENZOL; ANNULENE; (6)ANNULENE; RCRA U019; STCC 4908110; UN 1114; C6H6; MAT02610; RTECS CY1400000

CHEMICAL FAMILY: hydrocarbons, aromatic

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 18 2004

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: BENZENE
CAS NUMBER: 71-43-2
PERCENTAGE: >99

COMPONENT: THIOPHENE
CAS NUMBER: 110-02-1
PERCENTAGE: 0.00010

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=3 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless to yellow
PHYSICAL FORM: liquid
ODOR: distinct odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous

system depression, cancer hazard (in humans)
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:
INHALATION:
SHORT TERM EXPOSURE: irritation, ringing in the ears, nausea, vomiting, chest pain, difficulty breathing, irregular heartbeat, headache, drowsiness, symptoms of drunkenness, disorientation, blurred vision, lung congestion, blood disorders, paralysis, convulsions, coma
LONG TERM EXPOSURE: hearing loss, visual disturbances, reproductive effects, brain damage, cancer
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation, blisters
LONG TERM EXPOSURE: tingling sensation
EYE CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: no information on significant adverse effects
INGESTION:
SHORT TERM EXPOSURE: nausea, vomiting, chest pain, headache, drowsiness, symptoms of drunkenness, disorientation, visual disturbances, lung congestion, paralysis, convulsions, coma
LONG TERM EXPOSURE: impotence, cancer

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: Contact local poison control center or physician immediately. Never make an unconscious person vomit or drink fluids. When vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For inhalation, consider oxygen. For ingestion, consider gastric lavage.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Moderate explosion hazard. Vapor/air mixtures are explosive. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Electrostatic discharges may be generated by flow or agitation resulting in ignition or explosion.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT: 12 F (-11 C) (CC)
LOWER FLAMMABLE LIMIT: 1.2%
UPPER FLAMMABLE LIMIT: 7.8%
AUTOIGNITION: 928 F (498 C)
FLAMMABILITY CLASS (OSHA): IB

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Stay upwind and keep out of low areas.

SOIL RELEASE:
Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Absorb with sand or other non-combustible material.

WATER RELEASE:
Cover with absorbent sheets, spill-control pads or pillows. Apply detergents, soaps, alcohols or another surface active agent. Collect with absorbent into suitable container. Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment. Subject to California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Keep out of water supplies and sewers.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Protect from physical damage. Store outside or in a detached building. Store with flammable liquids. Keep separated from incompatible substances. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
BENZENE:
1 ppm OSHA TWA
5 ppm OSHA STEL 15 minute(s)
0.5 ppm OSHA action level
10 ppm OSHA TWA (applies to industry exempt from benzene standard 1910.1028)
25 ppm OSHA ceiling (applies to industry exempt from benzene standard 1910.1028)
50 ppm OSHA peak 10 minute(s) (applies to industry exempt from benzene standard 1910.1028)
0.5 ppm ACGIH TWA (skin)
2.5 ppm ACGIH STEL (skin)
0.1 ppm NIOSH recommended TWA 10 hour(s)
1 ppm NIOSH recommended STEL

VENTILATION: Provide local exhaust or process enclosure ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves. OSHA REGULATED SUBSTANCES: U.S. OSHA 29 CFR 1910.1028.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
10 ppm
Any air-purifying respirator with a full facepiece and an organic vapor canister.
50 ppm
Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s).
Any air-purifying respirator with a full facepiece and a canister providing protection against this substance.
100 ppm
Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s).
1000 ppm
Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or

other positive-pressure mode.
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
COLOR: colorless to yellow
ODOR: distinct odor
MOLECULAR WEIGHT: 78.11
MOLECULAR FORMULA: C6-H6
BOILING POINT: 176 F (80 C)
FREEZING POINT: 43 F (6 C)
VAPOR PRESSURE: 75 mmHg @ 20 C
VAPOR DENSITY (air=1): 2.8
SPECIFIC GRAVITY (water=1): 0.8765 @ 20 C
WATER SOLUBILITY: 0.18% @ 25 C
PH: Not available
VOLATILITY: 100%
ODOR THRESHOLD: 4.68 ppm
EVAPORATION RATE: 5.1 (butyl acetate=1)
VISCOSITY: 0.6468 cP @ 20 C
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: acetone, alcohol, carbon disulfide, acetic acid, carbon tetrachloride, chloroform, ether, oils

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: acids, bases, halogens, oxidizing materials, metal salts

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of carbon

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

BENZENE:
IRRITATION DATA:
15 mg/24 hour(s) open skin-rabbit mild; 20 mg/24 hour(s) skin-rabbit moderate; 88 mg eyes-rabbit moderate; 2 mg/24 hour(s) eyes-rabbit severe
TOXICITY DATA:
10000 ppm/7 hour(s) inhalation-rat LC50; >9400 ul/kg skin-rabbit LD50; 930 mg/kg oral-rat LD50
CARCINOGEN STATUS: OSHA: Carcinogen; NTP: Known Human Carcinogen; IARC: Human Sufficient Evidence, Animal Sufficient Evidence, Group 1; ACGIH: A1 -Confirmed Human Carcinogen; EC: Category 1
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Highly Toxic: dermal absorption
Moderately Toxic: ingestion
Slightly Toxic: inhalation
TARGET ORGANS: immune system (blood), central nervous system
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: blood system disorders, immune system disorders or allergies
TUMORIGENIC DATA: Available.
MUTAGENIC DATA: Available.
REPRODUCTIVE EFFECTS DATA: Available.
ADDITIONAL DATA: May cross the placenta. Alcohol may enhance the toxic effects. Interactions with drugs may occur.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 9200 ug/L 96 hour(s) LC50 (Mortality) Rainbow trout,donaldson trout (Oncorhynchus mykiss)

INVERTEBRATE TOXICITY: 10000 ug/L 48 hour(s) EC50 (Immobilization) Water flea (Daphnia magna)

ALGAL TOXICITY: 41000 ug/L 8 hour(s) EC50 (Growth) Green algae (Selenastrum capricornutum)

OTHER TOXICITY: 25 ug/L 24 day(s) (Residue) Wood frog (Rana sylvatica)

FATE AND TRANSPORT:
BIOCONCENTRATION: 4360 ug/L 24 day(s) BCF (Residue) Northern anchovy (Engraulis mordax) 97 ug/L

13. DISPOSAL CONSIDERATIONS

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): U019. Hazardous Waste Number(s): D018. Dispose of in accordance with U.S. EPA 40 CFR 262 for concentrations at or above the Regulatory level. Regulatory level- 0.5 mg/L. Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Benzene
ID NUMBER: UN1114
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Benzene
UN NUMBER: UN1114
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
Benzene: 10 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: Yes
FIRE: Yes
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
Benzene

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65:
Known to the state of California to cause the following:
Benzene
Cancer (Feb 27, 1987)
Developmental toxicity (Dec 26, 1997)
Male reproductive toxicity (Dec 26, 1997)

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: BD2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

MSDS SUMMARY OF CHANGES
8. EXPOSURE CONTROLS, PERSONAL PROTECTION

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1,1-Dichloroethene

1,1-DICHLOROETHYLENE

Division of Facilities Services
DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

1,1-DICHLOROETHYLENE

Section 1 - Product and Company Identification Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview Section 11 - Toxicological Information
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Section 1 - Product and Company Identification
1,1-DICHLOROETHYLENE

Product Identification: 1,1-DICHLOROETHYLENE
Date of MSDS: 10/16/1997 Technical Review Date: 05/06/1999

FSC: 6830 NIIN: LIIN: 00N090900
Submitter: N EN
Status Code: A
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information
Manufacturer's Name: SCOTT SPECIALTY GASES
Post Office Box: 310
Manufacturer's Address1: 6141 EASTON RD
Manufacturer's Address2: PLUMSTEADVILLE, PA 18949-0310
Manufacturer's Country: US
General Information Telephone: 215-766-8861
Emergency Telephone: 215-766-8861
Other Number for MSDS Information: 75-35-4/E-1
Emergency Telephone: 215-766-8861
Proprietary: N
Reviewed: Y
Published: Y
CAGE: 51847

Contractor Information
Contractor's Name: SCOTT SPECIALTY GASES
Post Office Box: 310
Contractor's Address1: 6141 EASTON RD
Contractor's Address2: PLUMSTEADVILLE, PA 18949-0310
Contractor's Telephone: 215-766-8861
Contract Number: N00406-98-M-Q646
Contractor's CAGE: 51847

Section 2 - Compositon/Information on Ingredients
1,1-DICHLOROETHYLENE

Ingredient Name: 1,1-DICHLOROETHYLENE
Ingredient CAS Number: 75-35-4 Ingredient CAS Code: T
RTECS Number: KV9275000 RTECS Code: T
=WT: =WT Code:
=Volume: =Volume Code:
>WT: 99. >WT Code: M

>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text:
% Enviromental Weight:
Other REC Limits: N/K (FP N)
OSHA PEL: 1 PPM OSHA PEL Code: M
OSHA STEL: 100 PPM OSHA STEL Code: M
ACGIH TLV: 20 MG/M3;5 PPM ACGIH TLV Code: T
ACGIH STEL: 79 MG/M3;20 PPM ACGIH STEL Code: T
EPA Reporting Quantity: 100 LBS
DOT Reporting Quantity: 100 LBS
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
1,1-DICHLOROETHYLENE

Health Hazards Acute & Chronic: ACUTE: INHALATION CAUSES IRRITATION OF THE RESPIRATORY TRACT. SYMPTOMS INCLUDE SHORTNESS OF BREATH, HEADACHE, CONFUSION,
NAUSEA, DIZZINESS, AND UNCONSCIOUSNESS. SEVERE EXPOSURE MAY CAUSE UNCONCIOUSN
ESS AND DEATH. EYE CONTACT MAY CAUSE IRRITATION, REDNESS, OR BLURRED VISION.
SKIN CONTACT CAN CAUSE DEFATTING AND DERMATITIS. CAN BE ABSORBED THROUGH THE
SKIN. INGESTION IRRITATES THE DIGESTIVE TR ACT AND MAY CAUSE PARTIAL PARALYSIS,
UNCONSCIOUSNESS AND KIDNEY DAMAGE. CHRONIC: KIDNEY AND LIVER DAMAGE. HEART
DAMAGE. ALTERATION OF GENETIC MATERIAL.

Signs & Symptoms of Overexposure:
NONE.

Medical Conditions Aggravated by Exposure:
NONE KNOWN.

LD50 LC50 Mixture: N/P

Route of Entry Indicators:
Inhalation: YES
Skin: YES
Ingestion: YES
Carcenogenicity Indicators
NTP: NO
IARC: NO
OSHA: NO
Carcinogenicity Explanation: N/P

Section 4 - First Aid Measures
1,1-DICHLOROETHYLENE

First Aid:
INHALATION: IMMEDIATELY REMOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED,
GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. EYES:
IMMEDIATELY FLUSH WITH COPIOUS AMOUNTS OF WA TER FOR AT LEAST 15 MINUTES.
SKIN:
IMMEDIATELY FLUSH WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE
REMOVING CONTAMINATED CLOTHING. INGESTION: NEVER GIVE ANYTHING BY MOUTH TO AN
UNCONSC IOUS PERSON. HAVE CONSCIOUS AND ALERT PERSON DRINK 1 TO 2 GLASSES OF
WATER. INDUCE VOMITING AFTER VICTIM DRINKS WATER. IN EVENT OF EXPOSURE, CONSULT
A PHYSICIAN. NOTE TO PHYSICIAN: NONE.

Section 5 - Fire Fighting Measures
1,1-DICHLOROETHYLENE

Fire Fighting Procedures:
WEAR NIOSH APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT (FP N). KEEP FIRE-EXPOSED
CYLINDERS COOL WITH WATER SPRAY. IF POSSIBLE, STOP THE PRODUCT FLOW.
Unusual Fire or Explosion Hazard:
EMITS TOXIC FUMES UNDER FIRE CONDITIONS. CYLINDER RUPTURE MAY OCCUR UNDER FIRE
CONDITIONS. HAZARDOUS COMBUSTION PRODUCTS: TOXIC CARBON MONOXIDE, HYDROGEN
CHLORIDE AND PHOSGENE.
Extinguishing Media:
CARBON DIOXIDE, FOAM, OR DRY CHEMICAL.
Flash Point: =-17.7C, -3.1F Flash Point Text:

Autoignition Temperature: =570.C, 1058.F
Autoignition Temperature Text:
Lower Limit(s): 7.3%
Upper Limit(s): 16%

Section 6 - Accidental Release Measures
1,1-DICHLOROETHYLENE

Spill Release Procedures:
REMOVE LEAKING CYLINDER TO EXHAUST HOOD OR SAFE OUTDOOR AREA IF THIS CAN BE DONE
SAFELY. EVACUATE AND VENTILATE AREA. USE A NIOSH APPROVED SCBA IN CASE OF EMERGENCY OR NON-ROUTINE USE. SHUT OFF SOU RCE IF POSSIBLE AND REMOVE SOURCE OF
HEAT. ABSORB WITH SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL. SPECIALIZED EQUIPMENT: NONE.

Section 7 - Handling and Storage
1,1-DICHLOROETHYLENE

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
1,1-DICHLOROETHYLENE

Repiratory Protection:
USE A NIOSH APPROVED SCBA IN CASE OF EMERGENCY OR NON-ROUTINE USE.
Ventilation:
PROVIDE ADEQUATE GENERAL AND LOCAL EXHAUST VENTILATION TO MAINTAIN CONCENTRATIONS BELOW EXPOSURE AND FLAMMABLE LIMITS.
Protective Gloves:
IMPERVIOUS GLOVES.
Eye Protection: ANSI APPROVED CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: EMERGENCY EYEWASH AND DELUGE SHOWER MEETING ANSI DESIGN CRITERIA (FP N). COVERALLS, BOOTS, AND/OR OTHER RESISTANT PROTECTIVE CLOTHING. SAFETY SHOES WHEN HANDLING CYLINDERS.
Work Hygenic Practices: N/P
Supplemental Health & Safety Information: N/P

Section 9 - Physical & Chemical Properties
1,1-DICHLOROETHYLENE

HCC:
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: =31.8C, 89.4F Boiling Point Text:
Melting/Freezing Point: Melting/Freezing Text: N/P
Decomposition Point: Decomposition Text: N/P
Vapor Pressure: 500 MM HG @ 20C Vapor Density: 3.25 AIR=1
Percent Volatile Organic Content:
Specific Gravity: 1.218 @ 20C (H*2O=1)
Volatile Organic Content Pounds per Gallon:
pH: N/P
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: N/K
Solubility in Water: INSOLUBLE
Appearance and Odor: COLORLESS LIQUID WITH SWEET CHLOROFORM ODOR.

Percent Volatiles by Volume: N/P
Corrosion Rate: N/P

Section 10 - Stability & Reactivity Data
1,1-DICHLOROETHYLENE

Stability Indicator: YES
Materials to Avoid:
POWDERED ALKALI OR ALKALINE EARTH METALS, STRONG OXIDIZING AGENTS.
Stability Condition to Avoid:
STORAGE IN POORLY VENTILATED AREAS. STORAGE NEAR A HEAT SOURCE. EXPOSURE TO
LIGHT, MOISTURE, AND IGNITION SOURCES.
Hazardous Decomposition Products:
HCL GAS, PHOSGENE GAS, CARBON MONOXIDE AND OXIDES OF CHLORINE.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
N/P

Section 11 - Toxicological Information
1,1-DICHLOROETHYLENE

Toxicological Information:
LETHAL CONCENTRATION (LC50): NONE. ESTABLISED LETHAL DOSE 50 (LD50): NOT APPLICABLE. TERATOGENICITY: NOT APPLICABLE. REPRODUCTIVE EFFECTS: NOT APPLICABLE. MUTAGENICITY: NOT APPLICABLE.

Section 12 - Ecological Information
1,1-DICHLOROETHYLENE

Ecological Information:
NO ADVERSE ECOLOGICAL EFFECTS ARE EXPECTED.

Section 13 - Disposal Considerations
1,1-DICHLOROETHYLENE

Waste Disposal Methods:
DISPOSE OF NON-REFILLABLE CYLINDERS I/A/W FEDERAL, STATE & LOCAL REGS. ALLOW GAS
TO VENT SLOWLY TO ATM IN UNCONFINED AREA/EXHAUST HOOD. IF CYLINDERS ARE THE
REFILLABLE TYPE, RETURN CYLINDER TO SUPPL IER W/ANY VALVE OUTLET PLUGS/ CAPS
SECURED & VALVE PROT CAPS IN PLACE. WASTE CAN BE BURNED IN APPROV ED INCINERATOR
EQUIPPED W/AFTERBURNER & SCRUBBER.

Section 14 - MSDS Transport Information
1,1-DICHLOROETHYLENE

Transport Information:
CONCENTRATION: 99+%. DOT DESCRIPTION (US ONLY): PROPER SHIPPING NAME: VINYLIDENE
CHLORIDE, INHIBITED; HAZARD CLASS: 3 (FLAMMABLE), PACKING GROUP I;
IDENTIFICATION NUMBER: UN1303; REPORTABLE QUANTI TIES: 100 LB; LABELING:
FLAMMABLE LIQUID. ADR/RID (EU ONLY): CLASS 3, 1A. SPECIAL PRECAUTIONS: CYLINDERS
SHOULD BE TRANSPORTED IN A SECURE UPRIGHT POSITION IN A WELL-VENTILATED TRUCK.

Section 15 - Regulatory Information
1,1-DICHLOROETHYLENE

SARA Title III Information:
THE THRESHOLD PLANNING QUANTITY FOR MATERIAL IS 10,000 LBS.
Federal Regulatory Information:
OSHA: PROCESS SAFETY MANAGEMENT: MATERIAL IS NOT LISTED IN APPENDIX A OF 29 CFR

1910.119 AS HIGHLY HAZARDOUS CHEMICAL. TSCA: MATERIAL IS LISTED IN TSCA INVENTORY. EU NUMBER: 200-864-0. NUMBER IN AN NEX 1 OF DIR 67/548: MATERIAL IS LISTED IN ANNEX 1. EU CLASSIFICATION: NOT AVAILABLE. R: 12-20-40. S: 7-16-29.
State Regulatory Information:
N/P

Section 16 - Other Information
1,1-DICHLOROETHYLENE

Other Information:
ODOR THRESHOLD: 500PPM.

HAZCOM Label Information
Product Identification: 1,1-DICHLOROETHYLENE
CAGE: 51847
Assigned Individual: N
Company Name: SCOTT SPECIALTY GASES
Company PO Box: 310
Company Street Address1: 6141 EASTON RD
Company Street Address2: PLUMSTEADVILLE, PA 18949-0310 US
Health Emergency Telephone: 215-766-8861
Label Required Indicator: Y
Date Label Reviewed: 05/06/1999
Status Code: A
Manufacturer's Label Number:
Date of Label:
Year Procured: N/K
Organization Code: F
Chronic Hazard Indicator: Y
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: WARNING
Health Hazard: Moderate
Contact Hazard: Moderate
Fire Hazard: None
Reactivity Hazard: None

8/9/2002 10:37:58 AM

Cis-1,2-Dichloroethene

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: CIS-1,2-DICHLOROETHYLENE

TRADE NAMES/SYNONYMS:
CIS-ACETYLENE DICHLORIDE; 1,2-DICHLOROETHYLENE; C2H2CL2; MAT05125; RTECS KV9420000

CHEMICAL FAMILY: halogenated, aliphatic

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 19 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: CIS-1,2-DICHLOROETHYLENE
CAS NUMBER: 156-59-2
PERCENTAGE: 100.0

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=3 REACTIVITY=2

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: pleasant odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire. May react on contact with air, heat, light or water.

POTENTIAL HEALTH EFFECTS:
INHALATION:

SHORT TERM EXPOSURE: irritation, nausea, vomiting, drowsiness, symptoms of drunkenness
LONG TERM EXPOSURE: no information on significant adverse effects
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: same as effects reported in short term exposure
EYE CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: same as effects reported in short term exposure
INGESTION:
SHORT TERM EXPOSURE: symptoms of drunkenness
LONG TERM EXPOSURE: no information on significant adverse effects

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: If vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For ingestion, consider gastric lavage. Consider oxygen.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Moderate explosion hazard. Vapor/air mixtures are explosive above flash point. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile).

Do not attempt to extinguish fire unless flow of material can be stopped first. Flood with fine water spray. Do not scatter spilled material with high-pressure water streams. Cool containers with water spray until well after the fire is out. Apply water from a protected location or from a safe distance. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas. Water may be ineffective.

FLASH POINT: 39 F (4 C) (CC)
LOWER FLAMMABLE LIMIT: 9.7%
UPPER FLAMMABLE LIMIT: 12.8%
FLAMMABILITY CLASS (OSHA): IB

6. ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry.

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
CIS-1,2-DICHLOROETHYLENE:
1,2-DICHLOROETHYLENE (ALL ISOMERS):
200 ppm (790 mg/m3) OSHA TWA
200 ppm ACGIH TWA
200 ppm (790 mg/m3) NIOSH recommended TWA 10 hour(s)

VENTILATION: Provide local exhaust ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles with a faceshield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
1000 ppm
Any supplied-air respirator operated in a continuous-flow mode.
Any powered, air-purifying respirator with organic vapor cartridge(s).
Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s).
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any self-contained breathing apparatus with a full facepiece.
Any supplied-air respirator with a full facepiece.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
COLOR: colorless
ODOR: pleasant odor
MOLECULAR WEIGHT: 96.94
MOLECULAR FORMULA: C2-H2-CL2
BOILING POINT: 140 F (60 C)
FREEZING POINT: -114 F (-81 C)
VAPOR PRESSURE: 400 mmHg @ 41 C
VAPOR DENSITY (air=1): 3.34
SPECIFIC GRAVITY (water=1): 1.2837
WATER SOLUBILITY: insoluble
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: Not available
EVAPORATION RATE: Not available
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: acetone, benzene, ether, alcohol

10. STABILITY AND REACTIVITY

REACTIVITY: May decompose on contact with air, light, moisture, heat or storage and use above room temperature. Releases toxic, corrosive, flammable or explosive gases.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may

rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: bases, metals, combustible materials, oxidizing materials, acids

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: phosgene, halogenated compounds, oxides of carbon

POLYMERIZATION: May polymerize. Avoid contact with incompatible materials.

11. TOXICOLOGICAL INFORMATION

CIS-1,2-DICHLOROETHYLENE:
TOXICITY DATA:
13700 ppm inhalation-rat LC50
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Slightly Toxic: inhalation
TARGET ORGANS: central nervous system
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: respiratory disorders
MUTAGENIC DATA: Available.

12. ECOLOGICAL INFORMATION

Not available

13. DISPOSAL CONSIDERATIONS

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): D001. Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: 1,2-Dichloroethylene
ID NUMBER: UN1150
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: 1,2-Dichloroethylene

UN NUMBER: UN1150
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4): Not regulated.

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: No
FIRE: Yes
REACTIVE: Yes
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
1,2-DICHLOROETHYLENE (ALL ISOMERS)

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: BD2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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1,2-dichloropropane

1,2-DICHLOROPROPANE, O-638

Division of Facilities Services
DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

1,2-DICHLOROPROPANE, O-638

Section 1 - Product and Company Identification Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview Section 11 - Toxicological Information
Section 4 - First Aid Measures Section 12 - Ecological Information
Section 5 - Fire Fighting Measures Section 13 - Disposal Considerations
Section 6 - Accidental Release Measures Section 14 - MSDS Transport Information
Section 7 - Handling and Storage Section 15 - Regulatory Information
Section 8 - Exposure Controls & Personal Protection Section 16 - Other Information

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Section 1 - Product and Company Identification

1,2-DICHLOROPROPANE, O-638

Product Identification: 1,2-DICHLOROPROPANE, O-638
Date of MSDS: 09/01/1988 Technical Review Date: 02/08/1996

FSC: 6810 NIIN: LIIN: 00N067785
Submitter: N EN
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information
Manufacturer's Name: CHEM SERVICE INC
Post Office Box: 3108
Manufacturer's Address1:
Manufacturer's Address2: WEST CHESTER, PA 19381
Manufacturer's Country: US
General Information Telephone: 215-692-3026
Emergency Telephone: 215-692-3026
Emergency Telephone: 215-692-3026
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: N
Published: Y
CAGE: 84898
Special Project Code: N

Contractor Information
Contractor's Name: CHEM SERVICE INC
Post Office Box: 3108
Contractor's Address1: N/K
Contractor's Address2: WEST CHESTER, PA 19381
Contractor's Telephone: 215-692-3026
Contractor's CAGE: 84898

Contractor Information
Contractor's Name: CHEM SERVICE, INC
Post Office Box: 599
Contractor's Address1: 660 TOWER LN
Contractor's Address2: WEST CHESTER, PA 19301-9650
Contractor's Telephone: 610-692-3026
Contractor's CAGE: 8Y898

Section 2 - Compositon/Information on Ingredients
1,2-DICHLOROPROPANE, O-638

Ingredient Name: PROPANE, 1,2-DICHLORO-; (1,2-DICHLOROPROPANE) (SARA 313) (CERCLA)
Ingredient CAS Number: 78-87-5 Ingredient CAS Code: M
RTECS Number: TX9625000 RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: N/K
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: 75 PPM OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 75 PPM; 110 STEL ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity: 1000 LBS
DOT Reporting Quantity: 1000 LBS
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
1,2-DICHLOROPROPANE, O-638

Health Hazards Acute & Chronic: ALL CHEMICALS SHOULD BE CONSIDERED HAZARDOUS - AVOID DIRECT PHYSICAL CONTACT! CAN BE HARMFUL IF ABSORBED THROUGH THE SKIN. CAN
BE HARMFUL IF INHALED. CAN CAUSE SKIN IRRITATION. CAN BE IRRITATING TO MU COUS
MEMBRANES. SUSPECTED CARCINOGEN-MAY PRODUCE CANCER. CAN CAUSE EYE IRRITATION.
CAN BE HARMFUL IF (EFTS OF OVEREXP)

Signs & Symptoms of Overexposure:
HLTH HAZ: SWALLOWED. PROLONGED EXPOSURE MAY CAUSE NAUSEA/HEADACHE/ DIZZINESS
AND/OR EYE DAMAGE. CAN CAUSE NERVOUS SYSTEM INJURY. CAN CAUSE LIVER INJURY. CAN
CAUSE KIDNEY INJURY. CAN CAUSE AN ALLERGIC S KIN REACTION. CAN BE IRRITATING TO
MUCOUS MEMBRANES.

Medical Conditions Aggravated by Exposure:
NONE SPECIFIED BY MANUFACTURER.

LD50 LC50 Mixture: LD50: (RAT) 2196 MG/KG

Route of Entry Indicators:
Inhalation: YES
Skin: YES
Ingestion: YES
Carcenogenicity Indicators
NTP: NO
IARC: NO
OSHA: NO
Carcinogenicity Explanation: NOT RELEVANT

Section 4 - First Aid Measures
1,2-DICHLOROPROPANE, O-638

First Aid:
ANTIDOTE IS SUBSTANCE INTENDED TO COUNTERACT EFT OF POISON. IT SHOULD BE ADMIN
ONLY BY MD/TRAINED EMER PERS. MED ADVICE CAN BE OBTAINED FROM POIS CTL CTR.
EYES:FLUSH CONTINUOUSLY W/WATER FOR AT LEAST 15-20 MIN. SKIN: FLUSH W/ WATER FOR
15-20 MIN. IF NO BURNS HAVE OCCURRED-USE SOAP & WATER TO CLEANSE SKIN. INHAL:
REMOVE TO FRESH AIR. ADMIN OXYGEN IF HAVING DFCLTY BRTHG. IF BRTHG HAS STOPPED
(SUPDAT)

Section 5 - Fire Fighting Measures
1,2-DICHLOROPROPANE, O-638

Fire Fighting Procedures:
USE NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire or Explosion Hazard:
THIS IS A FLAMMABLE CHEMICAL.
Extinguishing Media:
CARBON DIOXIDE, DRY CHEMICAL POWDER OR WATER SPRAY.
Flash Point: Flash Point Text: 39.2F,4.0C

Autoignition Temperature:
Autoignition Temperature Text: N/A
Lower Limit(s): 3.4%
Upper Limit(s): 14.5%

Section 6 - Accidental Release Measures
1,2-DICHLOROPROPANE, O-638

Spill Release Procedures:
EVACUATE AREA. WEAR APPROPRIATE OSHA-REGULATED EQUIPMENT. VENTILATE AREA. ABSORB
ON VERMICULITE OR SIMILAR MATERIAL. SWEEP UP AND PLACE IN AN APPROPRIATE CONTAINER. HOLD FOR DISPOSAL. WASH CONTAMINATE D SURFACES TO REMOVE ANY
RESIDUES.

Section 7 - Handling and Storage
1,2-DICHLOROPROPANE, O-638

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
1,2-DICHLOROPROPANE, O-638

Repiratory Protection:
USE NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation:
THIS CHEMICAL SHOULD BE HANDLED ONLY IN A HOOD.
Protective Gloves:
IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPRVD CHEM WORKERS GOGGLES (FP N).
Other Protective Equipment: ANSI APPROVED EYE WASH & DELUGE SHOWER (FP N). USE APPROPRIATE OSHA/MSHA APPROVED SAFETY EQUIPMENT.
Work Hygenic Practices: CONTACT LENSES SHOULD NOT BE WORN IN THE LABORATORY.
Supplemental Health & Safety Information: FIRST AID PROC: ADMIN ARTF RESP. IF IN CARD ARREST ADMIN CPR. CONTINUE LIFE SUPPORTING MEASURES UNTIL MED ASSISTANCE
HAS ARRIVED.

Section 9 - Physical & Chemical Properties
1,2-DICHLOROPROPANE, O-638

HCC:
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: 205F,96C
Melting/Freezing Point: Melting/Freezing Text: -148F,-100C
Decomposition Point: Decomposition Text: N/K
Vapor Pressure: 40 @ 20C Vapor Density: N/K
Percent Volatile Organic Content:
Specific Gravity: 1.156
Volatile Organic Content Pounds per Gallon:
pH: N/K
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: N/K
Solubility in Water: INSOL (IMMISCIBLE)

Appearance and Odor: COLORLESS LIQUID; ETHER LIKE ODOR.
Percent Volatiles by Volume: N/K
Corrosion Rate: N/K

Section 10 - Stability & Reactivity Data
1,2-DICHLOROPROPANE, O-638

Stability Indicator: YES
Materials to Avoid:
INCOMPATIBLE WITH STRONG BASES. INCOMPATIBLE WITH STRONG OXIDIZING AGENTS.
INCOMPATIBLE WITH STRONG ACIDS.
Stability Condition to Avoid:
FLAMMABLE. DO NOT USE MAGNESIUM/ALUMINUM OR THEIR ALLOYS AS CONTAINERS.
Hazardous Decomposition Products:
DECOMPOSITION LIBERATES TOXIC FUMES. DECOMPOSITION PRODUCTS ARE CORROSIVE.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
NOT RELEVANT

Section 11 - Toxicological Information
1,2-DICHLOROPROPANE, O-638

Toxicological Information:
N/P

Section 12 - Ecological Information
1,2-DICHLOROPROPANE, O-638

Ecological Information:
N/P

Section 13 - Disposal Considerations
1,2-DICHLOROPROPANE, O-638

Waste Disposal Methods:
DISPOSAL MUST BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N).
BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.

Section 14 - MSDS Transport Information
1,2-DICHLOROPROPANE, O-638

Transport Information:
N/P

Section 15 - Regulatory Information
1,2-DICHLOROPROPANE, O-638

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
1,2-DICHLOROPROPANE, O-638

Other Information:
N/P

HAZCOM Label Information
Product Identification: 1,2-DICHLOROPROPANE, O-638
CAGE: 84898
Assigned Individual: N
Company Name: CHEM SERVICE INC
Company PO Box: 3108
Company Street Address1: N/K
Company Street Address2: WEST CHESTER, PA 19381 US
Health Emergency Telephone: 215-692-3026
Label Required Indicator: Y
Date Label Reviewed: 02/08/1996
Status Code: C
Manufacturer's Label Number:
Date of Label: 02/08/1996
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: Y
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: DANGER
Health Hazard: Moderate
Contact Hazard: Slight
Fire Hazard: Severe
Reactivity Hazard: None

8/9/2002 9:28:23 AM

Ethyl Benzene

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: ETHYL BENZENE

TRADE NAMES/SYNONYMS:
MTG MSDS 185; BENZENE, ETHYL-; EB; PHENYLETHANE; ETHYLBENZENE; ETHYLBENZOL; ALPHA-METHYLTOLUENE; UN 1175; C8H10; MAT08780

CHEMICAL FAMILY: hydrocarbons, aromatic

CREATION DATE: Jan 24 1989
REVISION DATE: Dec 15 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: ETHYL BENZENE
CAS NUMBER: 100-41-4
PERCENTAGE: 100

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=3 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: aromatic odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, aspiration hazard, central nervous system depression, suspect cancer hazard (in animals)
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:
INHALATION:
SHORT TERM EXPOSURE: irritation (possibly severe), chest pain, difficulty breathing, headache,

drowsiness, dizziness, loss of coordination, coma
LONG TERM EXPOSURE: irritation, headache, drowsiness, emotional disturbances, cancer
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe)
LONG TERM EXPOSURE: irritation
EYE CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe)
LONG TERM EXPOSURE: irritation
INGESTION:
SHORT TERM EXPOSURE: nausea, vomiting, stomach pain, aspiration hazard
LONG TERM EXPOSURE: no information on significant adverse effects

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get immediate medical attention. Thoroughly clean and dry contaminated clothing and shoes before reuse. Destroy contaminated shoes.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: Contact local poison control center or physician immediately. Never make an unconscious person vomit or drink fluids. When vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For inhalation, consider oxygen. For ingestion, consider gastric lavage and activated charcoal slurry.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Vapor/air mixtures are explosive above flash point. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Electrostatic discharges may be generated by flow or agitation resulting in ignition or explosion.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is

impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT: 59 F (15 C) (CC)
LOWER FLAMMABLE LIMIT: 0.8%
UPPER FLAMMABLE LIMIT: 6.7%
AUTOIGNITION: 810 F (432 C)
FLAMMABILITY CLASS (OSHA): IB

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Stay upwind and keep out of low areas.

SOIL RELEASE:
Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Absorb with sand or other non-combustible material.

WATER RELEASE:
Cover with absorbent sheets, spill-control pads or pillows. Neutralize. Collect with absorbent into suitable container. Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Protect from physical damage. Store outside or in a detached building. Store with flammable liquids. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
ETHYL BENZENE:
100 ppm (435 mg/m3) OSHA TWA
125 ppm (543 mg/m3) OSHA STEL (vacated by 58 FR 35338, June 30, 1993)
100 ppm ACGIH TWA
125 ppm ACGIH STEL
100 ppm (435 mg/m3) NIOSH recommended TWA 10 hour(s)
125 ppm (545 mg/m3) NIOSH recommended STEL

VENTILATION: Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles with a faceshield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
800 ppm
Any chemical cartridge respirator with organic vapor cartridge(s).
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any powered, air-purifying respirator with organic vapor cartridge(s).
Any supplied-air respirator.
Any self-contained breathing apparatus with a full facepiece.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
COLOR: colorless
ODOR: aromatic odor
MOLECULAR WEIGHT: 106.17
MOLECULAR FORMULA: C-H3-C-H2-C6-H5
BOILING POINT: 277 F (136 C)
FREEZING POINT: -139 F (-95 C)
VAPOR PRESSURE: 7.1 mmHg @ 20 C

VAPOR DENSITY (air=1): 3.66
SPECIFIC GRAVITY (water=1): 0.8670
WATER SOLUBILITY: 0.015%
PH: Not available
VOLATILITY: 100%
ODOR THRESHOLD: 140 ppm
EVAPORATION RATE:
VISCOSITY: 0.64 cP @ 25 C
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, benzene, sulfur dioxide, carbon tetrachloride
Insoluble: ammonia

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: acids, bases, oxidizing materials, combustible materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of carbon

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

ETHYL BENZENE:
IRRITATION DATA:
15 mg/24 hour(s) open skin-rabbit mild; 500 mg eyes-rabbit severe
TOXICITY DATA:
17800 ul/kg skin-rabbit LD50; 3500 mg/kg oral-rat LD50
CARCINOGEN STATUS: IARC: Human Inadequate Evidence, Animal Sufficient Evidence, Group 2B; ACGIH: A3 -Animal Carcinogen
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Moderately Toxic: ingestion
Slightly Toxic: dermal absorption
TARGET ORGANS: central nervous system
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: kidney disorders, liver disorders, respiratory disorders, skin disorders and allergies
TUMORIGENIC DATA: Available.

MUTAGENIC DATA: Available.
REPRODUCTIVE EFFECTS DATA: Available.
ADDITIONAL DATA: May cross the placenta.

12. ECOLOGICAL INFORMATION

FATE AND TRANSPORT:
KOW: 154170.05 (log = 5.196) (estimated from water solubility)

KOC: 44668.36 (log = 4.657) (estimated from water solubility)

HENRY'S LAW CONSTANT: 6.6 E -3 atm-m3/mol

BIOCONCENTRATION: 36.39 (estimated from water solubility)

AQUATIC PROCESSES: 2.6730095 hours (River Model: 1 m deep, 1 m/s flow, 3 m/s wind)

ENVIRONMENTAL SUMMARY: Relatively non-persistent in the environment. Not expected to leach through the soil or the sediment. Accumulates very little in the bodies of living organisms. Highly volatile from water.

13. DISPOSAL CONSIDERATIONS

Dispose in accordance with all applicable regulations. Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): D001.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Ethylbenzene
ID NUMBER: UN1175
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Ethylbenzene
UN NUMBER: UN1175
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
ETHYL BENZENE: 1000 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: Yes
FIRE: Yes
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
ETHYL BENZENE

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: B2.

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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Hydrochloric Acid

HYDROCHLORIC ACID (10%-33%)

MSDS Number: H3886 * * * * * Effective Date: 05/07/03 * * * * * Supercedes: 11/12/01

HYDROCHLORIC ACID (10%-33%)

1. Product Identification

Synonyms: This MSDS applies to the concentrated standard used to make laboratory solutions and any solution that contains more than 10% but less than 33% Hydrochloric acid. For diluted product, see MSDS for Hydrochloric Acid (less than 10%). For saturated solution
CAS No.: 7647-01-0
Molecular Weight: 36.46
Chemical Formula: HCl in H2O
Product Codes:
J.T. Baker: 0323, 0327, 4654, 4657, 5618, 5619
Mallinckrodt: 2608, 2609, 2625, H151, H168, V035, V328

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hydrogen Chloride	7647-01-0	10 - 33%	Yes
Water	7732-18-5	67 - 90%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED.

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 (Corrosive)

Potential Health Effects

Inhalation:
Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.
Ingestion:
Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea, and in severe cases, death.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.
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. Long term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

4. First Aid Measures
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
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.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. May react with metals or heat to release flammable hydrogen gas.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Water or water spray. Neutralize with soda ash or slaked lime.
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. Structural firefighter's protective clothing is ineffective for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out.

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® or TEAM® 'Low Na+' 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.

When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. 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:
For Hydrochloric acid:
- OSHA Permissible Exposure Limit (PEL):
5 ppm (Ceiling)
- ACGIH Threshold Limit Value (TLV):
2 ppm (Ceiling), A4 Not classifiable as a human carcinogen

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 full facepiece respirator with an acid gas cartridge 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. 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:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure 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.

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Pungent odor.
Solubility:
Infinitely soluble.

Density:
1.05 @ 15C (59F)
pH:
For HCL solutions: 0.1 (1.0 N), 1.1 (0.1 N), 2.02 (0.01 N)
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
101 - 103C (214 - 217F)
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:
When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A strong mineral acid, concentrated hydrochloric acid is highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.
Conditions to Avoid:
Heat, direct sunlight.

11. Toxicological Information

Hydrochloric acid: Inhalation rat LC50: 3124 ppm/1H; Oral rabbit LD50: 900 mg/kg. Investigated as a tumorigen, mutagen, reproductive effector.

--------\Cancer Lists\----------

	---NTP Carcinogen---		
Ingredient	Known	Anticipated	IARC Category
---	---	---	---

Hydrogen Chloride (7647-01-0)	No	No	3
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to biodegrade. When released into the soil, this material may leach into groundwater.
Environmental Toxicity:
This material is expected to be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste 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

Domestic (Land, D.O.T.)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
Packing Group: II
Information reported for product/size: 200L

International (Water, I.M.O.)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
Packing Group: II
Information reported for product/size: 200L

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Hydrogen Chloride (7647-01-0)	Yes	Yes	Yes	Yes

```
Water (7732-18-5)                          Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\--------------------------------
                                          --Canada--
Ingredient                                Korea  DSL   NDSL  Phil.
---------------------------------------------- -----  ---   ----  -----
Hydrogen Chloride (7647-01-0)                   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.
---------------------------------------- ---   -----   ----  --------------
Hydrogen Chloride (7647-01-0)            5000  500*    Yes       No
Water (7732-18-5)                     No    No      No        No

--------\Federal, State & International Regulations - Part 2\----------------
                                          -RCRA-    -TSCA-
Ingredient                            CERCLA     261.33     8(d)
---------------------------------------- ------     ------    ------
Hydrogen Chloride (7647-01-0)            5000       No        No
Water (7732-18-5)                     No        No        No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No         (Mixture / Liquid)


Australian Hazchem Code: 2R
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: 3 Flammability: 0 Reactivity: 0
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY
TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Avoid breathing vapor or mist.
Keep container closed.
Use 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. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician.
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.)

Klozur™

MATERIAL SAFETY DATA SHEET

Klozür™

MSDS Ref. No.: 7775-27-1-12
Date Approved: 02/22/2005
Revision No.: 1

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazardous Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	Klozür™
SYNONYMS:	Sodium Persulfate, Sodium Peroxydisulfate; Disodium Peroxydisulfate
GENERAL USE:	In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications.

MANUFACTURER

FMC CORPORATION
Active Oxidants Division
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)

EMERGENCY TELEPHONE NUMBERS

(800) 424-9300 (CHEMTREC - U.S.)
(303) 595-9048 (Medical - Call Collect)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

- White, odorless, crystals
- Oxidizer.
- Decomposes in storage under conditions of moisture (water/water vapor) and/or excessive heat causing release of oxides of sulfur and oxygen that supports combustion. Decomposition could form a high temperature melt. See Section 10 ("Stability and Reactivity").

POTENTIAL HEALTH EFFECTS: Airborne persulfate dust may be irritating to eyes, nose, lungs, throat and skin upon contact. Exposure to high levels of persulfate dust may cause difficulty in breathing in sensitive persons.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%	EC No.	EC Class
Sodium Persulfate	7775-27-1	>99	231-892-1	Not classified as hazardous

4. FIRST AID MEASURES

EYES: Flush with plenty of water. Get medical attention if irritation occurs and persists.

SKIN: Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: This product has low oral toxicity and is not irritating to the eyes and skin. Flooding of exposed areas with water is suggested, but gastric lavage or emesis induction for ingestions must consider possible aggravation of esophageal injury and the expected absence of system effects. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Deluge with water.

FIRE / EXPLOSION HAZARDS: Product is non-combustible. On decomposition releases oxygen which may intensify fire. Presence of water accelerates decomposition.

FIRE FIGHTING PROCEDURES: Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect on decomposing persulfates. Wear full protective clothing and self-contained breathing apparatus.

FLAMMABLE LIMITS: Non-combustible

SENSITIVITY TO IMPACT: No data available

SENSITIVITY TO STATIC DISCHARGE: Not available

6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to regulatory agencies procedures.

7. HANDLING AND STORAGE

HANDLING: Use adequate ventilation when transferring product from bags or drums. Wear respiratory protection if ventilation is inadequate or not available. Use eye and skin protection. Use clean plastic or stainless steel scoops only.

STORAGE: Store (unopened) in a cool, clean, dry place away from point sources of heat, e.g. radiant heaters or steam pipes. Use first in, first out storage system. Avoid contamination of opened product. In case of fire or decomposition (fuming/smoking) deluge with plenty of water to control decomposition. For storage, refer to NFPA Bulletin 430 on storage of liquid and solid oxidizing materials.

COMMENTS: VENTILATION: Provide mechanical general and/or local exhaust ventilation to prevent release of dust into work environment. Spills should be collected into suitable containers to prevent dispersion into the air.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Sodium Persulfate	0.1 mg/m^3 (TWA)		

ENGINEERING CONTROLS: Provide mechanical local general room ventilation to prevent release of dust into the work environment. Remove contaminated clothing immediately and wash before reuse.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Use cup type chemical goggles. Full face shield may be used.

RESPIRATORY: Use approved dust respirator when airborne dust is expected.

PROTECTIVE CLOTHING: Normal work clothes. Rubber or neoprene footwear.

GLOVES: Rubber or neoprene gloves. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	None
APPEARANCE:	White crystals
AUTOIGNITION TEMPERATURE:	Not applicable. No evidence of combustion up to 800°C. Decomposition will occur upon heating.
BOILING POINT:	Not applicable
COEFFICIENT OF OIL / WATER:	Not applicable
DENSITY / WEIGHT PER VOLUME:	Not available
EVAPORATION RATE:	Not applicable (Butyl Acetate = 1)
FLASH POINT:	Non-combustible
MELTING POINT:	Decomposes
ODOR THRESHOLD:	Not applicable
OXIDIZING PROPERTIES:	Oxidizer
PERCENT VOLATILE:	Not applicable
pH:	typically 5.0 - 7.0 @ 25 °C (1% solution)
SOLUBILITY IN WATER:	73 % @ 25 °C (by wt.)
SPECIFIC GRAVITY:	2.6 (H_2O=1)
VAPOR DENSITY:	Not applicable (Air = 1)
VAPOR PRESSURE:	Not applicable

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID:	Heat, moisture and contamination.
STABILITY:	Stable (becomes unstable in presence of heat, moisture and/or contamination).
POLYMERIZATION:	Will not occur
INCOMPATIBLE MATERIALS:	Acids, alkalis, halides (fluorides, chlorides, bromides and iodides), combustible materials, most metals and heavy metals, oxidizable materials, other oxidizers, reducing agents, cleaners, and organic or carbon containing compounds. Contact

with incompatible materials can result in a material decomposition or other uncontrolled reactions.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxygen that supports combustion and oxides of sulfur.

COMMENTS: PRECAUTIONARY STATEMENT: Pumping and transport of Klozür persulfate requires appropriate precautions and design considerations for pressure and thermal relief.

Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated.

Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

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11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Non-irritating (rabbit) [FMC Study Number: ICG/T-79.029]

SKIN EFFECTS: Non-irritating (rabbit) [FMC Study Number: ICG/T-79.029]

DERMAL LD_{50}: > 10 g/kg [FMC Study Number: ICG/T-79.029]

ORAL LD_{50}: 895 mg/kg (rat) [FMC Study Number: ICG/T-79.029]

INHALATION LC_{50}: 5.1 mg/l (rat) [FMC I95-2017]

SENSITIZATION: May be sensitizing to allergic persons. [FMC Study Number: ICG/T-79.029]

TARGET ORGANS: Eyes, skin, respiratory passages

ACUTE EFFECTS FROM OVEREXPOSURE: Dust may be harmful and irritating. May be harmful if swallowed.

CHRONIC EFFECTS FROM OVEREXPOSURE: Sensitive persons may develop dermatitis and asthma [Respiration 38:144, 1979]. Groups of male and female rats were fed 0, 300 or 3000 ppm sodium persulfate in the diet for 13 weeks, followed by 5000 ppm for 5 weeks. Microscopic examination of tissues revealed some injury to the gastrointestinal tract at the high dose (3000 ppm) only. This effect is not unexpected for an oxidizer at high concentrations. [Ref. FMC I90-1151, Toxicologist 1:149, 1981].

CARCINOGENICITY:

NTP:	Not listed
IARC:	Not listed
OSHA:	Not listed
OTHER:	ACGIH: Not listed

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION:

Bluegill sunfish, 96-hour LC_{50} = 771 mg/L [FMC Study I92-1250]
Rainbow trout, 96-hour LC_{50} = 163 mg/L [FMC Study I92-1251]
Daphnia, 48-hour LC_{50} = 133 mg/L [FMC Study I92-1252]
Grass shrimp, 96-hour LC_{50} = 519 mg/L [FMC Study I92-1253]

CHEMICAL FATE INFORMATION: Biodegradability does not apply to inorganic substances.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Dispose as a hazardous waste in accordance with local, state and federal regulatory agencies.

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME:	Sodium Persulfate
PRIMARY HAZARD CLASS / DIVISION:	5.1 (Oxidizer)
UN/NA NUMBER:	UN 1505
PACKING GROUP:	III
LABEL(S):	5.1 (Oxidizer)
PLACARD(S):	5.1 (Oxidizer)
MARKING(S):	Sodium Persulfate, UN 1505
ADDITIONAL INFORMATION:	Hazardous Substance/RQ: Not applicable

49 STCC Number: 4918733

This material is shipped in 225 lb. fiber drums, 55 lb. poly bags and 1000 - 2200 lb. IBC's (supersacks).

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

PROPER SHIPPING NAME: Sodium Persulfate

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

PROPER SHIPPING NAME: Sodium Persulfate

OTHER INFORMATION:

Protect from physical damage. Do not store near acids, moisture or heat.

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15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):
Not applicable

SECTION 311 HAZARD CATEGORIES (40 CFR 370):
Fire Hazard, Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):
Not listed

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):
Unlisted, RQ = 100 lbs., Ignitability

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA INVENTORY STATUS (40 CFR 710):

Listed

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):
Waste Number: D001

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

Product Identification Number: 1505
Hazard Classification / Division: Class C (Oxidizer), Class D, Div. 2, Subdiv. B. (Toxic)
Ingredient Disclosure List: Listed

INTERNATIONAL LISTINGS

Sodium persulfate:
Australia (AICS): Listed
China: Listed
Japan (ENCS): (1)-1131
Korea: KE-12369
Philippines (PICCS): Listed

HAZARD, RISK AND SAFETY PHRASE DESCRIPTIONS:

EC Symbols: (Not classified as hazardous)

EC Risk Phrases: (Not classified as hazardous)

EC Safety Phrases: (Not classified as hazardous)

16. OTHER INFORMATION

HMIS

Health	1
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe

3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

NFPA

Health	1
Flammability	0
Reactivity	1
Special	OX

SPECIAL = OX (Oxidizer)

NFPA = National Fire Protection Association

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

REVISION SUMMARY:
New MSDS

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Nitric Acid

NITRIC ACID, 50-70%

MSDS Number: N3660 * * * * * Effective Date: 07/02/02 * * * * * Supercedes: 07/13/00

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: HNO3
Product Codes:
J.T. Baker: 411D, 412D, 5371, 5796, 5801, 5826, 5856, 5876, 5896, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9608, 9610, 9616, 9617, 9670
Mallinckrodt: 1409, 2704, 2716, 6623, H862, H993, H998, V077, V633, 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.

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.

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® or TEAM® 'Low Na+' 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.

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.

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.

11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- 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 (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 150LB

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 150LB

International (Air, I.C.A.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 150LB

15. Regulatory Information

--------\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	DSL	NDSL	--Canada-- 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	-RCRA- CERCLA	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: 3.
Disclaimer:
****

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Bis-(2-ethylhexyl) phthalate

BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Division of Facilities Services
DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Section 1 - Product and Company Identification Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview Section 11 - Toxicological Information
Section 4 - First Aid Measures Section 12 - Ecological Information
Section 5 - Fire Fighting Measures Section 13 - Disposal Considerations
Section 6 - Accidental Release Measures Section 14 - MSDS Transport Information
Section 7 - Handling and Storage Section 15 - Regulatory Information
Section 8 - Exposure Controls & Personal Protection Section 16 - Other Information

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Section 1 - Product and Company Identification
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Product Identification: BIS(2-ETHYLHEXYL)PHTHALATE, 0-516
Date of MSDS: 01/25/1995 Technical Review Date: 07/23/1997

FSC: 6810 NIIN: LIIN: 00N077996
Submitter: N EN
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information
Manufacturer's Name: CHEM SERVICE INC
Post Office Box: 3108
Manufacturer's Address1:
Manufacturer's Address2: WEST CHESTER, PA 19381
Manufacturer's Country: US
General Information Telephone: 610-692-3026
Emergency Telephone: 610-692-3026
Emergency Telephone: 610-692-3026
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: N
Published: Y
CAGE: 84898
Special Project Code: N

Contractor Information
Contractor's Name: CHEM SERVICE INC
Post Office Box: 3108
Contractor's Address1: N/K
Contractor's Address2: WEST CHESTER, PA 19381
Contractor's Telephone: 215-692-3026
Contractor's CAGE: 84898

Contractor Information
Contractor's Name: CHEM SERVICE, INC
Post Office Box: 599
Contractor's Address1: 660 TOWER LN
Contractor's Address2: WEST CHESTER, PA 19301-9650
Contractor's Telephone: 610-692-3026
Contractor's CAGE: 8Y898

Section 2 - Compositon/Information on Ingredients
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Ingredient Name: ING 1:LD50:(ORAL,RAT) 31,000 MG/KG.
Ingredient CAS Number: Ingredient CAS Code: X
RTECS Number: 9999999ZZ RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: N/K
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: N/K (FP N) OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: N/K (FP N) ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical:

Ingredient Name: PHTHALIC ACID, BIS(2-ETHYLHEXYL) ESTER;
(BIS(2-ETHYLHEXYL)PHTHALATE) (SARA 313) (CERCLA). (ING 2)
Ingredient CAS Number: 117-81-7 Ingredient CAS Code: M
RTECS Number: TI0350000 RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: N/K
% Enviromental Weight:
Other REC Limits: N/K

OSHA PEL: 5 MG/M3 OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 5 MG/M3 ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity: 100 LBS
DOT Reporting Quantity: 100 LBS
Ozone Depleting Chemical: N

Ingredient Name: SUPP DATA:OBTAINED FROM A POISON CONTROL CENTER.
Ingredient CAS Number: Ingredient CAS Code: X
RTECS Number: 9999999ZZ RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: N/K
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: NOT APPLICABLE OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: NOT APPLICABLE ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical:

Section 3 - Hazards Identification, Including Emergency Overview
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Health Hazards Acute & Chronic: ALL CHEMICALS SHOULD BE CONSIDERED HAZARDOUS - AVOID DIRECT PHYSICAL CONTACT! MAY BE HARMFUL IF INHALED, SWALLOWED OR ABSORBED
THROUGH SKIN. DUST AND/OR VAPORS CAN CAUSE IRRITATION TO RESPIRATORY

TRAC T. CAN
BE IRRITATING TO MUCOUS MEMBRANES. CAN CAUSE EYE AND SKIN IRRITATION.
PROPOSITION 65 - THIS (EFTS OF OVEREXP)

Signs & Symptoms of Overexposure:
HLTH HAZ:CHEMICAL IS CONSIDERED TO BE A CARCINOGEN BY THE STATE OF CALIFORNIA.
THIS COMPOUND IS GENERALLY CONSIDERED TO BE NON-TOXIC.

Medical Conditions Aggravated by Exposure:
NONE SPECIFIED BY MANUFACTURER.

LD50 LC50 Mixture: SEE INGREDIENT 1.

Route of Entry Indicators:
Inhalation: YES
Skin: YES
Ingestion: YES
Carcenogenicity Indicators
NTP: YES
IARC: YES
OSHA: NO
Carcinogenicity Explanation: PHTHALIC ACID, BIS(2-ETHYLHEXYL)ESTER:IARC MONOGRAPHS, SUPP, VOL 7, PG 56, 1989:GRP 2B. NTP 7TH ANNUAL RPT ON (SUPDAT)

Section 4 - First Aid Measures
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

First Aid:
INGEST:CALL MD IMMED (FP N). EYES:FLUSH CONTINUOUSLY W/WATER FOR AT LST 15-20
MINS. SKIN:FLUSH W/WATER FOR 15-20 MINS. IF NO BURNS HAVE OCCURRED-USE SOAP &
WATER TO CLEANSE. DO NOT WEAR SHOES/CLTHG UN TIL ABSOLUTELY FREE OF ALL CHEM
ODORS. INHAL:REMOVE PATIENT TO FRESH AIR. ADMIN OXYG IF PATIENT IS HAVING DFCLTY
BRTHG. IF PATIENT HAS STOPPED BRTHG ADMIN ARTF RESP. IF PATIENT IS IN CARD (SUPP
DATA)

Section 5 - Fire Fighting Measures
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Fire Fighting Procedures:
USE NIOSH APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire or Explosion Hazard:
NO EXPLOSION LIMITS ARE AVAILABLE FOR THIS COMPOUND.
Extinguishing Media:
CARBON DIOXIDE OR DRY CHEMICAL POWDER. DO NOT USE WATER!
Flash Point: Flash Point Text: N/K

Autoignition Temperature:
Autoignition Temperature Text: N/A
Lower Limit(s): N/K
Upper Limit(s): N/K

Section 6 - Accidental Release Measures
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Spill Release Procedures:
EVACUATE AREA. WEAR APPROPRIATE OSHA REGULATED EQUIPMENT. VENTILATE AREA. ABSORB
ON VERMICULITE OR SIMILAR MATERIAL. SWEEP UP & PLACE IN APPROPRIATE CONTAINER.
HOLD FOR DISPOSAL. WASH CONTAMINATED SUR FACES TO REMOVE ANY RESIDUES.

Section 7 - Handling and Storage
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Repiratory Protection:
NIOSH APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation:
THIS CHEMICAL SHOULD BE HANDLED ONLY IN A HOOD.
Protective Gloves:
IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPROVED CHEM WORKERS GOGGS (FP N).
Other Protective Equipment: EYE WASH FOUNTAIN & DELUGE SHOWER WHICH MEET ANSI DESIGN CRITERIA (FP N). USE APPROPRIATE OSHA APPROVED SAFETY EQUIP.
Work Hygenic Practices: CONTACT LENSES SHOULD NOT BE WORN IN THE LABORATORY.
Supplemental Health & Safety Information: EXPLAN OF CARCIN:CARCINS, 1994:ANTIC
TO BE CARCIN. ANIMAL:LIVER, TESTES. FIRST AID PROC:ARREST ADMIN CPR. CONTINUE
LIFE SUPPORTING MEASURES UNTIL MED ASSISTANCE HAS ARRIVED. NOTE:AN ANTIDOTE IS A
SUBS TANCE INTENDED TO COUNTERACT EFT OF A POIS. IT SHOULD BE ADMIN ONLY BY
MD/TRAINED EMER PERS. MED ADVICE CAN BE (ING 3)

Section 9 - Physical & Chemical Properties
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

HCC:
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: 729F,387C
Melting/Freezing Point: Melting/Freezing Text: -51F,-46C
Decomposition Point: Decomposition Text: N/K
Vapor Pressure: <0.01 @20C Vapor Density: N/K
Percent Volatile Organic Content:
Specific Gravity: 0.981
Volatile Organic Content Pounds per Gallon:
pH: N/K
Volatile Organic Content Grams per Liter:

Viscosity: N/P
Evaporation Weight and Reference: N/K
Solubility in Water: INSOL (IMMISCIBLE)
Appearance and Odor: COLORLESS LIQUID.
Percent Volatiles by Volume: N/K
Corrosion Rate: N/K

Section 10 - Stability & Reactivity Data
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Stability Indicator: YES
Materials to Avoid:
INCOMPATIBLE W/STRONG OXIDIZING AGENTS.
Stability Condition to Avoid:
NONE SPECIFIED BY MANUFACTURER.
Hazardous Decomposition Products:
DECOMPOSITION LIBERATES TOXIC FUMES.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
NOT RELEVANT

Section 11 - Toxicological Information
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Toxicological Information:
N/P

Section 12 - Ecological Information
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Ecological Information:
N/P

Section 13 - Disposal Considerations
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Waste Disposal Methods:
DISPOSAL MUST BE I/A/W FEDERAL, STATE & LOCAL REGULATIONS (FP N). BURN IN A CHEMICAL INCINERATOR EQUIPPED W/AFTERBURNER & SCRUBBER.

Section 14 - MSDS Transport Information
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Transport Information:
N/P

Section 15 - Regulatory Information
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
BIS(2-ETHYLHEXYL)PHTHALATE, 0-516

Other Information:
N/P

HAZCOM Label Information
Product Identification: BIS(2-ETHYLHEXYL)PHTHALATE, 0-516
CAGE: 84898

Assigned Individual: N
Company Name: CHEM SERVICE INC
Company PO Box: 3108
Company Street Address1: N/K
Company Street Address2: WEST CHESTER, PA 19381 US
Health Emergency Telephone: 610-692-3026
Label Required Indicator: Y
Date Label Reviewed: 07/23/1997
Status Code: C
Manufacturer's Label Number:
Date of Label: 07/23/1997
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: Y
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: DANGER
Health Hazard: Severe
Contact Hazard: Moderate
Fire Hazard: None
Reactivity Hazard: None

8/9/2002 9:59:59 AM

Potassium Permanganate

CARUS CHEMICAL COMPANY -- CAIROX POTASSIUM PERMANGANATE

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MSDS Safety Information

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FSC: 6810
NIIN: 00-264-6620
MSDS Date: 05/01/2000
MSDS Num: CLBPR
Product ID: CAIROX POTASSIUM PERMANGANATE
MFN: 01
Responsible Party
Cage: TO644
Name: CARUS CHEMICAL COMPANY
Address: 1500 EIGHTH STREET
Box: 1500
City: LASALLE IL 61301
Info Phone Number: 815-223-1500
Emergency Phone Number: (800)424-9300

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Item Description Information

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Item Manager: S9G
Item Name: POTASSIUM PERMANGANATE,TECHNICAL
Specification Number: MIL-P-11970
Type/Grade/Class: NONE
Unit of Issue: DR
Quantitative Expression: 00000000110LB
UI Container Qty: 1
Type of Container: DRUM

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Ingredients

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Cas: 7722-64-7
RTECS #: SD6475000
Name: POTASSIUM PERMANGANATE
Percent by Wt: 97.
OSHA PEL: C5 MG/M3 OF AIR
ACGIH TLV: 0.2 MG/M3 OF AIR
ACGIH STEL: NOT ESTABLISHED
EPA Rpt Qty: 100 LBS
DOT Rpt Qty: 100 LBS

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Health Hazards Data

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Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: EYE: POTASSIUM PERMANGANATE IS DAMAGING TO EYE TISSUE ON CONTACT. IT MAY CAUSE SEVERE BURNS THAT RESULT IN DAMAGE TO THE EYE. SKIN: CONTACT OF SOLUTIONS AT ROOM TEMPERATURE MAY BE IRRITATING TO THE SK IN, LEAVING BROWN STAINS. CONCENTRATED SOLUTIONS AT ELEVATED TEMPERATURE AND CRYSTALS ARE DAMAGING TO THE SKIN. INHALATION: ACUTE INHALATIION TOXICITY DATA NOT AVAILABLE. HOWEVER, AIRBORNE CONCENTRATI ONS OF POTASSIUM PERMANGANATE IN THE FORM OF DUST OR MIST MAY CAUSE DAMAGE TO THE RESPIRATORY TRACT. INGESTION: POTASSIUM PERMANANATE IF SWALLOWED MAY CAUSE SEVERE BURNS TO THE MUCOUS MEMBRANES OF THE MOUTH, THROAT, ESOPHAGUS AND STOMACH.
Signs And Symptions Of Overexposure: EYE: IT MAY CAUSE SEVERE BURNS THAT RESULT IN DAMAGE TO THE EYE. SKIN: LEAVING BROWN STAINS. INGESTION: POTASSIUM PERMANANATE IF SWALLOWED MAY CAUSE SEVERE BURNS TO THE MUCOUS MEMBRANES OF THE MOUTH, THROAT, ESOPHAGUS AND STOMACH.
Medical Cond Aggravated By Exposure: POTASSIUM PERMANGANATE WILL CAUSE FURTHER IRRITATION OF OPEN WOUNDS, BURNS OR MUCOUS MEMBRANES.
First Aid: EYES-IMMEDIATELY FLUSH WITHWATER FOR 15 MINS HOLDING LIDS APART. DO NOT ATTEMPT TO NEUTRALIZE CHEMICALLY. SEEK MEDICAL AID IMMEDIATELY. NOTE TO PHYSICIAN: SOLUBLE DECOMPOSTION PRODUCT ARE ALKALINE. INSOLUBLE DECOMPOSTION PRODUCT IS BROWN MANGANESE DIOXIDE. SKIN-IMMEDIATELY WASH CONTAMINATED AREAS WITH WATER. REMOVE CONTAMINATED CLOTHING/FOOTWEAR. SEEK MEDICAL AID IMMEDIATELY IF IRRITATION IS SEV ERE OR PERSISTENT.

INHALATION-REMOVE PERSON FROM ARE TO FRESH AIR. IF BREATHING HAS STOPPED, RESUSCITATE & GIVE OXYGEN IF AVAILABLE. SEEK MEDICAL AID. INGESTION-IF CONSCIOUS, GIVE LARGE AMOUNTS OF WAT ER. SEEK MEDICAL AID IMMEDIATELY.

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Handling and Disposal

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Spill Release Procedures: CLEAN UP SPILLS IMMEDIATELY BY SWEEPING OR SHOVELING UP THE MATERIAL. DO NOT RETURN SPILLED MATERIAL TO THE ORIGINAL CONTAINER. TRANSFER TO A CLEAN METAL DRUM. EPA BANNED THE AND DISPOSAL OF D001 (IGN ITABLE WASTE OXIDEZERS. "SEE OTHER INFORMATION"

Neutralizing Agent: NEUTRALIZE WITH SODIUM BICARBONATE TO NEUTRAL PH

Waste Disposal Methods: REDUCE POTASSIUM PERMANGANATE IN AQUEOUS SOLUTION WITH SODIUM THIOSULFATE (HYPO), OR SOLIUM BISULFITE SALT SOLUTION. THE THIOSULFITE OR FERROUS SALT MAY REQUIRE SOME DILUTE SULFARIC ACID (TO PROMOTE R APID REDUCTION. IF ACID WAS USED, NEUTRALIZE WITH SODIUM BICARBONATE TO NEUTRAL PH. DECANT OR FILTER , AND MIX THE SLUDGE WITH SODIUM CARBONATE AND

Handling And Storage Precautions: STORE IN ACCORDANCE WITH NFPA 430 REQUIREMENTS FOR GLASS IF OXIDIZES. PROTECT CONTAINERS FROM PHYSICAL DAMAGE, STORE IN A COOL, DRY AREA IN CLOSED CONTAINERS. SEGREGATE FROM ACIDS, PEROXIDES, FORMALDE HYDE, & ALL COMBUSTIBLE, ORGANIC OR EASILY OXIDABLE MATERIALS INCLUDING ANTI-FREEZE/HYDRAULIC FLUID.

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Fire and Explosion Hazard Information

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Flash Point Text: NONE

Extinguishing Media: USE LARGE QUANTITIES OF WATER. WATER WILL TURN PINK TO PURPLE IF IN CONTACT WITH POTASSIUM PERMANGANATE. DIKE TO CONTAIN. DO NOT USE DRY CHEMICAL, CO2, HALON OR FOAMS.

Fire Fighting Procedures: IF MATERIAL IS INVOLVED IN FIRE, FLOOD WITH WATER. COOL ALL AFFECTED CONTAINERS WITH LARGE QUANTITIES OF WATER. APPLY WATER FROM AS FAR A DISTANCE AS POSSIBLE. WEAR SELF-CONTIANED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.

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Control Measures

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Respiratory Protection: IN THE CASE WHERE OVEREXPOSURE MAY EXIST, THE USE OF AN APPROVED NIOSH-MSHA DUST RESPIRATOR OR AN AIR SUPPLIED RESPIRATOR IS ADVISED. ENGINEERING OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO CO NTROL DUST.

Ventilation: PROVIDE SUFFICIENT AREA OF LOCAL EXHAUST TO MAINTAIN EXPOSURE BELOW THE TLV-TWA.

Protective Gloves: RUBBER OR PLASTIC GLOVES SHOULD BE WORN.

Eye Protection: FACESHIELD, GOGGLES OR SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN.

Other Protective Equipment: PROVIDE EYE WASH IN WORKING AREA. NORMAL WORK CLOTHING, COVERING ARMS AND LEGS AND RUBBER OR PLASTIC APRON SHOULD BE WORN.

Work Hygienic Practices: WASH HANDS THOROUGHLY WITH SOAP AND WATER AFTER HANDLING POTASSIUM PERMANGANATE, AND BEFORE EATING OR SMOKING. WEAR PROPER PROTECTIVE EQUIPMENT. REMOVE CONTAMINATED CLOTHING.

Supplemental Safety and Health: SYNONYMS: PERMANGANIC ACID POTASSIUM SALT, CHAMELEON MINERAL, CONDY'S CRYSTALS, PERMANGANATE OF POTASH,. TRADE NAME: CAIROX POTASSIUM PERMANGNATE.

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Physical/Chemical Properties

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HCC: D1

B.P. Text: NA

Melt/Freeze Pt: >150.C, 302.F

M.P/F.P Text: DECOMPOSES

Vapor Pres: NA

Vapor Density: NA

Spec Gravity: 2.7

Evaporation Rate & Reference: NA (BUTLY ACETATE=1)

Solubility in Water: 6% AT 20C

Appearance and Odor: DARK PURPLE SOLID WITH A METALLIC LUSTER. ODORLESS

Percent Volatiles by Volume: NA

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Reactivity Data

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Stability Indicator: YES

Stability Condition To Avoid: CONTACT WITH INCOMPATIBLE MATERIEALS OR HEAT

(>105C/302F).
Materials To Avoid: CONTACT WITH PEROXIDES, FOMALDEHYDE, ANTI-FREEZE, HYDRAULIC FLUIDS, AND ALL COMBUSTIBLE ORGANIC OR READILY OXIDIZABLE INORGANIC MATERIALS INCLUDING METAL POWDERS WITH HYDROCHLORIC ACID, TOXIC CHLORINE GAS IS LIBERATED.
Hazardous Decomposition Products: WHEN INVOLVED IN A FIRE, POTASSIUM PERMANGANATE MAY LIBERATE CORROSIVE FUMES.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: WILL NOT OCCUR

Toxicological Information

Toxicological Information: POTASSIUM PERMANGANATE: ACUTE ORAL LD50 (RAT)=780 MG/KG MALE (14 DAYS); 525 MG/KG FEMALE (14 DAYS). THE FATAL ADULT HUMAN DOSE BY INGESTION IS ESTIMATED TO BE 10 GRAMS. EFFECTS OF OVEREXPOSURE" ACUTE OVEREXPOSURE-IRRITATING TO BODY TISSUE WITH WHICH IT COMES INTO CONTACT. CHRONIC OVEREXPOSURE-NO KNOWN CASES OF CHRONIC POISONING DUE TO POTASSIUM PERMANGANATE HAVE BEEN REPORTED. PROLONGED EXPOSURE, USUALLY OVER MANY YEARS, TO HEAVY CONCENTRATIONS OF MANGANESE OXIDES IN THE FORM OF DUST & FUMES, MAY LEAD TO CHRONIC MANGANESE POISONINGG, CHIEFLY INVOLVING THE CENTRAL NERVOUS SYSTEM.

Ecological Information

Ecological: ENTRY TO THE ENVIRONMENT: POTASSIUM PERMANGNATE HAS A LOWER ESTIMATED LIFETIME IN THE ENVIRONMENT, BEING READILY CONVERTED BY OXIDIZABLE MATERIALS TO INSOLUBE MANGANESE DIOXIDE (MNO2). BIOCONCENTRATIO N POTENTIAL: IN NON-REDUCING & NON-ACIDIC ENVIRONMENTS MANGANESE DIOXIDE (MN02) IS SOLUBLE & HAS A VERY LOW BIOACCUMULATIVE POTENTIAL. AQUATIC TOXICITY: RAINBOW TROUT, 96 HOUR LC50: 1.8 MG/L. BLUEGILL SUNFISH, 96 HOUR LC50: 2.3 MG/L.

MSDS Transport Information

Transport Information: U.S. DEPARTMENT OF TRANSPORTATION INFORMATION: PROPER SHIPPING NAME: 49 CFR 172.101?POTASSIUM PERMANGANATE. ID NUMBER: 49 CFR 172.101?UN1490. HAZARD CLASS: 49 CFR 172.101?OXIDIZER. DIVISION: 49 CFR 17 2.101?5.1. PACKING GROUP: 49 CFR 172.101?II.

Regulatory Information

Sara Title III Information: SARA TITLE III INFORMATION: SECTION 302-EXTREMELY HAZARDOUS SUBSTANCES, NOT LISTED. SECTION 311/312-HAZARDOUS CATEGORIES; FIRE, ACUTE AND CHRONIC TOXICITY. SECTION 313: CAIROX POTASSIUM PERMANGANATE C ONTAINS 97% MANGANESE COMPOUND AS PART OF THE CHEMICAL STRUCTURE (MANGANESE COMPOUNDS CAS REG. NO. N/A) AND IS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF TITLE III, SUPERFUND AMENDMENTS A ND REAUTHORIZATION ACT OF 1986 & 40 CFR 372.
Federal Regulatory Information: TSCA: LISTED IN THE TSCA CHEMICAL SUBSTANCE INVENTORY.
CERCLA: HAZARDOUS SUBSTANCE-REPORTABLE QUANTITY=RQ 100 LBS. 40 CFR 116.4 40 CFR 302.4. RCRA: OXIDIZERS SUCH AS POTASSIUM PERMANGANATE MEET THE CR ITERIA OF IGNITABLE WASTE, 40 CFR 261.21.
State Regulatory Information: MICHIGAN CRITICAL MATERIALS REGISTER: NOT LISTED. CALIFORNIA PROPOSITION 65: NOT LISTED. MASSACHUSETTES SUBSTANCE LIST: 5 F8. PENNSYLVANIA HAZARD SUBSTANCE LIST: E.

Other Information

Other Information: SPILL: THESE WASTES MUST BE DEACTIVATED BY REDUCTION. TO CLEAN FLOORS, FLUSH WITH ABUNDANT QUANTITES OF WATER INTO SEWER , IF PERMITTED BY FEDERAL, STATE, AND LOCAL REGULATIONS. IF NOT PERMITTED, COL LECT WATER & TREAT CHEMICALLY. PERSONAL PRECAUTIONS: PERSONNEL SHOULD WEAR PROTECTIVE CLOTHING SUITABLE FOR THE TASK. REMOVA ALL IGNITION SOURCES & INCOMPATIBLE MATERIALS BEFORE ATTEMPTING CLEAN-UP. * *FOREIGN LISTS: CANADIAN DOMESTIC SUBSTANCE LIST (DSL)-LISTED. CANADIAN INGREDIENTS DISCLOSURE LIST-LISTED. EUROPEAN INVENTORY OF EXISTING CHEMICAL SUBSTANCES (EINECS)-2317603.

Transportation Information

Responsible Party Cage: TO644
Trans ID NO: 156594
Product ID: CAIROX POTASSIUM PERMANGANATE
MSDS Prepared Date: 05/01/2000
Review Date: 04/10/2001
MFN: 1
Net Unit Weight: 110 LBS
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: DR
Container QTY: 1
Type Of Container: DRUM

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Detail DOT Information

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DOT PSN AU
DOT Proper Shipping Name: POTASSIUM PERMANGANATE
Hazard Class: 5.1
UN ID Num: UN1490
DOT Packaging Group: II
Label: OXIDIZER
Special Provision: B12
Packaging Exception: 152
Non Bulk Pack: 212
Bulk Pack: 240
Max Qty Pass: 5 KG
Max Qty Cargo: 25 KG
Vessel Stow Req: D
Water/Ship/Other Req: 56,58,69,106,107

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Detail IMO Information

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IMO PSN FN
IMO Proper Shipping Name: POTASSIUM PERMANGANATE
IMDG Page Number: 5173
UN Number: 1490
UN Hazard Class: 5.1
IMO Packaging Group: II
Subsidiary Risk Label: -
EMS Number: 5.1-06
MED First Aid Guide NUM: 715

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Detail IATA Information

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IATA PSN Code: URW
IATA UN ID Num: 1490
IATA Proper Shipping Name: POTASSIUM PERMANGANATE
IATA UN Class: 5.1
IATA Label: OXIDIZER
UN Packing Group: II
Packing Note Passenger: 508
Max Quant Pass: 5KG
Max Quant Cargo: 25KG
Packaging Note Cargo: 511

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Detail AFI Information

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AFI PSN Code: URW
AFI Proper Shipping Name: POTASSIUM PERMANGANATE
AFI Hazard Class: 5.1
AFI UN ID NUM: UN1490
AFI Packing Group: II
Special Provisions: P5
Back Pack Reference: A9.8

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HAZCOM Label

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Product ID: CAIROX POTASSIUM PERMANGANATE
Cage: TO644
Assigned IND: Y
Company Name: CARUS CHEMICAL COMPANY

Street: 1500 EIGHTH STREET
PO Box: 1500
City: LASALLE IL
Zipcode: 61301
Health Emergency Phone: (800)424-9300
Label Required IND: Y
Date Of Label Review: 04/10/2001
Status Code: A
Year Procured: 2000
Origination Code: F
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: CAUTION
Respiratory Protection IND: YES
Health Hazard: Slight
Contact Hazard: Slight
Fire Hazard: None
Reactivity Hazard: None
Hazard And Precautions: EYE: POTASSIUM PERMANGANATE IS DAMAGING TO EYE TISSUE ON CONTACT. IT MAY CAUSE SEVERE BURNS THAT RESULT IN DAMAGE TO THE EYE. SKIN: CONTACT OF SOLUTIONS AT ROOM TEMPERATURE MAY BE IRRITATING TO THE SK IN, LEAVING BROWN STAINS. CONCENTRATED SOLUTIONS AT ELEVATED TEMPERATURE AND CRYSTALS ARE DAMAGING TO THE SKIN. INHALATION: ACUTE INHALATIION TOXICITY DATA NOT AVAILABLE. HOWEVER, AIRBORNE CONCENTRATI ONS OF POTASSIUM PERMANGANATE IN THE FORM OF DUST OR MIST MAY CAUSE DAMAGE TO THE RESPIRATORY TRACT. INGESTION: POTASSIUM PERMANANATE IF SWALLOWED MAY CAUSE SEVERE BURNS TO THE MUCOUS MEMBRANES OF THE MOUTH, THROAT, ESOPHAGUS AND STOMACH.

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Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever expressly or implied warrants, states, or intends said information to have any application, use or viability by or to any person or persons outside the Department of Defense nor any person or persons contracting with any instrumentality of the United States of America and disclaims all liability for such use. Any person utilizing this instruction who is not a military or civilian employee of the United States of America should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation regardless of similarity to a corresponding Department of Defense or other government situation.

RTB-1

Material Safety Data Sheet

Redox Tech, LLC

1006A Morrisville Parkway
Morrisville, NC 27560
(919) 460-0330

SECTION 1 - MATERIAL IDENTIFICATION AND INFORMATION

Material Name: NI DHE microbial consortium (RTB-1) MSDS #: ENV 1033

Date Prepared: 10/06/2003 CAS #: N/A (Not Applicable)

Prepared By: Simon Vainberg Formula #: N/A

Material Description: Non-hazardous, naturally occurring non-altered anaerobic microbes and enzymes in a water-based medium.

SECTION 2 - INGREDIENTS

Components	%	OSHA PEL	ACGIH TLV	OTHER LIMITS
Non-Hazardous Ingredients	100	N/A	N/A	N/A

SECTION 3 - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point: 100°C (water) Specific Gravity (H_2O = 1): 0.9 - 1.1

Vapor Pressure @ 25°C: 24 mm Hg (water) Melting Point: 0°C (water)

Vapor Density: N/A Evaporation Rate (H_2O = 1): 0.9 - 1.1

Solubility in Water: Soluble Water Reactive: No

pH: 6.0 - 8.0

Appearance and Odor: Murky, yellow water. Musty odor.

SECTION 4 - FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A

Flammable Limits: N/A

Extinguishing Media: Foam, carbon dioxide, water

Special Fire Fighting Procedures: None

Unusual Fire and Explosion Hazards: None

SECTION 5 - REACTIVITY DATA

Stability: Stable

Conditions to Avoid: None

Incompatibility (Materials to Avoid): Water-reactive materials

Hazardous Decomposition Byproducts: None

SECTION 6 - HEALTH HAZARD DATA

HEALTH EFFECTS

The effects of exposure to this material have not been determined. Safe handling of this material on a long-term basis will avoid any possible effect from repetitive acute exposures. Below are possible health effects based on information from similar materials. Individuals hyper allergic to enzymes or other related proteins should not handle.

Ingestion: Ingestion of large quantities may result in abdominal discomfort including nausea, vomiting, cramps, diarrhea, and fever.

Inhalation: Hypersensitive individuals may experience breathing difficulties after inhalation of aerosols.

Skin Absorption: N/A

Skin Contact: May cause skin irritation. Hypersensitive individuals may experience allergic reactions to enzymes.

Eye Contact: May cause eye irritation.

FIRST AID

Ingestion: Get medical attention if allergic symptoms develop (observe for 48 hours). Never give anything by mouth to an unconscious or convulsing person.

Inhalation: Get medical attention if allergic symptoms develop.

Skin Absorption: N/A

Skin Contact: Wash affected area with soap and water. Get medical attention if allergic symptoms develop.

Eye Contact: Flush eyes with plenty of water for at least 15 minutes using an eyewash fountain, if available. Get medical attention if irritation occurs.

NOTE TO PHYSICIANS: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this material may have occurred.

SECTION 7 - SPILL AND LEAK PROCEDURES

Reportable quantities (in lbs of EPA Hazardous Substances): N/A

Steps to be taken in case of spill or release: No emergency results from spillage. However, spills should be cleaned up promptly. All personnel involved in the cleanup must wear protective clothing and avoid skin contact. Absorb spilled material or vacuum into a container. After clean-up, disinfect all cleaning materials and storage containers that come in contact with the spilled liquid.

Waste Disposal Method: No special disposal methods are required. The material may be sewered, and is compatible with all known biological treatment methods. To reduce odors and permanently inactivate microorganisms, mix 100 parts (by volume) of NI DHE consortium with 1 part (by volume) of bleach. Dispose of in accordance with local, state and federal regulations.

SECTION 8 - HANDLING AND STORAGE

Hand Protection: Rubber gloves.

Eye Protection: Safety goggles with side splash shields.

Protective Clothing: Use adequate clothing to prevent skin contact.

Respiratory Protection: Surgical mask.

Ventilation: Provide adequate ventilation to remove odors.

Storage & Handling:
Material may be stored for up to 3 weeks at 2-4°C without aeration.

Other Precautions: An eyewash station in the work area is recommended.

While the information and recommendations set forth herein are believed to be accurate as of the date hereof, Shaw Environmental, Inc. MAKES NO WARRANTY WITH RESPECT HERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

Trichloroethene

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: TRICHLOROETHYLENE

TRADE NAMES/SYNONYMS:
MTG MSDS 199; ACETYLENE TRICHLORIDE; ETHYLENE TRICHLORIDE; 1-CHLORO-2,2-DICHLOROETHYLENE; 1,1-DICHLORO-2-CHLOROETHYLENE; TCE; ETHINYL TRICHLORIDE; TRICHLOROETHENE; 1,1,2-TRICHLOROETHYLENE; 1,1,2-TRICHLOROETHENE; UN 1710; RCRA U228; C2HCl3; MAT23850; RTECS KX4550000

CHEMICAL FAMILY: halogenated, alkenes

CREATION DATE: Jan 24 1989
REVISION DATE: Sep 18 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: TRICHLOROETHYLENE
CAS NUMBER: 79-01-6
PERCENTAGE: >99

COMPONENT: INHIBITORS
CAS NUMBER: Not assigned.
PERCENTAGE: <0.1

COMPONENT: AMINES
CAS NUMBER: Not assigned.
PERCENTAGE: <0.1

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=1 REACTIVITY=0

EMERGENCY OVERVIEW:

COLOR: colorless
PHYSICAL FORM: liquid
ODOR: sweet odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression, allergic reactions, cancer hazard (in humans)
PHYSICAL HAZARDS: May polymerize. Containers may rupture or explode. May decompose on contact with air, light, moisture, heat or storage and use above room temperature. Releases toxic, corrosive, flammable or explosive gases.

POTENTIAL HEALTH EFFECTS:
INHALATION:
SHORT TERM EXPOSURE: irritation, changes in blood pressure, nausea, vomiting, stomach pain, difficulty breathing, irregular heartbeat, headache, drowsiness, dizziness, disorientation, mood swings, tremors, loss of coordination, visual disturbances, bluish skin color, lung congestion, kidney damage, liver damage, unconsciousness, coma
LONG TERM EXPOSURE: same as effects reported in short term exposure, loss of appetite, weight loss, blood disorders, brain damage, cancer
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation, allergic reactions
LONG TERM EXPOSURE: irritation, allergic reactions, nausea, loss of appetite, weight loss, difficulty breathing, headache, drowsiness, dizziness, joint pain, loss of coordination, visual disturbances, paralysis
EYE CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe), blurred vision
LONG TERM EXPOSURE: irritation (possibly severe), eye damage
INGESTION:
SHORT TERM EXPOSURE: same as effects reported in short term inhalation
LONG TERM EXPOSURE: same as effects reported in long term inhalation

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: If vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For ingestion, consider gastric lavage. Consider oxygen.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Slight fire hazard.

EXTINGUISHING MEDIA: carbon dioxide, regular dry chemical

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For tank, rail car or tank truck, evacuation radius: 800 meters (1/2 mile).

FLASH POINT: No data available.
LOWER FLAMMABLE LIMIT: 7.8% @ 100 C
UPPER FLAMMABLE LIMIT: 52% @ 100 C
AUTOIGNITION: 770 F (410 C)

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Collect runoff for disposal as potential hazardous waste.

SOIL RELEASE:
Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Absorb with sand or other non-combustible material.

WATER RELEASE:
Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment. Subject to California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Keep out of water supplies and sewers.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Small liquid spills: Absorb with sand or other non-combustible material. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Store in a cool, dry place. Store in a well-ventilated area. Avoid heat, flames, sparks and other sources of ignition. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
TRICHLOROETHYLENE:
100 ppm OSHA TWA
200 ppm OSHA ceiling
300 ppm OSHA peak (5 minutes in any 2 hours)
50 ppm (269 mg/m3) OSHA TWA (vacated by 58 FR 35338, June 30, 1993)
200 ppm (1070 mg/m3) OSHA STEL (vacated by 58 FR 35338, June 30, 1993)
50 ppm ACGIH TWA
100 ppm ACGIH STEL

VENTILATION: Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
At any detectable concentration -
Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
COLOR: colorless
ODOR: sweet odor
MOLECULAR WEIGHT: 131.39
MOLECULAR FORMULA: Cl-C-H-C-Cl2

BOILING POINT: 189 F (87 C)
FREEZING POINT: -99 F (-73 C)
VAPOR PRESSURE: 58 mmHg @ 20 C
VAPOR DENSITY (air=1): 4.53
SPECIFIC GRAVITY (water=1): 1.4642
WATER SOLUBILITY: 0.1%
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: 21 ppm
EVAPORATION RATE: 0.69 (carbon tetrachloride=1)
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, acetone, chloroform, benzene, vegetable oils

10. STABILITY AND REACTIVITY

REACTIVITY: May decompose on contact with air, light, moisture, heat or storage and use above room temperature. Releases toxic, corrosive, flammable or explosive gases.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat.

INCOMPATIBILITIES: bases, metals, combustible materials, oxidizing materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: phosgene, halogenated compounds, oxides of carbon

POLYMERIZATION: May polymerize. Avoid contact with heat or light and monitor inhibitor content.

11. TOXICOLOGICAL INFORMATION

TRICHLOROETHYLENE:
IRRITATION DATA:
2 mg/24 hour(s) skin-rabbit severe; 20 mg/24 hour(s) eyes-rabbit moderate
TOXICITY DATA:
8450 ppm/4 hour(s) inhalation-mouse LC50; >20 gm/kg skin-rabbit LD50; 4920 mg/kg oral-rat LD50
CARCINOGEN STATUS: NTP: Anticipated Human Carcinogen; IARC: Human Limited Evidence, Animal Sufficient Evidence, Group 2A; ACGIH: A5 -Not Suspected as a Human Carcinogen
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Moderately Toxic: ingestion
Slightly Toxic: inhalation
TARGET ORGANS: immune system (sensitizer), central nervous system
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: heart problems

TUMORIGENIC DATA: Available.
MUTAGENIC DATA: Available.
REPRODUCTIVE EFFECTS DATA: Available.
ADDITIONAL DATA: May cross the placenta. Stimulants such as epinephrine may induce ventricular fibrillation.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 3100 ug/L 96 hour(s) LC50 (Mortality) Flagfish (Jordanella floridae)

INVERTEBRATE TOXICITY: 1700 ug/L 7 hour(s) EC50 (Regeneration) Flatworm (Dugesia japonica)

OTHER TOXICITY: 45000 ug/L 48 week(s) LC50 (Mortality) Clawed toad (Xenopus laevis)

FATE AND TRANSPORT:
BIOCONCENTRATION: 17 ug/L 1-14 hour(s) BCF (Residue) Bluegill (Lepomis macrochirus) 8.23 ug/L

13. DISPOSAL CONSIDERATIONS

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): U228. Hazardous Waste Number(s): D040. Dispose of in accordance with U.S. EPA 40 CFR 262 for concentrations at or above the Regulatory level. Regulatory level- 0.5 mg/L. Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Trichloroethylene
ID NUMBER: UN1710
HAZARD CLASS OR DIVISION: 6.1
PACKING GROUP: III
LABELING REQUIREMENTS: 6.1

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Trichloroethylene
UN NUMBER: UN1710
CLASS: 6.1
PACKING GROUP/RISK GROUP: III

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
TRICHLOROETHYLENE: 100 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: Yes
FIRE: No
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
TRICHLOROETHYLENE

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65:
Known to the state of California to cause the following:
TRICHLOROETHYLENE
Cancer (Apr 01, 1988)

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: D2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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Toluene

TOLUENE

Division of Facilities Services
DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

TOLUENE

Section 1 - Product and Company Identification Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview Section 11 - Toxicological Information
Section 4 - First Aid Measures Section 12 - Ecological Information
Section 5 - Fire Fighting Measures Section 13 - Disposal Considerations
Section 6 - Accidental Release Measures Section 14 - MSDS Transport Information
Section 7 - Handling and Storage Section 15 - Regulatory Information
Section 8 - Exposure Controls & Personal Protection Section 16 - Other Information

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Cornell University does not in any way warrant or imply the applicability, viability or use of this information to any person or for use in any situation.

Section 1 - Product and Company Identification
TOLUENE

Product Identification: TOLUENE
Date of MSDS: 01/01/1985 Technical Review Date: 12/02/1998

FSC: 8030 NIIN: 00-432-1544
Submitter: F BT
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information
Manufacturer's Name: ESSEX CHEMICAL CORP PRO-SEAL DIV
Manufacturer's Address1: 19451 SUSANA RD
Manufacturer's Address2: COMPTON, CA 90221-5713
Manufacturer's Country: US
General Information Telephone: 310-537-7600
Emergency Telephone: 310-537-7600
Emergency Telephone: 310-537-7600
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: Y
Published: Y
CAGE: 83527
Special Project Code: N

Item Description
Item Name: SEALING COMPOUND
Item Manager: GSA
Specification Number: MIL-S-8802
Type/Grade/Class: TYPE 2; CLASS C-80
Unit of Issue: KT
Unit of Issue Quantity: 0
Type of Container: METAL

Contractor Information
Contractor's Name: ESSEX CHEMICAL CORP PRO-SEAL DIV
Contractor's Address1: 19451 SUSANA RD
Contractor's Address2: COMPTON, CA 90221-5713
Contractor's Telephone: 310-537-7600
Contractor's CAGE: 83527

Section 2 - Compositon/Information on Ingredients
TOLUENE

Ingredient Name: TOLUENE (SARA III)
Ingredient CAS Number: 108-88-3 Ingredient CAS Code: M
RTECS Number: XS5250000 RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: N/P
% Enviromental Weight:
Other REC Limits: N/P
OSHA PEL: 200 PPM/150 STEL OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 50 PPM; 9293 ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity: 1000 LBS
DOT Reporting Quantity: 1000 LBS
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
TOLUENE

Health Hazards Acute & Chronic: N/P

Signs & Symptoms of Overexposure:
N/P

Medical Conditions Aggravated by Exposure:
N/P

LD50 LC50 Mixture: N/P

Route of Entry Indicators:

Inhalation: N/P
Skin: N/P
Ingestion: N/P
Carcenogenicity Indicators
NTP: N/P
IARC: N/P
OSHA: N/P
Carcinogenicity Explanation: N/P

Section 4 - First Aid Measures
TOLUENE

First Aid:
N/P

Section 5 - Fire Fighting Measures
TOLUENE

Fire Fighting Procedures:
WATER NOT RECOMMENDED
Unusual Fire or Explosion Hazard:
VOLIATILE SOLVENT
Extinguishing Media:
CO2, FOAM, DRY CHEMICAL
Flash Point: Flash Point Text: 66 F CLOSED CUP

Autoignition Temperature:
Autoignition Temperature Text: N/A
Lower Limit(s): 1.3
Upper Limit(s): 7

Section 6 - Accidental Release Measures
TOLUENE

Spill Release Procedures:

N/P

Section 7 - Handling and Storage
TOLUENE

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
TOLUENE

Repiratory Protection:
N/P
Ventilation:
N/P
Protective Gloves:
N/P
Eye Protection: N/P
Other Protective Equipment: N/P
Work Hygenic Practices: N/P
Supplemental Health & Safety Information: ESSEX CHEMICAL CORP., SPECIALTY CHEMICAL DIV. 19451 SUSANA ROAD, COMPTON, CA 90221

Section 9 - Physical & Chemical Properties
TOLUENE

HCC: F2
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: 110.7 C
Melting/Freezing Point: Melting/Freezing Text: N/A
Decomposition Point: Decomposition Text: N/A

Vapor Pressure: 36. Vapor Density: 3.1
Percent Volatile Organic Content:
Specific Gravity: 0.86
Volatile Organic Content Pounds per Gallon:
pH: N/P
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: 4.5
Solubility in Water: NIL
Appearance and Odor: WHITE PASTE, ORGANIC SULFIDE ODOR
Percent Volatiles by Volume: 14
Corrosion Rate: N/P

Section 10 - Stability & Reactivity Data
TOLUENE

Stability Indicator: N/P
Materials to Avoid:
N/P
Stability Condition to Avoid:
N/P
Hazardous Decomposition Products:
N/P
Hazardous Polymerization Indicator: N/P
Conditions to Avoid Polymerization:
N/P

Section 11 - Toxicological Information
TOLUENE

Toxicological Information:
N/P

Section 12 - Ecological Information
TOLUENE

Ecological Information:
N/P

Section 13 - Disposal Considerations
TOLUENE

Waste Disposal Methods:
N/P

Section 14 - MSDS Transport Information
TOLUENE

Transport Information:
N/P

Section 15 - Regulatory Information
TOLUENE

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
TOLUENE

Other Information:

N/P

HAZCOM Label Information
Product Identification: TOLUENE
CAGE: 83527
Assigned Individual: N
Company Name: ESSEX CHEMICAL CORP PRO-SEAL DIV
Company PO Box:
Company Street Address1: 19451 SUSANA RD
Company Street Address2: COMPTON, CA 90221-5713 US
Health Emergency Telephone: 213-537-7600
Label Required Indicator: Y
Date Label Reviewed: 12/16/1998
Status Code: C
Manufacturer's Label Number:
Date of Label: 12/16/1998
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: N/P
Eye Protection Indicator: N/P
Skin Protection Indicator: N/P
Respiratory Protection Indicator: N/P
Signal Word: N/P
Health Hazard:
Contact Hazard:
Fire Hazard:
Reactivity Hazard:

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Vinyl Chloride

POLY(VINYL CHLORIDE), 645

Division of Facilities Services
DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

POLY(VINYL CHLORIDE), 645

Section 1 - Product and Company Identification Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview Section 11 - Toxicological Information
Section 4 - First Aid Measures Section 12 - Ecological Information
Section 5 - Fire Fighting Measures Section 13 - Disposal Considerations
Section 6 - Accidental Release Measures Section 14 - MSDS Transport Information
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Section 1 - Product and Company Identification
POLY(VINYL CHLORIDE), 645

Product Identification: POLY(VINYL CHLORIDE), 645
Date of MSDS: 11/01/1991 Technical Review Date: 10/06/1995

FSC: 6810 NIIN: LIIN: 00N046795
Submitter: N EN
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information
Manufacturer's Name: SCIENTIFIC POLYMER PRODUCTS INC
Manufacturer's Address1: 6265 DEAN PARKWAY
Manufacturer's Address2: ONTARIO, NY 14519
Manufacturer's Country: US
General Information Telephone: 716-265-0413
Emergency Telephone: 716-265-0413
Emergency Telephone: 716-265-0413
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: N
Published: Y
CAGE: 0MWG0
Special Project Code: N

Contractor Information
Contractor's Name: SCIENTIFIC POLYMER PRODUCTS INC
Contractor's Address1: 6265 DEAN PARKWAY
Contractor's Address2: ONTARIO, NY 14519
Contractor's Telephone: 716-265-0413
Contractor's CAGE: 0MWG0

Section 2 - Compositon/Information on Ingredients
POLY(VINYL CHLORIDE), 645

Ingredient Name: ETHYLENE, CHLORO-, POLYMER; (POLYVINYL CHLORIDE RESIN). PEL: 15 MG/M3 TDUST; 5 RDUST(MFR)
Ingredient CAS Number: 9002-86-2 Ingredient CAS Code: M
RTECS Number: KV0350000 RTECS Code: M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:

<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: 100
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: SEE INGREDIENT NAME OSHA PEL Code: M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 10 MG/M3 TDUST ACGIH TLV Code: M
ACGIH STEL: N/P ACGIH STEL Code:
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
POLY(VINYL CHLORIDE), 645

Health Hazards Acute & Chronic: IRRITATION TO EYES, NOSE AND THROAT MAY BE CAUSED BY VAPORS. LONG TERM EXPOSURE TO VINYL CHLORIDE HAS CAUSED CANCER IN
ANIMALS INCLUDING A RARE FORM OF LIVER CANCER. OTHER TARGET ORGANS INCLUDE
BRAIN, LUNG, HEMO AND LYMPHOPOIETIC.

Signs & Symptoms of Overexposure:
SEE HEALTH HAZARDS.

Medical Conditions Aggravated by Exposure:
NONE SPECIFIED BY MANUFACTURER.

LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.

Route of Entry Indicators:
Inhalation: YES
Skin: NO
Ingestion: NO

Carcenogenicity Indicators
NTP: NO
IARC: NO
OSHA: NO
Carcinogenicity Explanation: NOT RELEVANT

Section 4 - First Aid Measures
POLY(VINYL CHLORIDE), 645

First Aid:
IN ALL CASES, IF IRRITATION DEVELOPS, SEEK MEDICAL ASSISTANCE. INHAL: REMOVE FROM EXPOSURE. IF BREATHING STOPS, BEGIN MOUTH TO MOUTH. EYES: FLUSH WITH WATER
FOR AT LEAST 15 MINUTES. SKIN: WASH AFFECTE D AREA WITH SOAP AND WATER. REMOVE
DIRTY CLOTHING. INGEST: CALL MD IMMED (FP N).

Section 5 - Fire Fighting Measures
POLY(VINYL CHLORIDE), 645

Fire Fighting Procedures:
WEAR NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire or Explosion Hazard:
NONE KNOWN.
Extinguishing Media:
WATER, DRY CHEMICAL, FOAM.
Flash Point: Flash Point Text: 735F,391C

Autoignition Temperature:
Autoignition Temperature Text: N/A
Lower Limit(s): N/A
Upper Limit(s): N/A

Section 6 - Accidental Release Measures
POLY(VINYL CHLORIDE), 645

Spill Release Procedures:
SWEEP UP AND PLACE IN CONTAINER FOR DISPOSAL.

Section 7 - Handling and Storage
POLY(VINYL CHLORIDE), 645

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
POLY(VINYL CHLORIDE), 645

Repiratory Protection:
IF NEEDED. USE NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation:
LOCAL EXHAUST.
Protective Gloves:
IMPERVIOUS.
Eye Protection: SAFETY GLASSES.
Other Protective Equipment: NONE SPECIFIED BY MANUFACTURER.
Work Hygenic Practices: GOOD HYGIENE PRACTICE SHOULD BE FOLLOWED.
Supplemental Health & Safety Information: NONE SPECIFIED BY MANUFACTURER.

Section 9 - Physical & Chemical Properties
POLY(VINYL CHLORIDE), 645

HCC: N1
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: N/A

Melting/Freezing Point: Melting/Freezing Text: N/A
Decomposition Point: Decomposition Text: N/K
Vapor Pressure: N/A Vapor Density: N/A
Percent Volatile Organic Content:
Specific Gravity: 1.40
Volatile Organic Content Pounds per Gallon:
pH: N/K
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: NOT APPLICABLE
Solubility in Water: INSOLUBLE
Appearance and Odor: WHITE POWDER, ODORLESS
Percent Volatiles by Volume: N/A
Corrosion Rate: N/K

Section 10 - Stability & Reactivity Data
POLY(VINYL CHLORIDE), 645

Stability Indicator: YES
Materials to Avoid:
ACETALS OR ACETAL COPOLYMERS.
Stability Condition to Avoid:
NONE KNOWN.
Hazardous Decomposition Products:
HYDROGEN CHLORIDE, CO2, CO.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
NOT RELEVANT

Section 11 - Toxicological Information
POLY(VINYL CHLORIDE), 645

Toxicological Information:
N/P

Section 12 - Ecological Information
POLY(VINYL CHLORIDE), 645

Ecological Information:
N/P

Section 13 - Disposal Considerations
POLY(VINYL CHLORIDE), 645

Waste Disposal Methods:
INCINERATE OR LANDFILL I/A/W STATE, FEDERAL AND LOCAL REGULATIONS.

Section 14 - MSDS Transport Information
POLY(VINYL CHLORIDE), 645

Transport Information:
N/P

Section 15 - Regulatory Information
POLY(VINYL CHLORIDE), 645

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
POLY(VINYL CHLORIDE), 645

Other Information:
N/P

HAZCOM Label Information
Product Identification: POLY(VINYL CHLORIDE), 645
CAGE: 0MWG0
Assigned Individual: N
Company Name: SCIENTIFIC POLYMER PRODUCTS INC
Company PO Box:
Company Street Address1: 6265 DEAN PARKWAY
Company Street Address2: ONTARIO, NY 14519 US
Health Emergency Telephone: 716-265-0413
Label Required Indicator: Y
Date Label Reviewed: 12/20/1993
Status Code: C
Manufacturer's Label Number:
Date of Label: 12/20/1993
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: Y
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: CAUTION
Health Hazard: Slight
Contact Hazard: Slight
Fire Hazard: Slight
Reactivity Hazard: None

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Xylene

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: M-XYLENE

TRADE NAMES/SYNONYMS:
MTG MSDS 122; BENZENE, 1,3-DIMETHYL-; M-DIMETHYLBENZENE; 1,3-DIMETHYLBENZENE; M-METHYLTOLUENE; 1,3-XYLENE; M-XYLOL; RCRA U239; STCC 4909350; UN 1307; O-5078; O-5079; MAT13240; RTECS ZE2275000

CHEMICAL FAMILY: hydrocarbons, aromatic

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 19 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: M-XYLENE
CAS NUMBER: 108-38-3
PERCENTAGE: 100.0

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=3 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: sweet odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:
INHALATION:

SHORT TERM EXPOSURE: irritation, low body temperature, ringing in the ears, nausea, vomiting, stomach pain, headache, drowsiness, symptoms of drunkenness, visual disturbances, lung congestion, kidney damage, liver damage, coma
LONG TERM EXPOSURE: tingling sensation, menstrual disorders, infertility, reproductive effects, convulsions
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation, blisters
LONG TERM EXPOSURE: rash
EYE CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe), tearing
LONG TERM EXPOSURE: blurred vision
INGESTION:
SHORT TERM EXPOSURE: digestive disorders, symptoms of drunkenness, lung congestion, kidney damage, liver damage
LONG TERM EXPOSURE: reproductive effects

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: Contact local poison control center or physician immediately. Never make an unconscious person vomit or drink fluids. When vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For inhalation, consider oxygen. For ingestion, consider gastric lavage.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Vapor/air mixtures are explosive above flash point. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Electrostatic discharges may be generated by flow or agitation resulting in ignition or explosion.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT: 81 F (27 C) (CC)
LOWER FLAMMABLE LIMIT: 1.1%
UPPER FLAMMABLE LIMIT: 7.0%
AUTOIGNITION: 981 F (527 C)
FLAMMABILITY CLASS (OSHA): IC

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Stay upwind and keep out of low areas.

SOIL RELEASE:
Trap spilled material at bottom in deep water pockets, excavated holding areas or within sand bag barriers. Dike for later disposal. Absorb with sand or other non-combustible material. Collect with absorbent into suitable container.

WATER RELEASE:
Cover with absorbent sheets, spill-control pads or pillows. Neutralize. Collect with absorbent into suitable container. Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Protect from physical damage. Store outside or in a detached building. Store with flammable liquids. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
M-XYLENE:
XYLENE:
100 ppm (435 mg/m3) OSHA TWA
150 ppm (651 mg/m3) OSHA STEL (vacated by 58 FR 35338, June 30, 1993)
100 ppm ACGIH TWA
150 ppm ACGIH STEL
100 ppm (435 mg/m3) NIOSH recommended TWA 10 hour(s)
150 ppm (655 mg/m3) NIOSH recommended STEL

VENTILATION: Provide local exhaust ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
900 ppm
Any chemical cartridge respirator with organic vapor cartridge(s).
Any powered, air-purifying respirator with organic vapor cartridge(s).
Any supplied-air respirator.
Any self-contained breathing apparatus with a full facepiece.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
APPEARANCE: clear
COLOR: colorless
ODOR: sweet odor

MOLECULAR WEIGHT: 106.17
MOLECULAR FORMULA: C8-H10
BOILING POINT: 282 F (139 C)
FREEZING POINT: -54 F (-48 C)
VAPOR PRESSURE: 8.3 mmHg @ 25 C
VAPOR DENSITY (air=1): 3.7
SPECIFIC GRAVITY (water=1): 0.8642
WATER SOLUBILITY: insoluble
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: 3.7 ppm
EVAPORATION RATE: 0.7 (butyl acetate=1)
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, acetone, benzene, organic solvents

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: oxidizing materials, acids

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of carbon

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

M-XYLENE:
IRRITATION DATA:
10 ug/24 hour(s) open skin-rabbit severe; 20 mg/24 hour(s) skin-rabbit moderate; 5 mg/24 hour(s) eyes-rabbit severe
TOXICITY DATA:
14100 ul/kg skin-rabbit LD50; 5 gm/kg oral-rat LD50
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Moderately Toxic: ingestion
Slightly Toxic: dermal absorption
TARGET ORGANS: central nervous system
REPRODUCTIVE EFFECTS DATA: Available.

ADDITIONAL DATA: Alcohol may enhance the toxic effects. Stimulants such as epinephrine may induce ventricular fibrillation.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 16000 ug/L 96 hour(s) LC50 (Mortality) Fathead minnow (Pimephales promelas)

INVERTEBRATE TOXICITY: 4700 ug/L 24 hour(s) EC50 (Immobilization) Water flea (Daphnia magna)

ALGAL TOXICITY: 3900 ug/L 8 hour(s) EC50 (Growth) Green algae (Selenastrum capricornutum)

13. DISPOSAL CONSIDERATIONS

Dispose in accordance with all applicable regulations. Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): U239.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Xylenes
ID NUMBER: UN1307
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Xylenes
UN NUMBER: UN1307
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
m-Xylene: 1000 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not

regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: No
FIRE: Yes
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
m-Xylene

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: BD2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: O-XYLENE

TRADE NAMES/SYNONYMS:
MTG MSDS 123; BENZENE, 1,2-DIMETHYL-; O-DIMETHYLBENZENE; 1,2-DIMETHYLBENZENE; O-METHYLTOLUENE; ORTHO-XYLENE; 1,2-XYLENE; O-XYLOL; RCRA U239; STCC 4909349; UN 1307; O-5081; MAT17180; RTECS ZE2450000

CHEMICAL FAMILY: hydrocarbons, aromatic

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 19 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: O-XYLENE
CAS NUMBER: 95-47-6
PERCENTAGE: 100.0

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=3 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: sweet odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:
INHALATION:

SHORT TERM EXPOSURE: irritation, low body temperature, ringing in the ears, nausea, vomiting, stomach pain, headache, drowsiness, symptoms of drunkenness, visual disturbances, lung congestion, kidney damage, liver damage, coma
LONG TERM EXPOSURE: same as effects reported in short term exposure, tingling sensation, menstrual disorders, infertility, blood disorders, reproductive effects
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation, blisters
LONG TERM EXPOSURE: same as effects reported in short term exposure, rash
EYE CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe), tearing
LONG TERM EXPOSURE: same as effects reported in short term exposure, blurred vision
INGESTION:
SHORT TERM EXPOSURE: same as effects reported in short term inhalation, digestive disorders, aspiration hazard
LONG TERM EXPOSURE: reproductive effects

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: If a large amount is swallowed, get medical attention.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Vapor/air mixtures are explosive. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Electrostatic discharges may be generated by flow or agitation resulting in ignition or explosion.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny

entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT: 63 F (17 C)
LOWER FLAMMABLE LIMIT: 0.9%
UPPER FLAMMABLE LIMIT: 6.7%
AUTOIGNITION: 865 F (463 C)
FLAMMABILITY CLASS (OSHA): IB

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Stay upwind and keep out of low areas.

SOIL RELEASE:
Trap spilled material at bottom in deep water pockets, excavated holding areas or within sand bag barriers. Dike for later disposal. Absorb with sand or other non-combustible material. Collect with absorbent into suitable container.

WATER RELEASE:
Cover with absorbent sheets, spill-control pads or pillows. Neutralize. Collect with absorbent into suitable container. Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Store and handle in accordance with all current regulations and standards. Grounding and bonding required. Protect from physical damage. Store outside or in a detached building. Store with flammable liquids. Keep separated from incompatible substances. Keep separated from incompatible substances. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
O-XYLENE:
XYLENE:
100 ppm (435 mg/m3) OSHA TWA
150 ppm (651 mg/m3) OSHA STEL (vacated by 58 FR 35338, June 30, 1993)
100 ppm ACGIH TWA
150 ppm ACGIH STEL
100 ppm (435 mg/m3) NIOSH recommended TWA 10 hour(s)
150 ppm (655 mg/m3) NIOSH recommended STEL

VENTILATION: Provide local exhaust ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Provide local exhaust ventilation system.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area. Wear splash resistant safety goggles with a faceshield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves. Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
900 ppm
Any chemical cartridge respirator with organic vapor cartridge(s).
Any powered, air-purifying respirator with organic vapor cartridge(s).
Any supplied-air respirator.
Any self-contained breathing apparatus with a full facepiece.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
APPEARANCE: clear

COLOR: colorless
ODOR: sweet odor
MOLECULAR WEIGHT: 106.17
MOLECULAR FORMULA: C8-H10
BOILING POINT: 291 F (144 C)
FREEZING POINT: -13 F (-25 C)
VAPOR PRESSURE: 5.2 mmHg @ 25 C
VAPOR DENSITY (air=1): 3.7
SPECIFIC GRAVITY (water=1): 0.8802
WATER SOLUBILITY: 0.0175% @ 20 C
PH: Not available
VOLATILITY: 100%
ODOR THRESHOLD:
EVAPORATION RATE: 0.7 (butyl acetate=1)
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, benzene, acetone, organic solvents

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: oxidizing materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of carbon

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

O-XYLENE:
TOXICITY DATA:
3617 mg/kg oral-rat LD50 (Phillips)
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Moderately Toxic: ingestion
TARGET ORGANS: central nervous system
REPRODUCTIVE EFFECTS DATA: Available.
ADDITIONAL DATA: Alcohol may enhance the toxic effects. Stimulants such as epinephrine may induce ventricular fibrillation.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 16400 ug/L 96 hour(s) LC50 (Mortality) Fathead minnow (Pimephales promelas)

INVERTEBRATE TOXICITY: 200 mg/L 24 hour(s) EC100 (Abundance) Water flea (Daphnia magna)

ALGAL TOXICITY: 4200 ug/L 8 hour(s) EC50 (Growth) Green algae (Selenastrum capricornutum)

OTHER TOXICITY: 73000 ug/L 48 hour(s) LC50 (Mortality) Clawed toad (Xenopus laevis)

13. DISPOSAL CONSIDERATIONS

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): U239.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Xylenes
ID NUMBER: UN1307
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Xylenes
UN NUMBER: UN1307
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
o-Xylene: 1000 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: No
FIRE: Yes
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
o-Xylene

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: BD2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
959 ROUTE 46 EAST
PARSIPPANY, NEW JERSEY 07054-0624

EMERGENCY CONTACT:
CHEMTREC 1-800-424-9300
INFORMATION CONTACT:
973-257-1100

SUBSTANCE: P-XYLENE

TRADE NAMES/SYNONYMS:
MTG MSDS 124; BENZENE, 1,4-DIMETHYL-; P-DIMETHYLBENZENE; 1,4-DIMETHYLBENZENE; P-METHYLTOLUENE; 4-METHYLTOLUENE; 1,4-XYLENE; P-XYLOL; RCRA U239; STCC 4909351; UN 1307; O-5082; MAT17940; RTECS ZE2625000

CHEMICAL FAMILY: hydrocarbons, aromatic

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 19 2003

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: P-XYLENE
CAS NUMBER: 106-42-3
PERCENTAGE: 100.0

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=3 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: sweet odor
MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression
PHYSICAL HAZARDS: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:
INHALATION:

SHORT TERM EXPOSURE: irritation, low body temperature, ringing in the ears, nausea, vomiting, stomach pain, headache, drowsiness, symptoms of drunkenness, visual disturbances, lung congestion, kidney damage, liver damage, coma
LONG TERM EXPOSURE: tingling sensation, menstrual disorders, infertility, reproductive effects, convulsions
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation, blisters
LONG TERM EXPOSURE: rash
EYE CONTACT:
SHORT TERM EXPOSURE: irritation (possibly severe), tearing
LONG TERM EXPOSURE: blurred vision
INGESTION:
SHORT TERM EXPOSURE: digestive disorders, symptoms of drunkenness, lung congestion, kidney damage, liver damage
LONG TERM EXPOSURE: reproductive effects

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: Contact local poison control center or physician immediately. Never make an unconscious person vomit or drink fluids. When vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

NOTE TO PHYSICIAN: For inhalation, consider oxygen. For ingestion, consider gastric lavage.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. Vapor/air mixtures are explosive above flash point. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Electrostatic discharges may be generated by flow or agitation resulting in ignition or explosion.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT: 81 F (27 C) (CC)
LOWER FLAMMABLE LIMIT: 1.1%
UPPER FLAMMABLE LIMIT: 7.0%
AUTOIGNITION: 982 F (528 C)
FLAMMABILITY CLASS (OSHA): IC

6. ACCIDENTAL RELEASE MEASURES

AIR RELEASE:
Reduce vapors with water spray. Stay upwind and keep out of low areas.

SOIL RELEASE:
Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Absorb with sand or other non-combustible material. Collect with absorbent into suitable container.

WATER RELEASE:
Cover with absorbent sheets, spill-control pads or pillows. Neutralize. Collect with absorbent into suitable container. Absorb with activated carbon. Remove trapped material with suction hoses. Collect spilled material using mechanical equipment.

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Protect from physical damage. Store outside or in a detached building. Store with flammable liquids. Keep separated from incompatible substances. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
P-XYLENE:
XYLENE:
100 ppm (435 mg/m3) OSHA TWA
150 ppm (651 mg/m3) OSHA STEL (vacated by 58 FR 35338, June 30, 1993)
100 ppm ACGIH TWA
150 ppm ACGIH STEL
100 ppm (435 mg/m3) NIOSH recommended TWA 10 hour(s)
150 ppm (655 mg/m3) NIOSH recommended STEL

VENTILATION: Provide local exhaust ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
900 ppm
Any chemical cartridge respirator with organic vapor cartridge(s).
Any powered, air-purifying respirator with organic vapor cartridge(s).
Any supplied-air respirator.
Any self-contained breathing apparatus with a full facepiece.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
APPEARANCE: clear
COLOR: colorless
ODOR: sweet odor

MOLECULAR WEIGHT: 106.17
MOLECULAR FORMULA: C8-H10
BOILING POINT: 280 F (138 C)
FREEZING POINT: 55 F (13 C)
VAPOR PRESSURE: 8.6 mmHg @ 25 C
VAPOR DENSITY (air=1): 3.7
SPECIFIC GRAVITY (water=1): 0.8611
WATER SOLUBILITY: insoluble
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: 0.47 ppm
EVAPORATION RATE: 0.7 (butyl acetate=1)
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, benzene, acetone, organic solvents

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: acids, combustible materials, oxidizing materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of carbon

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

P-XYLENE:
TOXICITY DATA:
4550 ppm/4 hour(s) inhalation-rat LC50; 5 gm/kg oral-rat LD50
LOCAL EFFECTS:
Irritant: inhalation, skin, eye
ACUTE TOXICITY LEVEL:
Moderately Toxic: inhalation, ingestion
TARGET ORGANS: central nervous system
REPRODUCTIVE EFFECTS DATA: Available.
ADDITIONAL DATA: Alcohol may enhance the toxic effects. Stimulants such as epinephrine may induce ventricular fibrillation.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 8800 ug/L 96 hour(s) LC50 (Mortality) Guppy (Poecilia reticulata)

INVERTEBRATE TOXICITY: 3600 ug/L 24 hour(s) EC50 (Immobilization) Water flea (Daphnia magna)

ALGAL TOXICITY: 4400 ug/L 8 hour(s) EC50 (Growth) Green algae (Selenastrum capricornutum)

13. DISPOSAL CONSIDERATIONS

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): U239. Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Xylenes
ID NUMBER: UN1307
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: II
LABELING REQUIREMENTS: 3

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Xylenes
UN NUMBER: UN1307
CLASS: 3
PACKING GROUP/RISK GROUP: II

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
p-Xylene: 100 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):

ACUTE: Yes
CHRONIC: No
FIRE: Yes
REACTIVE: No
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65):
p-Xylene

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: BD2

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

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ZVI

Material Safety Data Sheet

Section I. Chemical Product and Company Identification

Product Name/ Trade Name	**ATOMET 58**	**Code**	QMP-2-2927
Supplier	QUEBEC METAL POWDERS Ltd. 450-746-5050	**CAS#**	7439-89-6
		DSL	Not applicable.
Synonym	Reduced Iron Powder.	**CI#**	Not available.
		EINECS#	Not applicable.
Chemical Name	NA	**In case of Emergency**	450-746-5050
Chemical Family	Metals.		
Chemical Formula	Fe		
Manufacturer	Quebec Metal Powders Ltd. 1655 Marie-Victorin, Sorel-Tracy, Quebec, Canada. J3R 4R4 Tel: 450-746-5050	**Material Uses**	Powdered metallurgy.

Section II. Composition and Information on Ingredients

		Exposure Limits			
Name	**CAS #**	**TWA**	**STEL**	**CEIL**	**% by Weight**
Iron	7439-89-6	15 mg/m3	NA	NA	100

Toxicological Data on Ingredients This product has not been tested as a whole for all potential health effects.

Section III. Hazards Identification.

Potential Acute Health Effects

-Inhalation: over-exposure by inhalation may cause respiratory irritation.

-This product may irritate eyes (conjunctivitis, retinae) and skin upon contact.

-Ingestion: not a normal exposure route, but could induce gastric problem.

Potential Chronic Health Effects Repeated inhalation of dust can produce varying degrees of respiratory irritation.

Section IV. First Aid Measures

Eye Contact Check for and remove any contact lenses. IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Get medical attention.

Skin Contact Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Get medical attention if irritation persists.

Hazardous Skin Contact Seek medical attention.

Inhalation Allow the victim to rest in a well ventilated area. Seek medical attention if breathing difficulties persist.

Hazardous Inhalation Seek medical attention.

Ingestion Have conscious person drink several glasses of water or milk. DO NOT INDUCE VOMITING. Seek medical attention.

Hazardous Ingestion Seek medical attention.

Continued on Next Page

Section V. Fire and Explosion Data

The Product is:	Non-flammable. SEE SPÉCIAL REMARKS ON FIRE HAZARDS.
Auto-Ignition Temperature	Not applicable.
Flash Points	This material does not burn or give a flash point by conventional test methods.
Flammable Limits	No data.
Products of Combustion	Some metallic oxides.
Fire Hazards in Presence of Various Substances	No data.
Explosion Hazards in Presence of Various Substances	Non explosive under normal conditions.
Fire Fighting Media and Instructions	Do not use foam or carbon dioxide. USE A FOG NOZZLE to spray water.
Special Remarks on Fire Hazards	As with any finely granulated product (i.e flour) a risk of fire is present should the material be dispersed in air and exposed to a source of ignition. Fine powder forms flammable and explosive mixtures in air.
Special Remarks on Explosion Hazards	No additional remarks.

Section VI. Accidental Release Measures

Small Spill	No special procedures are required for clean-up of spills or leaks of this material. Avoid methods that result in water pollution.
Large Spill	No additional information in case of a spill and/or a leak of the product. Use a shovel to put the material into a convenient waste disposal container.

Section VII. Handling and Storage

Precautions	Avoid contact with skin and eyes. Do not breathe dust. Do not ingest.
Storage	Do not store in unlabelled containers. Empty containers may contain product residue. Do not reuse without adequate precautions.

Section VIII. Exposure Controls/Personal Protection

Engineering Controls	Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure of airborne contaminants below the permissible limits.
Personal Protection	Wear safety glasses or chemical goggles. Wear protective clothing. Use approved respiratory protection when airborne exposure limits are exceeded.
Protective Clothing	
Personal Protection in Case of a Large Spill	No more data.
Exposure Limits	TWA (1997): 15 mg/m3 - OSHA, for total dust base on Particulates Not Otherwise Regulated (PNOR).

Continued on Next Page

Section IX. Physical and Chemical Properties

Physical State and Appearance	Granular powder.	**Odor**	Odorless.
Molecular Weight	Not applicable.	**Taste**	Not available.
pH (1% soln/water)	Not applicable.	**Color**	Gray.

Boiling Point	2750.0 C (4982F) for Iron.
Melting Point	1535 C (2795 F) for Iron.
Critical Temperature	Not applicable.
Specific Gravity	7.8 (Water = 1) for Iron.
Vapor Pressure	Not available.
Vapor Density	Not available.
Volatility	Not available.
Odor Threshold	Not applicable.
Water/Oil Dist. Coeff.	Not available.
Ionicity (in Water)	Not available.
Dispersion Properties	Not available.
Solubility	Insoluble in cold or hot water.

Section X. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not applicable.
Conditions of Instability	Stable.
Incompatibility with various substances	Avoid contact with oxidizers and reducing agents.
Corrosivity	No data.
Special Remarks on Reactivity	No additional remarks.
Special Remarks on Corrosivity	No additional remarks.

Section XI. Toxicological Information

Routes of Entry	Ingestion, Inhalation.
Toxicity to Animals	LD50: 30 gm/kg. Oral-Rat for iron powder -325 mesh.
Chronic Effects on Humans	Repeated inhalation of dust can produce varying degrees of respiratory irritation.
Other Toxic Effects on Humans	-Inhalation: over-exposure by inhalation may cause respiratory irritation. -This product may irritate eyes (conjunctivitis, retinae) and skin upon contact. -Ingestion: not a normal exposure route, but could induce gastric problem.
Special Remarks on Toxicity to Animals	Iron: LDLo (lowest published lethal dose) = 20 mg/kg , intraperitoneal - rabbit.
Special Remarks on Chronic Effects on Humans	No additional remarks.
Special Remarks on Other Toxic Effects on Humans	No additional remarks.

Continued on Next Page

Section XII. Ecological Information

Ecotoxicity	Not available.
BOD5 and COD	No data.
Products of Biodegradation	No data.
Toxicity of the Products of Biodegradation	No data.
Special Remarks on the Products of Biodegradation	No additional remarks.

Section XIII. Disposal Considerations

Waste Disposal	Consult your local or regional authorities.

Section XIV. Transport Information

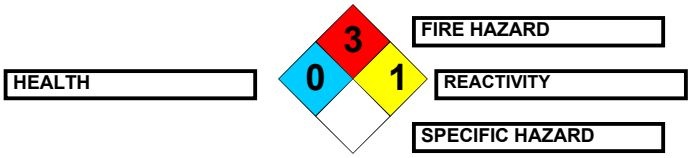
TDG Classification	Not controlled under TDG (Canada).	Not applicable.
DOT Classification	Not a DOT controlled material (United States).	Not applicable.
ADR Classification	Not controlled under ADR of the EEC.	Not applicable.
Special Provisions for Transport in Canada	No additional remarks.	
Special Provisions for Transport in the States	No additional remarks.	
Special Provisions for Transport in Europe	No additional remarks.	

Section XV. Other Regulatory Information and Pictograms

WHMIS (Canada) Not controlled under WHMIS (Canada).

WHMIS (Canada) (Pictograms)

NFPA (U.S.A.)



DSCL (EEC) Not controlled under DSCL

Continued on Next Page

DSCL (EEC)
(Pictograms)

Section XVI. Other Information

References

SAX, N.I. Dangerous Properties of Industrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984.

Guide to Occupationnal Exposure Values, ACGIH 1997.

ACGIH, threshold limit values for chemical substances and physical agents and biological exposure indices, 1997.

Chemical hazard communication guidebook, OSHA, EPA and DOT requirements, second edition, 1993.

SARA TITLE III: Hazardous Chemicals and The Right to Know, 1993.

Official Journal of the European Communities L180.

PEL-OSHA, Table Z-1 & Z-3, Limits of air contaminants, 08/1997.

Other Special Considerations

Rev. 0

Validated by Service d'hygiène industrielle on 30-06-05.

Verified by Service d'hygiène industrielle.

Printed 30-06-05.

Information Contact

QUEBEC METAL POWDERS Ltd.
450-746-5050

Notice to Reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

EXHIBIT 3

FIELD FORMS AND JOB SITE POSTINGS

All appropriate safety-related jobsite posters permits and forms will be listed here. Examples include the OSHA poster ("Safety and Health on the Job"), forklift operating rules, Carcinogen Registration Notice, Notice of workers compensation carrier, and Emergency phone listings. The actual posters, permits and forms will be provided to the Site Supervisor in a separate package.

Jobsite postings, permits and forms, as listed below, are being provided to the Site Supervisor for use on the job site only:

Postings	Permits	Forms
OSHA Poster Safety & Health Protection on the Job Notice - On-The-Job Injuries Access to Medical & Exposure Records Emergency Phone Numbers Workers Compensation Instructions	None required for H&S	Tailgate/Job Safety Meeting Daily Site Safety Briefing Form Safety Inspection Report HGL Incident Report/Analysis Form Photoionization Detector Calibration Log Underground/Overhead Utility Checklist Daily Field Log Entrance Log Visitor Log

TAILGATE/JOB SAFETY MEETINGS

1.0 PURPOSE:

To establish the minimum requirements regarding the conduct and content of tailgate/job safety meetings for HydroGeoLogic, Inc.

2.0 GENERAL:

A. Tailgate/job safety meetings are short meetings designed to promote the safety and well being of employees and sub-contractors in the work environment on project sites. The sharing of information on the work to be accomplished, the recognized hazards present, and methods to be used to prevent injury or illness accomplish this. These meetings shall be conducted at the following times:

1. Before field teams begin work at any hazardous material/waste site;
2. Before field teams begin work at any non-hazardous site;
3. Before each shift after a project starts;
4. Whenever there are changes to the conditions at the site;
5. Whenever a new activity is begun.
6. Whenever a change is made to the Site Specific Health and Safety Plan
7. Whenever new staff begins fieldwork.

B. Field personnel affected by the operations must attend the tailgate/job safety meeting. This includes sub-contractors, client representatives, and other visitors who need or wish to visit the job site. Visitors may attend this meeting in lieu of individual orientation training provided that the information contained in the Visitor Orientation Training is covered in the meeting. Attendees are to confirm their attendance at the meeting by signing in on Attachment A.

C. As a minimum the meeting agenda shall include the following:

1. Review of the Site Specific Health and Safety Plan as well as any modifications.
2. Review of work plan for the day.
3. Review of other relevant site-specific health and safety information.
4. Review of the Personal Protective Equipment to be worn on the job. Respiratory protection and fit checks of respirators shall be specifically included.

5. Review of hazards that may be encountered, and steps to be taken to protect the workers.

6. Question and answer session to allow input from all team members on the work to be completed, the hazards that may be encountered, and recommendations for protective action.

D. The Safe Plan of Action (SPA) format presented in Attachment A is to be used for the tailgate/job safety meeting. This form contains sections to identify the job location, the work to be performed, the hazards to be expected and how to control the hazards, any hazards created by others working in the area and how to control these hazards, hazards discovered at the job site not covered elsewhere on the form and how to control these hazards, and finally a section to print the names, company, and signature of those attending the meeting.

3.0 PROCEDURE:

Responsibility	Action
Office/Area Managers	1. Require the completion of the SPA form on a daily basis at each job site.
Project Managers/Supervisors	1. Convene the meeting
	2. Note the attendees and absentees.
	3. Provide all applicable information to the attendees.
	4. Make sure that any person missing the safety meeting is provided with the information discussed during the meeting and that they sign the SPA.
Area and Office Safety Officers	1. Support the Project Officers/Supervisors.
Corporate Safety Manager	1. Support the Project Managers/Supervisors and the Area and Office Safety Officers.
	2. Audit to check that the tailgate/job safety meetings are being conducted according to this procedure.

Attachment A: Safe Plan of Action Form
Attachment B: Direction to complete the Safe Plan of Action Form.

TAILGATE/JOB SAFETY MEETINGS

ATTACHMENT A

SAFE PLAN OF ACTION FORM

SAFE PLAN OF ACTION (SPA)
TAILGATE SAFETY MEETING

Project Name:_____ Date: _____

Project No: _____ Time: _____

Type of Work:_____ Supervisor: _____

Location: AOCs 6, 8, 11, 20, 22, Scott Air Force Base, Illinois

TASK HAZARD ASSESSMENT

HAZARDS	SAFE PLAN/CONTROL MEASURES
Hazards identified before work begins	
Chemical Hazards: Benzene, PAH, cis-1,2-DCE, Xylenes, Ethylbenzene, TCE	Reference Site Specific Safety and Health Plan (SSHP)
Physical Hazards: Slip, trip, fall, cold/heat stress, sunburn, noise, lifting, lacerations from hand tools, fires	Reference SSHP
Biological Hazards: Poisonous or stinging insects (wasps, hornets, bees); spiders (black widow and the brown recluse); and /or reptiles (snakes). Disease vectors (West Nile Virus) by biting insects such as ticks and mosquitoes. Bird excrement and animal droppings (rodent cary Hantavirus). Native vegetation such as **Poison Ivy**, and other thorny plants.	Reference SSHP
Hazards in the surrounding area that can affect the task	
Poison Ivy is the greatest hazard at the site.	Be aware of surrounding. Poison ivy may grow as a vine, but usually is a shrub. Any contact with the plant's oil, Urushiol, can cause allergic contact dermatitis. Contact can occur in three ways: 1. Direct contact 2. Indirect contact – touching something with urushiol oil on it 3. Airborne contact – usually from burning the plant
Tornados	Be aware of the area weather and regional forecast. Check the local radio for warnings and weather updates.
Hazards identified while performing task	
VOA vials with HCL preservative	Stand down wind when opening vials. Be cautious not to spill on yourself
Black widows in well heads	Open each well head with caution

TEAM MEMBER SIGNATURES

_____ _____ _____

_____ _____ _____

Protective Clothing/Equipment

- ❑ Modified Level D
  - o Steel toed boots
    - ❑ Leather
    - ❑ Rubber
  - o Eye protection
  - o Long pants
  - o Hearing protection
  - o Hard Hat
  - o Tyvek
  - o Rain Suit
  - o Other _____
- ❑ Hand Protection
  - o Nitrile
  - o PVC
  - o Rubber
  - o Neoprene
  - o Latex
  - o Silver Shield
  - o Leather
  - o Other _____
- ❑ Level C
  - o Full face
  - o Half face
  - o Gas mask

  Cartridge Type _____

Chemical Hazards:

Reference SSHP _____

_____

_____

_____

Physical Hazards

Reference SSHP _____

_____

_____

_____

Emergency Procedures

Reference SSHP _____

_____

_____

_____

Hospital/Clinic: St. Elizabeth's Hospital

Phone: 911 or (618) 234-2120

Address: 211 S. Third St.

Belleville, IL 62220

Other:_____

_____

_____

_____

_____

TAILGATE/JOB SAFETY MEETINGS

ATTACHMENT B

DIRECTIONS TO COMPLETE SAFE PLAN OF ACTION FORM

DIRECTIONS TO COMPLETE SAFE PLAN OF ACTION FORM

The Safe Plan of Action is utilized for the Tailgate/Job Safety Meeting. The form is to be completed by all of the personnel involved in the work at the location noted on the form. Participation in the completion of the form is paramount to the success of the process of understanding the work to be accomplished, the hazards involved and the methods to prevent accidents and injuries from occurring.

1. Complete the heading information:

    a. Project Name:
    b. Project Number
    c. Date
    d. Time
    e. Supervisor's name
    f. Subcontractor company name
    g. Location where the work will be performed
    h. What type of work will be performed

2. The supervisor and crew conduct a walkthrough survey of the work area. Plan and review the job task with all of the employees and subcontractors involved

3. In the "Hazards identified before work begins: " block, write down each hazard possible in conducting the task (How can someone get hurt doing the Job, i.e., slips, trips, fall, fire, burns, cuts, electric shock, rigging, struck by, lifting, etc.?)

4. On the right side of the form put down what can be done to control/eliminate the hazard. (i.e., housekeeping, fire watch, replace cords, etc.)

5. In the" Hazards in the surrounding area that can affect the task" block to check other operations in the area that may cause problems with your job (i.e., traffic, excavations, airport operations, etc.

6. Use the checklist on the back of this form to review personal protective equipments and to refresh your memory of chemical hazards, physical hazards, emergency procedures, the name, address and telephone number of the nearest emergency medical facility, and any other hazards or concerns noted.

7. Use the "Hazards identified while performing task" block to identify any additional hazards/problems noted while work is in progress (anyone on the crew can call a time out for safety)

8. When completing the Safe Plan of Action (SPA), include any hazards specific to the location of work, whether created by your work activity or previously existing.

9. If the task takes more than one day then complete a new SPA each day

10. Every time a new task is added, the SPA is to be updated. If a completely new job assignment is started, a new SPA is required. (e.g., If well monitoring is the assigned task then new drilling is started, a new SPA is required)

11. Turn the SPA in with the dailys of the project.

DAILY SITE SAFETY BRIEFING FORM

Project _____ **Location** _____
Date_____ **Time** _____
Type of Work _____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____
_____

Chemical Hazards_____

Physical Hazards _____

Biological Hazards _____
_____
_____
_____

Emergency Procedures _____

Hospital/Clinic _____ **Phone** _____ or **911**
Hospital Address _____
Special Equipment _____
Other (Refer to SSHP for Directions)_____

ATTENDEES

Name (Printed)	Signature
_____	_____
_____	_____
_____	_____
_____	_____

Meeting Conducted by: _____

Site Safety Officer: _____

SAFETY INSPECTION REPORT

Date:_____ Start Time:_____ Complete Time:_____

Project Name:_____ Project No:_____

Program Manager:_____ Project Manager_____

Project Description:_____

_____

Site Activities At Time Of Inspection:_____

_____

ITEM ONE

Interviewed Employee:_____

Safety Issue:_____

_____

Corrective Action:_____

_____

Assigned To:_____ Follow-Up Date:_____

Correction Verified By:_____ Date:_____

ITEM TWO

Interviewed Employee:_____

Safety Issue:_____

_____

Corrective Action:_____

_____

Assigned To:_____ Follow-Up Date:_____

Correction Verified By:_____ Date:_____

Inspection Completed By:_____ Date:_____

Health And Safety Review By: _____ Date:_____

SAFETY INSPECTION REPORT (Continued)

Item Number:_____ Safety Contact Employee (Name):_____

Safety Issue:_____

_____

Corrective Action:_____

_____

Assigned To:_____ Follow-Up Date: _____

Correction Verified:_____ Date: _____

Item Number:_____ Safety Contact Employee (Name):_____

Safety Issue:_____

_____

Corrective Action:_____

_____

Assigned To:_____ Follow-Up Date: _____

Correction Verified:_____ Date: _____

Item Number:_____ Safety Contact Employee (Name):_____

Safety Issue:_____

_____

Corrective Action:_____

_____

Assigned To:_____ Follow-Up Date: _____

Correction Verified:_____ Date: _____

SAFETY INSPECTION REPORT CHECKLIST

	Not Applicable	Not* Acceptable	Acceptable		Not Applicable	Not* Acceptable	Acceptable
HEALTH AND SAFETY DOCUMENTATION				**SITE CONTROL**			
Tailgate Safety Meeting				Security Maintained			
Hot Work Permit				Clearly Marked Exclusion Zone			
Confined Space Entry Permit				Clearly Marked Contamination Reduction Zone			
Hospital Route Map				Clearly Marked Support Zone			
OSHA 200 Log				Sign In/Out Log			
MSDS				Decontamination Procedures			
Air Monitoring Logs				Client Specific Passes			
Equipment Calibration Logs				**PERSONAL PROTECTIVE EQUIPMENT**			
Personnel Training Records				Hard Hats			
Personnel Medical Records				Safety Glasses			
Accident Forms				Steel-Toed Boots			
Emergency Phone Numbers				Gloves			
OSHA Job Protection Posters				Hearing Protection			
HGL H&S Program Manual				Traffic Vests			
Client Specific Documentation				Face Shields			
H&S Plan Acknowledgement				Chemical Resistant Coveralls			
				Chemical Resistant Gloves			
EMERGENCY EQUIPMENT				Respiratory Protection			
Fire Extinguishers				Back Support Devices			
Shower/Eyewash				Chaps			
Alarm System				Lifelines/Harness			
Transport Vehicle				Welder's Hood w/ Hard Hat			
Communication System				Welders Sleeves/Leathers			
First-Aid/CPR Provider				Personal Flotation Device			
				FALL PROTECTION			
				Fall Protection Used When Over 6 Feet Above Ground			
				Full Body Harness and Lanyard Used			

*Any "Not Acceptable" response must be documented on the corrective action form.

SAFETY INSPECTION REPORT CHECKLIST (Continued)

	Not Applicable	Not* Acceptable	Acceptable		Not Applicable	Not* Acceptable	Acceptable
HOUSEKEEPING AND SANITATION				**ELECTIRCAL**			
Adequate Illumination				GFCIs in Place			
Drinking Water/Disposable Cups				Lockout/Tagout Procedures			
Sanitary Facilities				Equipment UL Listed or FM Approved			
Break Area				Adequate Clearance from Overhead Lines			
General Housekeeping				Grounding and Bonding			
Walkways Clear				Qualified Electricians			
VEHICLE/EQUIPMENT OPERATIONS				Un-compromised Insulation			
Record of Regular Inspection and Maintenance				Utility Markouts Completed			
Back-up Alarm				**HAND TOOLS**			
Qualified Operators				Correct Tool Being Used for Job			
Proof of Insurance				Damaged Tools Repaired or Replaced			
Wheels chocked				All Guards in Place			
Brake Lights, Warning Devices Operative				Neat Storage, Safe Carrying			
Weight Limits and Load Sizes Controlled				Grounded 3-Prong Plugs			
DOT Requirements Met				**LADDERS**			
Fire Extinguisher				Regular Inspections			
All Glass in Good Condition				Secured at Top and Bottom			
SITE MONITORING				Side Rails Extend 3 Feet Above Top of Landing			
Volatile Organics				Wooden Ladders Not Painted			
Dust				Step Ladders Fully Opened When In Use			
Noise				Safety Feet in Use			
Radiation				Rungs Not Over 1 Foot on Center			
Illumination				Ladder Training			
Semi Volatile Organics				Top of Step Ladder Not Used as Step			
Inorganic							

*Any “Not Acceptable” response must be documented on the corrective action form.

SAFETY INSPECTION REPORT
CHECKLIST CORRECTIVE ACTIONS

Not Acceptable Findings	Corrective Action	Assigned To	Date Assigned	Date Completed	Verified By

HGL INCIDENT REPORT/ANALYSIS FORM

This report is for (check **ALL** that apply):
☐**close call** **OR**
☐employee injury/illness (reportable) **OR** ☐employee injury/illness (non-reportable) **OR** ☐damage to company equipment/ property/ vehicle
☐Third Party(private individual/contractor/client) injury/ illness **OR** **THEIR** ☐equipment/property/vehicle

If this incident involves off-site medical care or equipment damage >$1000, notify the Forensics Manager, Director of Engineering, or Director of Construction (whoever is responsible for the project/employee where the incident occurred) immediately.

SECTION 1. General Information (MUST be completed for EVERY incident – close calls and Third Party omit line 3)		
Date of Occurrence	**Time (am/pm)**	**Shift** ☐1st ☐2nd ☐ 3rd
Specific location of incident (e.g. bottom of excavation, office trailer, cab of haul truck, No. 203 monitoring well, etc.)		
HGL Employee Name: **HGL Job Title:** **HGL Employee Status** ☐ full time ☐ part time ☐ temporary ☐**Male** ☐**Female** **Time on Present Job**		
Third Party -Company Name:		
Specific task or activity involved (e.g. opening wells, driving forklift, sampling soil, erecting scaffold, washing trucks, etc.)		
Was employee involved working extended hours? (In excess of 8 hrs/day or 40 hrs/week) ☐Yes ☐No **Has employee performed the task before?** ☐Yes ☐No		
Description of incident or close call: Describe incident/close call in DETAIL. Include who, what, when where, and how. If close call, specify injury/damage avoided. List type and manufacturer of PPE individual was wearing (e.g. hearing protection, goggles, fall protection, etc.). Include names of witnesses if any. Attach additional sheets if necessary.		

SECTION 2. Description of Injury or Illness (MUST be completed for EVERY injury or illness NOT close calls)	
Specific body parts affected: (e.g. right leg, left eye, back of the head, right index finger, etc.)	
Type of injury (List all that apply): ☐fatality ☐muscle strain ☐joint strain ☐bruise/contusion ☐fracture ☐laceration, puncture ☐concussion ☐dismemberment ☐foreign object in eye ☐unconsciousness ☐loss of senses ☐thermal burn ☐chemical burn ☐electrical burn ☐electrical shock ☐other (specify)	
Type of Illness: ☐skin ☐respiratory ☐eye ☐heat stress ☐hypothermia ☐CNS ☐cardiovascular ☐systemic (liver, kidney, etc,) ☐hearing loss ☐other (specify)	
What caused the injury or illness (check all that apply): ☐fall on same level ☐fall from higher elevation ☐struck by ☐struck against ☐caught in, under, between ☐slip, trip ☐abraded ☐over extension ☐contact with electrical current ☐contact with temperature extremes ☐contact with plant, animal, insect ☐contact with material ☐inhalation of material ☐other (specify):	
Method of Treatment: ☐none ☐on-site 1st aid ☐clinic/doctor 1st aid ☐doctor's care ☐hospitalization (Attach HGL *Medical Assessment/Work Capacity Report*)	
Is injury covered by Workers' Compensation? ☐Yes ☐No	**Is the injury OSHA recordable?** ☐Yes ☐No
Will injury result in restricted activity? ☐Yes ☐No	**Will injury result in a lost workday?** ☐Yes ☐No

SECTION 3. Description of Equipment/Property/Vehicle Damage (MUST be completed for ALL damage)
Whose equipment/ property/ vehicle was damaged? ☐company ☐individual/contractor/client
Extent of damage: ☐minor - usable as is ☐repairable ☐destroyed
Estimated cost of repair/ replacement:
Describe the property damage: ☐heavy equipment _____ ☐process equipment_____ ☐tools_____ ☐vehicle_____ ☐building/structure_____ ☐utility_____ ☐other_____

SECTION 4. Corrective Actions (MUST be completed for all injury, illness, equipment damage incidents)
How could this incident have been avoided: e.g. change in procedures, different equipment, and additional workers?

SECTION 5. Estimated Cost of Incident (to be completed by Regional Manager for all injuries requiring medical care or equipment damage)	
What is the TOTAL cost of this incident?	
☐Medical (1st aid, emergency room, hospitalization, follow-up, rehab, etc.) $	
☐Equipment/Property/Vehicle (repair, replacement, rental)	$
☐Process (loss of product, down time, quality reduction, efficiency, etc.) $	
☐Personnel (coworkers, supervisor, replacement employee, manager, etc.) $	
☐Indirect (calculate increases in insurance, travel costs, regulatory fines, etc.) $	
☐Indirect (apply multiplier _____)	$
☐Other (specify)	$
TOTAL COST	**$**

SECTION 6. Corrective Actions Taken

SECTION 7. Signatures		
Supervisor (print):	**Signature:**	**Date**
Employee (print):	**Signature:**	**Date**
Witness (print):	**Signature:**	**Date**
Witness (print):	**Signature:**	**Date**

PHOTOIONIZATION DETECTOR CALIBRATION LOG

PROJECT NAME: _____ PROJECT NO: _____

DATE: _____ CLAIBRATED BY: _____

INSTRUMENT: MFG/MODEL/SERIAL NO: _____

Time	Probe Type (eV)	Battery Charged (Y/N)	Calibration Standard	Calibration Standard Concentration (ppm)	Span Setting	Meter Scale Setting	Zeroed (Y/N)	Expected Meter Reading (ppm)	Actual Meter Reading (ppm)

Comments: _____

UNDERGROUND/OVERHEAD UTILITY CHECKLIST

Project Name/Number: _____ **Date**: _____

Location: _____

Prepared By: _____ **Project Manager**: _____

This checklist must be completed for any intrusive subsurface work such as excavation or drilling. It records the fact that all underground and overhead structures and utilities in the work area are identified and located. The Project Manager shall request utility mark-outs before the start of field operations to allow the client and utility companies time to complete them. If complete information is not available, a geo-physical survey shall be performed to locate obstacles prior to excavation r drilling.

Procedure: A diagram of the project area depicting the proposed location of excavation or drilling sites must be attached to this form. The diagram must clearly indicate the areas checked for underground structures/utilities, and overhead power lines. This form and the diagram must be signed by the Project Manager, the HydroGeoLogic Site Supervisor, and the client representative.

Checklist:

Type of Structure	Present	Not Present	Method of Mark-out
Electric Power Line			
Natural Gas Line			
Telephone Line			
Water Line			
Product Line			
Steam Line			
Sewer Line			
Drain Line			
Underground Tank			
Overhead Power Line			
Overhead Product Line			
Septic Tank/Drain			
Other			
Other			

Client Representative: _____ Date: _____

HydroGeoLogic Project Manager: _____ Date: _____

HydroGeoLogic Site Supervisor: _____ Date: _____

DAILY FIELD LOG

Name/Initials:	Date:
Start Time:	Project Name:
Stop Time:	Project Location:

Work Performed (e.g. Sites visited, maintenance performed, locations Sampled, etc)**:**

Deviations from Schedule**:**

Deviations from Approved Plans/Procedures**:**

Names of Field Crew (C) / Visitors (V):
Check name or write in name(s)**:**

Problems Encountered**:**

Comments / Miscellaneous**:**

ENTRANCE LOG

This form shall be used to track entry into and departure from the ***EXCLUSION ZONE, CONTAMINATION REDUCTION ZONES, OR OTHER WORK ZONES*** on all HydroGeoLogic, Inc. sites. All Personnel shall sign in and out on the form by printing their name, initializing the form and noting the time in/out.

Date: _____

PRINTED NAME	INITIALS	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT

PRINTED NAME	INITIALS	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT

VISITOR LOG

This form shall be used to track entry onto and departure from HydroGeoLogic Inc. sites. Each visitor shall sign in and out on the form by printing their name, initializing the form and noting the time in or out.

PRINTED NAME	INITIALS	REASON FOR VISIT	TIME IN	TIME OUT	TIME IN	TIME OUT

PRINTED NAME	INITIALS	REASON FOR VISIT	TIME IN	TIME OUT	TIME IN	TIME OUT

Attachment 2

Resumes

Position Title: ***PROJECT MANAGER***
Name: ***MIQUETTE ROCHFORD, P.G.***
Current Employer: ***HYDROGEOLOGIC, INC.***
Geographic Location: ***GRAND JUNCTION, CO***

Education: M.S., Geology, 1992
B.S., Geology, 1990

Registrations: Professional Geologist / TN, TX

Certifications/Training: 40-Hour OSHA 29 CFR 1910.120, 1993; 8-Hour OSHA Health and Safety Refresher Training, 2003; 8-Hour OSHA Site Supervisor Training, 1997; USACE CQMC, 2003; Blood Borne Pathogens, 2003; American Red Cross First Aid, 2003; American Red Cross CPR, 2003

Experience: Ms. Rochford is a Project Manager with over 13 years of experience with all aspects of RIs. She is a Professional Geologist and has experience with scientific research, environmental sampling, report writing, and project management. Ms. Rochford's areas of expertise lie primarily with managing projects/programs involving RIs, remediation technology demonstration, and identifying and evaluating areas of environmental liability. Ms. Rochford is currently a Project Manager on RIs at USACE and USAF sites. As Project Manager, Ms. Rochford oversees the successful execution of 12 delivery CR/FP orders totaling over $10M and covering all aspects of environmental investigation, LTM, RD, and community relations support. In addition, Ms. Rochford has managed over $2M worth of delivery orders for USACE–Kansas City and Omaha Districts. Delivery order types range from PRP search/litigation support to Phase I environmental site assessments (ESAs), NEPA Compliance, EAs, and RIs.

HydroGeoLogic, Inc., Herndon, VA, Project Manager and Senior Hydrogeologist, 1992-Present

- **USACE, Former Forbes Atlas Missile Site (Site S-9), Holton, KS.** Project Manager for this full service remediation project with Performance-Based milestones, under the USACE - Omaha District FPRI contract. The project task order is valued at $5.5M and requires complete cleanup and site closure at this former missile site that has been converted to a rural high school. The site is high-profile because of serious concern about the health and safety of high school children and public exposure. The project involves multiple stakeholders including the school district, state and federal regulators, and county officials. Quarterly stakeholder meetings are held to facilitate the RI/remediation process. Site activities include characterization of TCE groundwater contamination, Interim Remedial Action (IRA) to mitigate continuing contamination from sumps, and soil borings to delineate contaminated soil sources. Responded

effectively to changing site conditions involving the discovery of TCE vapor in a school building. Implemented indoor air sampling and analysis, as part of site characterization, which revealed a complete groundwater-to-indoor air exposure pathway. After the RI and IRA are complete, a focused feasibility study (FFS), preliminary remediation plan, and decision document will be prepared to implement the remedy that HGL has proposed. Contract also includes the RA of enhanced reduction dechlorination to treat contaminated groundwater and installation of permanent monitoring wells for LTM. Early data from the 3-month performance monitoring of the ERD indicate that TCE concentrations in groundwater decreased from 1,000 μg/L to 58 μg/L. Ms. Rochford also manages the preparation of a Community Involvement Plan (CIP), compiles the AR and IR, and facilitates stakeholder interaction and regulatory agency negotiation.

- **AFCEE, Former Carswell AFB, TX.** Project Manager for this base-wide project, involving 13 FP and T&M task orders and totaling $16.5M under the PA through RD contract and the follow-on 4P A-E services contract. Single POC responsible for communication and reporting to client on a frequent basis to include performance, budget/cost, schedule/progress, technical performance, and quality. Directly managed over 40 subcontractors across all project phases. Tasks included UST investigations and site closure; RFI/CMS of landfills, waste accumulation areas, fire training areas, and other sites; Focused Feasibility Study (FFS); LTM of base-wide TCE groundwater plume; RD of GWTS; IRAs and hot-spot removals; sampling and chemical analyses; data validation, and data management in accordance with ERPIMS; community relations support; and installation and O&M of a PRB to remediate TCE plume. Negotiated site closures (42 to date) successfully with state (TCEQ) and federal regulators. Commended by AFCEE Team Chief Don Ficklen and Texas Regulators for excellent performance.

- **USACE–Kansas City District, Multi-Phased RI at Tyson Valley Powder Farm Site, MO.** Project Manager responsible for cost estimating, budgeting, scheduling, field coordination, client and regulatory interaction, and report preparation on this $1.7M FP project. Field investigation activities included monitoring well installation, mapping and geophysical surveys, soil borings, chemical sampling and analysis, sampling and handling radiological and mixed wastes, and UXO survey. Other tasks included identification of wildlife, vegetation, and ecological stresses in support of human health and ecological risk assessments. Also provided public outreach/ community relations support through development of a Community Relations Plan (CRP). Worked closely with state regulators to ensure comprehensiveness of data gathering and sampling activities, and to expedite the site closure process. Commended by CENWK for excellent performance.

- **USACE–Kansas City District, CR/FP Task Orders for PRP Investigation and NEPA EA.** Project Manager for PRP investigations at the former Malta Rocket Fuel Area Site, Malta, NY, and Miami Army Airfield, FL. Managed two NEPA EAs at Fort Riley, KS. Responsible for cost estimating, work plans (WPs), budgets, scheduling, preparing reports, and presenting findings. Performed literature searches; collected, compiled, and analyzed technical data including generation of plume maps; evaluated RI/FS; and interpreted aerial photographs. Managed ecological risk assessment and cultural/natural resources survey.

- **DoD CR Environmental Services Contract, Corporate Environmental R&D SERDP/ESTCP Programs, Washington, DC.** Responsibilities as the Assistant Deputy Program Manager of the National Environmental Technology Test Sites (NETTS) program included preparation of meeting materials, meeting summaries, conference materials, budget oversight, and budget tracking. Oversaw production of technical manual for NETTS program.

- **USACE–Kansas City District, Food and Drug Administration (FDA) Laboratories Nationwide.** Project Manager/Lead Researcher under CR task orders for conducting Phase I and II ESAs of FDA laboratories in support of decommissioning efforts. Identified waste streams and areas of potential contamination through SIs, interviews, and record review and collection in order to assess areas of potential liability. At FDA laboratories, was Manager for the identification of waste streams and areas of potential contamination as part of SIs at facilities to be decommissioned. Also conducted interviews and record review and collection in order to assess areas of potential liability. Received commendation and award from Kansas City District for contributing to the success of this Laboratory Decommissioning Program.

- **USACE–Omaha District, Fort McCoy, WI.** Conducted ECAS audits focused on natural resource compliance issues to include wetland management and permitting requirements under NPDES and Section 404. Conducted wetland regulatory research pertaining to federal, state, and local regulations. Assessments involved wetlands impacted by MILCON projects and maneuver training areas.

- **AFCEE, Scott AFB, IL.** Project Manager for soil and groundwater investigation, UST removal, and site closure at 45 UST sites. Duties included preparation of budget, cost estimates, WPs, SSHPs, and technical performance. Worked closely with the Illinois EPA to ensure compliance with both existing and past regulations for site closure.

- **EPA, OSW and Emergency Response, Washington, DC.** Project Scientist responsible for assisting in emergency planning and response, and collecting

data pertaining to the delisting of organobromine wastes for underground injection. Task Leader for Corrective Action Regulatory Options Remedy Selection for RCRA facilities. Evaluated proposed RAs for Corrective Action Management Units and Temporary Units for 40 Code of Federal Regulations (CFR) Part 260.

- **Federal Deposit Insurance Corporation (FDIC).** Project Manager responsible for environmental compliance audits at 35 sites in VA, MD, and FL. Assessment activities included interviews; SIs; historical investigations; records collection and management; and title searches. Collected and analyzed federal, state, and local regulatory agency documents; prepared reports; made regulatory compliance recommendations; and provided budget oversight. In addition, provided accurate environmental histories of the subject properties.

- **Chevron USA, Mid-Atlantic Region.** Project Manager for site investigator and closure at several UST sites in VA and MD. Activities included soil and groundwater sampling, monitoring well installation, soil-gas surveys, aquifer testing, database management, report preparation, and regulatory compliance recommendations.

U.S. Geological Survey, Menlo Park, CA, Research Assistant, 1991-1992

- Duties included laboratory analysis of igneous rock samples for isotopic age dating using gas chromatography/mass spectrometry (GC/MS). Zircon geochronology was also conducted using MS. Prepared rock samples, separated mineral fractions, and acid dilutions for sample analysis.

Position Title: ***REMEDIATION ENGINEER***
Name: ***WAYNE SMITH, P.E.***
Current Employer: ***HYDROGEOLOGIC, INC.***
Geographic Location: ***LENEXA, KS***

Education: M.S., Civil Engineering 1976
B.S., Civil Engineering, 1971

Registrations: Professional Engineer / KS, MO, NE

Certifications/Training: OSHA 29 CFR 1910.120 40-Hour Hazardous Waste Training and Annual refreshers; OSHA 8-Hour HAZWOPER Supervisor Training. Member: American Society of Civil Engineers, International Society of Soil Mechanics and Foundation Engineers, Kansas Society of Professional Engineers

HydroGeoLogic, Inc., Lenexa, KS, Senior Project Director, 2005 to present

Mr. Smith has over 32 years' engineering and project management experience in both the geotechnical and environmental fields. He also has experience in site characterization, remedial investigations, feasibility studies, remedial design, waste management, procurement and construction oversight. For HGL, he conducts project and program oversight on a variety of environmental engineering projects conducted at DoD installations, including the USACE and Air Force under FUDS and BRAC programs. Also supports U.S. EPA region 7 A/E Services contract, providing engineering consulting and design.

URS, Kansas City, Senior Consulting Professional, 1973 to 2005

- **USACE Kansas City District, multiple contracts.** Mr. Smith was project Manager of CERCLA investigations, remedial studies and remedial design for the 48,753 acre former Naval Ammunition Depot in Hastings, Nebraska. The remedial program was conducted for the U.S. Army Corps of Engineers with a project budget exceeding $20 million for a 9+ year period. Operable units included in this work include former production areas which have been developed under private ownership as the Hastings East Industrial Park, former Explosives Disposal Area, former Yard Dump, former Bomb and Mine Complex, and many other small waste disposal sites. The site contained many discrete areas of shallow and deep soil contamination and widespread groundwater contamination encompassing over six square miles. Remedial actions at the site included excavation, treatment (stabilization of metals, incineration of explosives) and disposal of contaminated surface soils; soil vapor extraction within source areas of VOCs; and a combination of institutional controls and innovative technologies to reduce contaminants levels in groundwater. Mr. Smith served as project manager, technical reviewer and contributing author on the following project assignments: RI/FS, PPs, RODs, RD/RA, PA/SIs, EE/CAs, ESDs, Treatability Studies, Pilot Studies, and long term planning.

- **USACE Kansas City District, A/E HTRW Environmental Services IDIQ.** Mr. Smith served as the contract manager for multiple A/E HTRW IDIQ. Contracts. Projects under this contract included the investigation and design of mitigation alternatives at a site contaminated with radioactive and carcinogenic substances; analysis of risk to human health and environment; and analysis of conceptual mitigation schemes. This contract also included the evaluation of flood and erosion problems and modeling of Brush Creek as well as Kansas Flood Hazard Studies. Under this contract over 27 task orders were completed for an estimated total of $9.3 million.

  Project Manager of technical services to an industrial client which owned and operated a hazardous waste surface impoundment. These services included characterization of the impoundment wastes, design and installation of a groundwater monitoring network, groundwater assessment and site characterization, preparation of contingency plans and closure plans, development of a bench scale testing program for waste treatment, conceptual design of a treatment plant, and preparation of a delisting petition for the treated wastes.

  Senior Project Engineer during preparation of a RCRA Part B application for a proposed hazardous waste landfill. Mr. Smith served as task team leader for design of a 1.3 million cubic yard capacity landfill. He supervised a group of four to six engineers and was responsible for preparation of design drawings and technical specifications for the landfill.

  Project Engineer/Project Manager of technical services to an industrial client which owns and operates a hazardous waste landfill for a secondary lead smelter. Mr. Smith was project engineer during landfill construction responsible for quality control testing and construction oversight of the liner and leachate collection systems. He designed a surface impoundment as part of a treatment system for waste waters generated at the site. He served as project engineer during site characterization activities, design and installation of monitoring wells, and provided technical assistance in preparation of a RCRA Part B permit application.

  Project Manager to investigate past disposal of hazardous waste (sludges) at a municipal landfill. Mr. Smith supervised field activities to evaluate the depth and lateral extent of soil and surface water contamination. He prepared a report that addressed remedial alternatives for the landfill and estimated costs for each alternative. A closure plan was prepared for the selected alternative. Mr. Smith served as project manager during closure providing confirmation sampling and field observations to document waste removal and capping of the site.

  Mr. Smith served as one of URS field engineers, providing on-site interpretation of subsurface conditions and field design for the Trans Alaskan Pipeline. He received a letter of commendation for his work from the client.

Mr. Smith served as resident project engineer during installation of over 1,500 driven pipe piles for a grain storage complex near Fargo, North Dakota. He was also project engineering during installation of over 1,700 driven piles for an industrial complex near Enfield, Connecticut. Both projects involved supervision of four to eight engineers and field technicians during load testing and installation of production piles. Both projects involved detailed construction observations as the high density of piles generated large lateral ground movements at the Fargo site, and induced ground subsidence at the Enfield site.

- **Planning and Engineering Support for Civil Works and Other Programs, IDIQ, USACE, Kansas City District.** Mr. Smith served as the office/resource manager for a USACE, Kansas City District Planning and Engineering IDIQ contract; providing resource allocation and administration services for this contract. Work under this IDIQ contract included preparation of flood damage reduction studies, hydrologic and hydraulic studies, reconnaissance and feasibility reports, plan formulation studies and reports, design and preparation of plans and specifications, environmental assessments and studies, fish and wildlife habitat restoration reports and designs, cultural resource surveys and reports, economic surveys and reports, estimating, GIS, value engineering studies and engineering services during construction. The IDIQ included 18 delivery orders for a total of $2.6 million.

- **Kansas Watershed/Dam Assessments IDIQ, NRCS-16-KS-03 Various Locations within the Missouri River Basin.** Mr. Smith served as the contract manager for multiple watershed and dam assessments within the Missouri River Basin. The project focused on performing individual site assessments of existing flood retarding or grade stabilization structures within Kansas. The scope of the project includes hydrologic and hydraulic analysis, inundation mapping, breach determination and routing, hazard classification, structure evaluation, and proposed repair or modification alternatives. The IDIQ included seven watershed joint districts delivery orders for a total of $260,000 in fees.

- **Geotechnical Services with Optional Drilling and Testing Services IDIQ, (Two Contracts), USACE Kansas City District.** Mr. Smith served as the principal-in-charge for two USACE, Kansas City Geotechnical Services with Optional Drilling and Testing Services IDIQ contracts; providing resource allocation, administration services, and technical consultation for these contract. Work under these IDIQ contracts included geotechnical testing, field investigation and evaluation; subsurface investigation reports; feasibility studies; drilling and sampling; and assessment of subsurface structures. Delivery orders included providing services on the Blue River Channel Flood Protection Feasibility Study, Evaluation and Recommendations for the Turkey Creek Tunnel, Specialized Drilling and Sampling at Tuttle Creek Dam, and Civil Engineering Support for Missouri River Levee L-385. The two IDIQ contracts include more than 25 delivery orders for a total of $1 million.

- **Security and Homeland Defense Services Design/Build MATOC Contract, USACE Kansas City District.** Mr. Smith served as a senior engineer and project manager for this homeland defense IDIQ contract that includes significant upgrades to Tuttle Creek Dam. Delivery orders include the design/build of a useable physical and electronic security system at a not-to-exceed price; the design/build of a 50 ft by 75 ft construction office building and a earthquake proof 10 ft by 12 ft critical systems building; and the design/build of a state-of-the art dam failure warning system to protect over 12,000 residents within the inundation area below the dam. As part of the dam failure warning system, goods and services from over 50 subcontractors and vendors were required to complete construction of the warning system. Under this contract, three taks orders were executed for an estimated total of $6 million.

  Mr. Smith was the principal geotechnical design engineer during final design of the roadway embankments, storm sewers, and proposed bridge for the Arthur C. Storz Expressway in Omaha, Nebraska. He was responsible for the field and laboratory investigations and design of embankments sited over soft high plastic clays. The embankment design made use of preloading techniques, wick drains to accelerate consolidation of the soft soils, temporary stabilizing berms for slope stability, and staged construction. Mr. Smith prepared specifications for wick drain installation and participated in developing an instrumental system to monitor embankment performance and the behavior of the foundation soils. During one of the initial construction contracts, Mr. Smith served as contract administrator performing labor compliance interviews of construction personnel, preparing contract summary sheets for contractor payment, and maintaining daily diaries and progress reports for submittal to the Nebraska DOT.

  Mr. Smith was principal geotechnical design engineer for evaluation of the U.S. Disciplinary Barracks at Ft. Leavenworth, Kansas. A geotechnical and structural evaluation of the 80 year old structure was made to investigate building performance and the feasibility of renovation. Mr. Smith was responsible for the field and laboratory investigations and performed forensic engineering studies to assess past building movements due to changes in loading conditions. Design recommendations were made for support of new structural elements, retaining walls, and floor slabs.

Position Title: ***SITE SUPERVISOR***
Name: ***CHRIS W. WILLIAMS, P.G., R.G., C.P.G.***
Current Employer: ***HYDROGEOLOGIC, INC.***
Geographic Location: ***LENEXA, KS***

Education: B.S., Geology, 1985

Registrations:
Registered Professional Geologist, States of Alaska, Missouri, and Texas
Licensed Professional Geologist, State of Kansas
Certified Professional Geologist, American Institute of Professional Geologists
Licensed Well Driller, State of Missouri

Certifications/Training: OSHA 40 Hour Hazardous Waste/Materials Health & Safety Training (29 CFR 1910.120), 1987; 8-Hour OSHA Health and Safety Refresher Training, 2003; 6-hour DOT/IATA Training, 2002; American Red Cross First Aid, 2003; American Red Cross CPR, 2003

Professional Development Courses: USACE Construction Quality Management for Contractors course

Experience: Mr. Williams has worked on contracts with the following Agencies/Companies: US Environmental Protection Agency: Field Investigation Team Contract (FIT), Technical Assistant Team Contract (TAT), Superfund Technical Assessment and Response Team (START); US Army Corps of Engineers (USACE): Kansas City District, Savannah District, Alaska District, Sacramento District; Federal Aviation Administration (FAA); Illinois Department of Transportation; State of Missouri; State of Nebraska; Kaneb Pipeline; Brooklyn Union Gas; Unocal; City of Muscatine, Iowa; Federal Bureau of Prisons; American Pipeline.

HydroGeoLogic, Inc., Lenexa, KS, Project Geologist, 2004

- **USACE–Kansas City District, Former Forbes Atlas Missile Site S-9, Holton, KS.** Technical Manager for the Follow-On Remedial Activities, consisting of installing additional monitoring wells, air sampling, direct-push soil sampling, and sump sampling. Also manages field activities for the ongoing ERD Pilot Study, including injection of substrate and performance monitoring.

Ecology and Environment, Inc. (E & E), Overland Park, Kansas, 1987-2004

- **USACE–Kansas City District, Fort Leavenworth RFIs.** Mr. Williams was E & Es project manager for six RCRA facility investigations (RFIs) addressing six solid waste management units (SWMUs), including three inactive demolition landfills, a former firefighting training area, an entomology shop, and a diesel tank leak area. For each RFI, Mr. Williams was responsible for the production of the field sampling plan, safety plan, QC plan, and final report. Activities at

the SWMUs consisted of rotasonic drilling of 35 wells, direct-push drilling for soil and groundwater sampling, seismic geophysical surveys (to determine bedrock topography), electromagnetic (EM) and magnetometer geophysical surveys to determine landfill boundaries, and groundwater and subsurface soil sampling at all SWMUs.

- **Fort Leavenworth Operations and Maintenance Account.** Mr. Williams was project manager for work conducted under the Operations and Maintenance Account (OMA). This project included landfill maintenance consisting of erosion repair, installation of an irrigation system, and establishing native grass on the landfill cap. Mr. Williams performed/managed a historical records search of maps and documents dating back to the 1880s in order to prepare a composite map and report delineating the locations and history of all of the fort's firing ranges and associated facilities. In addition, Mr. Williams prepared sampling plans and led the fieldwork and RFI report preparation for SWMUs FTL-12 (Used Oil Tank), -13 (Used Oil Tank), -63 (DRMO Scrap Yard), and -68 (Weed Control Area). Activities at these SWMUs included DPT drilling for soil sampling, and groundwater sampling of existing wells.

- **USACE–Savannah District, Fort Jackson, SC.** As E & E's field manager/project geologist for the RFI, Mr. Williams was responsible for drilling operations, soil and water sampling, sample custody and shipping, utility clearance, and logistics. The two-month field project addressed 11 SWMUs, including landfills and leachfields.

- **Fort Gordon, GA.** Mr. Williams was the Field Manager/Project Geologist at Fort Gordon. This encompassed 18 solid waste management units (SWMUs), including landfills, explosives demolition pits, leachfields, sludge piles, and hospital incinerator ash piles. Three of the SWMUs (two small arms burning grounds and an open detonation area) contained unexploded ordnance. As E & E field manager/project geologist, Mr. Williams was responsible for drilling operations, soil and water sampling, sample custody and shipping, utility clearance, and logistics. The two-month field effort included a comprehensive survey with sampling to identify and document explosives and metals, plus preparation of the RFI report. Subsequently, Mr. Williams was field manager for the 10-month, supplemental RFI for three operable units (17 SWMUs) that involved drilling/installation of 87 monitoring wells and the collection of several hundred soil and water samples. In a third project phase, I installed an additional 13 wells in order to finalize the RFI fieldwork. Mr. Williams was instrumental in the writing of the final RFI reports.

- **Ramey Air Force Base (AFB), Aguadilla, Puerto Rico.** Mr. Williams was E & E field manager/project geologist for a two-month investigation of landfills at the former AFB. Mr. Williams led the drilling of seven wells to depths of

200 to 250 feet in karst limestone using air rotary techniques and also was responsible for the well sampling.

- **USACE–Omaha District, CHAAP, Grand Island, NE. USACE Alaska District, Fort Wainwright, Fairbanks, AK.** Under E & E's multisite program for the USACE Alaska District, Mr. Williams supervised monitoring-well installation in perma-frost localities using hollow-stem auger drilling.

- **USACE Sacramento District, Hawthorne Army Depot, NV**. Mr. Williams was field team leader for soil and groundwater sampling at 33 SWMUs (landfills, waste disposal pits, and TNT and ammonium picrate high-explosive wastewater disposal pits).

- **Zone II EPA FIT Program, Western United States**. Mr. Williams was assigned to E & E's Zone II Uncontrolled Hazardous Waste Site Field Investigation Team (FIT) in Kansas City. To support EPA Region 7, Mr. Williams conducted interviews and site file searches/background literature reviews, and performed aerial photointerpretation. At over 40 hazardous waste sites, Mr. Williams conducted environmental sampling, planned/installed monitoring-well networks; provided drilling oversight, and operated a direct-push drill rig. Mr. Williams used the results of office surveys and fieldwork to assist in site characterizations, site mapping, the development of federal Hazard Ranking System site evaluation packages, and the identification/evaluation of site-specific remedial measures. In all, Mr. Williams managed/conducted 29 site inspections (SIs) and supervised seven preliminary assessments (PAs). The PA/SI work included investigations of landfills, public water supplies, explosives plants, former manufactured gas plants, mine tailing sites, and pipeline terminals.
- **Zone 2 TAT Program, Western United States.** Mr. Williams supported E & E's contract for the Zone II Technical Assistance Team (TAT) program for EPA. As hydrogeological task leader for the York Public Water Supply site in Nebraska and the Tillman House site in Missouri, Mr. Williams used a direct-push drill rig to collect subsurface soil samples, performed field screening, and sampled drinking water wells for volatile organic contamination. Mr. Williams also prepared the ESI report for the York site.

- **START Program Sites, IA and MO.** In support of E & E's Superfund Technical Assessment and Response Team (START) program for EPA Region 7, Mr. Williams was a project geologist for the expanded site inspection (ESI) for the Coggon Creamery site in Coggon, Iowa and for the Pools Prairie removal action in Neosho, Missouri. At both sites, Mr. Williams installed networks of double-cased monitoring wells into the karst aquifers and collected soil and groundwater samples.

- **Missouri Department of Natural Resources (MDNR) Valley Park TCE Superfund Site, Valley Park, MO.** For the MDNR, Mr. Williams managed E & E's Phase II remedial investigation (RI) for Operable Unit 2 (Groundwater) at this federal Superfund site. To evaluate groundwater flow and contaminant transport under various pumping conditions and Meramec River stages, Mr. Williams led quarterly groundwater sampling. Mr. Williams was responsible for the compilation and evaluation of all new and existing data and Mr. Williams also led the modeling of geochemical and hydrological conditions within the Valley Park alluvial aquifer to determine characteristics of the TCE plume.

- **North U Drive, Springfield, MO**. For MDNR, Mr. Williams was a team geologist for E & E's RI for this rural/residential and light industrial site, which is located in a karst area. Mr. Williams supervised the drilling subcontractor that performed soil boring and soil sampling; interpreted aerial photographs; and mapped karst formations (joints, sinkholes, springs, and linements).

- **FAA Alaska.** Mr. Williams prepared work plans and was field geologist for environmental compliance inspections (ECIs) for six FAA stations (Unalakleet, Nome, Farewell, Moses Point, Bethel, and McGrath) and wrote the final ECI reports for three of them. Each station is 1,000 to 3,000 acres in size and contains up to 23 separate hazardous material/waste areas. Each ECI included a record search and review; an on-site inspection to identify areas and waste governed under federal and state environmental laws and guidelines; initial characterization of drum, tank, and storage areas; and sampling of soil, water, drums, pits, and abandoned electrical transformers. Mr. Williams completed transformer oil sampling and UST inventories and identified and classified hazardous waste for removal.

- **Aniak FAA Station, AK.** Mr. Williams oversaw the drilling and installation of three monitoring wells and 11 soil borings to determine the extent of pesticide and petroleum, oil, and lubricant contamination and helped write the ESI/interim cleanup (IC) report.

- **Moses Point FAA Station, AK.** Mr. Williams helped prepare the ESI/IC work plan for this abandoned site and was field manager for the ESI fieldwork. Mr. Williams set up a work camp at the remote site; was responsible for team mobilization and logistics; coordinated the aerial and barge shipment of all heavy equipment, sampling materials, and provisions to the site; supervised the four-person E & E field team; helped coordinate the activities of seven subcontractor personnel; and helped write the ESI/IC report.

Position Title:	***CERTIFIED INDUSTRIAL HYGIENIST***
Name:	***MARY ANN HEANEY, CIH, CSP***
Current Employer:	***HYDROGEOLOGIC, INC.***
Geographic Location:	***DENVER, CO***

Education: M.S./Industrial Hygiene/1979; B.S./ Microbiology/1976

Certifications/Training: Certified Safety Professional, Board of Certified Safety Professionals, 1990; Certified Industrial Hygienist, American Board of Industrial Hygiene, 1983; EPA AHERA Instructor, 1993; Colorado Department of Health Asbestos Abatement Supervisor, 1993; Certified Industrial Audiometric Technician, Council of Audiology, Otolaryngology and Hearing Conservation, 1979-1984; Certified Pest Control Applicator, Arizona Structural Pest Control Board, 1985-1987; 40-Hour HAZWOPER Training, 1987 and annual refreshers to date.

Professional Development Courses: Introductory Occupational Toxicology, 1999; Principles of Machine Guarding, 1999; Electrical Hazards and the NEC, 2001; Fire Protection, 2001; National Electrical Code Workshop, 1994

Experience: Ms. Heaney is an Industrial Hygienist with 20 years experience with in the industrial hygiene, safety, and the environmental industry, including both private sector and government projects (DOE, Superfund, and Defense Marketing and Reutilization Office [DRMO]). She is a C.I.H. and also a Certified Safety Professional. Ms. Heaney has extensive experience managing and providing oversight for health and safety programs associated with remedial sites and hazardous waste as well as traditional manufacturing and construction projects. Her activities have included project planning and cost identification, health and safety project oversight (HASP development/approval, technical support and liaison for client/regulatory concerns, interface and coordination with subcontractors, on-site support, selection of PPE, development of exposure monitoring strategy, supervision of Health and Safety Site Officers) for a variety of hazardous waste projects: characterization, RAs; transportation, disposal; drilling and direct-push; vapor extraction; and, soil and water sampling.

HydroGeoLogic, Inc., Senior Industrial Hygienist, 2002-Present

In her role as Corporate Health and Safety Officer, Ms. Heaney oversees health and safety from a program level. She revised and updated the corporate Health and Safety Manual, and routinely conducts Activity Hazard Analysis at the site level for each definable feature of work. She reviews all site-specific health and safety plans prepared by project managers, and works with regional health and safety coordinators in developing SOPs to address new safety concerns, such as MEC and UXO issues. Ms. Heaney also conducts HAZWOPER refresher courses for HGL staff, top assure that staff level training requirements are met.

- Prepared HSP and conducted construction oversight at Kelly AFB during construction of a 12,00-foot-long permeable reactive barrier
- Oversaw health and safety at the Omaha Lead Site, where HGL was excavating lead-contaminated soils from residential properties. Worked with USACE and EPA Region 7 to establish site-specific action levels for lead and particulates. Action levels were designed to be protective of worker health and the public, and to meet aesthetic standards established by EPA and the community.

Occupational Health and Safety Management, LLC, Louisville, CO, Senior Industrial Hygienist, 1993-2002

- Fulfilled the role of Project Health and Safety Officer for the Lowry Landfill FTPA Waste Pit Remedy Project. The project excavated, removed and treated surface and subsurface drums, contaminated soils and waste pits. Responsibilities included review and comment on HASP, providing technical support to address client/regulatory concerns, on-site support, selection of PPE, development of monitoring strategy and supervision of Health and Safety Site Officers.

- Acted as Safety and Health Manager for the City of Denver's Metro Wastewater Reclamation District's Sanderson Gulch sanitary sewer line replacement project - tunnel boring operation through radioactively contaminated soil. Provided guidance for multiple subcontractors for operation of heavy equipment in a confined area, safe operation of conveyors and materials handling methods, decon and contaminant monitoring protocols.

- Acted as Site Health and Safety Manager for the Superfund Site Technical Assistance Program for the Colorado Department of Health at the Idarado, Eagle and ASARCO Globe sites.

- Developed audit protocols and conducted comprehensive audits for industrial hygiene and safety programs at a Canadian gold mining corporation's facilities in Chile. Audit included translation and interpretation of applicable Chilean regulations, review of written programs and procedures, inspections of facilities, employee interviews, review of exposure monitoring results, and development of recommendations for corrective actions at multiple mines.

- Developed the Air Monitoring Plan for a project conducted for California Department of Transportation during trenching and installation of conduit for roadside cameras. Plan included sample methodology, identification of action levels, specification of instrumentation and locations and numbers of samples.

- Reviewed and revised an HSP developed to address issues during soil excavation and removal at a major California film production studio.

Contaminants included primarily chlorinated substances and PCBs. Of particular concern was the potential for exposure of employees at on going operations; set design, construction and painting.

USPCI, Inc., Boulder, CO, Corporate Manager Health & Safety, 1987-1993

Responsibilities included all aspects of health and safety for divisions and subsidiaries, including corporate policy development, management of medical monitoring programs, administration of workers' compensation program, interpretation of regulations with respect to impact on the corporation, public/regulatory interface, and technical support to management and operating groups. Managed all industrial hygiene and safety staffs. Provided long range planning and scheduling guidelines; developed O&M, personnel and capital budgets. Conducted cost/benefit analysis on all health and safety related programs and expenditures.

- Acted as Health and Safety Manager for a contaminated soil and buried drum/cylinder removal project. Wrote the HASP and designed the air monitoring program. Conducted site specific employee training, provided on site technical support, supervised project health and safety personnel, acted as liaison with regulatory agency personnel and interfaced with the public when health concerns were raised.

- Developed the site HSP and provided site H&S support for DOE mercury and PCB cleanup projects at multiple compressor stations across the western United States.

- Worked with engineers during the design phase of the corporation's hazardous waste incinerator facility to minimize health and safety impacts during start-up and operation. Review included recommendations, for HVAC systems, local exhaust ventilation systems, noise controls, materials handling equipment (conveyors, machine guarding, lockout/ tagout issues), process flow, human factors aspects of equipment controls, transportation facilities, and employee facilities.

- Developed and instructed multiple Spill Assessment and Chemical Compatibility 3 day courses for a diverse group of employees responsible for spill response at a defense contractor. Operations employees, fire brigade members, supervisors, environmental department employees and USAF personnel participated in both classroom and hands on spill response exercises that were conducted in operating areas.

- Co-taught an Emergency Response Course that consisted of two days of classroom instruction and three days of hands on scenarios. The course was attended by local volunteer agencies (fire and medical providers), city and state

regulatory agency personnel and hazardous waste industry employees (disposal, remediation, transportation).

Arizona Public Service Company, Phoenix, AZ, Senior Environmental Scientist, 1984-1987

Managed corporate industrial hygiene and hazardous waste programs. Conducted facility audits to determine compliance with OSHA and RCRA regulations, acted as liaison with federal, state and municipal regulatory agencies, developed annual budgets and five year development plans. Investigated customer and public health related concerns and coordinated internal and external efforts to mitigate problems. Provided technical support for corporate hazardous waste, PCB and medical monitoring programs. Was responsible for radioactive source licensing, NESHAPS asbestos removal notifications, and SARA Title III reporting.

Position Title: ***SENIOR INDUSTRIAL HYGIENIST***
Name: ***COLBY SMITH, CIH***
Current Employer: ***HYDROGEOLOGIC, INC.***
Geographic Location: ***DENVER, CO***

Education: BS Environmental Health, Bowling Green State University, Bowling Emphasis in Industrial Hygiene & Occupational Safety, Minor in Biological Sciences

Certifications/Training: 40-Hour HAZWOPER Training and annual refreshers to date; Radiation Worker Safety; Certified Industrial Hygienist - American Board of Industrial Hygiene (CIH #8819); Colorado Air Monitoring Specialist – Colorado Department of Public Health and Environment; American Board of Industrial Hygienists; American Conference of Governmental Industrial Hygienists; American Industrial Hygiene Association; American Industrial Hygiene Association – Rocky Mountain Section

Professional Development Courses: OSHA 500: Trainer Course for the Construction Industry; OSHA 501: Trainer Course for the General Industry; OSHA 3095: Electrical Standards; OSHA 3010: Excavation, Trenching & Soil Mechanics; MSA (FP): Fall Prevention and Protection Training; Colorado Air Monitoring Specialist – Colorado Department of Public Health and Environment; Asbestos Building Inspector – Colorado Department of Public Health and Environment

Experience: Mr. Smith provides comprehensive consultation services in environmental health, occupational safety and industrial hygiene. His skills and expertise are used in the governmental, nuclear, industrial, manufacturing, remediation, insurance, drilling, construction, demolition and industries, supporting 11 regional offices. Hi project work includes developing and implementing companywide health safety programs to meet regulatory requirements for several regulatory entities, including OSHA, DOE, DOD, and USACE, and various DoD munitions safety programs. Mr. Smith conducts health and safety audits, oversees program development, and conducts training including fit testing of respirators. He reviews site-specific health and safety plans and evaluates site-specific contaminant levels and exposure scenarios to establish air monitoring programs consisting of action levels, monitoring frequency and respiratory protection.

HydroGeoLogic, Inc., Senior Industrial Hygienist, 2005-Present

- Omaha Lead Site, USACE/EPA – Audited HGL Health and Safety Program associated with removal of lead-contaminated soils from 120 residential properties and subsequent property restoration. Activities included use of heavy construction equipment, transport of contaminated soils through residential neighborhoods. Ambient air monitoring for lead and particulates, and noise minimization/abatement. Provided consultation services as needed.

- Hunter Army Airfield, USACE/DOD – Developed and implemented Accident Prevention Program and Site-Specific Health and Safety Program for project involving monitoring well installation, groundwater sampling/monitoring, and a pilot-scale treatability study using ERD to treat contaminated groundwater in situ. Provided CIH consultation services as needed.
- Ellsworth Air Force Base, USACE/DOD – Developed and implemented Accident Prevention Program and Site-Specific Health and Safety Program for removal of underground storage tanks; provided CIH consultation services as needed.
- Pine Ridge Gunnery Range, USACE/DOD – Developed and implemented Accident Prevention Program and Site-Specific Health and Safety Program for removal of unexploded ordnance; provided CIH consultation services as needed.
- Holloman Air Force Base, AFCEE/DOD – Reviewed and audited subcontractors health and safety programs to meet HGL, Inc. expectations and regulatory requirements.
- Langley Air Force Base, AFCEE/DOD – Developed basewide health and safety programs

Industrial Hygiene and Safety Specialist, RTG Inc., Lakewood, CO, 2000 to 2005

- **Rocky Flats Environmental Technology Site, DOE**. Lead Industrial Hygienist and Safety Professional for the decontamination and demolition and remediation of a DOE Nuclear Weapons Manufacturing Facility; 3-years in length, $50-million in budget. Ensured safe and compliant work evolutions in the decontamination and demolition of a beryllium and uranium contaminated machining and manufacturing building (B444). Provided oversight of craft work activities; recommended and implemented controls and procedures to minimize risk to harmful agents and conditions; monitored chemical, physical and biological stressors. Evaluated and audited EHS programs to determine project compliance with applicable Federal, State and/or DOE site regulations; Instructed craft personnel on EHS program requirements and training. Responded to and mitigated employee concerns regarding industrial hygiene and safety. Performed monitoring for particulate, metals, diesel fume, VOCs, bioaerosols, asbestos, noise; evaluated ventilation, illumination and thermal stresses; provided full exposure assessments of work activities. Reviewed daily work activities and briefed personnel on conditions and potential hazards. Planning Team member – developed work scope and agendas, estimated project duration to meet goals and objectives on schedule, under budget. Determined waste material disposition and followed applicable regulations (RCRA, CERCLA, TSCA), Maintained industrial hygiene database of exposure monitoring results (IHIS); wrote technical reports on findings and recommendations; addressed building and site management of results and relevant information.

Industrial Hygienist/Health and Safety Specialist – Contractor, KEH Inc., Littleton, Colorado, 1999 to 2000

- Provided comprehensive health and safety oversight services to Aerospace, Mining and Brewing companies
- Performed complete employee exposure assessments to identify, evaluate and control workplace hazards in wastewater and brewing operations; monitored various chemical, biological and physical hazards; wrote reports on findings and made recommendations
- Conducted ergonomic evaluations of workstations and line operations; Ergonomic Committee member
- Performed site safety surveys and audits, job hazard analyses
- Instructed subcontractors on various EHS courses, including: air purifying respirators, SCBAs, fire extinguishers, and Workplace Hazard Awareness Management (HAZCOM)
- Assisted in health and safety program development, maintenance, and training; Respirator Protection Program management; purchasing APRs and other PPE
- Performed NEPA site assessments for cell-phone service providers in Colorado

Safety Inspector/Consultant, Safety Services, Inc., Fort Collins, Colorado, 1998 to 1999

- Served as on-site safety supervisor for various utilities, manufacturing and construction companies
- Performed daily safety inspections; enforced CFR 1926, recommended appropriate corrective actions
- Conducted industrial hygiene monitoring of manufacturing facilities, processes and equipment
- Provided safety training classes, including: PPE, hazard communication, First Aid/CPR, blood borne pathogens, ergonomics, medical/exposure record keeping, construction safety
- Assisted in creating and implementing health and safety programs; offered regulatory support
- Maintained and documented all training, inspections, reports and OSHA logs for clients
- Aided clients in achieving Cost Containment Certification, decreasing workers compensation costs

Attachment 3

OSHA Form 300 and OSHA Form 300A

2005 OSHA Reporting
Tracking

EMR	.080 / 1.25
Total Employee Hrs Worked	318,450 / 23,643
OSHA Recordable Incident Rate	1,1
Lost Workday Incident Rate	0,0
Fatalities	0,0

Office Location	Avg. Emp.	Total Hrs
901 N. Stuart Street #303 Arlington, VA 22203	7	9,777
Northway 10 Executive Park 313 Ushers Road Ballston Lake, NY 12019	9	13,375
12343 Hymeadow Drive #3B Austin, TX 78750	6	9,261
2460 West 26th Ave Suite 450 C Denver, CO 80211	9	10,333
1155 Herndon Pkwy Suite 900 Herndon, VA 20170	103	174,097
8245 Nieman Rd Suite 101 Lenexa, KS 66214	21	38,828
2505 North 24th St Suite 414 Omaha, NE 68110	4	4,617
3504 Lake Lynda Drive, #185 Laurel Bld Orlando, FL 32817	3	6,554
340 East Palm Lane Suite A240 Phoenix, AZ 85004	11	18,605
719 Jadwin Ave, CSA Bldg, Office 12 Richland, WA 99352	1	1,904
4600 Northgate Blvd Suite 207 Sacramento, CA 95834	13	23,643
404 E. Ramsey Road, Suite 210 San Antonio, TX 78216	3	3,841
George AFB 18374 Phantom Drive Victorville, CA 92394	1	3,615

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2005

U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no work-related injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate before completing this summary.

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the Log. If you had no cases, write "0."

Employees, former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR Part 1904.35, in OSHA's recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of . . .

	(M)		
(1) Injuries	0	(4) Poisonings	0
(2) Skin disorders	0	(5) Hearing loss	0
(3) Respiratory conditions	0	(6) All other illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form.

Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any other aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistical Analysis, Room N-3644, 200 Constitution Avenue, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name: HydroGeologic, Inc

Street: 8245 Nieman Rd. Suite 101

City: Lenexa State: KS ZIP: 66214

Industry description (*e.g., Manufacture of motor truck trailers*): Environmental Consulting Firm

Standard Industrial Classification (SIC), if known (*e.g., 3715*): — — — —

OR

North American Industrial Classification (NAICS), if known (e.g., 336212): 562910

Employment information

(If you don't have these figures, see the Worksheet on the back of this page to estimate.)

Annual average number of employees: 21

Total hours worked by all employees last year: 38,828

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Charles L Smith — ASST. REG. MNGR
Company executive — Title

(913) 317-8860 — 1/31/06
Phone — Date

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 20 05

U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OMB no. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an Injury and Illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name _____

City _____ State _____

Identify the person			Describe the case			Classify the case (CHECK ONLY ONE box for each case based on the most serious outcome for that case:)				Enter the number of days the injured or ill worker was:		Check the "Injury" column or choose one type of illness:					
(A) Case no.	(B) Employee's name	(C) Job title (*e.g., Welder*)	(D) Date of injury or onset of illness	(E) Where the event occurred (*e.g., Loading dock north end*)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (*e.g., Second degree burns on right forearm from acetylene torch*)	Death (G)	Days away from work (H)	Remained at Work: Job transfer or restriction (I)	Remained at Work: Other recordable cases (J)	Away from work (K)	On job transfer or restriction (L)	(M) Injury (1)	Skin disorder (2)	Respiratory conditions (3)	Poisoning (4)	Hearing loss (5)	All other illnesses (6)
			month/day			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
			month/day			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
			month/day			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
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			month/day			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
					Page totals ➤	___	___	___	___	___	___	___	___	___	___	___	___
												Injury (1)	Skin disorder (2)	Respiratory conditions (3)	Poisoning (4)	Hearing loss (5)	All other illnesses (6)

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Page ___ of ___

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any other aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistical Analysis, Room N-3644, 200 Constitution Avenue, NW, Washington, DC 20210. Do not send the completed forms to this office.

Attachment 4

Directions to the Hospital, Emergency Telephone Numbers

Attachment 4
Directions to Hospital, Emergency Telephone Numbers

Emergency Phone Numbers

Fire Department, Salina Fire Department

Emergency	911
Non-Emergency	(785) 826-7340

Emergency Medical Care – Salina Ambulance

Emergency	911
Non-Emergency	(785) 826-7340

Police, Salina Police Department

Emergency	911
Non-Emergency	(785) 826-7210

Salina Regional Health Center
400 S Santa Fe
Salina, Kansas 66436
(785) 452-7000

Kansas Poison Control (800) 222-1222

National Response Center
Environmental Emergencies (800) 424-8802

Project Contacts

HGL Contacts:

Project Manager:	Miquette Rochford	(970) 243-3893
Site Supervisor:	Chris Williams	Site phone TBD
Certified Industrial Hygienist (CIH):	Colby Smith	(303-691-1978
Corporate Safety and Health Manager (CSHM)	Mary Ann Heaney	(303) 665-8528

USACE CENWK Point of Contact
U.S. Army Corps of Engineers, Kansas City
601 East 12th Street, Room 610
Kansas City, Missouri 64106
Robyn Kiefer (816) 389-3615

Directions to the Nearest Medical Facility

Go north on Centennial Road to W Schilling Road and head east to Interstate I-135; Take I-135 north to W Magnolia Rd and head east; Turn left on S 9th St; Turn right on W Claflin Ave; Turn left on S Santa Fe and proceed to hospital at 400 S Santa Fe.

Attachment 5

Substance Abuse Policy

HydroGeoLogic, Inc.
POLICIES AND PROCEDURES

Policy Title: Substance Abuse

 Policy No. 9

Policy Revised on _____ Policy Originated on July 1, 2004

Approval: _____

Purpose:

HydroGeoLogic, Inc. (HydroGeoLogic) is responsible for maintaining safe, healthy and efficient working conditions for its employees and for protecting the safety and security of its products, facilities, clients and the public.

While HydroGeoLogic has no intent of intruding into the private lives of its employees, the Company does expect employees to report for work in condition to perform their duties. Being under the influence of any drug and/or alcohol misuse on the job may pose serious safety and health risks not only to the users but to all those who work with the user. The intent of the substance abuse program is to offer assistance to those who need it, while sending a clear message that any drug abuse and alcohol misuse is incompatible with service in our organization, and will not be tolerated. Potential HydroGeoLogic new hires will be subject to pre-employment screenings to prevent and detect substance abuse. The Environmental Operations Division will be subject to routine random tests, because of the nature of the work they perform and high potential risk of injury, to prevent and detect substance abuse. Any form of substance abuse may affect the safety of operations through unsafe work behavior/performance or error in judgment. Substance abuse could jeopardize the safety and well-being of either the employee, other personnel or the general public.

The transfer, possession, distribution, use, manufacture, storage, or sale of an illegal drug (including unauthorized prescription use) and/or alcohol misuse in the workplace exposes HydroGeoLogic to the risk of property loss or damage, lower employee productivity, higher incidence of on the job injury, increased health and insurance costs, and higher rates of absenteeism and turnover. Substance abuse damages the reputation of HydroGeoLogic and its employees within the community, industry at large, and among our customers. HydroGeoLogic must also meet certain regulatory requirements and customer contractual obligations.

With these basic objectives in mind HydroGeoLogic has established the following policy with regard to the transfer, possession, distribution, use, manufacture, storage, or sale of an illegal drug (including unauthorized prescription use) and/or alcohol misuse. Where state laws or municipal ordinances are in conflict with this policy, the more stringent requirement shall apply.

Scope:

This policy applies to all employment applicants, regular full-time, regular part-time, temporary, and contract employees as well as to employees of contractors, subcontractors, suppliers, visitors and vendors working at all HydroGeoLogic facilities.

Policy:

On-The-Job Use, Possession or Sale of Drugs or Alcohol Misuse

The transfer, possession, distribution, use, manufacture, storage, or sale of an illegal drug or controlled substances (including unauthorized prescription use) and/or alcohol misuse by an employee while on the job or on Company property is cause for termination of employment. Company property includes all Company facilities, their surrounding grounds and parking lots, leased space, and Company rental vehicles.

1. Alcohol

Being under the influence[1] of alcohol while performing Company business or while in a Company facility is prohibited unless otherwise noted in this policy.

Beer and wine only may be served at company-sponsored employee functions held on business days and starting after 5:00 p.m. A wider range of alcoholic beverages may be offered at company-hosted customer/client social functions. These functions may be held during or after business hours, at HGL facilities or other locations. Employees are responsible for observing legal drinking age requirements. Employees attending these functions may be asked to present proof of age before being served. Employees must exercise good judgment regarding the amount of alcohol that they can reasonably consume, and are responsible for their behavior during such company-sponsored functions. Company-sponsored functions are any events an employee would not otherwise attend except for their connection to the workplace, including off-site parties and sporting events.

Employees operating vehicles and equipment covered under the Federal Motor Carrier Safety Administration (FMCSA)DOT or commercial driver's license regulations shall also be subject to disciplinary action up to and including termination and disqualification from operating a commercial motor vehicle if they are discovered either to be working with a breath alcohol concentration at or above 0.04%, having a container of alcohol in a commercial vehicle, or to be in possession or using unauthorized or illegal scheduled drugs.

No operator of a commercial motor vehicle shall consume an intoxicating beverage regardless of its alcoholic content, or be under the influence of an intoxicating beverage or controlled substance, while operating, or having physical control of a commercial motor vehicle or consume an intoxicating beverage regardless of its

[1] "**Under the influence**" means, for the purposes of this policy, that the employee is affected by a drug or alcohol or the combination of a drug and alcohol in any manner. The symptoms of influence are not confined to those consistent with misbehavior, nor to obvious impairment of physical or mental ability, such as slurred speech or a scientifically valid test.

alcoholic content, be under the influence of an intoxicating beverage or concentration of a controlled substance while on duty or while operating or in physical control of the commercial motor vehicle.

Furthermore, any employee, applicant, contractor employee, subcontractor employee, supplier, visitor or vendor will be denied consideration of employment and/or access to any of HydroGeoLogic's premises if there is a reasonable suspicion that the individual shows signs of using or being under the influence of drugs or alcohol.

2. Prescription and Over-the-Counter Drugs

Abuse of a prescribed controlled substance or use of a controlled drug not prescribed for the employee or applicant is prohibited. Employees and others covered by this policy may maintain on Company premises prescription drugs and "over-the-counter" medications provided:

a. The prescription drugs are prescribed by an authorized medical practitioner of the person in possession and the medicine is in its original container and in the employee's or person's name.

b. Employees must not consume prescribed drugs more often than as prescribed by the employee's physician and they must not allow any other person to consume the prescribed drug.

c. The drugs, both prescription and over-the-counter, must be kept in the original container.

d. Any employee who has been informed that the medication could cause adverse side effects while working or where medication indicates such warning, must inform their supervisor prior to using such substances on the job. The use of drugs/medicine prescribed by a licensed practitioner for the individual employee is permitted provided that it will not affect work performance. However, HydroGeoLogic reserves the right to have the Company's contracted medical director determine if use of a prescription drug or medication by an employee produces effects which may increase the risk of injury to the employee or others while working. If such a finding is made, HydroGeoLogic may check with the employee's doctor (with written consent) to see if other medications are available which would not affect the employee's ability to work safely. If appropriate substitute medicine is not available, HydroGeoLogic may have to limit or suspend the work activity of the employee during the period that the physician advises that the employee's ability to perform his job safely may be adversely affected by the consumption of such medication.

3. Illegal, Unauthorized or Prohibited Drugs

The transfer, possession, distribution, use, manufacture, storage, or sale of an illegal drug or controlled substances (including unauthorized prescription use) by an employee while in a Company facility or while performing Company business is prohibited.

Illegal drugs include but are not limited to: marijuana (pot, dope, hash or hashish), cocaine (coke, rock, crack or base), LSD (acid), PCP (angel dust, crystal), MDMA (ecstasy), heroin (smack, black stuff, black tar), opium and morphine.

Unauthorized (or prohibited) drugs include but are not limited to: nonprescription inhalants, stimulants and amphetamines (methamphetamine, crystal methamphetamine, speed, uppers, crank, ice, UPS, butyl nitrate, push, locker room, look-alikes) or any other tablets, capsules and powders containing controlled over-the-counter ingredients whose physical appearance mimics various prescription drug products which contain popular substances of abuse and are regulated under the provisions of the Controlled Substances Act of 1970. The term "unauthorized" includes prescribed drugs not legally obtained and prescribed drugs not being used for prescribed purposes as well as any abnormal or dangerous substances which may affect an employee's/person's mood, responses, motor functions or alter or affect a person's perception, performance, judgment, reactions or senses while working.

The presence of illegal unauthorized or prohibited drug in an employee, detectable by a drug screening test, while performing Company business, on Company property or while in a Company facility is prohibited.

Procedures:

Substance Abuse Screening

1. Conditions for Screening

HydroGeoLogic reserves the right, in certain circumstances, to require employees to submit to medical or physical examinations or tests at any time as a condition of employment or continued employment. This includes but is not limited to urine drug tests, breathalyzer, or other medical examinations to determine the use of any illegal or unauthorized drugs or substances prohibited in this policy or to prove the employee's satisfactory fitness for duty. These announced or unannounced tests may be utilized under the following circumstances:

a. Pre-employment Screening - Every prospective employee who has been offered a position with HydroGeoLogic is subject to screening prior to beginning employment. Those who test positive for illegal, unauthorized or prohibited drugs, will as a general rule, be rejected.

b. Reasonable Suspicion - Those persons reasonably suspected of using or being under the influence of a drug or alcohol misuse on the basis of behavioral characteristics or other information shall be subject to screening if a supervisor is concerned about the individual's safety or the safety of the general public and/or others due to the employee's physical condition or behavior while working. (Supervisors shall take part in Company-sponsored training programs to assist them in identifying and addressing illegal drug or alcohol misuse by employees or others while working.)

c. Post Incident - Employees involved in a workplace incident may be required to submit to drug screening, even if they do not exhibit observable symptoms of being under the influence. Incidents include, but are not limited to the following:

    1) Explosion or fire not intentionally set by the Company;
    2) Death of any person;
    3) Bodily harm to any person resulting in one or more of the following:
        a) Loss of consciousness.

b) Necessity to carry the person from the scene.
c) Necessity for medical treatment.
d) Disability which prevents the discharge of normal duties or the pursuit of normal activities beyond the day of the accident;

4) Caused estimated property damage, including cost of clean-up and recovery, value of lost product, and damage to the property of the Company or others, or both, exceeding $5,000

Random Tests

The primary purpose of random testing is to deter drug abuse and to ensure a drug-free work force. HGL requires that designated employees in the Environmental Operations Division be drug tested on an unannounced and random basis. (Other Divisions may also be randomly tested in the future)

1. HGL will conduct a number of urine drugs tests equal to at least 50 percent of all designated employees each calendar year, spread reasonably over a 12-month period. The random testing selection process will be conducted on a periodic basis. These rates are subject to change annually similar to the rates set by DOT/FMCSA regulations or this policy.
2. Employees in designated positions will be subject to random testing at any time. The random selection process will ensure that each employee has an equal chance of being selected.
3. Key aspects of the random testing selection process are:

   (1) Employees remain in the random selection pool at all times, regardless of whether or not they have been previously selected.
   (2) Employees will be selected for testing by using a computer-based random number generator or equivalent random selection method that is matched with employee and social security numbers.
   (3) The process will be unannounced as well as random. Each employee will be notified that they have been selected for testing after reporting for duty.
   (4) Employees will be selected for random testing based on the number of testing designated employees at the time and the necessary testing rate.
   (5) Specimen collection will be conducted on different days of the week throughout the annual cycle.

4. Steps for random testing:

   (1) The employer representative, or designee, will provide a computer disk containing the names, employee and social security numbers, and base locations for all designated employees to the Medical Review Officer.
   (2) By using a random number generator, the Medical Review Officer will generate a list of employees to be randomly tested during the month. The random testing list will be confidentially submitted to the employer representative.
   (3) The list of employees selected for testing will be retained in the employer representative's files.

5. Notification of employees.

The employer representative, or designee, will use the following procedure to initiate the random testing process:

(1) Employees will be notified by their immediate supervisor that they have been selected for a random test after they have reported for duty.
(2) The employee will be notified to report to the collection site at a designated time.
(3) Employees will be notified so that they have 30 minutes plus travel time to the collection site.
(4) Supervisors will report any problems encountered during employee notification to the employer representative, or designee.
(5) Once notified, the employee cannot volunteer for rehabilitation.

d. Government-Required Testing - When testing is mandated by the Department of Transportation (DOT), Federal Motor Carrier Safety Administration (FMCSA), Department of Defense (DOD) or other agencies for employees working in regulated safety sensitive positions.

e. Reasonable Suspicion - The determination that reasonable suspicion exists will be based on specific, contemporaneous observations concerning physical, behavioral, or performance indicators. The employee's supervisor will substantiate and concur to test an employee. The concurrence may be accomplished by phone, by discussions a few hours later, or by having the other supervisor travel to the job site.

f. Contractual - Tests necessary to comply with the contractual or legal obligations of our customers, clients, additional federal government or individual state drug testing laws. Those employees affected by these types of tests will be notified as to their applicability of these requirements as information becomes available.

g. Post-Counseling/Rehabilitation - Tests warranted when an employee returns to work as a result of a condition of reinstatement upon completion of a reasonable drug and alcohol treatment or counseling program.

An employee's consent to submit to such a test is a material condition of employment and the employee's refusal to consent may result in disciplinary action, up to and including termination.

The above is not an exhaustive list of all circumstances under which screening may occur. There may be circumstances where such testing is warranted, subject to approval by Senior Management, e.g., where being under the influence of a drug or alcohol would result in a significant risk to the safety of employees or the safe operation of Company facilities.

2. Sample Collection and Analysis

Urine samples for drugs will be collected by contract medical facilities providing services to HydroGeoLogic, medical facilities designated by HydroGeoLogic as collection facilities (including after hours and remote location services), and/or professional collection specialists/technicians. These agents will collect, process and prepare the specimens for transport to an approved (certified) laboratory for actual testing, using chain of

custody procedures. Additionally, in certain circumstances, collections may be taken at the work site by professional collection specialists or technicians.

Each initial urine test (screen) shall be run by immunoassay (sensitivity test). All specimens identified as positive on the initial test shall be confirmed by a second test using gas chromatography/mass spectrometry (GC/MS) techniques (specificity-type methodology).

3. Medical Review Officer

HydroGeoLogic shall utilize the services of a Medical Review Officer (MRO) to interpret all laboratory test results. An MRO is a licensed physician who has knowledge of substance abuse disorders and has appropriate medical training to interpret and evaluate an individual's laboratory positive test result as it relates to the employee's medical history and any other biomedical information.

Disciplinary Action

Violation of this policy may result in disciplinary action, up to and including termination. An employee's failure to cooperate fully in an investigation of suspected violations may also result in disciplinary action up to and including termination.

1. Alternative Disciplinary Action

Any employee found in possession of alcohol or manufacturing, using, being under the influence of or transporting any unauthorized or illegal drugs, alcohol, or other substances and items (i.e., drug paraphernalia) in violation of this policy will be subject to disciplinary action up to and including termination.

Preliminary findings of a policy violation may require that the employee be placed on suspension pending a review of all relevant facts concerning the policy violation.

2. First Offense Discharge

An employee shall be subject to discharge for the following:

a. The employee either refuses to submit to a search or inspection, urine drug or blood test as outlined by this policy.

b. The employee has submitted to a test and has degraded, diluted, switched, altered or tampered with that sample.

c. While on company premises, the employee was caught using alcohol, or using, manufacturing, distributing, dispensing, selling or possessing any illegal or unlawful drugs.

d. While residing in company paid for lodging, the employee was caught using, manufacturing, distributing, dispensing, selling or possessing any illegal or unlawful drugs.

e. The employee failed to contact a qualified substance abuse care provider within five (5) regular working days after notification of a MRO verified confirmed positive test result.

3. First-Test Positive Referrals

Employees who test positive for a substance prohibited by this policy as a result of a MRO verified confirmed urine test without an explanation satisfactory to HydroGeoLogic may be offered a referral to an approved counseling or rehabilitation program for the first offense only.

However, an employee may not be offered rehabilitation, and the above policy may not apply to a first offense where:

a. Violations of the policy occur in connection with a violation of other work or health and safety rules which would ordinarily result in discharge.

b. The employee's prior disciplinary record in connection with the policy violation would ordinarily result in discharge.

Any first offense referral as a result of substance abuse testing may also require an indefinite suspension of regular employment until the admission to and completion of a reasonable drug and alcohol treatment or counseling program and the satisfactory passing of a return-to-work examination and substance abuse testing.

4. Non-Employee Disciplinary Action

Any other person having business with HydroGeoLogic who refuses to submit to a search, urine test or is found to be in possession of the above-mentioned drugs and unauthorized items will not be allowed to return to any of HydroGeoLogic's premises, properties, facilities or work areas as described above and may be subject to legal action.

Human Resources should be contacted for specific disciplinary procedures.

Alcohol and Drug Abuse Policy: Relationship to Employee Assistance Program

Company is committed to a policy of rehabilitation wherever and whenever an employee agrees to begin and complete a rehabilitation program. Employees who voluntarily request assistance in dealing with a personal drug habit may participate in a rehabilitation program without jeopardizing their continued employment with HydroGeoLogic.

HydroGeoLogic maintained Employee Assistance Program (eEAP) provides a professional assistance service that offers valuable resources that help employees who suffer from alcohol or drug abuse and other personal/emotional problems which may affect job performance. In most circumstances employees who test positively for drugs or alcohol will be offered rehabilitation and will be encouraged to contact eEAP to help identify a suitable rehabilitation program for a first offense. However, it is the responsibility of each employee to seek assistance from the eEAP before alcohol and drug problems lead to disciplinary action up to and including termination. Once a violation of this policy occurs, subsequently using the eEAP to identify a

rehabilitation program on a voluntary basis will not necessarily lessen disciplinary action and may, in fact, have no bearing on the determination of appropriate disciplinary action.

The employee's decision to seek assistance from the Employee Assistance Program or a rehabilitation program will not be used as the basis for disciplinary action and will not be used against the employee in any disciplinary proceeding. On the other hand, using the eEAP to identify and enter a rehabilitation program will not be a defense to the imposition of disciplinary action where facts providing a violation of this policy are obtained outside the program.

Accordingly, the purposes and practices of this policy and the eEAP are not in conflict and are distinctly separate in their applications.

Rehabilitation of Employees with Drug and Alcohol Dependency Problems

An employee who is identified as having a drug or alcohol dependency problem which constitutes a violation of this policy will be directed to enter rehabilitation as deemed appropriate by one or all parties including the immediate supervisor, Division Manager, and Human Resources. Refusal to participate in rehabilitation, as prescribed, will be a cause for disciplinary action up to and including termination.

All costs associated with any recommended treatment or rehabilitation program are subject to payment in accordance with applicable benefits of the employee's health care plan and are not otherwise supplemented by HydroGeoLogic. An employee entering such a rehabilitation/treatment program will be eligible for benefits as with any other medically related absence.

An employee is eligible to participate in a Company approved substance abuse related rehabilitation with job retention and benefits only once during the term of employment.

Confidentiality

All medical records pertaining to drug screening and rehabilitation of drug or alcohol dependent employees are protected by Company's policy on medical confidentiality. All blood and urine sampling will be performed with concern for each employee's or person's personal privacy, dignity and confidentially. The results of any program testing will be considered a confidential record disseminated strictly on a need-to-know basis or as may be legally required. Records shall not be maintained in personnel files.

Information concerning drug screening and rehabilitation procedures involving current employees will only be revealed as appropriate on a need-to-know basis for the purpose of protecting employee safety and Company property.

Searches

HydroGeoLogic reserves the right to conduct unannounced, random searches of its property and facilities, including work areas, vehicles, desks and lockers assigned to employees, at any time. No employee has the right to interfere with or prevent such searches of Company property.

Any illegal substances discovered through searches will be turned over to the appropriate law enforcement agency and may result in criminal prosecution.

Personal searches of employees by HydroGeoLogic, including articles of clothing being worn by employees, are prohibited.

Searches may be initiated without prior notice and conducted at times and locations as deemed appropriate by HydroGeoLogic. Searches must be cleared in advance with the Human Resources and Legal Counsel.