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MEMORANDUM FOR NEW MEXICO ENVIRONMENT DEPARTMENT
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FROM: 49 CES/CEV
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Subject: Final TRIAD Approach Dynamic Work Plan RCRA Facility Investigation SWMU 183 – Base-wide Sewer System Holloman AFB, New Mexico

1. The attached subject work plan is hereby submitted to NMED for review and approval.

2. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3. If you have any questions, please feel free to contact Ms. Deborah Hartell at (575) 572-3931.

A. DAVID BUDAK
Deputy Base Civil Engineer

Attachment
Final TRIAD Work Plan (SWMU 183)

cc:

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FINAL
TRIAD APPROACH DYNAMIC WORK PLAN
RCRA FACILITY INVESTIGATION
SWMU 183 – BASEWIDE SEWER SYSTEM
HOLLOMAN AFB, NEW MEXICO

Holloman Air Force Base
New Mexico

February 2008

Contract No.: DACA45-03-D-0023
Delivery/Task Order: 0006
Bhate Project No.: 9040238.11.02

Headquarters, Air Combat Command
Langley Air Force Base, Virginia

49 CES/CEV
Holloman Air Force Base, New Mexico

FINAL TRIAD APPROACH DYNAMIC WORK PLAN
RCRA FACILITY INVESTIGATION
SWMU 183 - BASEWIDE SEWER SYSTEM
HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska
Contract No. DACA45-03-D-0023
Task Order No. 0006

February 2008

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FINAL TRIAD APPROACH DYNAMIC WORK PLAN
RCRA FACILITY INVESTIGATION
SWMU 183 - BASEWIDE SEWER SYSTEM
HOLLOMAN AIR FORCE BASE, NEW MEXICO

REVIEW SHEET

This Work Plan has been reviewed and approved by:

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FINAL TRIAD APPROACH DYNAMIC WORK PLAN
RCRA FACILITY INVESTIGATION
SWMU 183 - BASEWIDE SEWER SYSTEM
HOLLOMAN AIR FORCE BASE, NEW MEXICO

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B Historical Data Summaries

C Applicable or Relevant and Appropriate Requirements

D HAFB Site-Specific Health and Safety Plan (HASP)

ACRONYMS AND ABBREVIATIONS

AAF	Army Air Field
ACC	Air Combat Command
AFFF	Aqueous Film-Forming Foam
amsl	Above mean sea level
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate
ASTM	American Society for Testing and Materials
atm m^3/mol	Atmospheres-cubic meters per mole
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
BMPs	Best Management Practices
BOD	Biological oxygen demand
°C	Degrees Celsius
CCD	Customer Concept Document
CES/CEV	Civil Engineering Squadron/Environmental Flight
CFR	Code of Federal Regulations
cm/sec	Centimeters per second
CMS	Corrective Measures Study
COC	Chain-of-custody
COD	Chemical oxygen demand
CSM	Conceptual Site Model
DAF	Dilution-Attenuation Factor
DOD	Department of Defense
DOE	Department of Energy
DPT	Direct Push Technology
DQOs	Data Quality Objectives
E&E	Ecology and Environment, Inc.
EA	Environmental Assessment
EDD	Electronic Data Deliverable
EDRO	Extended Diesel Range Organics
EDV	Environmental Data Viewer
EI	Environmental Indicator
ERP	Environmental Restoration Program
ESRI	Environmental Systems Research Institute
EST	Eastern Standard Time
°F	Degrees Fahrenheit

FEP	Fluorinated Ethylene Propylene
FID	Flame Ionization Detector
f_{oc}	Fractional Organic Carbon Content
ft	Feet
FWENC	Foster Wheeler Environmental Corporation
GC/FID	Gas Chromatograph/Flame Ionization Detector
GC/MS	Gas Chromatograph/Mass Spectrophotometer
GEL	General Engineering Laboratories, LLC
GIS	Geographic Information System
gpd	Gallons per day
GPS	Global Positioning System
GRO	Gasoline Range Organics
GW	Groundwater
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
HSA	Hollow Stem Auger
IA	Immunoassay
IC	Ion Chromotagraphy
ICV	Independent Calibration Verification
ID	Identification
IDW	Investigation-Derived Waste
I/I	Infiltration and Inflow
INRMP	Integrated Natural Resource Management Plan
ISE	Ion Selective Electrode
IWPMP	Industrial Wastewater Pretreatment Management Plan
LCS	Laboratory Control Sample
LD	Laboratory Duplicate
LIMS	Laboratory Information Management System
LOCs	Lines of Concern
LQM	Laboratory Quality Manual
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MFH	Military Family Housing
MGD	Million gallons per day
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliter
MS/MSD	Matrix Spike/Matrix Spike Duplicate

MW	Monitoring Well
NELAP	National Environmental Laboratory Accreditation Program
NFD	No Further Delineation
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NO_3	Nitrate
NPDES	National Pollution Discharge Elimination System
O&G	Oil and Grease
OSD	Office of the Secretary of Defense
OSWER	Office of Solid Waste and Emergency Response
OWS	Oil / water separator
PAH	Polycyclic aromatic hydrocarbons
PARCC	Precision, accuracy, representativeness, comparability, and completeness
pCi/g	Pico-curies per gram
PID	Photoionization Detector
PMP	Project Management Plan
POCs	Pollutants of concern
POLs	Petroleum, oil, and lubricants
PPE	Personal Protection Equipment
ppm	Parts per million
PQL	Practical Quantitation Limit
PRT	Post Run Tubing
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RLs	Reporting Limits
ROWPU	Reverse Osmosis Water Purification Unit
SAP	Sampling and Analysis Plan
SG	Soil Gas
SO_2	Sulfur dioxide
SOP	Standard Operating Procedure
SPME	Solid Phase Micro-Extraction
SSPs	Study Specific Procedures

SSLs	Soil Screening Levels
Stone	Stone Environmental, Inc.
SVOCs	Semi-volatile organic compounds
SWMU	Solid Waste Management Unit
TAL – DEN	TestAmerica Laboratories, Denver, Colorado
TAL – LA	TestAmerica Laboratories, Los Angeles, California
TAT	Turn-around time
TDS	Total Dissolved Solids
TIG	Tungsten Inert Gas
TL	Trigger Level
TPH	Total Petroleum Hydrocarbons
Triad	'Triad' is not an acronym; it is included herein to dispel common misconception
TSS	Total Suspended Solids
TW	Temporary Well
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
$\mu g/m^3$	Micrograms per cubic meter
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WQCC	Water Quality Control Commission
WRCC	Western Regional Climate Center
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

Bhate Environmental Associates, Inc., (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contract DACA45-03-D-0023, Task Order No. 0006, to conduct a Triad Approach-Based Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of Solid Waste Management Unit (SWMU) 183, the basewide sewer system at Holloman Air Force Base (HAFB), New Mexico.

The purpose of the RCRA RFI is to gather necessary data to support a Corrective Measures Study (CMS) and/or selection of Interim Measures.

The SWMU 183 RFI is being performed according to the requirements set forth in the HAFB Hazardous Waste Facility Permit No. NM6572124422; Appendix 4-B RCRA Facility Investigation (RFI) Outline, dated February 2004 (HAFB RCRA Permit).

Stone Environmental, Inc., (Stone) was retained by Bhate to provide support for the project and accordingly, was assigned the role of developing this Triad Approach Dynamic Work Plan (Triad Work Plan).

1.1 Triad Dynamic Work Plan Organization

The Triad Work Plan will serve as the primary working document for the investigation of potential hazardous waste releases from SWMU 183. The Triad Work Plan is organized according to the requirements outline set forth in Appendix 4-B of the HAFB RCRA Permit as follows:

- Section 1 presents a summary of the Triad Approach and its key elements, project and data quality objectives, HAFB background information, and relevant existing assessment data.
- Section 2 details the environmental setting in terms of hydrogeology, soils, surface water and sediment, and climate.
- Section 3 provides information on the sewer system as a RCRA SWMU and the types, characteristics, and sources of the wastes moving through the system.
- Section 4 provides information on the human populations and environmental systems as potential receptors that could be affected by a potential release from the sewer.
- Section 5 presents the Initial Conceptual Site Model (CSM) for the site, including a summary narrative; a detailed outline of CSM elements, including key site decisions (primary and subsidiary), requirements narrative, status and required actions; and a not-to-scale, 3-dimensional block diagram illustrating the major elements of the Initial CSM.

- Section 6 presents the Sampling and Analysis Plan (SAP) for the characterization of sewer-related releases, highlighting the Triad Approach dynamic sampling strategy proposed for the RFI effort, as well as the specific sampling procedures, sample analysis and related sample quality assurance/quality control (QA/QC) measures to be employed during the conduct of the investigation.

- Section 7 describes the unique data management plan that will be used to support the Triad Approach investigation, specifically as related to real-time, near real-time, and standard turnaround data generation and use in decision making.

- Section 8 presents the project management plan (PMP), including the project organization, team member roles and responsibilities, and project master schedule.

- Section 9 provides full references of the publications used to support the development of this document.

- Figures, tables, and large plate diagrams are presented together under separate tabs.

- Appendices provide other key elements of the Work Plan, such as the Basewide QAPP Addendum, historical site data, regulatory criteria, and a site-specific health and safety plan.

1.2 Summary Description of the Triad Approach

The RFI is being performed using the U.S. Environmental Protection Agency's (USEPA's) Triad Approach, in accordance with a verbal agreement reached in an October 25, 2005, meeting between the New Mexico Environment Department (NMED), the US Army Corps of Engineers (USACE) Omaha District as service agents to the U.S. Air Force (USAF) Air Combat Command (ACC), HAFB, Bhate, Stone, and Schick Consulting.

The Triad Approach is a scientifically sound method of managing hazardous waste site decision uncertainty by leveraging appropriate characterization strategies and tools. Triad refers to the three primary components of the Triad Approach:

- Systematic Planning, including development of the initial CSM,

- Dynamic Work Strategies, and

- Real-Time Measurement Technologies, as described below.

1.2.1 Systematic Planning

Systematic planning is performed by stakeholders and key support organization representatives. It is the first stage of the Triad process, during which:

- Decisions that need to be made to support end-state site uses/goals are identified;
- Environmental and other site attributes critical to support site decisions are identified;
- The current state of site information is reviewed;
- Critical environmental and site knowledge gaps are identified;
- Specific investigative actions required to resolve knowledge gaps are defined;
- Decision-based data quality objectives (DQOs) are identified;
- Decision makers are identified; and
- Decision-making rules and processes are developed.

An Initial CSM is developed and is used as a guide to complete the systematic planning effort. The Initial CSM is an informed hypothesis, or set of hypotheses, that is created at the beginning of an investigation and confirmed or modified through the subsequent collection and evaluation of field analytical data, historic information, and professional judgment. The CSM provides a model of how chemicals were released at a site, their transport mechanisms and fate processes, and exposure routes for both ecological and human receptors. The CSM provides the basis for designing site investigation objectives and requirements and is meant to be updated as information about the site is confirmed. The CSM then provides a tool for communicating site understanding to stakeholders and for managing uncertainties as related to specific issues of concern. As issues are adequately defined, a Final CSM is resolved that provides a platform for stakeholders to reach consensus on whether all needed activities have been completed and to make decisions about the site relative to remediation and closure and/or other necessary actions.

1.2.2 Dynamic Work Strategies

Dynamic work strategies incorporate the flexibility to change or adapt investigation activities to changes in the CSM resulting from information generated during the field investigation activities. As information is gathered at the site, it is used to automatically initiate pre-designated actions outlined in site-specific decision logic diagrams, to make decisions about what actions should be taken to best resolve remaining data and decision uncertainties and/or to meet regulatory requirements.

1.2.3 Real-Time Measurement Technologies

Real-time measurement technologies refer to data generation mechanisms that support real-time and near real time decision-making. These include direct sensing measurement technologies; sampling methods; analytical methods; and data management, evaluation, and presentation technologies.

The Triad approach emphasizes managing decision uncertainty, rather than analytical uncertainty only. For example, embedded in the Triad approach is recognition that the contribution of sampling uncertainty to decision uncertainty often outweighs the contribution of analytical uncertainty. Accordingly, the Triad focuses on data collection methods that can increase spatial coverage for an area without sacrificing sample representativeness or driving up total sampling program costs. The Triad uses a weight of evidence approach to decision-making where appropriate, based on collaborative data sets. Collaborative data sets can contain data from a number of sources, including quantitative and screening analytical methods.

Additional information on the Triad Approach is available via the following Internet websites:

- http://www.triadcentral.org/
- http://www.itrcweb.org/gd.asp

1.3 Triad Systematic Planning Summary

A series of systematic planning meetings were held in support of developing this Triad Work Plan.

An extensive review of historical information was performed to serve as the basis for designing the Triad RFI. Historical data in electronic, tabular, and graphic formats were integrated with the HAFB GeoBase (USAF infrastructure mapping system) into a geographic information system (GIS) database for the purposes of spatial analysis, historical records review and relational access, and dynamic strategy / Triad decision making support. The database is supported by a web-based environmental data viewer (EDV) with query capability. Together, these systems and technologies comprise the GeoBase EDV. All members of the Triad Team and their support personnel will be provided web-based access to the GeoBase EDV for the purposes of supporting efforts to understand the Site, to participate in periodic Triad team conference calls (or meetings), and to conduct independent Site environmental queries. More detail on the GeoBase EDV system and plans for user access to it are provided in Section 7 of this Work Plan (Data Management Plan).

An initial project planning presentation was made to NMED during the October 25, 2005, meeting, which included a primer on the Triad Approach, an introduction to a series of real-time technologies, and a demonstration of the effectiveness of the Triad Approach via specific project case studies. Detailed discussions followed to address various points of technical interest, regulatory compliance and organizational ability, and constraints in regard to supporting a Triad Approach-based project. Based on the verbal agreements reached at the meeting, the project has proceeded based on using the Triad Approach.

Subsequent to the October 25, 2005, meeting, a series of systematic planning and Initial CSM design sessions were held at HAFB with personnel from HAFB's Environmental Directorate,

USACE Omaha District, Bhate, Stone, and Schick Consulting. An Initial CSM was developed, as were the basic elements of the dynamic investigation strategy, multi-media sampling and analytical requirements, data management plan, and decision rules and processes. These elements were modified during a series of subsequent teleconferences and document exchanges. This Triad Work Plan is the product of those efforts.

1.4 RCRA Permit Required RFI Tasks

Appendix 4-B of the HAFB RCRA permit provides an outline of the RFI portion of the RCRA corrective action process, the purpose of which is to evaluate the nature and extent of releases of hazardous wastes and/or hazardous constituents and to gather data to support a CMS and/or Interim Measures. The permit requires HAFB to accomplish the RFI through the following progression of tasks:

1. Gather information on the source of the release(s) to the environment (Source Characterization). The results of this task are addressed in Section 3 of this Work Plan.

2. Gather information on the physical aspects of the environment which will affect the migration and fate of the release and identification of exposure pathways for both humans and non-human members of the environment (Environmental Setting). The results of this task are addressed in Section 2 of this Work Plan.

3. Use Source Characterization and Environmental Setting to develop a conceptual model of the release which will be used to plan and conduct a program to define the nature, rate, and extent of the release (Sampling and Analysis Plan). The results of this task are addressed in Sections 5 and 6 of this Work Plan, respectively.

1.5 Project Objectives

The primary project objectives of the SWMU 183 RFI are to:

1. Identify locations where releases to the environment from the sewer system have occurred,

2. Characterize the nature and extent of contaminants of concern in identified releases to soil and/or groundwater,

3. Determine the affect of releases on environmental media (soil, groundwater and/or soil gas-indoor air) and receptors, and

4. Identify structures that may be at potential risk for vapor intrusion.

1.6 Data Quality Objectives

The DQO process is designed to generate performance criteria for the collection of new data. Performance criteria represent the full set of specifications that are needed to design a data collection effort such that newly-collected data are of sufficient quality and quantity to address the primary project objectives outlined in Section 1.5 of this Work Plan.

The steps of the DQO process are:

1. Define the nature of the problem to be studied and develop a conceptual model of the environmental hazard to be investigated (see Section 5 of this Work Plan).

2. State the decisions or estimates that need to be made (see Table 5-1 of this Work Plan).

3. Determine the type(s) of data needed for decision-making (see Table 5-1 of this Work Plan)

4. Develop a decision making process or rules that define how the data will be used to draw conclusions from the investigation results (see Section 6.1 of this Work Plan and Figures 6-1 through 6-4).

5. Establish acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data. These criteria are known as performance criteria, or DQOs (see Section 6.3 of this Work Plan).

6. Design a data collection program that will generate data meeting the quantitative and qualitative criteria specified in Step 5 which includes:

    - Type of data (see Sections 6.2 and Section 6.3 of this Work Plan),

    - Number, location, and physical quantity of samples (see Sections 6.1 and 6.3 of this Work Plan)

    - QA and QC activities to ensure that sampling design and measurement errors are managed sufficiently to meet the performance or acceptance criteria specified in the DQOs. The DQO criteria include measures of precision, accuracy, representativeness, comparability, and completeness (PARCC).

The results of this process are used to develop a Quality Assurance Project Plan (QAPP) (see the HAFB Basewide QAPP and the HAFB Basewide QAPP Addendum included in Appendix A of this Work Plan).

1.7 Facility Description

HAFB is located in south central New Mexico, in the northwest central part of Otero County, approximately 75 miles north-northeast of El Paso, Texas (Figure 1-1). HAFB has a population of 6,000, supports approximately 21,000 active-duty Air Force, National Guard, Air Force Reserve, retirees, civilians, and their family members. HAFB occupies approximately 60,000 acres in the northeast quarter of Section 1, Township 17 South, Range 8 East. The White Sands Missile Range testing facilities occupy additional land extending northward from the Base. Private and public owned lands border the remainder of HAFB. The major highway servicing HAFB is Highway 70, which runs southwest from the town of Alamogordo and separates HAFB from publicly owned lands to the south. Alamogordo is located approximately 7 miles east of the base and has a population of approximately 35,000.

The SWMU 183 site (see Figure 1-2 and Plates 1 and 2) is unique in that, rather than being a waste management system of limited to moderate size in a singular physical location, it is a subsurface feature comprised of approximately 22 miles of sewer line that serves the entire developed portions of the Base. In addition to the sewer lines, the system includes over 800 active and approximately 100 abandoned manholes, approximately 10 lift (pumping) stations, and hundreds of variably contributing sources distributed throughout the entire Base, including direct discharges from industrial/operational facilities and domestic structures, as well as pass-through discharges from additional waste management systems such as oil / water separators. The sewer collects and transports both sanitary and mixed industrial wastes to the Base's wastewater treatment plant (WWTP), which is located at the central-southern boundary of the Base (see Figure 1-2).

1.8 Facility Operation History

HAFB was first established in 1942 as Alamogordo Army Air Field (AAF). From 1942 through 1945, Alamogordo AAF served as the training ground for over 20 different flight groups, flying primarily B-17s, B-24s, and B-29s. After World War II, most operations had ceased at the Base. In 1947, Air Material Command announced the air field would be its primary site for the testing and development of un-manned aircraft, guided missiles, and other research programs. On January 13, 1948, the Alamogordo installation was renamed Holloman Air Force Base, in honor of the late Col. George V. Holloman; a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at HAFB and has remained since, conducting fighter aircraft training and operations. HAFB has also served as the German Air Force's Tactical Training Center since 1996.

The sewer system was originally installed in 1947 and expanded to its current configuration as the Base was subsequently developed. In 1996, the 1.5 million gallon per day (gpd) WWTP was constructed and remains in service.

1.9 Industrial Activities and Waste Generation

The industrial operations facilities at the Base historically produced a variety of wastes, many of which were discharged to the sewer system. Current waste discharges are conveyed to the Base WWTP. In a prior industrial wastewater pretreatment study (Ecology & Environment, 1998) the industrial wastewater discharges of 55 industrial facilities were assessed to identify what pollutants of concern (POCs) were being introduced into the wastewater system. The study identified a number of POCs, including:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Petroleum, oil, and lubricants (POLs);
- Oil and grease;
- Heavy metals;
- Herbicides and pesticides;
- Total Suspended Solids (TSS);
- Biological oxygen demand (BOD) and chemical oxygen demand (COD);
- Phosphates, sulfides, and chlorides; and
- Possible radionuclides (Carbon-14, tritium, iodine 125, radium 226, and radium 228).

Common waste-generating activities noted included vehicle, aircraft, equipment and floor washing; x-ray and photo processing, and fuel canister rinsing. Many of these facilities utilized pretreatment features such as grit chambers, grease traps, holding ponds, and oil / water separators (OWS) before wastes were discharged into the sewer system. Table 1-7 in Appendix B) (Ecology & Environment, 1998) presents a summary of study results, including building name and number, waste flow type, average and maximum daily flow volumes, identified POCs, and pretreatment systems existing at the time of the study. Plates 1 and 2 show the locations of all of the buildings identified as discharging POCs into the sewer system, as well as the HAFB-designated Sewer Subareas each is located within.

1.10 Nature and Extent of Any Known Contamination

At present, the nature and extent of contamination resulting from any suspected or unknown releases from the sewer system is undefined. There are two suspected sewer release areas located in the approximate center of Sewer Subarea 9 and the eastern portion of Sewer Subarea 10. However, based on prior structural evaluations of the sewer, certain lengths of the sewer have been lined to improve the integrity of the sewer system. It is possible that releases to the environment may have occurred in sewer lines whose material of construction has been compromised.

1.11 Summary of Interim Measures and Past Assessments

A number of past studies and removal actions have been performed in direct relation to SWMU 183 and its tributary systems, including:

- An industrial wastewater pretreatment survey,
- An inflow and infiltration study,
- RCRA Facility Investigation planning,
- An Environmental Assessment (EA) in support of a wastewater utility privatization, and
- Oil / water separator removals.

Each of these actions is described below.

1.11.1 Industrial Wastewater Pretreatment Study

An industrial wastewater pretreatment study was conducted on the sewer system in 1997 in support of developing an Industrial Wastewater Pretreatment Management Plan (IWPMP) and Customer Concept Document (CCD) (Ecology & Environment, Inc, 1998). This study provides the most comprehensive understanding of the nature and likely source of various wastes historically discharged to the sewer, and therefore, served as a substantive guidance for the development of the focus and strategy of this RCRA RFI. The scope of the three-phase study was to:

1. Identify wastewater sources and potential POCs from industrial activities at the base;
2. Develop a SAP and associated Health and Safety Plan (HASP) for the purpose of collecting detailed industrial wastewater and treatment works characterization data, develop a Pollution Prevention Technical Report, and develop a Pretreatment Management Technical Report; and
3. Develop a Pre-Concept Analysis and Design, a CCD technical report, and environmental justification for the project.

Fifty-five industrial facilities, comprising approximately 80 buildings, were surveyed. A summary of major project findings for this effort are presented in Section 3 of this Work Plan. As indicated above, Table 1-7 located in Appendix B of this Work Plan (Ecology & Environment, 1998) provides a summary of the actual results from the original basewide industrial wastewater pretreatment study.

1.11.2 Inflow and Infiltration Study

An infiltration and inflow (I/I) study was conducted on the HAFB sewer system in 1998 by Radian International LLC (Radian International, 1998). The purpose of the study was to determine if the base sanitary system had excessive groundwater infiltration or stormwater inflow that could potentially cause regulatory noncompliance. Three phases of field work were conducted, including: 1) sewage flow, rainfall monitoring, and manhole inspections; 2) smoke testing, and; 3) TV inspection and dyed-water flooding.

The primary findings of the study were that some of the sewer exhibited system structural and hydraulic problems, but that "the most significant system problem appeared to be an excessive amount of steady inflow into the system". The following are summaries of the primary study findings pertinent to the physical condition of the sewer system as potentially relevant to this RCRA RFI:

1.11.2.1 Structural Condition

Although most of the active lines in the sewer system were determined to have been repaired or replaced, there were still a number of lines that were in critical and serious structural condition that needed to be addressed. Some sections of sewer line in the southern portion of the base had been impacted by hydrogen sulfide generated in the lines and were corroded. It was noted that base personnel were at the time implementing a corrective action plan to control the gas generation.

1.11.2.2 Hydraulic Condition

Some of the newer sewer lines were determined to be in good structural condition, but having poor hydraulics. Mismatched inverts, very low slopes and sagging had all contributed to a buildup of debris in the lines. The majority of lines observed contained debris, some with accumulations of up to 30% of the pipe diameter. Despite this, most of the lines were determined to have sufficient capacity to convey the required flows. A minor number of lines were observed to exceed their capacity as evidenced by in-manhole surcharging (i.e., no surface discharge).

1.11.2.3 Steady Infiltration

Flow monitoring data indicated that approximately 542,000 gpd of steady I/I enters the sewer system. The average baseflow measured (sewage generation rates not including I/I) for the facility was approximately 485,000 gpd. These data indicated that I/I volumes exceeded the average baseflow, and was also greater than what was generally considered to be excessive. The majority of I/I to the system was determined to be groundwater capture via service lines and laterals located beneath the water table. This situation is most prevalent in the southeastern area of HAFB where depth to groundwater is relatively shallow (5 feet or less).

1.11.2.4 Stormwater Inflow and Infiltration

Radian identified approximately 30 sources of possible inflow during smoke testing conducted in select portions of the system. It was concluded that inflow at HAFB is not a significant concern due to the small amount of regional rainfall. Only four lines were found to exceed the line capacity following a large rainfall.

Various information and data from these previous programs was used to develop the Initial CSM, in addition to populating the GeoBase EDV for the purposes of project planning and future spatial analysis needs in support of the field effort and project reporting.

1.11.3 RCRA Facility Investigation Planning

An RFI Work Plan was prepared in response to a USEPA policy issuance, wherein sewer systems were to be treated and characterized as SWMUs. The RFI was intended to comply with the RCRA corrective action process wherein releases or potential releases from SWMUs were to be identified and, as necessary, characterized and remediated. The work plan was developed in April 2005 (Foster Wheeler Environmental Corp., [FWENC]/Radian Corp., 1995).

In the work plan, HAFB's sanitary and industrial sewer lines that drain to the WWTP were referred to as SWMU 183. Storm sewer lines and the new WWTP, which began operation in July 1996, were not considered part of SWMU 183.

The Work Plan identified lines of concern (LOCs) as sewer line segments that met two criteria:

- Physical condition indicating that they may have leaked; and
- Location downgradient from a potential source of hazardous constituents connected directly to the sewer system.

Based on funding appropriation constraints, the RFI Work Plan was never implemented.

1.11.4 Environmental Assessment for Wastewater Utilities Privatization

In 2005, the Air Force evaluated the concept of selling the entire HAFB wastewater collection and treatment system to a non-Air Force entity. The purpose of the proposed action was to meet Congressional and Office of the Secretary of Defense (OSD) mandates regarding the privatization of non-combat military activities, including utilities.

The system proposed to be sold included all equipment, fixtures, right-of-way, and other improvements utilized in connection with the wastewater treatment system. The real property upon, under, or around the utility system was not to be included in the sale. The acquiring entity would have been required to provide all necessary labor, management, supervision, permits,

equipment, supplies, materials, transportation, and any other incidental services for the complete ownership, operation, maintenance, repair, upgrades, and improvements to the wastewater treatment system.

The EA analyzed 10 resource areas for both the proposed action and the no action alternative. The resource areas included: physiography, geology, and topography; soils; water resources; biological resources; air quality; land use; socioeconomic conditions; and cultural resources.

The EA analysis concluded that, as long as the functioning of the HAFB wastewater collection and treatment system remained substantially the same, there would be no significant environmental impacts resulting from the proposed action. However, it was determined that the transfer of ownership of the system to a private or public entity might cause complex regulatory, economic, and/or mission impacts with significant and unacceptable levels of regulatory, economic, and technical risk.

Therefore, the No Action Alternative was recommended, and the wastewater utility system to date remains an Air Force asset.

1.11.5 Oil / Water Separator Removals

A series of investigations and corrective actions to remove OWSs have been conducted at HAFB since the mid-1990s. The corrective actions have included removal of OWS units, removal and/or capping of associated piping, removal of contaminated soils, and replacing select OWS systems or connecting building discharges directly to the sewer.

Each of the OWS systems are regulated RCRA SWMUs listed in the HAFB RCRA operating permit. According to permit Table A (i.e., sites requiring corrective action) and permit Table B (i.e., sites requiring No Further Action), the following is the status of SWMU sites as of September 30, 2005:

- Table A: 3 sites requiring corrective action,
- Table A: 2 sites with source removal/remediation planned for 2008, and
- Table B: 36 sites are listed as requiring No Further Action (NFA).

Table 1-1 of this Work Plan lists each of the OWS SWMU sites and their current (2007) permitted status.

2 ENVIRONMENTAL SETTING

2.1 Physiography and Topography

HAFB is located within the Sacramento Mountains Physiographic Province on the western edge of the Sacramento Mountains. HAFB is approximately 60,000 acres in area, and is located at a mean elevation of 4,093 feet above mean sea level (amsl). The region is characterized by high tablelands with rolling summit plains; cuesta-formed mountains dipping eastward and of west-facing escarpments with the wide bracketed basin forming the basin and range complex. The Base is located in the Tularosa Sub-basin, which is part of the Central Closed Basins. The bordering mountains rise abruptly to altitudes of 7,000 to 12,000 feet amsl. The San Andres Mountains bound the basin to the west (about 30 miles) with the Sacramento Mountains approximately 10 miles to the east. At its widest point, the basin is about 60 miles east to west and stretches approximately 150 miles north to south.

In the vicinity of HAFB, the ground surface is relatively flat and slopes gently to the southwest. There are localized areas of greater topographic relief related to arroyos present on the Base, as described in Section 2.3 of this Work Plan.

2.2 Climate

As a whole, New Mexico has a mild, arid to semi-arid, continental climate characterized by light precipitation totals; abundant sunshine, relatively low humidity and relatively large annual and diurnal temperature range (Western Regional Climate Center [WRCC], 2003). The climate of the Central Closed Basins varies with elevation. The base is found in the low areas and is characterized by warm temperatures and dry air. Daytime temperatures often exceed 100 degrees Fahrenheit (°F) in the summer months and middle 50s in the winter. A preponderance of clear skies and relatively low humidity permits rapid night time cooling resulting in average diurnal temperature ranges of 25 to 35°F. Potential evapotranspiration, at 67 inches per year, significantly exceeds annual precipitation, which is usually less than 10 inches. The very low rainfall amounts resulting in the arid conditions, which with the topographically induced wind patterns combining with the sparse vegetation, tend to cause localized "dust devils". Much of the precipitation falls during the mid-summer monsoonal period (July and August) as brief, yet frequent, intense thunderstorms culminating in 30 – 40% of the total annual rainfall.

2.3 Surface Water and Hydrology

Because of the high net evaporation of rainfall, there are no natural perennial streams in the immediate area of the sewer lines. Intermittent streams and arroyos in the basin lowlands are important only during the infrequent periods of heavy rainfall. The Tularosa Basin contains all of the surface flow in its boundaries. The nearest inflow of surface waters to the Base comes from the Lost River, located in the north-central region of the Base. The upper reaches of the Three Rivers and the Sacramento River are perennial in the basin. HAFB is dissected by several

southwest trending arroyos that control the surface drainage. Hay Draw arroyo is located in the far north. Malone and Rita's Draw, which drain into the Lost River and Dillard Draw arroyos, are located along the eastern perimeter of the Base. Approximately 10,000 years ago, indications are of a much wetter climate. The present day Lake Otero encompassed a much larger area, possibly upwards of several hundred square miles. Its remains are the Alkali Flat and Lake Lucero. Lake Lucero is a temporary feature of merely a few inches in depth during the rainy season.

Potable water is available from municipal wells along the margins of the basin with more saline water towards the center. The principal sources of potable water are located in a long narrow north-south trending area on the upslope sides of Tularosa and Alamogordo and in the far southern part of the basin. HAFB is also supplied potable water from Lake Bonito, which is in the Pecos River Basin.

The hydrology of the southern portion of the Base (south of the wastewater treatment plant) is dominated by several manmade features that form a connected hydrologic system. The principal components of this system are: the stormwater drainage canal, Lagoon G, Lake Holloman, and Lake Stinky. In addition, there are both natural and constructed wetlands in this area, some of which are related to and dependent on the manmade surface water features.

HAFB currently generates under 1 million gallons per day (MGD) of wastewater. Approximately 200,000 to 250,000 gpd of treated effluent empty into Lagoon G (approximately 46 acres) through a 6-inch force-main. This effluent is eventually discharged to the stormwater drainage canal southwest of Lagoon G and north of Highway 70. A berm surrounding this lagoon prevents stormwater from flowing into the lagoon. The stormwater drainage canal starts at a point north of Lagoon G, and then extends southwest of the lagoon into Lake Holloman. The canal is about 2 feet wide and 1 mile long with an elevation change of about 5 feet between Lagoon G and Lake Holloman. The Base storm sewer system drains directly into this canal. The drainage basin for the storm sewer system encompasses about 13 acres. The canal also receives effluent from Lagoon G.

Lake Holloman was created in 1965 to receive excess flow from the previous sewage treatment lagoon system. It was formed by the construction of a non-engineered earthen dam midway along an existing ephemeral lake (playa) that normally received runoff from HAFB. Lake Holloman receives water from the stormwater drainage canal, Lagoon G, and effluent from the WWTP. The amount of effluent going to Lake Holloman can be adjusted depending on the water requirements of Lagoon G and the constructed wetlands. The lake is in a state of dynamic equilibrium, rising and falling with seasonal and annual variations in runoff, local shallow groundwater, and treated effluent from the WWTP.

Lake Stinky encompasses as much as 35 acres of playa below Lake Holloman. This area represents a remnant of the original playa grassland present in the project area prior to the construction of the lagoon system for the original wastewater treatment system in 1948. Persistent seepage from Lake Holloman is sufficient to maintain a limited surface water

expression in Lake Stinky, as well as a substantial growth of wetland vegetation (tamarisk and saltgrass) at the base of the dam separating Lake Stinky and Lake Holloman. During most years, total annual discharge to Lake Holloman is sufficient to result in overflow to Lake Stinky. On these occasions, Lake Stinky extends south from the dam through culverts underneath U.S. Highway 70/82 to encompass as much as 61 acres.

There are approximately 119 acres of jurisdictional wetlands on the main base (United States Air Force, 1996), the majority of which are located south of the WWTP near Lagoon G and Lake Holloman (79 acres). Some of these areas are fed partly by seepage from artificial impoundments (e.g., north end of Lake Stinky; west and south of Lagoon G). Others may have an independent existence, or be only slightly affected by the impoundments. These latter areas seem to be remnants of the wetlands that existed before the construction of the present system. Many of the wetlands located south of the WWTP are important foraging areas for resident and migrating birds and/or bats.

2.4 Regional Geology

The sedimentary rocks which make up the adjacent mountain ranges are between 500 and 250 million years old. During the period when the area was submerged under the shallow intra-continental sea, the layers of limestone, shale, gypsum, and sandstone were deposited. In time, these layers were pushed upward through various tectonic forces forming a large bulge on the surface. Approximately 10 million years ago the center began to subside resulting in a vertical drop of thousands of feet leaving the edges still standing (the present day Sacramento and San Andres mountain ranges). In the millions of years following, rainfall, snowmelt, and wind eroded the mountain sediments depositing them in the valley (i.e. Tularosa Basin). Water carrying eroded gypsum, limestone, dolomite, gravel, and other alluvial matter continues to flow into the basin with no route of exit.

The Tularosa sub-basin is geologically described as a bolson, which is an extensive flat alluvium-floored depression, into which drainage from the surrounding mountains flows toward a central playa. The overlying alluvium generally consists of unconsolidated gravels (limestone, dolomite, and gypsum), sands, and clays. A fining sequence from the San Andreas and Sacramento Ranges towards the basin's center characterizes the area with the near surface soils as alluvial, eolian, and lacustrine deposits. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt, and clay while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually indistinguishable due to the reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of silty clay containing gypsum and are contiguous with the alluvial fan and eolian deposits.

Mesozoic rocks in the northwest mark the Colorado Plateau, topped by younger Tertiary strata. Quaternary age sediments have washed off the Southern Rockies into the open basins and the Rio Grande Rift, a failed spreading center or aulacogen. This would-be ocean basin runs up the center of the state with the Rio Grande flowing down its middle, exposing the Paleozoic and

Precambrian rocks on its uplifted flanks. Later Cenozoic volcanic intrusions of Quaternary and Tertiary age are also associated with the rifting.

The great Permian Basin of Texas continues into the state from the southeast with younger Quaternary-Tertiary sediments of the Great Plains cover the whole eastern edge. Basin-and-range terrain of Tertiary sediments and volcanics appear in the extreme southwest coupled with wide dry basins choked with Quaternary coarse sediments eroded from the blocks of uplifted older rocks.

2.5 Regional Hydrogeology

The preponderance of the groundwater occurs as an unconfined aquifer in the unconsolidated deposits of the central basin, with the primary source of recharge as rainfall percolation and minor amounts of stream run-off along the western edge of the Sacramento Mountains. Surface water/rainfall migrates downward into the alluvial sediments at the edge of the shallow aquifer near the ranges, and flows downgradient through progressively finer-grained sediments towards the central basin. Because the Tularosa Basin is a closed system, water that enters the area only leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table. Beneath HAFB, the water table ranges from 5 to 50 feet below ground surface (bgs). Flow for the Base is generally towards the southwest with localized influences from the variations in the topography of the Base. The ground surface slopes at a slightly higher rate than the water table such that the depth to groundwater in the northern areas of the Base is comparably greater (25 to 40 feet bgs) than in the southern areas of the Base (less than 10 feet bgs). Near the arroyos, groundwater flows directly toward the surface drainage feature.

Figure 2-1 shows the general groundwater flow direction at the Base. Groundwater quality in the Tularosa Basin is of potable quality at the recharge areas in close proximity to the Sacramento Mountains and becomes increasingly mineralized toward the central portion of the basin and discharge areas (Radian, 1993). The majority (over 70 %) of the Environmental Restoration Program (ERP) Sites, SWMUs, and Areas of Concern (AOC) located across HAFB have groundwater monitoring wells containing water with an average total dissolved solids (TDS) concentration greater than 10,000 milligrams per liter (mg/L). This TDS data supports the hypothesis that TDS concentrations below 10,000 mg/L at HAFB are caused by dilution of natural groundwater from leaking water lines and surface irrigation from the domestic water supply. TDS concentrations greater than 10,000 mg/L exceed the New Mexico Water Quality Control Commission (WQCC) limit as potable water and thus, the groundwater beneath HAFB has been designated as unfit for human consumption. Likewise, USEPA guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L.

In addition, there are no potable water wells on HAFB. Potable water for the Base (Boles, Douglas and San Andres well fields) and the city of Alamogordo is derived from the foot of the nearby Sacramento Mountains, just south of Alamogordo. The only production water well, used for livestock irrigation, is located approximately 7 miles southwest of HAFB.

2.6 Soils

Two soil types have been identified on the installation. The main soil type is the Holloman-Gypsum land-Yesum complex, 0 to 5 percent slopes. The other soil type is Mead silty clay loam, 0 to 1 percent slopes. This soil type is located only across the main drainage area for the installation.

The Holloman-Gypsum land-Yesum complex, 0 to 5 percent slopes soil consists of large areas of shallow and deep, well drained soils and areas of exposed gypsum. The Holloman soil makes up about 35 percent of the complex. Typically, the surface layer is light brown very fine sandy loam about 3 inches thick. The upper 13 inches of the substratum is pink very fine sandy loam that is very high in gypsum. Below that, the substratum is white gypsum to a depth of more than 60 inches. This soil is calcareous and mildly alkaline to moderately alkaline throughout. Permeability is moderate, and available water capacity is very low.

Gypsum land makes up about 30 percent of the Holloman-Gypsum land-Yesum complex, 0 to 5 percent slopes. Typically, less than 1 inch of very fine sandy loam overlies soft to hard, white gypsum. The deep Yesum very fine sandy loam makes up about 20 percent of the complex. Typically, the surface layer is light brown very fine sandy loam about 3 inches thick. The upper 9 inches of the substratum is light brown fine sandy loam that is very high in gypsum. Below that, the substratum is pink very fine sandy loam to a depth of more than 60 inches. The soil is calcareous throughout and is mildly alkaline. Permeability is moderate, and available water capacity is moderate. Many fine gypsum crystals are found throughout the profile.

The soil type located across the main drainage area for the installation is Mead silty clay loam, 0 to 1 percent slopes. This deep, poorly drained, nearly level soil is on outer fringes of alluvial fans. This soil formed in fine textured alluvium over lacustrine lake sediment. It is very high in salt content because of periodic flooding and poor drainage. Slopes are smooth and concave. Typically, the surface layer is reddish brown silty clay loam and clay loam about 5 inches thick. The substratum, to a depth of 48 inches, is light reddish brown clay that has a high content of salts. Below that, the substratum is lacustrine material of variable texture and color to a depth of more than 60 inches. Included with this soil are areas of Holloman soils and Gypsum land along the margins of the unit of steep, short gully sides and knolls. These inclusions make up about 15 percent of the map unit for this soil type. Individual areas are generally smaller than 10 acres. This soil is moderately calcareous throughout and is moderately to strongly alkaline. It has a layer of salt that is more soluble than gypsum. Permeability is very slow, and available water capacity is low.

2.7 Site-Specific Setting

As the sewer line traverses the majority of the Base, the site-specific geologic and hydrogeologic setting varies somewhat depending on the location of interest anywhere where along its length.

Based on previous investigations conducted at HAFB, site-specific geology may range as follows:

- Five to six feet of brown or tan silty clays overlying a pink to tan gypsum clayey sand;
- A near surface dry silty sand overlying alternating beds of clayey silts (mottled with laterally discontinuous, dry, and very dense gypsum lenses and microcrystalline gypsum crystals) and thin silty sands down to 22 to 27 feet bgs where the capillary fringe is encountered. The clayey silt continues to a dense silty sand layer at approximately 32 to 35 feet bgs;
- Seven to 10 feet of low plasticity silt and silty sand overlying 5 to 15 feet of interbedded highly plastic silt and silty clays, overlying 7 to 15 feet of well sorted, fine grained sand with intermittent gypsum and clay layers. A dense basal silty clay is inconsistently present at approximately 40 to 45 feet bgs;
- Near surface deposits of low to medium plastic silt varying in thickness from 2 to 15 ft thick overlying a well sorted, very fine to fine grained sand interspersed with small clay, silty clay, and caliche lenses with gypsum crystals; or
- Silty sands interbedded with clayey sands overlying a dense caliche layer overlying white fine grained sand layers at approximately 20 feet bgs which grades into a clayey silt interbedded with gypsum lenses and extends 20 to 25 feet to a water bearing silty sand at approximately 40 to 45 feet bgs.

Similarly, site-specific hydrogeology may range as follows:

- Groundwater occurring in a shallow unconfined aquifer at approximately 5 feet bgs in silty sand with potentiometric surface elevations ranging from 4073.44 to 4071.5 feet amsl and having a hydraulic gradient of approximately 8.5×10^{-3};
- Groundwater occurring in an unconfined aquifer at approximately 22 to 27 feet bgs with a potentiometric surface elevation of approximately 4082.74 feet amsl and having a hydraulic gradient of approximately 1.8×10^{-3};
- Groundwater occurring in an unconfined aquifer at approximately 30 to 35 feet bgs in sand and basal clay units with potentiometric surface elevations ranging from 4047.31 to 4054.35 feet amsl and having a hydraulic gradient ranging from 4.0×10^{-3} to 8.9×10^{-3}; or
- Groundwater occurring in a shallow unconfined aquifer beneath the site approximately 20 feet bgs in the fine grained sand deposits with potentiometric surface elevations ranging from 4036.38 to 4035.32 feet amsl and having a hydraulic gradient of approximately 8.7 x 10-3.

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3 SOURCE CHARACTERIZATION

3.1 The HAFB Sanitary Sewer System and Wastewater Treatment Plant

The HAFB sewer system was constructed in 1947 and serves both residential and industrial facilities. The system consists of over 165,000 feet of sewer lines that, on average, are located approximately 6 feet bgs. As indicated in Figure 3-1, the SWMU 183 sewer line is expected to be below the water table in the southern portion of the Base, as evidenced by a comparison of groundwater and sewer invert elevations. While the HAFB systems also include storm sewer lines and a WWTP located at the central-southern boundary of HAFB, SWMU 183 consists only of the sewer lines. SWMU 183 is a unique solid waste management unit because it is large, laterally extensive, and receives wastes from numerous sources.

Wastewater collection and treatment for HAFB is provided for most of the base facilities. The sewer collection system contains a series of gravity collection mains, lift stations, and force mains which route the wastewater to WWTP. Septic systems serve the remaining base population. It is estimated that approximately 30 septic tanks remain in remote areas of the base.

Prior to the construction of the current WWTP in 1996, waste flowed into a collection box and was ground and screened before being pumped into treatment lagoons. The waste now enters the WWTP, which carries out screening, grit removal, flow measurement, aeration, secondary clarification, chlorine contact for effluent disinfection, dechlorination (through the use of sulfur dioxide [SO_2]), and effluent flow measurement. Solids handling facilities include aerobic sludge digesters and paved sludge drying beds. A septage disposal basin for the acceptance of waste from pumped septic tanks and/or portable toilets on the installation is also located at the WWTP. The wastewater treatment facility was designed for an average flow of 1.5 MGD. Treated effluent is discharged into Lake Holloman or nearby constructed wetlands.

3.2 Physical Condition of the Sewer System

Some sections of the SWMU 183 sewer lines remain from the original construction, but the majority of the sections have been lined, replaced, or abandoned within the past 20 years. The newer sewer lines consist of polyvinyl chloride (PVC) pipes, while the older sections consist of clay, concrete, or asbestos cement pipe. In addition to the replaced sections, still other sections have been added or modified in response to changes in the base population or use.

The type and status of the sewer lines is shown on Plates 1 and 2. Table 3-1 lists the pre-designated sampling locations planned for the project and indicates the historical condition of the sewer line for each location.

3.3 Waste Characteristics

The HAFB sanitary sewer system and WWTP receive and treat domestic and industrial waste streams being discharged to the system. The sewer system has historically received a variety of chemical compounds from a diverse number of industrial and operational activities.

Table 3-2 provides a list of the chemicals known to have been discharged to the sewer system based on the previous industrial pretreatment study (Ecology & Environment, 1998).

Table 3-3 provides a list of the types of wastewater generating processes known to have discharged POCs into the sewer system (Ecology & Environment, 1998).

Table 1-7 in Appendix B of this Work Plan (Ecology & Environment, 1998) is the actual summary of results list from the industrial pretreatment study (Ecology & Environment, 1998). It lists the number and name of the 55 specific industrial buildings known to have discharged POCs, their waste generation activities/processes, their average and maximum daily flow contributions (in gpd), the specific POCs associated with each building, as well as the then existing pretreatment practices in use at each site. Each of the 55 buildings is also shown on Plates 1 and 2.

Some pretreatment practices are in place to minimize the hazardous waste entering the sewer system. These include OWSs, AFFF ponds, grit and sediment traps, and screens.

The diversity of compounds, variability in their chemical formulation, and complex and extensive intermixing environment of the sewer limit the practicality of providing detailed physical and chemical characteristics information for each identified compound. Similarly, each of the primary hazardous classifications (i.e., flammable, reactive, corrosive, oxidizing, reducing, etc.) appears to be represented within the spectrum of all of the identified compounds. Further, it is not practical at this time to specify the mitigation and dispersal characteristics of each of the individual wastes. Instead, at the point where specific compounds are identified and confirmed as having been released to environment media (soil, groundwater, and soil gas), the physio-chemical properties of those compounds will be provided.

3.4 Sewer Release Indicator Compounds

Based on the above information, and the logistical and cost impracticability of sampling and analyzing for every class of POC at every location, a subset of these POCs will be used as indicators to identify whether a release to the environment has occurred in a given location. The selected indicators and the iterative analytical approach to sampling and testing for their presence in soils, groundwater and/or soil gas, are presented in Section 6.1 of this Work Plan.

In addition, given the diversity in POCs, the range of volume discharged from each source, and the complex flow and mixing environment within the sewer, it is not practical to sample only for specific compounds at locations near or immediately downgradient of facilities where they were

known to be discharged. Hypothetically, as sampling efforts continually progressed downgradient from known discharge locations, new analytes would have to be added to the analytical program to account for every new POC known to have been discharged at that location. Based on this approach, the sampling and analytical program would grow to an impractical size and breadth to the point wherein every sample would have to be analyzed for all constituents.

One significant compound, nitrate (NO_3), was not considered in the prior pretreatment study, but is expected to be present where releases have occurred, and therefore is uniquely germane to the RFI. Nitrate is known to be generated by the nitrification of the ammonium and present in domestic wastewaters in relatively large quantities. Denitrification will not occur in aerobic conditions, so nitrate is expected to persist in the shallow subsurface environment. Other sources of nitrate in the subsurface include fertilizers and animal wastes. Neither of these are present in significant quantities over most of the Base area. Therefore, nitrate is considered a unique and useful indicator for identifying whether a release from the sewer has occurred and will be used for that purpose in conjunction with other indicator parameters.

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4 POTENTIAL RECEPTORS

This section identifies and describes potential receptors and environmental systems that are susceptible to contaminant exposure associated with the potential releases of hazardous materials from SWMU 183. The potential receptors include HAFB personnel and residents as well as the flora and fauna of the surrounding ecosystem.

4.1 Current Local Uses and Planned Future Uses of Groundwater

There are no potable water wells on HAFB. Potable water for the Base and the City of Alamogordo is derived from the nearby Sacramento Mountains. The only production water well, used for livestock irrigation, is located approximately 7 miles southwest of HAFB.

There are no water supply wells on the Base because the preponderance of groundwater beneath HAFB contains water with an average TDS concentration greater than 10,000 mg/L (see Figure 4-1) which exceeds the New Mexico WQCC limit as potable water and thus, the groundwater beneath HAFB has been designated as unfit for human consumption. Likewise, USEPA guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L.

4.2 Current Local Uses and Planned Future Uses of Surface Waters Directly Impacted by the Facility

Due to low rainfall and high evaporation, surface water at HAFB is limited and, therefore, is not used for domestic or municipal purposes nor is it used for recreation or agriculture. The ponds in the southern part of the Base receive effluent from the NPDES-permitted WWTP and are saline (normally about half the salinity of seawater), sulfate-rich, and very rich in nutrients. These ponds provide habitat for numerous plant and wildlife species, so water quality of these receiving waters is important.

4.3 Potential Human Receptors

Potential human receptors include residents, military and civilian workers, construction and maintenance workers, vendors and service providers, and transient visitors. Human use facilities primarily consist of residential housing and industrial/operational facilities. The Base also has a hospital and three schools and a variety of other public service facilities.

As sewer lines are on average 6 feet below ground surface, the average HAFB resident; non-invasive worker, vendor or service provider; or visitor would not likely be adversely affected by a potential subsurface leak from the sewer system. While groundwater is not locally extracted for use, human exposure to pollutants may result from dermal contact or ingestion from physical

contact with contaminated soils, and potentially through inhalation of VOCs in indoor air resulting from vapor intrusion.

4.4 Potential Biological Receptors

Potential receptors include the flora and fauna of the surrounding ecosystem, as described in the following subsections. This information was generated in 2005 by Bhate during development of the EA for the wastewater utility privatization evaluation.

4.4.1 Flora

HAFB flora is dominated by xerophytic shrubland and grassland communities having plant assemblages biogeographically related to the Great Basin and Chihuahuan Desert. Other plant communities on the installation include those that are located in brackish marshes and riparian and/or wetland areas, such as those south of the WWTP. Field investigations and vegetation surveys have identified the plant species that are listed in Table 4-1 of this Work Plan.

4.4.2 Fauna

A wide variety of fauna can be found at HAFB as it provides a relatively diverse range of habitats for both aquatic and terrestrial species. Habitats found on the installation provide ideal environments for a variety of reptiles and amphibians, mammals, and birds. Available habitats include upland grasslands, xerophytic shrublands, brackish marshlands, playas, and surface water habitats. Additionally, the area south of the WWTP also offers a relatively extensive amount of shoreline/edge habitat along Lakes Holloman and Stinky, the stormwater drainage canal, Lagoon G, and associated constructed wetlands.

Previously performed wildlife inventories have identified numerous species of wildlife throughout the installation. Major groups of fauna are discussed below.

4.4.2.1 Invertebrates

Though invertebrates are an important feature of the desert ecosystem, little is known about their diversity in arid lands. Invertebrates play important roles as beneficial pollinators, parasites, predators, detritivores, and as prey for small mammals, reptiles, fish, and birds. To date, there have been no base-wide studies at HAFB to determine invertebrate species diversity.

However, studies on reptiles, birds, and mosquitofish (*Gambusia affinis*) habitat suggest that the roles taken by invertebrates contribute to ecosystem function. For example, it has been found that the animals on the installation consume insects such as grasshoppers (*Orthoptera*), butterflies and moths (*Lepidoptera*), beetles (*Coleoptera and Bledius*), adult chironomids (*Diptera*), and corixids (aquatic *Hemiptera*).

A total of 26 different aquatic invertebrate taxa have been identified in the area south of the WWTP (Freehling, et al., 1999) and certain fish populations located in Lost River and Malone Draw feed on mosquitoes, amphipods, and annelid worms (Suminski, 1977; Turner, 1987). Some of the invertebrate species that have been identified on the installation include harvester ants (*Pogonomyrmex* spp.), honeypot ants (*Myrmecocystus*), and grasshoppers (*Orthoptera*).

4.4.2.2 Reptiles and Amphibians

Two herpetofauna species surveys have been performed at HAFB: (1) along roads for the Texas horned lizard (*Phrynosoma cornutum*) (Mehlhop, et al., 1998), and (2) at the cinetheodolite missile towers (Johnson, et al., 1997a). The Texas horned lizard survey was conducted on the Main Base and the Boles Wells Water System Annex. The Texas horned lizard, formerly a Category 2 species for federal listing as endangered or threatened, was reclassified February 28, 1996, as a species of concern (United States Department of Interior, 1996). This lizard appears to be abundant on HAFB (Mehlhop, et al., 1998) and was found within the major plant community types on both the Main Base and Boles Wells Water System Annex. Other reptiles found during these surveys are listed in Table 4-2 of this Work Plan.

Other reptiles and/or amphibians that may occur at HAFB that are not listed above include rat snakes (*Elaphe* spp.), rattlesnakes (*C. molossus*), and the greater earless lizard (*Cophosaurus texanus*).

4.4.2.3 Mammals

The most common mammals at HAFB consist of various rodent species and the black-tailed jackrabbit (*Lepus californicus*), found throughout the Great Basin Desert Shrub habitats in New Mexico (Frey and Yates, 1996). Numerous small colonies of bats that forage for insects at the numerous playas, wetlands, and riparian habitats (Johnson et al., 1997a) can be found on the installation. Bats on HAFB roost in abandoned and inhabited buildings and culverts. Table 4-3 of this Work Plan lists some of the bat species that have been observed at HAFB.

Fourteen species of rodents have been identified on the dune periphery of the installation. These species are listed in Table 4-4 of this Work Plan.

The Ord's Kangaroo Rat (*Dipodomys ordii*), Desert Pocket Mouse (*Chaetodipus penicillatus*), and the Plains Pocket Mouse with the lighter pelage (*Perognathus flavescens gypsi*) were found primarily within the dunes; others were found equally distributed or too few were captured to determine the habitat affinity (Root and Demarais, 1997; Johnson et al., 1997a; Johnson, et al., 1997b).

At least five mammalian species that have been or could be observed on HAFB have been introduced by man. These five species include the house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), horse (*Equus caballus*), barbary sheep (*Ammotragus lervia*), and gemsbok (*Oryx gazella*). The latter two species were introduced by the New Mexico Department of Game

and Fish in the late 1960s. Native big game mammals are uncommon in the project area and include mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*). Predators include bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and coyote (*Canis latrans*). Badger (*Taxidea taxus*) and striped skunk (*Mephitis mephitis*) are uncommon predators and omnivores, respectively.

4.4.2.4 Birds

The complex of constructed wetlands south of the WWTP provides important habitat for a number of bird species. Bird censuses are ongoing at HAFB and a complete list of birds can be found in the HAFB Integrated Natural Resource Management Plan (INRMP). The HAFB INRMP further details the relationship between habitat at HAFB and the bird species found there. Table 4-5 lists some of the previously observed bird species at HAFB.

4.5 Endangered or Threatened Species

The following summarizes the status of endangered and threatened species in the HAFB area.

4.5.1 Endangered Species

Although not noted as being observed at HAFB, the oplomado falcon (*Falco femoralis)* is known to be present in the HAFB area. The oplomado falcon ranges from northern Mexico (and very rarely into southern Texas and New Mexico) southward to the southern tip of South America. In this huge range the species may be common or very rare depending upon habitat and location. This species sometimes hunts over grassland fires and feeds on small birds and/or insects fleeing the flames.

While still legally protected from hunting, the oplomado falcon is not protected by Endangered Species Act requirements to preserve habitat and the like. It is believed that mainly habitat destruction caused the species' (near-)disappearance from the U.S. and hinders reestablishment of a wild breeding population; thus, a coalition of environmental groups is attempting to have full protection restored so as not to jeopardize the success of the expanding wild population and the reintroduction efforts (Associated Press, 2006).

4.5.2 Threatened Species

Although not noted as being observed at HAFB, the burrowing owl (*Athene cunicularia*; formerly *Speotyto cunicularia)* is known to be present in the HAFB area. The burrowing owl is a grassland bird historically found in vast numbers across the prairies of the western Great Plains. While the formal environmental status of the burrowing owl varies based on geography, there is an overall decline of this species, particularly where burrowing owls are strongly associated with prairie dog towns. They are listed as endangered, threatened, or a species of special concern in most states and provinces where they occur. The primary threats across its North American range are habitat loss and fragmentation due to the incursion of agriculture and urban encroachment, suppression of naturally occurring fire, and habitat degradation from the extermination of small mammals like prairie dogs and squirrels. Increases in predators such as foxes, badgers, and coyotes are also taking a toll (The Nature Conservancy, 2007; The Owl Pages, 2005).

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5 INITIAL CONCEPTUAL SITE MODEL

5.1 Initial CSM Development

The Initial CSM was developed during the Triad Systematic Planning phase of the project, as described in Section 1.3 of this Work Plan. The Initial CSM development efforts were used to create the following summary description, as well as Table 5-1, a detailed outline of the Initial CSM and Figure 5-1, a 3-dimensional representation of the Initial CSM.

5.2 Initial CSM Summary Description

SWMU 183 is a subsurface sewer system that serves the developed portions of the approximately 60,000-acre property comprising HAFB. The system is comprised of:

- Approximately 22 miles of sewer line constructed of various materials,
- Over 500 active and approximately 100 abandoned manholes,
- Approximately 20 lift (pumping) stations and force mains,
- 17 wash racks,
- 42 oil/water separators,
- WWTP, and
- Hundreds of variably contributing sources distributed throughout the entire Base, including discharges from 55 operational facilities as well as domestic structures.

Although the WWTP is part of the sewer system, it is regulated under a separate National Pollution Discharge Elimination System (NPDES) permit, and therefore, is not part of SWMU 183). The WWTP was designed for flows of 1.5 MGD and has experienced actual flows of approximately 1.0 MGD. The operations-related contribution to the sewer is estimated at 58,000 gpd or 6% of the total flow. Flows attributable to the permanent and commuter populations (sanitary waste) is estimated at 427,000 gpd or 42% of the total. Steady infiltration and inflow is estimated at 542,000 gpd or 52% of the total.

Common industrial/commercial activities (generating 6% of the total flows) which generated wastes discharged to the sewer system included:

- Vehicle, aircraft, equipment, and floor washing;
- Vehicle, aircraft, and equipment maintenance,
- X-ray and photo processing, and
- Fuel canister rinsing.

Many of the facilities generating the waste utilized pretreatment features such as grit chambers, grease traps, holding ponds, and OWSs before wastes were discharged into the sewer system. Classes of POCs discharged to the sewer system include:

- VOCs
- SVOCs
- POLs
- Oil and grease
- Metals
- Herbicides and pesticides
- TSS
- BOD and COD
- Phosphate, nitrate, sulfides, and chloride
- Radionuclides

The contaminants listed above could be released from the sewer system through any of the following features where the sewer line is above the elevation of the water table:

- Broken/cracked pipes in services, laterals, and/or mains;
- Corroded pipes in services, laterals, and/or mains;
- Defective joints in services, laterals, and/or mains;
- Defective connections in services, laterals, and/or mains;
- Defective OWS connections; and/or
- Defective manhole casings.

Where the sewer line is below the elevation of the water table, the gradient is inward from the aquifer to the sewer line and the contents of the sewer are not released to the environment. This condition results in the high degree of infiltration which characterizes the overall system in which 54% of the total flow results from infiltration. The infiltration occurs primarily in the southern part of the Base, particularly in the vicinity of the golf course and the Military Family Housing (MFH) area (Subareas 1, 2, 4, 5, and 6 (see Plate 2)). The depth to the water table is as little as 3 feet (ft) bgs in this area. In the northern portions of the base, the depth to the water table may be as great as 30 to 40 feet bgs.

Where the sewer line and associated features are located above the water table, liquids in the line may have leaked, or be currently leaking, out into soils and/or groundwater. These may be episodic events such as manholes being surcharged during storm events or pumping station failures; or they may be continual releases such as those occurring from cracked pipes. To the extent that the liquid in the sewer line contains POCs, they will be released into the unsaturated zone soils at and below the elevation of the leak.

The nature of the subsequent transport and fate of POCs is dependent on environmental conditions and the nature of the POC. The most significant POCs in terms of likely mass are VOCs, SVOCs, and inorganic compounds such as nitrate and phosphate. VOCs are likely to be the most mobile POCs and may travel further than other classes of POCs.

The leaked liquids and the POCs may reach groundwater, dependent on the size and duration of the release and the depth to groundwater. Once in groundwater the POCs will travel in the direction of groundwater flow by advection and dispersion. The resultant plumes may be spread laterally and vertically only very slightly by dispersion. Plumes may migrate along the sewer line in a preferred pathway formed by the gravel pack and/or disturbed soils underlying the sewer. The plumes are very likely to be found near the water table, though they may plunge downward with distance from the source in response to displacement by infiltrating water and downward components of the hydraulic gradients where they occur.

Metals, SVOCs, POLs, and oil and grease have a low degree of mobility in the subsurface. The presence of these classes of POCs is likely to be limited to the soils in the vicinity of the leak. Nitrate is created by the nitrification of ammonium in the sewer line where reducing conditions prevail. Nitrate is not sorbed significantly to soils and will likely only be found in the pore water in the unsaturated zone. Nitrate will be likely to migrate to the water table and then with groundwater flow if released in sufficient quantities. Similarly, chloride is quite mobile in the environment, but chloride is naturally abundant in the natural subsurface environment at HAFB. Phosphate is highly retarded by sorption both above and below the water table and is not expected to migrate far unless a sustained release occurs for a long period of time.

Soil-gas contamination may result from the release of VOCs to the subsurface, both from the unsaturated zone and from groundwater plumes that occur within a few feet of the water table. These soil-gas plumes would then spread by diffusion and in response to pressure, temperature, and density gradients. Soil gas plumes, if they exist, would only pose a potential risk if they enter occupied structures.

Any releases from the sewer system occur in the context of their location in the Tularosa sub-basin, which is geologically described as a bolson (an extensive, flat, alluvium-floored depression) into which drainage from the surrounding mountains flows toward a central playa. Water carrying eroded gypsum, limestone, dolomite, gravel, and other alluvial matter continues to flow into the basin with no route of exit.

Unconsolidated deposits in the basin include alluvium generally consisting of gravels (limestone, dolomite, and gypsum), sands, and clays. At the base, the area is characterized by near-surface soils of alluvial, eolian, and lacustrine origin. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt, and clay while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually indistinguishable due to the reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of silty clay containing gypsum and are contiguous with the alluvial fan and eolian deposits.

Potential evapotranspiration, at 67 inches per year, significantly exceeds annual precipitation, which is usually less than 10 inches per year. Much of the precipitation falls during the mid-summer monsoonal period (July and August) as brief, yet frequent, intense thunderstorms accounting for 30–40% of the total annual rainfall.

The result is that the surficial deposits are a hydrogeologic feature characterized by relatively low hydraulic conductivities (e.g., less than 10^{-4} centimeters per second [cm/sec]) in which the groundwater is non-potable due to high concentrations of TDS. The low recharge, low permeability (and hence yield), and high TDS combine to negate the utility of the groundwater for potable or other purposes.

Potable water at HAFB is supplied by municipal wells along the margins of the basin where the water has lower TDS and the permeability is higher. These locations are hydraulically upgradient of the Base. The more saline waters (high TDS) at the Base result from long travel paths or residence times of the water in contact with the gypsum and other soluble geological materials. Small zones of fresh water (with lower TDS) may occur in areas where leakage from water supply lines and the sewer line occur. Potable water is also provided by Bonita Lake, which is located approximately 60 miles northeast of the Base.

Figure 5-1 provides a 3-dimensional block diagram of the Initial CSM as described in the previous paragraphs. The diagram presents a generalized rendering of the Site; examples of key Site features; local geology/hydrogeology; and inferred contaminant type, pathways, and distributions. The diagram is not to scale, nor does it fully or accurately depict actual Site features and conditions.

It is important to re-emphasize that the Initial CSM provides an informed hypothesis or set of hypotheses about the Site, thus, actual conditions at the Site may vary significantly from those depicted in the block diagram.

Table 5-1 presents details on key site decisions (primary and subsidiary), current conceptual understanding of the Site, decision information requirements, status of information gathering, and actions required to obtain information. This information was used to create the DQOs outlined in Section 1.6 of this Work Plan.

6 SAMPLING AND ANALYSIS PLAN FOR CHARACTERIZATION OF RELEASES OF HAZARDOUS WASTE

This section presents the SAP for the SWMU 183 Triad RFI, including:

- Sampling Strategy,
- Sampling Procedures, and
- Sample Analysis.

The SAP is based on Triad Approach concepts of dynamic work strategies and real-time and near real-time measurements to make decisions in the field according to pre-designed decision logic diagrams. Sampling procedures utilize industry standard methods to ensure sample quality and provide a platform for efficient collection. Sample analysis includes onsite analysis and screening methods and offsite analysis to provide an efficient means of identifying release locations, determining what constituents are present in identified release areas, and delineating the nature and extent of identified constituents.

6.1 Sampling Strategy

The sampling strategy for the SWMU 183 Triad RFI has been designed according to the concepts and guiding principles of the USEPA's Triad Approach, specifically for dynamic work strategies. This section presents the Triad RFI plan, dynamic work strategy, decision logic diagrams to support field-based decision making, and the overall field effort logistics strategy. Pre-designated sampling locations, quantities, and location rationale are also presented.

As presented in Section 1.5 of this Work Plan, the primary project objectives of the Triad RFI sampling plan are to:

- Identify locations where releases from the sewer to soil and/or groundwater have occurred,
- Determine the nature of contamination at each identified release location,
- Delineate soil and/or groundwater contamination at locations of confirmed releases, and
- Identify and assess the potential for vapor intrusion associated with specific structures.

As described in Section 6.2 of this Work Plan, conventional direct push technology (DPT) and hollow stem augur (HSA) drilling techniques will be used to collect samples during each Stage of work, as follows:

- Soil samples will be collected via DPT using Geoprobe Systems® MacroCore® and Dual-Tube tooling and via HSA using split spoon samplers.

- Groundwater samples will be collected from:

  - Temporary 1-inch PVC pre-pack well screens installed via DPT in areas where groundwater is located less than 25 ft bgs

  - Two-inch outside diameter PVC wells installed via HSA where groundwater is located at depths at, or greater than, 25 ft bgs where the practicable use of DPT is exceeded

- Soil-gas samples, as necessary, will be collected using a direct push Geoprobe® Post Run Tubing (PRT) tool.

It is anticipated that HSA will only be required in the areas of HAFB located north of Dezonia Road (see Figure 1-2 and Plate 1).

Indoor air samples, as necessary, will be collected using Summa® canisters.

As described in Section 6.3 of this Work Plan, a combination of standard analytical methods and screening methods will be used to analyze and screen soil, groundwater, and soil-gas samples onsite. Offsite analyses will be performed for additional analytes where onsite results indicate a potential release location, or at a 10% frequency for locations whose onsite results indicate no release has occurred.

6.1.1 Triad Dynamic Work Strategy

The Triad dynamic work strategy is comprised of four iterative sampling and analysis stages, as follows:

- Stage 1 - Sewer Release Identification. SWMU-wide sampling focused on providing "yes / no" identifications of release locations from the sewer at pre-designated sampling locations via onsite analysis and screening. Pre-designated sampling locations are shown on Plates 1 and 2. Table 3-1 presents the primary sampling plan design rationale and location control information for each of the pre-designated sampling locations.

- Stage 2 - Expanded Analyte List Analysis. Sampling and off-site analyses of additional analytes to determine the nature of contaminants present at each identified ("yes") release location.

- Stage 3 - Identified Release Area Delineation. Dynamic work strategy delineations in the areas of identified release locations. Delineations will focus on detected analytes.

- Stage 4 - Vapor Intrusion Evaluation. Implement vapor intrusion evaluation based on USEPA guidance where existing buildings or areas of planned future development might be at risk of VOC vapor intrusion.

6.1.2 Field-Based Decision Logic Diagrams

The Triad dynamic work strategy incorporates the use of field-based decision logic diagrams to enable field crews with the ability to make sound decisions in real-time in the field. The decision logic diagrams also enables the Triad Team to make larger scale project decisions in real-time or in significantly reduced time compared to standard project methods.

The decision logic diagrams for the SWMU 183 Triad RFI were developed during the Systematic Planning Process and include the following:

- Figure 6-1 outlines the overall four stage dynamic work strategy and field-based logic framework for Stage escalation. The decision to escalate field sampling activities to the next Stage at any given pre-designated sampling location will be based on the concentration(s) of detected compound(s) exceeding their associated standard(s) or trigger level (TL), as applicable to each analyte.

- Figures 6-2 and 6-3 provide field-based decision logic for Stage 3 dynamic sampling and analysis of soil and groundwater release areas, respectively.

- Figure 6-4 provides field-based decision logic for Stage 4 vapor intrusion site identification and evaluation.

6.1.3 Dynamic Use of Applicable or Relevant and Appropriate Requirements

As shown in the decision logic diagrams, the results from various analyses and screenings to be performed will be compared to their respective Applicable or Relevant and Appropriate Requirement (ARAR) (action level) criteria for the analytes and media of concern. The results of the comparisons will be dynamically used to make decisions relating to subsequent actions to be taken.

The specific action levels to be used include the following:

6.1.3.1 Soils

6.1.3.1.1 VOCs, Pesticides/Herbicides, Polycyclic Aromatic Hydrocarbons, and RCRA 8 Metals

The residential Soil Screening Levels (SSLs) established in NMED's *Technical Background Document for Development of Soil Screening Levels* (NMED, June 2006) will be used as the

action levels for VOCs, Pesticides/Herbicides, Polycyclic Aromatic Hydrocarbons (PAHs), and RCRA 8 Metals. The NMED SSLs are listed on Table C-1 in Appendix C of this Work Plan.

6.1.3.1.2 Total Petroleum Hydrocarbons (TPH)

The action levels for TPH are established in the *New Mexico Environment Department TPH Screening Guidelines* (NMED, October 2006). However, since it is not known what type of petroleum contamination may be present, TPH screening will be used as an indicator of release from the sewer system only during Stage 1. Based on the guidance document, the lowest value of 200 milligrams per kilogram (mg/kg) for an unknown oil in a residential exposure scenario will be used as the action level. The TPH SSLs presented on Table C-1 in Appendix C of this Work Plan are provided for convenience in the event the TPH is to be considered for regulatory compliance in the future stages of this work.

6.1.3.1.3 Radionuclides

Table A.1 (Decay Corrected) of USEPA's *Soil Screening Guidance for Radionuclides: Technical Background Document* (USEPA, October 2000), provides generic SSLs for 60 radionuclides in units of pico-curies per gram (pCi/g) and mg/kg, respectively. The values listed in the "Migration to Groundwater (Dilution-Attenuation Factor [DAF] = 1)" column of Table A.1 assume that no decay, dilution, or attenuation of contaminants will occur and have been developed assuming future residential land and related exposure scenarios; thus offering the most conservative values for these contaminants. These generic SSLs are listed in Table C-1 in Appendix C of this Work Plan. If the SSLs presented in these tables are exceeded, a more site-specific evaluation will be performed to ensure that the site conditions and exposure pathways match those used to develop generic SSLs. The site-specific evaluation involves developing an exposure pathway scenario that addresses the risk associated with these contaminants knowing the use or future use of the particular area of the Site. The evaluation may also include collecting site-specific soil parameters (such as the dry bulk density and percent soil moisture), and further sampling of soils to measure radionuclide levels in surface and subsurface soils.

Given the historical use of radioactive materials at HAFB, the following isotopes may still be present in the subsurface: tritium, carbon 14, radium 226, and radium 228. Although iodine 125 is reported to have been used at HAFB, it is likely that this isoptope has degraded (via decay) to acceptable levels. This statement is based on the understanding that iodine 125 has not been used in approximately 30 years and that it is known to have a half-life of 60 days.

6.1.3.1.4 Nitrate (NO_3)

As sanitary wastes typically contain very high levels of nitrate that are detectable in the environment after release, nitrate will be used as an indicator of release from the sewer system.

Background levels of nitrate in the soil at the site are currently unknown. However, there is a background study for soils and groundwater to be conducted at HAFB which includes assessing nitrate concentrations in soils. It is presumed that the study will be completed prior to the

execution of this Work Plan. A concentration equal to one standard deviation above the average of nitrate concentrations from the background study in soils will be used as the action level for determining whether nitrate is present in soils at a concentration indicative of a release from the sewer. This approximate 95 percent confidence interval should result in false indications of sewer releases in no more than 5 percent of samples analyzed.

6.1.3.2 Groundwater

6.1.3.2.1 VOCs, Pesticides/Herbicides, PAH, and RCRA 8 Metals

There are two potentially applicable standards for groundwater: New Mexico WQCC groundwater standards for contaminants (20.6.2.3103 New Mexico Administrative Code [NMAC]) and the USEPA's National Priority Drinking Water Standards Maximum Contaminant Levels (MCLs). The lower of the two standards will be used as action levels for VOCs, Pesticides/Herbicides, PAH, and RCRA 8 Metals in water. The specific action levels are listed in Table C-1 in Appendix C of this Work Plan.

6.1.3.2.2 Radionuclides

Table 2.3 of USEPA's *Soil Screening Guidance for Radionuclides: Technical Background Document* (USEPA, October 2000), provides the Federal MCLs for 60 radionuclides in groundwater. The MCLs in Table 2.3 were obtained from Drinking Water Regulations and Health Advisories (USEPA, 1995) and are listed in Table C-1 in Appendix C of this Work Plan.

Given the historical use of radioactive materials at HAFB, the following isotopes may still be present in the subsurface: tritium, carbon 14, radium 226, and radium 228. Although iodine 125 has been used at HAFB, it is likely that this isoptope has degraded (via decay) to acceptable levels. This statement is based on the understanding that iodine 125 has not been used in approximately 30 years and that it is known to have a half-life of 60-days.

6.1.3.2.3 Nitrate

Background levels of nitrate in the groundwater at HAFB exist based on analysis of samples previously collected from two background wells, MW-BG-02 and MW-BG-04, which are located outside of the influence of the sewer system. However, the pending background study for soils and groundwater to be conducted for HAFB includes assessing nitrate in groundwater. It is presumed that the study will be completed prior to the execution of this Work Plan. A concentration equal to one standard deviation above the average of nitrate concentrations from the background study in groundwater will be used as the action level for determining whether nitrate is present in groundwater at a concentration indicative of a release from the sewer. This approximate 95 percent confidence interval should result in false indications of sewer releases in no more than 5 percent of samples analyzed.

6.1.3.3 Vapor Intrusion

According to the USEPA's [Office of Solid Waste and Emergency Response] *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, November 2002, if the primary screening does not rule out the threat of vapor intrusion, a more site-specific (secondary) evaluation is required. The logic associated with the primary and secondary screening processes is covered in greater detail in Section 6.1.5.4 of this Work Plan. Prior to obtaining action values for indoor air, soil-gas, and groundwater for a given scenario, one needs to assign the appropriate value of risk to be used. Tables 2a, 2b, and 2c of the OSWER document offer various levels of target indoor air, soil gas (both shallow and deep), and groundwater values, depending on the level of risk assigned to a given scenario. Tables 2a, 2b, and 2c are provided in Appendix C of this Work Plan.

6.1.3.4 Geotechnical Parameters

The following geotechnical parameters will be used to support risk assessment needs to understand the physical aspects of the environment which would affect the migration and fate of the release and identification of exposure pathways for both humans and non-human receptors:

- Moisture content (USEPA Method 160.3M)
- Dry bulk density (ASTM Method D2937)
- Specific gravity (ASTM Method D1429)
- Fractional organic carbon content (ASTM Method D2974)

Moisture content data will be derived from the soil analyses performed as part of the offsite analyses portion of the investigation. The remaining parameters will be obtained from data sets generated during investigations conducted in 2006 and 2007 the following nine SWMU sites, which are located throughout HAFB:

- OT-20 Sewage Lagoons Disposal Trenches
- OT-32 Collapsed PRA Sewage Lines
- OT-38 Bldg 1166 Test Site Maintenance Area
- OT-45 Old AGE Refueling Station
- SS-12 NE Fuel Line Spill Site
- SS-18 Chromic Acid Spill Area

- RW-42 Radioactive Waste Burial Area
- OT-37 Early Missile Test Site
- SD-08 Bldg 131 Washrack

6.1.4 Dynamic Work Strategy Logistics

The primary purpose of the dynamic work strategy is to complete the RFI field effort as efficiently and cost effectively as possible while reducing decision uncertainty to acceptable levels. The ideal is to complete the field effort, to the maximum extent practicable, in a single mobilization, or as few mobilizations as possible. The dynamic work strategy has been designed toward achieving these goals.

A number of unique and integrated logistical factors affect the overall execution of the dynamic work strategy. Examples include, but are not limited to:

- The large spatial scale of SWMU 183;
- The variability in "real time" sample result turnaround times for the different media, analytes, and analytical methods;
- Utility location requirements and related time constraints;
- The need to ensure traffic safety and other operational impacts given that the majority of the sewer lines are present under or adjacent to roadways for most of their length;
- Low aquifer hydraulic conductivities which will impact the speed and efficiency of collecting groundwater samples;
- General personnel and site security clearance management; and
- The cost / benefit of operating multiple sampling platforms simultaneously in order to maximize the efficiency of using an onsite analytical laboratory for some analyses.

In order to maintain an effective and productive use of resources and meet project objectives, Stage 1 (Sewer Release Identification) and Stage 2 (Expanded Analyte List Analysis) activities will be performed throughout the entire sewer lattice at all pre-designated sample locations prior to any Stage 3 (Identified Release Area Delineations) or Stage 4 (Vapor Intrusion Evaluation) activities being initiated. As release areas are identified, the pre-designated sampling locations of concern will be documented and those areas earmarked for Stage 3 activities to be conducted after completion of all Stage 1 and 2 activities. At that point, field sampling teams will return to each location of confirmed release and conduct Stage 3 activities. Stage 4 activities will then be performed for those areas identified during Stage 3 activities as being at potential risk for impacts to indoor air quality.

As indicated in Section 6.1, shallow groundwater samples will be collected from temporary 1-inch PVC pre-pack well screens installed via DPT and deeper groundwater samples will be collected from 2-inch outside diameter PVC wells installed via HSA technology. In the areas of deeper groundwater, soil samples will initially be collected using DPT technology. If screening analyses indicates the presence of one of the target analytes, the pre-designated sampling location of concern will be documented and earmarked for Stage 3 activities. Upon completion of all Stage 1 and 2 activities throughout SWMU 183, field sampling teams will return to each earmarked location of confirmed release and conduct Stage 3 activities using HSA technology.

6.1.5 Stage-Specific Activities

During each Stage, specific sampling and analyses activities will be conducted to support dynamic decision making relative to the subsequent Stages. The following subsections describe the activities that will be conducted and the decisions that will be made based on analytical results and the relevant field-based decision logic diagram(s).

6.1.5.1 Stage 1 - Sewer Release Identification

As shown in Figure 6-1, at each pre-designated sampling location, a confirmation of sewer invert depth as related to groundwater depth will be performed to determine whether the sewer line is situated above or below the water table. This activity is premised on a prior GIS-based spatial analysis that will be updated prior to the field effort comparing select manhole invert elevations to Base-wide groundwater elevations. The initial analysis indicated that while the majority of the sewer line is situated above the water table, the sewer line in some areas of the southeast region of HAFB is most likely situated below the water table.

Where the sewer line is determined to be situated above the water table, soil samples will be collected as the initial release identification activity. Where soil analysis and/or screening results either confirm or indicate a potential release to soils, a groundwater sample will be also be collected.

Where the sewer line is determined to be situated below the water table, the sampling actions performed will be dependent on whether the sewer line is pressurized or non-pressurized (gravity flow). If the sewer is pressurized, a groundwater sample will be collected based on the presumption that flow under pressure would be released from a sewer with material and/or structural integrity concerns. If the sewer is non-pressurized, no further action will be taken based on the presumption that groundwater would discharge into a sewer with similar physical concerns.

Soil samples will be analyzed in an onsite laboratory for VOCs using gas chromatography / mass spectrometry (GC/MS-EPA 8260) and gas chromatography / flame ionization detection (GC/FID-ASTM D6520) and nitrate (NO3) using ion chromatography (IC) via EPA Method 300.0. Soil samples will be screened in the onsite laboratory for PAHs and TPH using field fluorometer analytical test kits as primary indicators of a potential sewer release. Soils will also be field-screened by the sampling team for the presence of radionuclides using a hand held alpha

beta survey instrument (Ludlum 44-9). Additional sample volume will be collected for offsite analysis of additional analytes as described in Sections 6.2.2.1 and 6.2.2.2 of this Work Plan.

Groundwater will be analyzed in the onsite laboratory for VOCs and NO3 using GC/MS-EPA 8260 and GC/FID-ASTM D6520 and screened in the onsite laboratory for PAHs using immunoassay test kits via EPA Method 4035. The presence of radionuclides will be determined in the field using a hand held alpha beta survey instrument (Ludlum 44-9).

At every groundwater sampling location, a sample will be collected for offsite analysis of total dissolved solids (TDS). Additional samples will be collected for offsite analysis of additional analytes as described in Section 6.2.3 of this Work Plan.

Samples collected from the two pre-designated sample locations closest to, and downgradient from, Building 374 will also be analyzed offsite for pesticides/herbicides based on its relevant and unique operational history.

Table 6-1 provides the specific onsite and offsite analytical plan for Stage 1.

6.1.5.2 Stage 2 - Expanded Analyte List Analysis

Stage 1 analytical results for each medium and analytical or screening method will be compared to their respective regulatory criteria.

Where onsite analytical or screening results indicate contaminants in soils at concentration levels below the applicable SSLs or nitrate trigger level, 10 percent of the samples will be submitted for offsite analysis of SVOCs, RCRA 8 Metals, and radionuclides. Samples collected from the two closest pre-designated locations downgradient of Building 374 will also be analyzed offsite for pesticides/herbicides as described above. Where results indicate contaminants in soils at concentrations above the applicable SSLs or nitrate trigger level, the location will be documented as an identified release location and earmarked for delineation.

Where onsite analytical or screening results indicate contaminants in groundwater at concentrations at or below the applicable criteria or nitrate trigger level, 10 percent of the samples will be submitted for offsite analysis for SVOCs, RCRA 8 Metals, and radionuclides. Samples from the two closest pre-designated locations downgradient of Building 374 will also be analyzed offsite for pesticides/herbicides as described above. Where results indicate contaminants in groundwater at concentrations above the applicable criteria or nitrate trigger level, 100 percent of the samples will be submitted for offsite analysis of SVOCs, RCRA 8 Metals, radionuclides, and pesticides/herbicides (Building 374-related locations only). The location will be documented as an identified release location and earmarked for delineation. The results from the Stage 2 sampling will be integrated into the data set generated during Stage 3 delineation.

Table 6-1 provides the specific onsite and offsite analytical plan for Stage 2.

6.1.5.3 Stage 3 - Identified Release Area Delineation

Contaminant delineation activities will be performed at locations where releases from the sewer have been identified and where concentrations are determined to exceed relevant criteria. The delineations will focus on the specific contaminants of concern identified during Stage 1 and/or Stage 2. Delineation will be accomplished using a dynamic work strategy approach. Figures 6-2 and 6-3 of this Work Plan present the dynamic decision logics that will be used to delineate groundwater and soil contamination, respectively.

Prior to conducting delineation activities, the Triad team will utilize the GeoBase EDV to determine whether the contaminant(s) detected at the earmarked location are located within the bounds of a current ERP, AOC, or other SWMU site investigation. If it is determined that the detected contaminant(s) are within the bounds of an existing investigation, no further delineation efforts will be conducted as part of this Triad RFI program. If detected contaminants are different than those being assessed under the current investigation, a decision will be made by the Triad Team to conduct a contaminant-specific delineation, or to add those contaminants to the analytical plans for the current investigations.

As shown in Figure 6-2 of this Work Plan, dynamic delineation of groundwater contamination will be performed by sampling along transects normal to the direction of local groundwater flow. Transect sampling will be performed as an iterative process as a function of the analytical data generated. The initial transect will be located approximately 50 feet downgradient of the sampling location that triggered the delineation. Sampling locations along each transect will be at a 50 foot spacing and will be initiated in the transect center zone, with subsequent sampling locations located horizontally toward each of the transect's two flanks. Based on the analytical results of this transect, the subsequent transect will be located approximately 100 feet downgradient of the first transect. Sampling locations within the 100 foot downgradient transect will also be at a 50 foot spacing, initiated in the transect center zone, with subsequent sampling locations located horizontally toward each of the transect's two flanks. The total number of sampling locations along a given transect will be adjusted based on the area width of detected contamination in order to delineate contamination with the minimum number of sampling locations. The iterative transect process will be repeated until groundwater contamination is delineated or the delineation effort intercepts the bounds of a downgradient current ERP, AOC, or other SWMU site investigation, as predetermined by GeoBase EDV spatial analysis.

Soil contamination will be delineated using an orthogonal grid-based strategy, wherein, soil samples will be collected at a 50 ft spacing from locations oriented orthogonally (4 perpendicular azimuths) centered on the original pre-designated sampling location of concern. Sampling will start in the origins of grid lines and progress laterally in opposite directions along each grid line until analytical data indicate sampling is complete.

Delineation sampling and analysis for soils and groundwater will utilize the same sampling and analytical designation protocol as Stages 1 and 2.

Table 6-1 provides the specific onsite and offsite analytical plan for Stage 3.

6.1.5.4 Stage 4 - Vapor Intrusion Evaluation

Where delineations of VOCs in groundwater and soils are performed, vapor intrusion evaluations may be conducted in the areas of identified buildings of concern and/or future zones of development. Vapor intrusion evaluations will be performed according to the USEPA's guidance: *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, November 2002. Figure 6-4 of this Work Plan presents the dynamic decision logic for vapor intrusion evaluation developed based on the USEPA's guidance.

The USEPA's guidance specifies methods to identify, rank, and assess buildings and future zones of development where subsurface releases might pose risk for vapor intrusion. As per this guidance, the possibility of exposure to harmful vapors should be considered if the presence of volatile chemicals (Henry's Law Constant > 10^{-5} atmospheres-cubic meters per mole [atm m^3/mol]) in soil or groundwater is known or suspected to be located:

- 100 feet or less in depth; or
- In close proximity to existing buildings or future buildings (see Primary Screening Question #2 for definition of close proximity); or
- Next to the expected footprint of potential future buildings (for non-environmental indicator (EI) determinations).

To assist in the vapor intrusion evaluation beyond the primary screening steps shown on Figure 6-4 of this Work Plan, a qualified risk assessor will establish appropriate risk and attenuation factors associated with the generic, semi-site specific, and site specific (Johnson and Ettinger Vapor Intrusion Model) risk assessment stages.

Soil-gas sampling and analyses may be performed, as deemed necessary, during the initial stages of the secondary screening process. According to the USEPA guidance, a soil-gas survey may not be a necessary step to determine whether an unacceptable level of risk is present.

If the pathway for vapor intrusion is deemed to be incomplete at any point along this evaluation process, no further action will be taken at the location. If it is determined that the pathway may be complete and indoor air sampling and analyses indicates unacceptable levels of VOCs are present, the proper chain of authority will be advised and mitigation measures will be recommended.

Table 6-1 provides the specific onsite and offsite analytical plan for Stage 4.

6.1.6 Field Sampling Location Plan Design Basis

A design basis was used to develop the Triad Approach RFI field sampling location plan (see Plates 1 and 2 and Table 3-1 of this Work Plan). The design basis was used to provide a

consistent rationale for pre-designating Stage 1 sampling locations along the sewer in the context of historical (pre-1998 sewer line conditions) and current sewer construction and operational use information. As the majority of the sewer line has been lined or replaced since 1998, effort was made to maximize the value of historical information in identifying lengths of sewer where releases were most reasonably and likely to have occurred.

The following are the key elements of the design basis used for Stage 1:

- Sample at the three documented release / repair locations
- Sample every 2,000 ft or per sewer segment along known "good" condition lines
- Sample every 1,000 ft or per sewer segment near known "degraded" condition lines:
    - As indicated by "poor" and/or "fair" condition characterizations
    - As indicated by a "lined" characterization; i.e., a formerly degraded condition line
- Sample every 1,000 ft or per sewer segment along "abandoned" lines
- Sample immediately adjacent to sewer lift stations
- Sample every 1,000 ft along sewer force mains
- Sample downgradient of buildings with known hazardous materials / waste disposal to sewer
- Sample at closed OWS pipe / sewer line connections
- No samples will be collected under the active runway
- No samples will be collected along residential lines, except where lines are downstream of buildings with known hazardous materials / waste disposal to sewer
- Sample quantities will be balanced against available funding

A limited number of currently pre-designated sampling locations may be removed from consideration based on the following attributes:

- The locations are directly in areas where other investigation efforts have been, or are currently being, conducted.
- The locations are in areas within the airfield / flightline where aircraft operations safety is of paramount concern.

- The locations are in areas of restricted access with high-level personnel security clearance requirements.

The designs for each of the subsequent stages will be developed in the field based on the decision logic diagrams developed for each respective stage.

6.2 Sampling Procedures

This section describes the sampling procedures and technologies to be used during the project. References are made to documents describing standard methodologies from a variety of sources including:

- *Final Basewide Quality Assurance Project Plan* (Bhate, November 2003)
- HAFB Standard Operating Procedures (SOPs) prepared by Foster Wheeler from Appendix A of the HAFB Basewide QAPP (e.g., SOP B-3 or SOP HAFB-#)
- SOPs prepared by Stone (e.g., SOP SEI-#.#.#)
- Study specific procedures (SSPs) prepared by Stone (e.g., SSP SEI-######.#.#)
- SOPs prepared by equipment manufacturers (e.g., Geoprobe® DT325 Dual Tube Sampling System Standard Operating Procedure, Technical Bulletin No. MK3138)

6.2.1 Environmental Media to be Sampled

Up to four environmental media (matrices) will be sampled using six methodologies during the Triad RFI, as follows:

1. Soil
    a. DPT core sampling
    b. HSA technology borehole sampling
2. Groundwater
    a. DPT-installed temporary wells
    b. HSA-installed temporary wells
3. Soil-gas
    a. DPT sampling
4. Indoor air
    a. Summa® canisters

6.2.2 Soil Sampling

As described in Section 6.1.5.1 of this Work Plan, soil sampling will be undertaken at each of the pre-determined sampling locations where the sewer line is above the water table. Each location will be cleared for subsurface utilities in accordance with SOP B-3 in the HAFB Basewide QAPP. Each sample will initially be subjected to the following onsite testing:

- Laboratory Analysis
  - VOCs
  - NO_3
- Immunoassay Screening
  - PAHs
  - TPH
- Direct Instrument Screening
  - Radionuclides

These initial onsite analyses and screening methods will serve as primary indicators of a potential sewer release. Additional samples will be collected for offsite analysis for an expanded analyte list as described below.

Soil sampling will follow SOP HAFB-5 of the HAFB Basewide QAPP. Table 6-2 of this Work Plan provides details on sample volumes, containers, preservation, and method of analysis for other analyses. Soil cores will be logged for stratigraphy in accordance with SOP HAFB-7 of the HAFB Basewide QAPP.

Upon completion of sampling at each location, the DPT corehole or HSA borehole will be abandoned using the procedures described in Bhate's SOP B-10.

6.2.2.1 Direct Push Soil Sampling

Samples will be collected using DPT in all areas along SWMU 183 where the sampling depth is anticipated to be 25 ft bgs or less, based on previous technology performance at HAFB. Where sampling depths are anticipated to exceed 25 ft bgs, HSA drilling and split spoon sampling will be used to collect samples as described in Section 6.2.2.2 of this Work Plan.

The first round of samples will be collected using a Geoprobe® MacroCore® soil coring tool driven by a Geoprobe Systems® 66 series rig or equivalent as described in HAFB SOP-4. Samples will be collected from the MacroCore® tool for onsite analyses only. If analyses of these samples indicates that contaminant SSLs or nitrate trigger level have been exceeded, then the crew will return to the location the following day, or as soon thereafter as logistically possible, to collect additional volume of soil for offsite analyses and for groundwater sample collection. This second round of sampling will be accomplished using a Geoprobe Systems®

DT325 Dual Tube Sampling System (coring tool) in accordance with the Standard Operating Procedure (Geoprobe Systems® Technical Bulletin MK3138) in the Basewide QAPP Addendum (in Appendix A of this Work Plan).

The MacroCore® coring tool will be advanced to a depth just below the sewer line, as determined at each sampling location. Most sampling locations along SWMU 183 will be above the water table, but for some of the locations, particularly in the south and southeast areas of the lattice, the sewer line may be beneath the water table and soils will be saturated. Figure 3-1 of this Work Plan shows the sewer system along with groundwater contours, indicating manholes situated above and below the water table, as determined from a comparison of water table elevation and manhole invert data. The coring tool may either be advanced in piston mode (i.e., without retrieval of a core until the targeted sampling depth is reached) or in coring mode (where a continuous soil core is collected from the ground surface to the sampling depth).

Once the target sampling depth is reached, the MacroCore® will be removed from the ground and the clear PVC liner will be removed from the core barrel at the ground surface. The liner will be capped and marked with the depth of the top and bottom of the liner using an indelible pen. The borehole number will also be written on the liner. The liner will then be opened with a cutting tool and the samples for VOC analysis will immediately be collected by placing 10-12 gram subsamples from the core into 40 milliliter (mL) Volatile Organic Analysis (VOA) vials in which 10 mL of methanol has been added. The VOA vials and methanol will be prepared beforehand and will be weighed so that the mass of soil added can be determined exactly in the onsite laboratory. Samples for the other onsite analyses will then be collected into the appropriate containers.

At 10% of the locations where screening analyses results indicate no release has occurred, samples will be collected for the full analyte list as described in Section 6.1.5.2 of this Work Plan. At these locations, the volume of soil required for the analyses will require use of the DT325 Dual Tube Coring tool.

6.2.2.2 Hollow Stem Auger/Split Spoon

In areas of the site where the sampling depth is expected to exceed 25 ft bgs (primarily north of Dezonia Road), sampling will be accomplished using a rotary drill rig with hollow stem augers and split spoon samplers. Note that the depth to the sewer line in these locations is likely to be less than 10 ft bgs.

The Stage 1 sampling will be done using DPT as described above. If Stage 2 sampling is required and groundwater samples or deep soil samples need to be collected, the HSA rig will be used. Augers will be 8½-inch outside diameter, 4¼-inch inside diameter augurs fitted with a bit on the lead length. Augers will be added in 5-foot flights as drilling proceeds. A plug on the end of the AW-series sized drill rod will be kept in place in the lead auger during auger advancement. Once the desired depth is reached, the plug will be removed and a 2-foot long, 2-inch diameter, split spoon sampler will be lowered down through the inside of the augers. The sampler will be driven with a safety driver a distance of 2 feet below the bottom of the auger. When driving is

complete, the split spoon will be retrieved from the hole and will be opened at the surface. The samples for VOC analysis will immediately be collected by placing 10-12 gram subsamples from the sampler into 40-mL VOA vials in which 10 mL of methanol has been added. The VOA vials and methanol will be prepared beforehand and will be weighed so that the dry mass of soil added can be determined in the laboratory. Samples for the other in-field analyses will then be collected into the appropriate containers. If additional volume of soil is needed, the augers will be advanced 2 feet and the split spoon will be driven a successive 2-foot interval beneath the augers.

At 10% of the locations where screening analyses results indicate no release has occurred, samples will be collected for the full analyte list as described in Section 6.1.5.2.

6.2.3 Groundwater Sampling

If the results of soil sample analyses exceed SSLs or the nitrate trigger level, or if the sewer line depth and the depth to groundwater are coincident, groundwater samples will be collected for analyses. Groundwater samples will be collected from small diameter temporary wells installed through the DPT soil core holes or HSA soil boreholes as described in the preceding sections. In areas of the site where the depth to groundwater is less than 25 feet bgs (e.g., south of Dezonia Road) temporary wells will be installed through the outer casing of the DT325 dual tube coring tool. Where the water table is deeper than 25 feet bgs the temporary wells will be installed through the HSA auger casing advanced using a conventional rotary drill rig.

Following installation of the well, the riser will be cut off below the surface of the street or sidewalk. The elevation of the measuring point at the top of the casing will be established and the water level will be monitored over time until it stabilizes. If the well is located in an active street or roadway, a steel traffic plate fitted with a downward facing anchor rod will be placed over the hole with the rod inserted into the riser to protect the well and to prevent objects from falling into the annulus.

Water levels in temporary monitoring wells will be monitored until levels have reached equilibrium based on three successive water level measurements made over a period of 10 minutes. Due to the relatively low hydraulic conductivity present at HAFB, some wells may require the well to be capped with an anchor rod and allowed to recharge over a 24 hour or longer period as necessary. Once the equilibrium water level has been recorded, the well will be purged using SOP SEI-6.34.0 for low flow sampling of monitoring wells. A peristaltic pump and fluorinated ethylene propylene (FEP) tubing will be used to bring sample water to the surface where indicator field parameters will be monitored in a flow through cell. Samples for VOC analyses will be collected in a zero headspace sampling jig on the suction side of the pump. Other analytes will be collected from the discharge side of the pump.

A new length of FEP tubing will be used for each well and the tubing in the peristaltic pump head will be replaced with a new piece of tubing for each well. Water level indicators or pressure transducers will be decontaminated prior to use at each well.

Table 6-2 provides details on sample volumes, containers, preservation, and method of analysis.

6.2.3.1 Direct Push Temporary Wells

Where the depth to groundwater is less than 25 feet bgs, groundwater samples will be collected from temporary 1-inch diameter, PVC, pre-packed well screens installed using DPT methods. The coring tool will be advanced at least 3 feet below the water table within the same hole that the soil samples were collected from and the core barrel will then be removed. The pre-packed screens will have a length of 3 feet and will be lowered to the bottom of the coring tool outer casing. The pre-packed screens will be connected to 1-inch, PVC flush joint riser pipe in 5 or 10 foot length sections. The temporary wells will be installed through the casing of the Geoprobe Systems® DT325 Dual Tube Sampling system.

Once the screen and riser are in place in the bottom of the casing below the water table, the outer casing of the coring tool will be retracted to expose the screen to the formation. The coring tool will be removed, the equilibrium water level will be recorded until equilibrium is reached, whereupon the well will be sampled.

Once sampling is completed, the well will be pulled out if possible and the borehole will be abandoned in accordance with the procedures described in Bhate's SOP B-10.

6.2.3.2 Hollow Stem Auger-Installed Temporary Wells

Where the depth to the water table is greater than 25 ft bgs and groundwater sampling is required, sampling will be accomplished by installing temporary wells using a conventional HSA rotary drill rig. Augers will be 8 ½-inch outside diameter, 4 ¼-inch inside diameter hollow stem augers fitted with a bit on the lead length. The temporary well will be installed through the augers in the same borehole from which the soil samples were collected.

The augers will be advanced in 5-foot flights until the lead auger is at least 3 feet below the water table. The well will be constructed of a 3-foot length of 2-inch outside diameter, 0.010 slot screen with a silica sandpack placed around the annulus of the screen and extending 2 feet above the top of the screen. Bentonite chips will be placed above the sand pack. The screen will be connected to 2-inch outside diameter flush joint riser in 5 or 10 foot length sections.

Once the screen and riser are in place in the bottom of the augers below the water table, sand will be added as the augurs are retracted. Sand will continue to be added as the augurs are pulled up to ensure that a continuous sand pack is emplaced. Once the bentonite chips are added, the water level in the well will be monitored until it reaches equilibrium. The equilibrium depth to water will be recorded and the well will then be sampled with a peristaltic pump and FEP tubing using the slow purge method described in SOP SEI-6.34.0.

Once sampling is completed, the well will be pulled out if possible and the hole will be abandoned in accordance with the procedures described in Bhate's SOP B-10.

6.2.4 Direct Push Soil-Gas Sampling

Soil-gas sampling and analysis will be undertaken if the results of soil and/or groundwater sampling indicate that there is a potential risk of indoor air contamination in a nearby facility as described in Section 6.1.5.4, Stage 4 – Vapor Intrusion Evaluation.

Soil-gas samples will be collected using a direct push Geoprobe® Post Run Tubing (PRT) tool in accordance with SOP SEI-6.36.0. Samples will be collected at a depth of 4 feet bgs or at a depth just above the water table if the water table is at a depth of less than 4 feet bgs. Samples will be collected into a Tedlar bag using a vacuum box. The Tedlar bags will be labeled appropriately, placed on ice in a cooler, and transported to the onsite laboratory for analysis of VOCs in accordance with SOP SEI-10.15.3.

6.2.5 Indoor Air Sampling

Indoor air quality sampling and analysis may be undertaken if the results of soil, groundwater, and soil-gas sampling indicate that an inhabited structure may be at risk of indoor air quality that is degraded to unacceptable levels. The decision process leading to indoor air sampling is discussed in Section 6.1.5.4, Stage 4 - Vapor Intrusion Evaluation.

Samples will be collected in accordance with SSP SEI-051687.1.0 for analysis by USEPA Method TO-15. The number and location of samples collected from a given building will be based on the building construction and the nature of occupancy/use. In general, a single sample will be collected from the ground floor if no occupied basement is present. A background sample will be collected at one outdoor location to be determined. Sample collection will consist of positioning a sub-atmospheric canister (Summa® canister) within each zone of interest in the breathing zone (approximately 5 ft above the floor for buildings occupied by adults and approximately 3 ft above the floor in buildings occupied by children).

6.2.6 Documentation

Documentation, sample handling, chain-of-custody, and shipping will be managed in accordance with SOP HAFB-1 of the HAFB Basewide QAPP.

Sampling personnel will use a bound field log book with moisture resistant pages to record pertinent sampling information with waterproof ink in addition to any forms provided in, or specified by applicable SOPs. The log book will identify project name, project number, project manager and telephone number, and principal street address or geographic location of the site. Daily field activities and sampling information will be entered in the log book on dated, initialed, and serially-numbered pages. Corrections will be made to entries by initialed and dated line-out deletions. A diagonal line will be drawn across the remaining blank space of the last page of each day's entry. Each day's entry will be signed and dated by the author.

The date and time of sample preparation, collection, and personnel who conducted sampling will be recorded with the sample identification number in the field log book and on the chain-of-custody (COC) form. The names of visitors and any other persons on site will also be recorded in the field log book. Sampling personnel will record the ambient weather conditions and other conditions at the sampling location that may affect sample collection, the apparent representativeness of the sample, or sample analysis.

Sample nomenclature and labeling requirements are described in Section 7.3.1 of this Work Plan.

6.2.7 Decontamination

Sampling equipment will be decontaminated as described in SOP HAFB-2 of the HAFB Basewide QAPP. Equipment to be steam cleaned includes:

- DT325 Dual Tube Sampling System - prior to each hole
- Hollow Stem Augurs and drill rods - prior to each hole
- DPT push rig - prior to demobilization or as needed to remove soil, etc.
- Rotary drill rig - prior to demobilization or as needed to remove soil, etc.

Equipment to be washed with soap and potable water supplied by HAFB includes:

- DT325 System core barrel - prior to each use
- Soil sampling tools (spatulas, spoons etc)
- Split Spoon sampler - prior to each use
- PRT Soil-Gas sampling tool - prior to use

6.2.8 Management of Investigation-Derived Waste

Investigation-derived waste (IDW) will be managed in accordance with SOP HAFB-9 of the HAFB Basewide QAPP.

Solid waste such as soil core liners, personal protective equipment (PPE), empty grout bags, and used tubing, etc., will be placed in trash bags and disposed of in dumpsters on site for ultimate disposal as non-hazardous solid waste.

Decontamination and purge waters will be locally contained in 5 gallon pails and conveyed to a 1,000 gallon portable storage tank. Waters contained in the portable tank will be subsequently transported to the HAFB wastewater treatment plant for proper disposal.

Drill cuttings and excess soils from sampling will be visually assessed for staining and screened with a PID and hand-held scintillation meter. If the cuttings and/or soils are visibly stained or if they have PID headspace readings above background and/or the hand-held scintillation meter indicates the presence of radionuclides, they will be contained and temporarily staged at the FT-31 Landfarm pending receipt of sample analytical results. If analytical results indicate contaminants present at concentrations above the landfarm's acceptance levels, the material will be properly disposed offsite. If the analytical results indicate contaminants present at levels below the landfarm's acceptance levels, the material will be land-farmed. If none of the visual, screening or analytical results based conditions are met, the material will be used as backfill or spread around borehole locations as described in SOP HAFB-9 of the HAFB Basewide QAPP.

6.3 Sample Analysis

This section describes the objectives and procedures associated with the onsite and offsite analytical programs. The analytical strategies for the Triad RFI have been designed according to the concepts and guiding principles of USEPA's Triad Approach, specifically for dynamic work strategies and real time measurement technologies, as described in Section 6.1 of this Work Plan.

Table 6-1 of this Work Plan details the onsite and offsite analytical plan, including stage of investigation, media, analytes, methods, and location (onsite/offsite) for each analysis.

6.3.1 Data Quality Objectives

The analytical methods outlined in Table 6-1 of this Work Plan were selected based on their ability to provide reliable results which can be used to determine whether a given contaminant (or contaminant class) is present at concentrations:

- Above reporting limits (RLs),
- Above RLs and below its respective ARAR action level criteria, or
- Above its respective ARAR action level criteria.

In several cases, laboratory method detection limits (MDLs) will be used to compare to ARARs. Concentrations that fall between the practical quantitation limits (PQL) and the MDL will be qualified accordingly. Exceptions to meeting the ARARs are listed in Section 6.3.3 below.

The selectivity and accuracy of the selected analytical techniques have all been adequately proven either by virtue of being an accepted method or, in the case of the siteLAB® screening method, via a USEPA verification program (USEPA, September 2001). The screening methods will be used to provide near-real-time data for field-based decisions and, in the case of the PAH analyses, will be supported by offsite definitive analytical methods.

Specific DQOs for the onsite and offsite laboratory programs are described in Sections 6.3.2 and 6.3.3 of this Work Plan, respectively.

Analytical chemistry data will be reviewed according to latest revision of the USEPA *Contract Laboratory Program National Function Guidelines for Inorganic Data Review* (October 2004) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (October 1999). One hundred percent (100 %) of the analytical data will be subjected to review modeled after the USEPA Tier I guideline (USEPA Region I, 1996). The Tier I review will include a review of completeness. In addition, as specified by the Project Chemist, the definitive data may also be subjected to review modeled after the USEPA Tier II guideline (USEPA Region I, 1996). This review will compare selected quality control (QC) parameters (holding time, laboratory control sample [LCS], method blanks, field blanks, surrogates, matrix spike [MS]/matrix spike duplicate [MSD]/laboratory duplicate [LD], and field duplicates) and DQOs with the acceptance criteria described in the HAFB Basewide QAPP and the HAFB Basewide QAPP Addendum (in Appendix A of this Work Plan).

Qualifiers may be applied to data that fails to satisfy the acceptance criteria as detailed in the HAFB Basewide QAPP. Unless otherwise noted, all data validated using the methods noted above will be considered suitable for use in meeting the objectives of this study.

6.3.2 Onsite Analytical Program

Soil, groundwater, and soil-gas samples will be analyzed in the onsite laboratory. The purpose of performing onsite analyses is two-fold:

1. Samples will be analyzed soon (i.e., near-real-time) after they are collected, allowing the field team(s) to adjust sampling locations and depths in response to new data as they are generated; and

2. As a large number of samples will be generated in a short time, they can be analyzed more cost-effectively than can be achieved at a fixed based laboratory.

6.3.2.1 Analytical Procedures

The onsite analytical program will analyze for VOCs and nitrate, and screen for PAHs and TPH. The specific methods and general description of methods and RLs for each are presented below.

6.3.2.1.1 Volatile Organic Compounds

Soil, groundwater, and air samples will be analyzed for VOCs using a Solid Phase Micro-extraction (SPME) sample preparation technique followed by analysis on a Hewlett Packard 5890 Series II equipped with both Mass Spectrometer and Flame Ionization detectors (MS and FID, respectively). The SPME technique is a standard practice (American Society for Testing and Materials [ASTM] D 6520-00) for the extraction of VOCs that Stone has successfully used for over 10 years, including projects performed at other Department of Defense sites. Further, Stone's use of SPME in its onsite VOC analytical program for non-potable waters and solids is accredited through the National Environmental Laboratory Accreditation Program (NELAP) via the State of Florida. In addition, the SPME-based method and supporting methods comparison

data were presented to NMED by Stone during the October 25, 2005, meeting between NMED and representatives of HAFB, USACE, Bhate, Stone, and Schick Consulting.

Stone will also use an analytical configuration that is capable of analyzing two samples simultaneously. This is achieved by configuring two injection ports, two capillary columns, and two detectors (MS) and (FID) in parallel within a single gas chromatograph (GC). The MS detector system will be used for the low level analyses. The FID will be used to augment the program by analyzing samples containing medium to high concentrations of VOCs. The system is capable of detecting VOCs between 2 to 5 micrograms per liter (μg/L) in water and 60 micrograms per kilogram (μg/kg) in soil. Detection limits for soil-gas are expected to be in the range of 20 to 100 micrograms per cubic meter (μg/m^3).

Analyses will be conducted according to SOPs SEI-10.1.3 and SEI-10.15.0 which are each located in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan. All samples will be analyzed using quality assurance (QA)/quality control (QC) protocols that are outlined in these SOPs and are designed to follow USEPA SW846 8000 methodologies. MDLs for these methods have also been provided in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan. A summary of the QC parameters for the onsite VOC analytical program are listed in Table 6-3 of this Work Plan. Appendix C of the HAFB Basewide QAPP provides quality control limits for the VOC analytical program that are based on the Department of Defense (DOD) *Quality Systems Manual (QSM) for Environmental Laboratories*, Version 1, dated October 2000.

The target VOCs for this project will include 37 analytes via GC/MS methods and 14 analytes via GC/FID methods. The analytes are listed in the Laboratory Scope of Accreditation of Stone's NELAP certification, which is provided in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan

6.3.2.1.2 Polycyclic Aromatic Hydrocarbons

Soil and groundwater samples will be screened for PAHs using a combination of field fluorometry (SiteLAB® Analytical Test Kit UVF-3100A) and Immunoassay (IA) analytical techniques.

The field fluorometry technique offers a much faster turn-around-time (TAT) then the IA technique. Field fluorometry is capable of detecting 16 PAHs included in the USEPA Method 8270C list at levels below the NMED SSLs. For example, the SSL for benzo(a)pyrne is 0.62 mg/kg and the detection limit for the PAH analyses will be 0.05 mg/kg. Stone will conduct these analyses in accordance with the SiteLAB® Operating Manual (included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan).

Since the groundwater action level for PAHs (0.2 μg/kg for benzo(a)pyrene) is lower than SiteLAB's detection limit, Stone will use the Rapid Assay Carcinogenic PAH Test for the groundwater PAH analyses. A copy of the manufacturer's procedural document is included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan. The IA test screens

for 16 of the carcinogenic PAHs that are listed in the manufacturer's SOP documentation. The detection limit will be 0.2 µg/kg for water samples.

All samples having positive detections of PAHs above the RL, and 10% of the total PAH samples with results below the RL, will be submitted to the offsite laboratory facility for definitive analyses to identify and quantify any specific PAH compounds.

Over the course of the investigation, the onsite PAH screening data will be compared to the offsite definitive data to ensure that the screening methods are adequately identifying and quantifying the contaminants of interest. The comparisons will be conducted using a standard linear regression technique to determine the correlation coefficient and whether there is a bias to the data.

A summary of the QC parameters for the onsite PAH program are listed in Table 6-3 of this Work Plan.

6.3.2.1.3 Total Petroleum Hydrocarbons

Soil samples will be screened using a field fluorometer technique (SiteLAB® Analytical Test Kit UVF-3100A) in accordance with the SiteLAB® Operating Manual (included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan). As historical information indicates a variety of petroleum hydrocarbon class(s) may have been introduced into the sewer, both the Gasoline Range Organics (GRO, C_6 through C_{10}) and Extended Diesel Range Organics (EDRO, C_{10} through C_{36}) will be analyzed since these two classes cover a very broad range of fuel and oil types. The detection limits for the TPH screening analyses will be less than 600 mg/kg for soil samples.

A summary of the QC parameters for the onsite TPH program are listed in Table 6-3 of this Work Plan.

6.3.2.1.4 Nitrate

Soil and groundwater will be analyzed for nitrate using ion chromatography (IC) via USEPA Method 300 (included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan). The IC method provides the most reliable platform for removing interferences (i.e. high concentrations of chloride) while being able to detect nitrate in the low-part per million (ppm) range. Other techniques such as ion selective electrodes (ISE) and spectrophotometry are likely to encounter matrix interferences that are difficult to resolve in the field. The detection limit for nitrate will be 2.0 mg/L and 6.0 mg/kg in water and soil, respectively.

As per USEPA Method 300, nitrate will be extracted from the soil samples using analyte-free reagent water. The method stipulates that a volume of water, equal to 10-times the weight of soil, is used for the extraction. This 10-fold dilution will increase the detection limit by a factor of 10. To reduce this dilution effect, Stone will add approximately 10-grams of soil to 30-ml of deionized water. Since nitrate is known to be very poorly-sorbed to soil particles and is

extremely soluble in water, this extraction technique will be more than adequate for these analyses. To demonstrate the extraction efficiency, Stone plans to conduct matrix spike (MS) analyses as specified in Table 6-3 of this Work Plan.

Stone expects elevated levels of chloride to be present in HAFB soil and groundwater samples. As such, Stone plans to dilute the samples accordingly to reduce the chloride levels to a concentration that does not interfere with the chromatographic process.

A summary of the QC parameters for the onsite nitrate program are listed in Table 6-3 of this work plan.

6.3.2.1.5 Radionuclides

Soil and groundwater samples will be passively screened for alpha-beta emitting radionuclides using a hand-held Ludlum 449 scintillation meter. The field-based radioactive survey is not intended to detect levels of radioactive material at or below the ARARs. The survey is intended to determine if gross levels of radioactivity are present in the subsurface. Definitive radiochemical analyses will be conducted on the soil and groundwater samples where screening indicates no radionuclide presence, at a minimum frequency of 10%.

6.3.2.2 Chain of Custody Procedures

All samples submitted for onsite laboratory analyses will be logged using the "Onsite Laboratory Sample Log-in" sheet included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan. This form will be used to identify all persons having contact with the samples and to document any problems or discrepancies associated with the samples. Any problems or discrepancies will be reported immediately to the Bhate Project Manager, Stone Laboratory Services Manager, and/or Stone Quality Assurance Manager.

All COC forms will be kept in a permanent project file at the onsite laboratory and will be available for inspection during normal business hours.

6.3.2.3 Holding Times and Sample Storage

Requirements for sample container types, holding times, and preservation chemicals are included in Table 6-1 of this Work Plan.

Typically, for onsite analytical work, samples will be analyzed on the same day that they are received. Therefore, meeting holding times for onsite analysis are not anticipated to be a significant concern. If it is expected that the samples will not be analyzed within 4 hours, the samples will be stored in a refrigerator at approximately 4 degrees Celsius (°C). Prior to analyses, the samples shall be removed from the refrigerator and allowed to warm to room temperature. If any holding times are not met, the laboratory will immediately inform the Bhate Project Manager, Stone Laboratory Services Manager, and/or Stone Quality Assurance Manager.

6.3.2.4 Data Reduction, Review, and Reporting

Stone's Laboratory Quality Manual (LQM) provides general information regarding the data reduction and review processes that will be applied to the onsite laboratory work for this project. The LQM is provided in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan.

Stone expects to provide a Level III laboratory deliverable which consists of an analytical report with results and QA/QC summaries. Internal quality control results, not included as part of the Level III package, will be retained on file at the onsite laboratory.

Results for all samples will be presented in hard copy Form-1 and electronic data deliverable (EDD) formats. Electronic data shall be delivered in an appropriate format such that the data can be uploaded to the project database for subsequent manipulation and presentation.

6.3.2.5 Internal Quality Control Checks and Corrective Action

Stone's LQM provides general information regarding the internal QC checks that will be conducted as part of the onsite laboratory work for this project. Table 6-3 of this Work Plan lists the QC checks, the frequency at which they will be run, and the appropriate corrective action. The table also provides information regarding data quality level, i.e., definitive or screening.

The level of data quality indicates whether the data are screening level, which can be used for presence/absence determinations for investigation Stages 1, 2, and 3, or definitive level, which can be used as final, defensible data for identifying release areas and for Stage 3 delineation.

6.3.3 Offsite Laboratory Analytical Methods

Offsite analyses will be completed by the following environmental testing laboratories:

- TestAmerica Laboratories in Denver, Colorado (TAL DEN),
- TestAmerica Laboratories in Los Angeles, California (TAL LA), and
- General Engineering Laboratories, LLC (GEL) in Charleston, South Carolina.

TAL DEN will be conducting all of the analyses with the exception of the TO-15 and radiochemical analyses, which will be conducted at TAL LA and GEL, respectively.

The offsite chemical analysis of soil and groundwater samples will follow the USEPA SW-846 and Department of Energy (DOE) methods listed in Table 6-2 of this Work Plan.

Copies of the following documents for each of the laboratories have been included in the HAFB Basewide QAPP Addendum in Appendix A of this Work Plan:

- "Self Declaration" statement for the TAL DEN and GEL facilities' compliance with DOD QSM v.3 (Note: the statement included in the HAFB Basewide QAPP Addendum is for Severn Trent Laboratories who recently purchased TAL DEN and TAL LA. Revised statements are not currently available.)

- Standard Operating Procedure for TAL LA addressing compliance with DOD QSM v.3 and;

- MDL studies for the analytical methods specified in Table 6-2 of this Work Plan.

SOPs for the offsite analytical methods are not physically included as part of this Work Plan, however, the SOPs have been reviewed and can be made available by the laboratory upon request.

The analytical requirements, including various QA/QC parameters, preparation methods, and analytical methods for soil and groundwater samples are summarized in the HAFB Basewide QAPP in:

- Table 3-1 (Project Data Quality Objectives),

- Table 10-1 (Sample Containers, Preservatives, and Holding Times),

- Table 13-1 (Extraction and Digestion Procedures), and,

- Table 13-2 (Analytical Procedures).

The specific analyte lists for each of the analytical suites for groundwater and soil are provided in Table C-1 (see Appendix C of this Work Plan). The analyte lists are based on Table 5-1 (Comprehensive Analyte and Data Quality Objectives, Groundwater) and Table 5-3 (Comprehensive Analyte and Data Quality Objectives, Soil) of the HAFB Basewide QAPP.

As noted previously, for several compounds, MDLs will be used to meet the respective ARARs. Where concentrations fall between the PQLs and the MDLs, the data will be qualified accordingly. Exceptions to meeting the ARARs include:

- Benzo(a)pyrene and pentachlorophenol which have federal MCLs of 0.2 µg/L and 1.0 µg/L, respectively. TAL DEN's MDLs for these compounds are 0.74 µg/L and 20 µg/L, respectively and;

- Radium 226 and radium 226 which both have ARAR values of 0.016 pCi/g (see Table C-1 in Appendix C of this Work Plan). GEL's MDLs for these isotopes are 1.0 pCi/g and 3.0 pCi/g, respectively. According to GEL, these isotopes are typically present in background soils at values well above the 0.016 pCi/g values, therefore, the ARAR values for these isotopes may prove to be non-applicable to the DQOs for this project.

Samples selected for laboratory analysis will be labeled, handled, and prepared for shipment in accordance with HAFB SOP-1 of the HAFB Basewide QAPP. The PQLs for all analytical parameters and the QA sampling requirements (trip blanks, duplicates, and MS/MSD) are summarized in Table 6-2 of this Work Plan.

Each cooler containing samples to be shipped for offsite VOC analysis will require a trip blank. The samples will be placed on ice and shipped under strict chain-of-custody to the appropriate laboratory. Specifics regarding the container types, holding times, and preservation chemicals are included in Table 6-2 of this Work Plan.

The offsite laboratories will each provide Level III laboratory deliverables which consist of an analytical report with results and QA/QC summaries. Internal QC results, not included as part of the Level III package, will be retained on file at each of the offsite laboratories.

Results for all samples will be presented in hard copy Form-1 and EDD formats. Electronic data shall be delivered in an appropriate format such that the data can be uploaded to the project database for subsequent manipulation and presentation.

Standard turnaround times of 2 weeks will be expected for all organic and inorganic results and 3-weeks for the radiochemical results; except for special conditions wherein expedited analyses may be required, such as for urgent Summa® canister sample analysis.

7 DATA MANAGEMENT PLAN

This section describes the overall data management strategy and plan for the SWMU 183 Triad RFI.

7.1 Data Management System and Strategy

The data management plan to be used for the SWMU 183 RFI has been developed to support the project's Triad Approach-based dynamic work strategy. The data management plan will be used to accommodate and manage a variety of historical, field-based, and fixed-based laboratory generated data at various 'real-time', near-real-time", standard turnaround, and 'as-available' time junctures to support project decision making. Data to be generated includes chemical analytical data, as well as spatial and features information, hydrogeologic data, and various supporting data, such as photographs and standard daily forms information.

The data management system is comprised of a number of unique and integrated data generation and manipulation technologies, including:

- Onsite and offsite laboratory information management systems (LIMS)
- Central project and relational reporting database
- GeoBase EDV; developed by Stone for this project

Each of these systems supports the subsequent system, with the GeoBase EDV being the system where all data are ultimately integrated for the purposes of spatial analysis and reporting.

7.2 Data Type

As shown in Table 7-1, laboratory analytical data type and management requirements will vary based on the stage of project activity, type of data, laboratory QA/QC requirements, decision making, and remote access query and analysis needs.

Analytical data will be generated by onsite laboratory analysis and screening, as well as by offsite laboratory analysis. All data associated with the onsite laboratory will be managed using Stone's LIMS. Prior to project startup, the LIMS will be prepared for the project by entering basic project information, analysis methods and analytes, instruments and detectors, and matrices. In addition, all vial preparation information will be entered including initial mass for each vial.

Analytical data generated by offsite laboratories will be initially managed by the respective laboratory's LIMS and transferred to the project team for use via EDD and hard copy

Prior to project startup, formats for the offsite laboratory EDDs will be final approved to ensure smooth transfer and importation of the data into the central project database upon receipt.

7.3 Data Access and Use

Analytical results will be made available to the field team(s), data management personnel; and Triad Team in different formats depending on when in the analysis lifecycle the data are released for use. The general flow of data generation, processing, transfer, and use is described below. Table 7-1 of this Work Plan indicates the data format for each analyte at each stage of investigation, as described in greater detail below.

The onsite laboratory will produce hardcopy and electronic data in the field as they are generated. The hardcopy data will be labeled as "preliminary" as they will not yet have undergone a secondary review process. To aid in the near real-time decision making process, the data reports will include results and action level criteria (i.e., ARARs) and indicate whether the reported value is above or below the respective action level for each analyte of concern. This information will provide the field team with the ability to make immediate field-based decisions in regard to subsequent actions to be performed.

Hard copy data summary results and EDDs will be submitted to Stone's Laboratory QA Manager for secondary review and approval for use. The secondary data review process will occur at a minimum of every 2 weeks or more frequently, depending on the project's "real-time" decision and logistical needs.

Following completion of secondary data review, onsite and offsite laboratory data will be submitted to the data management team in EDD format for importation into the project database.

Upon identification of release locations during Stages 1 and 2, the GeoBase EDV will be used to perform spatial analysis to determine whether those locations are within the bounds of an existing HAFB environmental site. It will also be used to evaluate strategic options for conducting Stage 3 delineations. Individual Triad Team members will also be able to conduct individual web-based queries in support of their own site evaluation needs and interests.

The data management system will be used to support both Stage 3 delineations, as well as Stage 4 vapor intrusion evaluations, as necessary.

Upon completion of Stages 3 and/or 4, the data management system will be used to perform final spatial analysis, as well as to support tabular and graphic report development for deliverables and miscellaneous project communications as needed.

7.3.1 Sample Nomenclature

The sample identification (ID) nomenclature contains specific information about the sample site, location, matrix, and whether the sample is to be analyzed by the onsite or offsite laboratories.

Additional designation letters and numbers will be used to denote sample depths or identify QC samples.

Prior to collecting each sample, sample containers will be labeled with the following information:

- Date and time,
- Sample ID,
- Sampling personnel,
- Preservatives (if any), and
- Analytical parameters and laboratory (onsite versus offsite) identifiers.

All information pertaining to a particular sample will be referenced by the sample ID recorded on the sample bottle(s), the field log book, and on the COC forms.

Sample ID formats will include the following attributes in the following order:

1. Site type designation
    a. SR = Sewer (Stages 1 and 2)
    b. RA = Release Area (Stages 3 and 4)
2. Pre-designated sample location, three digits
3. Sample type designation
    a. SB = Soil Boring (soil sample)
    b. TW = Temporary Well (groundwater sample)
    c. SG = Soil-Gas Sample
    d. VI = Vapor Intrusion (indoor air sample)
4. Soil and groundwater Delineation Samples
    a. Soil: SB, followed by delineation step-out grouping (one letter), followed by consecutive sample number (two digits) followed by; sample depth, in feet.
    b. Groundwater: TW, followed by delineation transect location (single alphabetic), followed by consecutive sample number (two digits).
5. Vapor intrusion or indoor air sample
    a. SG or VI, followed by the building number for the building of concern (alphanumeric), followed by; consecutive sample location number (two digits).
6. QC extension (if applicable); and
7. Onsite/offsite laboratory identifier.

The project site name "SWMU 183" will not be included in the functional use of the sample IDs, however, "SWMU 183" will be associated with each sample within the laboratory data management database so that if data are exported out of the database for other uses the samples will remain correctly associated with the Site.

7.3.1.1 Sample Depth Designations

All soil samples collected from a temporary well boring will have the temporary well designation followed by the sample ending depth (groundwater samples will not contain a sample depth designator).

7.3.1.2 Soil Release Area Transects

As described in Section 6.1 of this Work Plan, soil contamination in Identified Release Areas will be delineated using an orthogonal grid-based strategy, wherein, soil samples will be collected at a 50 ft spacing from locations oriented orthogonally (4 perpendicular azimuths) centered on the original pre-designated sampling location of concern. Grid axes will be designated alphabetically and numerically and each sampling location along grid lines will begin with –01 and continue consecutively until the completion of the grid line of concern. Sampling will start in the origins of grid lines and progress laterally in opposite directions along each grid line until analytical data indicate sampling is complete. As a result, the numbering sequence along a grid line, although numerically consecutive, will not be geographically consecutive.

7.3.1.3 Groundwater Release Area Transects

As described in Section 6.1 of this Work Plan, groundwater contamination in Identified Release Areas will be delineated using a transect-based strategy, wherein, groundwater samples will be collected from locations oriented linearly normal (perpendicular) to the regional groundwater flow direction and orthogonal from the original pre-designated sampling location. Each transect will be designated alphabetically and each sampling location along transects will begin with –01 and continue consecutively until the completion of each transect of concern. Sampling will start in the centers of transects and progress laterally in opposite directions along each transect until analytical data indicate sampling is complete. As a result, the numbering sequence along each transect, although numerically consecutive, will not be geographically consecutive.

7.3.1.4 Laboratory Identifiers

Sample containers submitted for onsite and offsite analyses will have unique identifiers to indicate which laboratory the sample is intended to be analyzed by. These identifiers will be assigned one of the following the suffixes:

- ON = onsite laboratory
- OFF = offsite laboratory

7.3.1.5 QC Extensions

QC samples will be denoted by adding a specific QC extension to the sample ID as indicated in Table 7-2 of this Work Plan. As noted, the program specific QC extensions deviate from the QC extensions listed in the HAFB Basewide QAPP. The deviations in the QC extensions are necessitated by the fact that this nomenclature is hard-coded into the design of Stone's onsite LIMS. To minimize confusion associated with having two sets of QC extensions, the program specific QC extensions will be used for both onsite and offsite laboratory sample nomenclature.

If multiple QC extensions are required, the extensions will be listed in the order specified above, separated by a comma.

7.3.2 Example Sample IDs

The following are example sample IDs for the various samples that are anticipated for the SWMU 183 Triad RFI.

7.3.2.1 Stage 1 - Sewer Release Identification

- A soil sample collected for onsite analysis, at pre-designated sampling location # 153, at a depth of 15.0 feet:
    - SR153-SB-15.0-ON
- A groundwater sample collected for offsite analyses, from a temporary well, at pre-designated sampling location #52:
    - SR052-TW-OFF
- A groundwater sample, collected for offsite MS/MSD analyses, from a temporary well, at pre-designated sampling location #32:
    - SR032-TW-MS,MSD-OFF

7.3.2.2 Stage 2 - Expanded Analyte List Analysis

- All primary soil and groundwater samples:
    - Same format as for Stage 1.
- A field duplicate groundwater sample, collected for offsite analyses, from a temporary well, at pre-designated sampling location #38:
    - SR038-TW-FD-OFF

7.3.2.3 Stage 3 - Identified Release Area Delineation

- A soil sample, collected for onsite analysis, at the third consecutive sampling location, in the second transect (B), conducted at confirmed Release Area 5, at a depth of 18 feet:
  - RA005-SB-B03-18.0-ON
- A groundwater field split sample, collected for offsite analysis, in the seventh consecutive sampling location, of the third transect (C) conducted, at confirmed Release Area 2:
  - RA002-TW-C07-SPLT-OFF

7.3.2.4 Stage 4 - Vapor Intrusion Evaluation

- The fourth consecutive soil-gas sample, collected for onsite analyses, within Release Area 9, adjacent to Building # 1088:
  - RA009-SG-1088-04-ON
- The third consecutive indoor air sample collected for offsite analysis within Release Area 6 inside Building # 898:
  - RA06-VI-898-03-OFF

7.3.3 Data Recording

The following paragraphs describe the data recording activities that will be performed for field data, offsite and onsite laboratory analytical data, and photographs.

7.3.3.1 Field Data

All information pertinent to a field and/or sampling survey will be recorded on appropriate data sheets, or in the project field logbook as described Section 10.5 of the HAFB Basewide QAPP. Specific data sheets are required by certain SOPs/SSPs. Samplers use a bound field logbook with consecutively numbered pages. Entries in the logbook will be made using indelible ink and will include at a minimum the following information:

- Name and address of the field contact (on logbook cover),
- Date of entry,
- Names and companies of personnel on site,
- General descriptions of each day's field activities,
- Documentation of weather conditions during field activities,
- Location of sampling (e.g., monitoring well),
- Data points for field equipment derived during calibration procedures,
- Observation of sample or collection environment,

- Identification of sampling device,
- Any field measurements made,
- Sequence of collection of environmental samples,
- Type of sample matrix (e.g., vapor, groundwater, etc.),
- Date and time of environmental sample collection,
- Field sample identification number,
- Sample distribution (e.g., which laboratory shipped to for analysis),
- Sampler's name,
- Sample type (e.g., composite, normal, duplicate, other QC, etc.),
- For groundwater samples, which samples were filtered if any and filter size and type, and
- Preservative used, if applicable, for the environmental sample.

If an error is made on the document or in the logbook, corrections will be made simply by crossing a line through the error in such a manner that the original entry can still be read, and the correct information added as the change. All corrections will be initialed by the author and dated.

Each page in the logbook will be signed or initialed by the person making the entries. In addition to the information entered into the logbook, the appropriate data forms must be filled out as each activity is completed.

7.3.3.2 Onsite and Offsite Laboratory Analytical Data

The onsite and offsite laboratories shall maintain electronic and hardcopy records sufficient to recreate each analytical event conducted. The minimum records the laboratory shall keep include the following:

- COC forms,
- Initial and continuing calibration records including standards preparation traceable to the original material and lot number,
- Instrument tuning records (as applicable),
- Method blank results,
- Internal standard results,
- Surrogate spiking records and results (as applicable),
- Spike and spike duplicate records and results,
- Laboratory records,
- Raw data, including instrument printouts, bench work sheets, and/or chromatograms with compound identification and quantitation reports,
- Corrective action reports,
- Other method and project required QC samples and results, and
- Laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of project sample analysis.

7.3.3.3 Photographs

Any photographic documentation will be recorded in the appropriate logbook. Information to be recorded includes:

- Camera make and model,
- Time and date,
- Photographer,
- Details for the location of the photograph, preferably with global positioning system (GPS) coordinates,
- Direction of photograph, preferably measured with field compass,
- Subject of the photograph,
- Significant or relevant features, and
- Names of any personnel included in photograph.

7.4 Data Reporting

Project data will generally be reported in tabular and/or graphical display as described below.

7.4.1 Tabular Displays

All analytical chemistry data will be presented as either Form 1 reports and/or summary reports. The formats for the summary reports will be generated on an as-needed basis throughout the course of the project. The Form 1 analytical reports will contain the following:

- Laboratory Name, address, telephone number, contact person, and location where the test was carried out if different from the fixed laboratory address,
- Unique Laboratory Project Number,
- Total number of pages (report must be paginated),
- Client Project Number (if applicable),
- Laboratory Sample Identification (if applicable),
- Client Sample Identification,
- Test Method,
- Matrix and/or description of sample,
- Dates: sample collection, collection time, sample receipt, preparation, and/or analysis date,
- Definition of data qualifiers,
- Reporting units,
- Solid samples: indicate dry or wet weight, and
- Indication by flagging where results are reported below the quantitation limit.

Offsite laboratories shall provide data deliverables within the standard or expedited times specified. Analytical results for all samples will be presented in hard copy Form-1 and EDD formats. Electronic data shall be delivered in an appropriate format such that the data can be uploaded to the project database for subsequent manipulation and presentation.

Tabular summary reports listing of non-chemical, field measurement data will also be generated as part of this project. These summary reports will be created on an as-needed basis to support field sampling efforts and/or final project reporting.

7.4.2 Graphical Displays

A variety of graphical displays will be used to support the field effort and project reporting.

During the field effort, Plates 1 and 2 will be used by the field teams to guide their sampling activities. Staff will hand-annotate these maps for interim documentation of notable spatial information, such as:

- Indicating which locations have been sampled,
- Documenting in-field sample location adjustments,
- Manually posting analytical results for real-time delineation of identified sewer release areas,
- Manually posting analytical results for real-time soil-gas surveys in support of vapor intrusion evaluations, and
- Documenting unique information learned in the field about SWMU 183's constructed form, conditions differing from expectations, system anomalies, surrounding features of note, and any new knowledge of potential release locations.

After completion of all, or substantive portions, of Stage 1 (Sewer Release Identification) and Stage 2 (Expanded Analyte List Analysis) activities, desktop GIS software and the GeoBase EDV will be used to perform computer-based spatial analysis to determine which Identified Release Areas should be delineated under Stage 3 (Delineation). The GeoBase EDV will be accessible to all Triad Team members for the purposes of individual query and group viewing during Triad Team conference calls.

The Geobase EDV will also be used as a resource to provide updated versions of Plates 1 and 2 and to develop other specialty information maps and tables for final RFI reporting, such as final sampling locations, groundwater contour maps, and soil and groundwater contamination delineation maps

Due to its complex design and unique web-accessible format, users currently unfamiliar with the system will require a moderate level of training prior to use. Web-supported teleconference training will be provided as needed to all project team members and regulatory staff requiring access. Training sessions will primarily be held to train groups of individuals; however, individual trainings will be conducted as needed. Each user will be provided with information to allow secure web access to the GeoBase EDV and be provided with technical support during normal business hours in Eastern Standard Time (EST). General users will be able to view and query a broad range of spatial and analytical information, but will not be able to input new, or change any existing, source data. Administrators will perform data input and changes, as well as work with the report development team to generate requested graphical and tabular reporting documents.

Creation of presentation quality maps, as well as complex map layouts, and other complex displays, analysis, and processing of spatial data, will be performed using desktop GIS software (such as Environmental Systems Research Institute's [ESRI's] ArcGIS program suite). The desktop GIS software will be used to produce maps intended for use in reports, as well as all plate-sized map prints.

7.5 Data Archiving

Hardcopy and electronic data shall be archived in project files and on electronic archive media for the duration of the project and for a minimum of 5 years, whichever is longer.

8 PROJECT MANAGEMENT PLAN AND SCHEDULE OF IMPLEMENTATION

This section presents the project management plan (PMP) to be used during the performance of the SWMU 183 Triad RFI.

8.1 Management Control Structure

The management control structure for the project is based on providing Best Management Practices (BMPs) as developed through years of service and integrated project delivery by the organizations charged with performing the project.

Figure 8-1 presents the organization chart for the project with Triad Team representatives from each primary stakeholder organization highlighted.

The following bullets describe the basic management control relationships and key attributes of each organization.

- Regulatory: The NMED is the lead regulatory agency for the project.
- Command: The USAF ACC is responsible for the management of environmental activities at all ACC Bases. ACC delegates the execution of environmental projects to various Department of Defense service agencies. In the case of HAFB, the designated service agency is the USACE Omaha District. Mr. Stanley Scott will serve as the Command Program Manager for the project.
- Base: Environmental Flight 49 Civil Engineering Squadron/Environmental Flight (CES/CEV) is responsible for the management of all HAFB environmental activities. George Fish will serve as the official Point of Contact for formal communications with NMED.
- Service Agency: USACE Omaha District has been a long-term provider of environmental program management, technical, and contractor management and oversight services to the ACC. The Omaha District contracts with private contractors to perform projects and maintains a robust quality management process with which contractors must comply to ensure its customers are being properly served. Mr. Tom Zink will serve as Service Program Manager for the project; supported by dedicated project resources in the areas of geology, chemistry, health and safety, and risk assessment.
- Prime Contractor: As Prime Contractor, Bhate maintains project management processes and systems to support the execution of its projects, with specific elements of those processes tailored to comply with general federal requirements, and USACE Omaha District's specific requirements. Further, Bhate is currently performing a number of other

environmental projects at HAFB and, therefore, has a solid understanding of the requirements for performing work at HAFB and relationships with key individuals and departments to facilitate the various logistical actions required to perform projects efficiently and in compliance with HAFB requirements.

Mr. Frank Gardner will serve as Prime Contractor Program Manager for the project. Mr. James Moore will serve as Project Manager; supported by project resources in the areas of field team leadership, geology, engineering, chemistry, health and safety, and quality assurance.

Bhate has subcontracted Stone for its specialty expertise in designing and performing Triad Approach-based projects.

- Specialty Subcontractor: As a Specialty Subcontractor, Stone has the responsibility for providing technical services and resources to Bhate to ensure the successful performance of the SWMU 183 Triad RFI. Stone has provided Triad systematic planning support services up through the development of this Work Plan and will provide onsite laboratory services, data management, and web-based data visualization development and support. Stone maintains project management processes and systems to support the execution of its projects, with specific elements of those processes tailored to comply with general federal requirements. Having provided services to Bhate since 2005, Stone also has developed processes and systems to comply with Bhate's requirements in support of their efforts to serve its clients, including USACE Omaha District and ACC.

  Mr. Gerald Edwards will serve as Specialty Subcontractor Task Manager. He will be supported by Mr. Seth Pitkin for Triad planning support and contaminant hydrogeology; Mr. Michael Rossi for onsite and offsite laboratory services; Ms. Kim Watson for data quality assurance, Ms. Barbara Patterson for database development and management, and Mr. Nicholas Floersch for web-based data visualization development and support.

- General Support Subcontractors: Bhate has processes and systems in place to procure and manage the services of general contractors, such as drillers, laboratories, surveyors, waste management firms, and other providers as deemed necessary to perform its projects. All General Support Subcontractors will be contracted with, and report directly to, Bhate for the SWMU 183 Triad RFI project. Stone will provide guidance and perform technical delivery and data interface functions with offsite laboratories.

8.2 Project Roles and Responsibilities

The organizational concept for the project is designed to support performance of a Triad Approach-based project, which is premised on the concept of using real-time technologies within a dynamic work strategy framework to support efficient decision-making. To be effective, dynamic work strategies require active participation of a core group of project participants, known as "Primary Triad Team Members". Primary members of the Triad Team each have an

active role in the project and together they engage in a consistent dialogue, conferring on project status and findings, and making pre-designated decisions at defined junctures, as well as resolving unanticipated issues as they are encountered. The Primary Triad Team Members will be supported by the other named staff within their respective organizations. These staff and potentially others will participate in Triad Team conference calls and meetings on an as-needed basis.

Table 8-1 of this Work Plan presents the roles and responsibilities of the project team members.

8.3 Project Schedule

Figure 8-2 of this Work Plan presents a Gantt Chart depiction of the master project schedule for all project phases. The schedule provides detailed activities for preparation phases and Stage 1 and 2 activities, including Triad Team conference calls and meetings. The post-Stage 3 portions of the schedule are "to be determined" at this time due the contingent nature and unknown level of effort that may be required to execute Stage 3 – Identified Release Delineation and Stage 4 – Vapor Intrusion Evaluation.

The actual project schedule will be maintained by Bhate in Microsoft Project™ software in order to provide the flexibility to adapt to various levels of change anticipated to be experienced under the dynamic work strategy format. The project schedule will be updated regularly and posted on a web-accessible platform for access by all Team members.

8.4 Triad Decision Making Process

Based on the geographic distribution of its various representatives, it is assumed that the Triad Team will meet via conference call (at a frequency to be determined) that provides effective decision-making support to the project. Physical meetings may be held at significant decision junctures, such as prior to initiating Stage 3 – Identified Release Delineation, or as may be required by NMED during the course of securing specialty support and/or resolution on a key in-field decision. It is also presumed that a stakeholder meeting will be held after the field effort is completed to present and discuss primary investigation findings, conclusions, and recommendations and to discuss plans and requirements for preparing the Draft SWMU 183 Triad RFI Report.

Triad Team meetings and discussions will be supported with data in various forms of completion, based on the timing of the meeting relative to the generation and processing of the particular data set(s) of concern. The level of data presentation format will depend on the time available to produce the requested information prior to the subject meeting, particularly as related to real-time and near real-time data.

The Initial CSM presented in Section 5 of this Work Plan presents the strategic level decisions that need to be made to complete this Triad RFI project. Section 6.1 of this Work Plan presents the sampling strategy for the project, the specific field-based decisions to be made, and the

decision-logic based process by which those decisions will be made. Detailed descriptions of data management processes and systems to support decision-making are provided in Section 7 of this Work Plan – Data Management Plan. Table 8-2 of this Work Plan presents a summary of the anticipated decision-making activities for the project.

8.5 Reporting

A variety of reports mechanisms will be utilized throughout the SWMU 183 Triad RFI to facilitate communication between HAFB, USACE, NMED, and Contractors. These reports will include the standard daily quality control and monthly progress reports outlined in the HAFB Basewide QAPP, as well as the flowing additional reports:

- Triad Team Conference Call / Meeting Minutes
- NMED Conference Call / Meeting Minutes
- Draft and Final SWMU 183 Triad RFI Reports

Each of these reports will be instrumental in maintaining and documenting the continuing communication between various entities involved in the project. Each report is described in the following subsections.

8.5.1 Triad Team Conference Call / Meeting Minutes

Conference calls and/or meetings of the Triad Team will be held at predetermined junctures and ad hoc as needed to facilitate dynamic decision making in support of the SWMU 183 Triad RFI. Meeting minutes will be recorded to document the decisions made and action items identified during discussions. Minutes will be distributed for review and revision prior to posting in a central, web-accessible location.

8.5.2 NMED Conference Call / Meeting Minutes

Conference calls and meetings with NMED may be held periodically to present the project status, conduct a technical review of results to date and resolve an interim update of the Conceptual Site Model. Available analytical data and field observations may be reviewed at this time and adjustments to the sampling strategy and/or methods made as necessary. Additional calls and/or meetings may be held to discuss draft deliverables in response to NMED's information needs and/or review comments. Meeting minutes will be recorded to document the decisions made and action items identified during discussions. Minutes will be distributed for review and revision prior to posting in a central, web-accessible location.

8.5.3 Draft and Final SWMU 183 Triad RFI Reports

The project team will prepare the required Draft and Final SWMU Triad RFI reports according to the requirements set forth in HAFB's Hazardous Waste Permit: Appendix 4-B RFI Outline; Section II. RFI Report Requirements – Elements of the RFI Report.

A Draft SWMU 183 Triad RFI Report will be prepared and undergo a series of internal reviews by subcontractor, prime contractor prior to submission to USACE Omaha District, as the agency service provider, prior to revision and submission to NMED for review. Upon receipt of NMED comments, the Draft SWMU 183 Triad RFI Report will be revised to Final format accordingly. As needed, a meeting may be requested to address any issues of significance that are not readily resolved through standard revision-level processes. The Triad Team will be responsible for resolving any issues that rise to that level of discourse.

Specifically, the SWMU 183 Triad RFI Report(s) will include the following elements:

- Introduction
- Environmental Setting
- Source Characterization [(1)]
- Sampling and Analysis Results
- Data Quality Assurance/Data Quality Control Review
- Conclusions
- Recommendations
- Work Plan for Additional Investigations (as determined needed) [(2)]

[(1)] Due to the size and complexity of the SWMU 183 sewer systems, any confirmed, and subsequently delineated, release areas will be considered separate 'sites' for the purposes of reporting. This will also simplify any subsequent management effort required to process those areas to No Further Action closure as independent sites (or sub-sites).

[(2)] A primary intent in using the Triad Approach to design and execute the SWMU 183 RFI project is eliminate and/or reduce the need for performing multiple mobilizations to characterize identified release areas.

8.6 Records Management

Project files will contain the following information:

- Correspondence
  - – External and internal correspondence
  - – Notes/minutes of meetings and phone conversations
  - – Personnel, organization, and responsibilities
  - – Planning and scheduling
  - – QA auditing and inspection reports

- All Field Generated Data
- Contractual Documentation
  - Prime Contract
  - Delivery Orders / Task Orders
  - Change Orders
  - Subcontracts
  - Competitive bid evaluations
- Laboratory Analytical Data
- Submittals/Reports
- Miscellaneous project information as required

Project files will be maintained by Project Management and Quality Assurance personnel, as supported by designated document control personnel.

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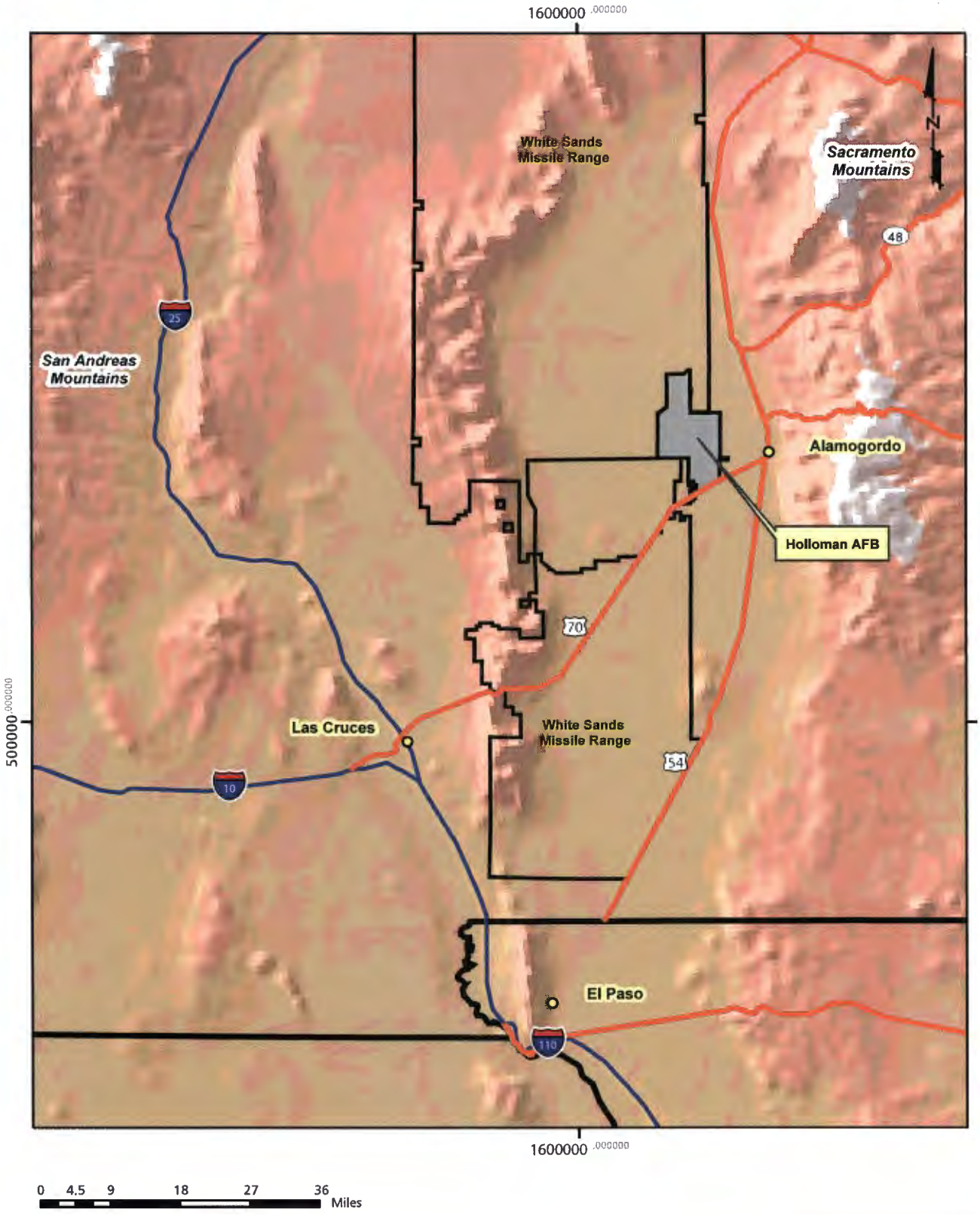
FIGURES



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05602 USA

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Figure 1-1

General Site Location Map

PROJECT NO.	SCALE	DATE	DRAWN BY:
	1"=18 Miles	2007-11-08	DRAWING NO:

TRIAD Approach Dynamic Work Plan, RCRA RFI

SWMU 183 - Basewide Sewer System, Holloman Air Force Base, New Mexico

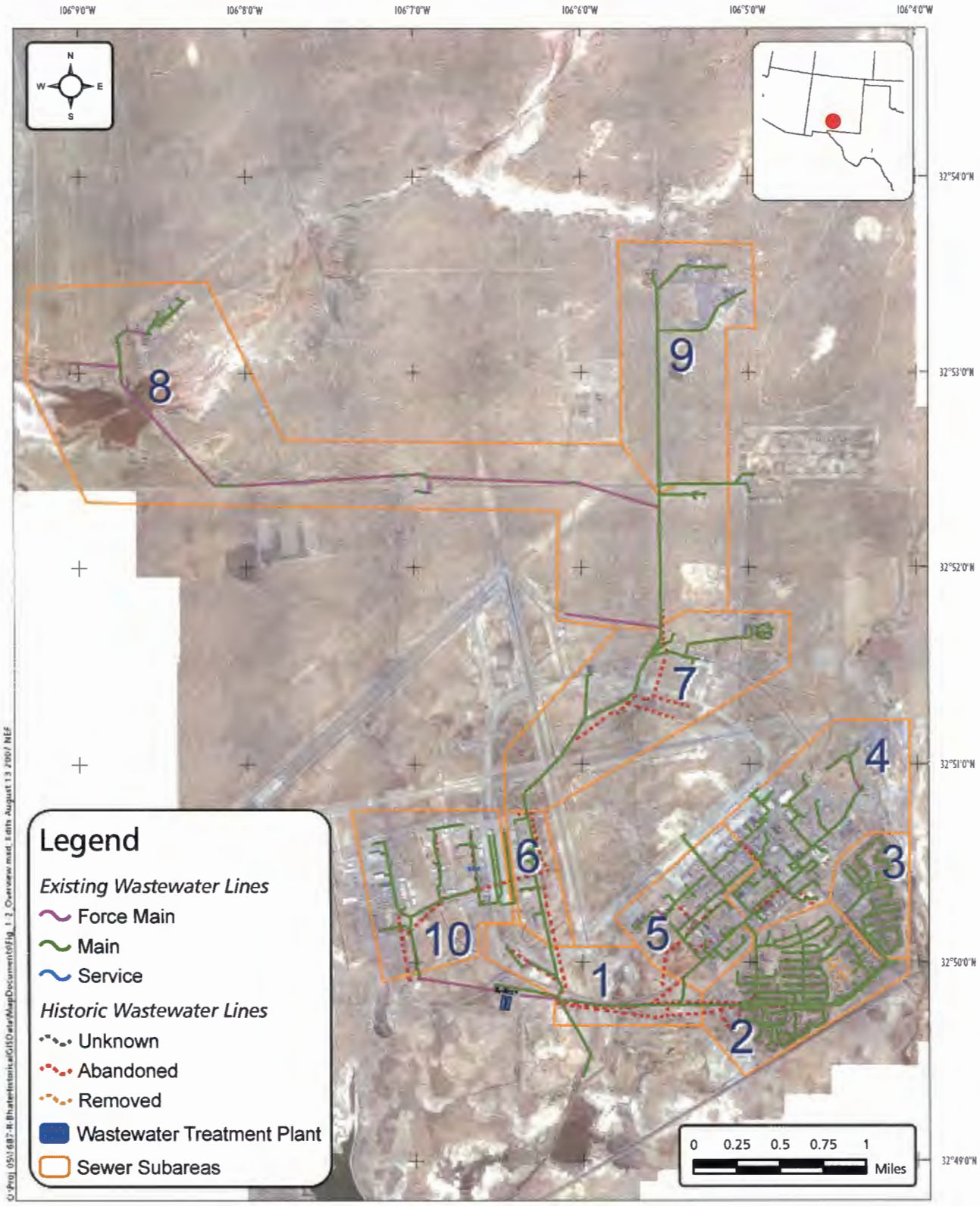

Fig 1-2: Site Location Map
SWMU183, Holloman Air Force Base, New Mexico

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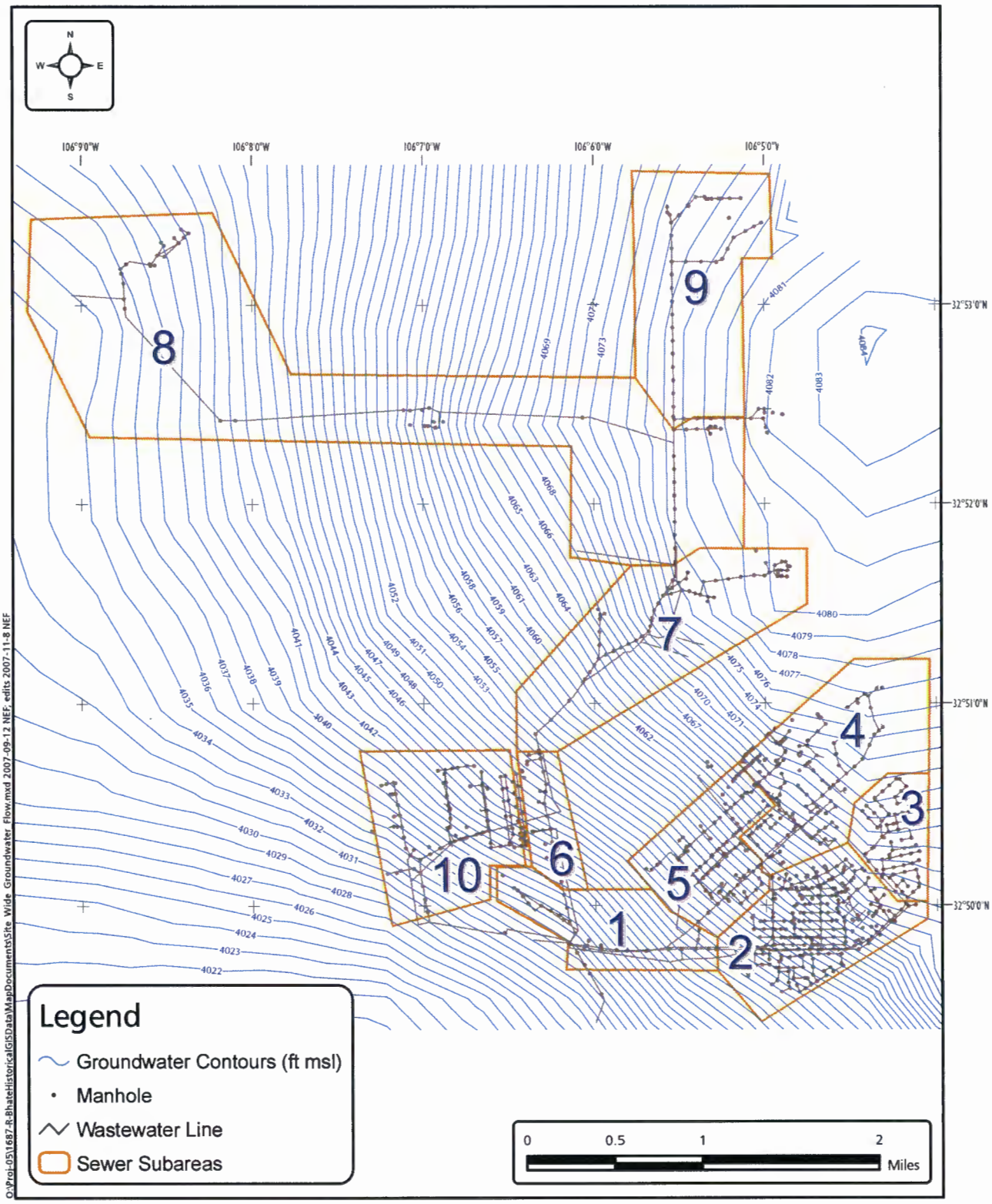

Figure 2-1: Base-wide Groundwater Flow Direction SWMU183, Holloman Air Force Base, New Mexico

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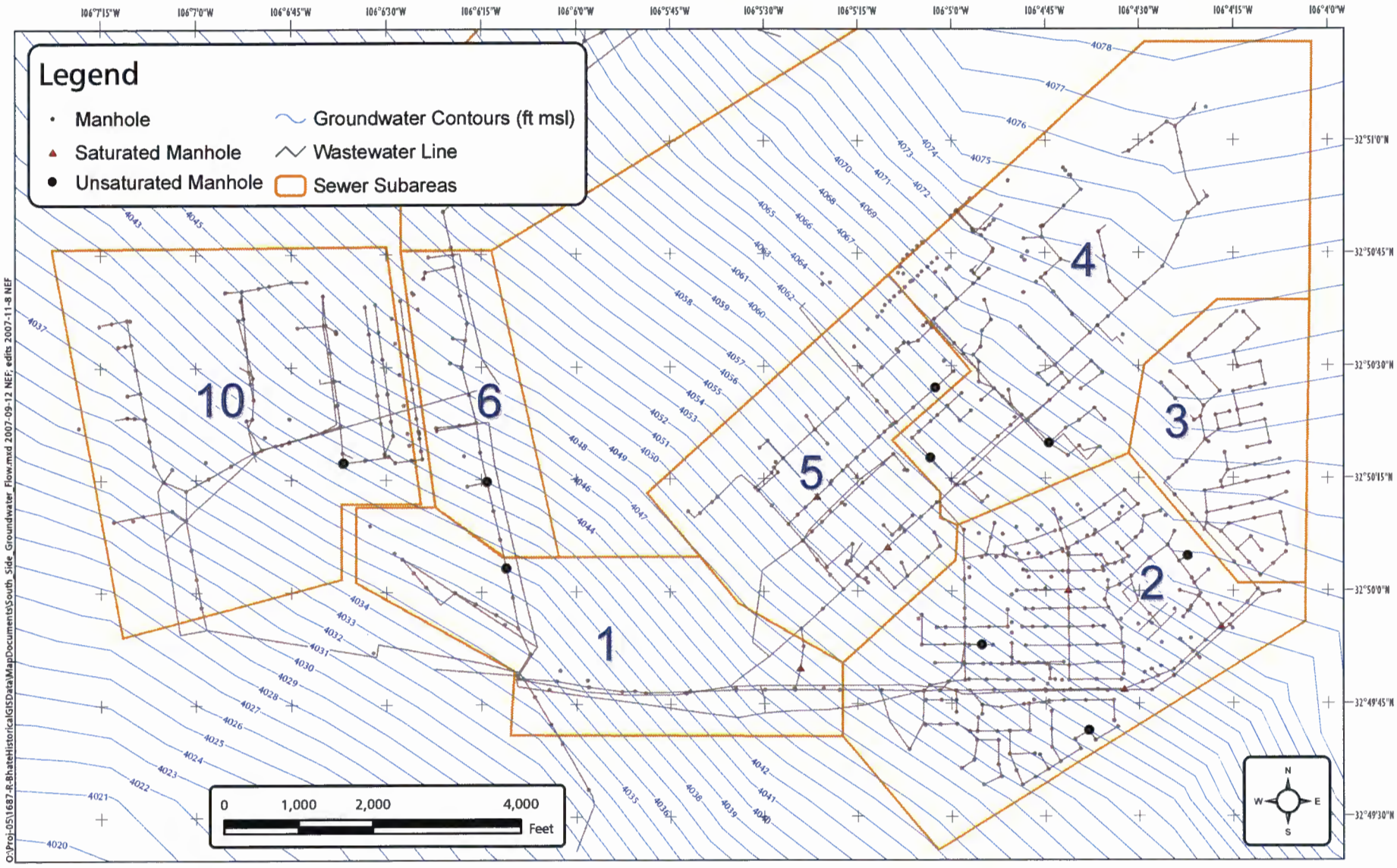

Figure 3-1: Groundwater Flow and Elevation Compared to Manhole Invert Elevations, Southern Portion of Base
SWMU183, Holloman Air Force Base, New Mexico

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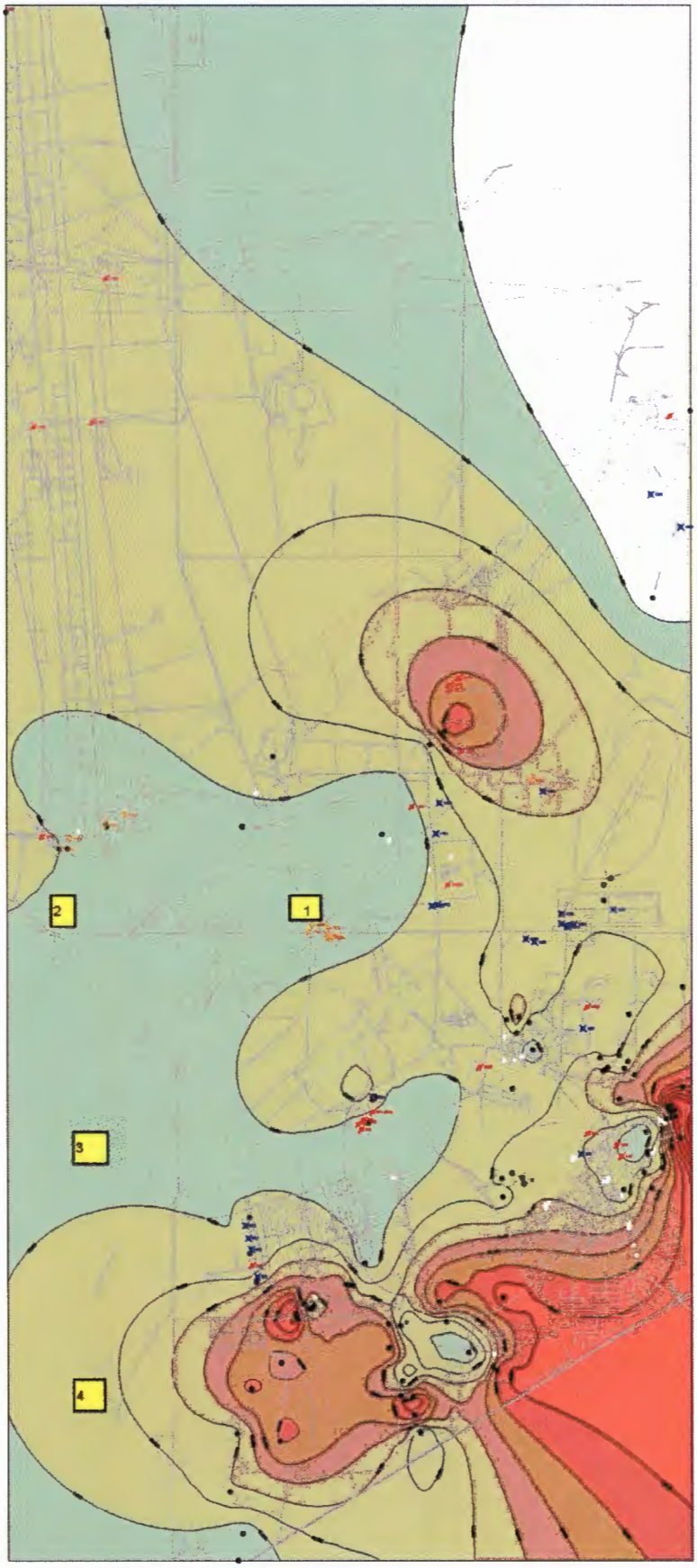
This information is depicted to provide visual aid within the context of this report and should not be used as a sole reference to precise dimensioning of all features indicated. Please verify the location of all features including underground and aboveground utilities prior to conducting any subsurface exploration or site assessment.



Color Scale:
(ppm)

75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000

Legend:

- Sampling Points
- 10,000 — Total Dissolved Solids (TDS) above 10,000 mg/L
- White Dots indicate known TDS anomalies
- 837 Active Septic Tank w/ Building Number
- 1190 Inactive Septic Tank w/ Building Number
- 1108 Removed Septic Tank w/ Building Number
- 3 Proposed Well Locations

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Figure 4-1
Total Dissolved Solids Concentrations in Groundwater

PROJECT NO.	SCALE	DATE	DRAWN BY:
	NTS	2007-11-09	DRAWING NO:

Triad Approach
Dynamic Workplan, RCRA RFI

SWMU 183 - Basewide Sewer System, Holloman Air Force Base, New Mexico

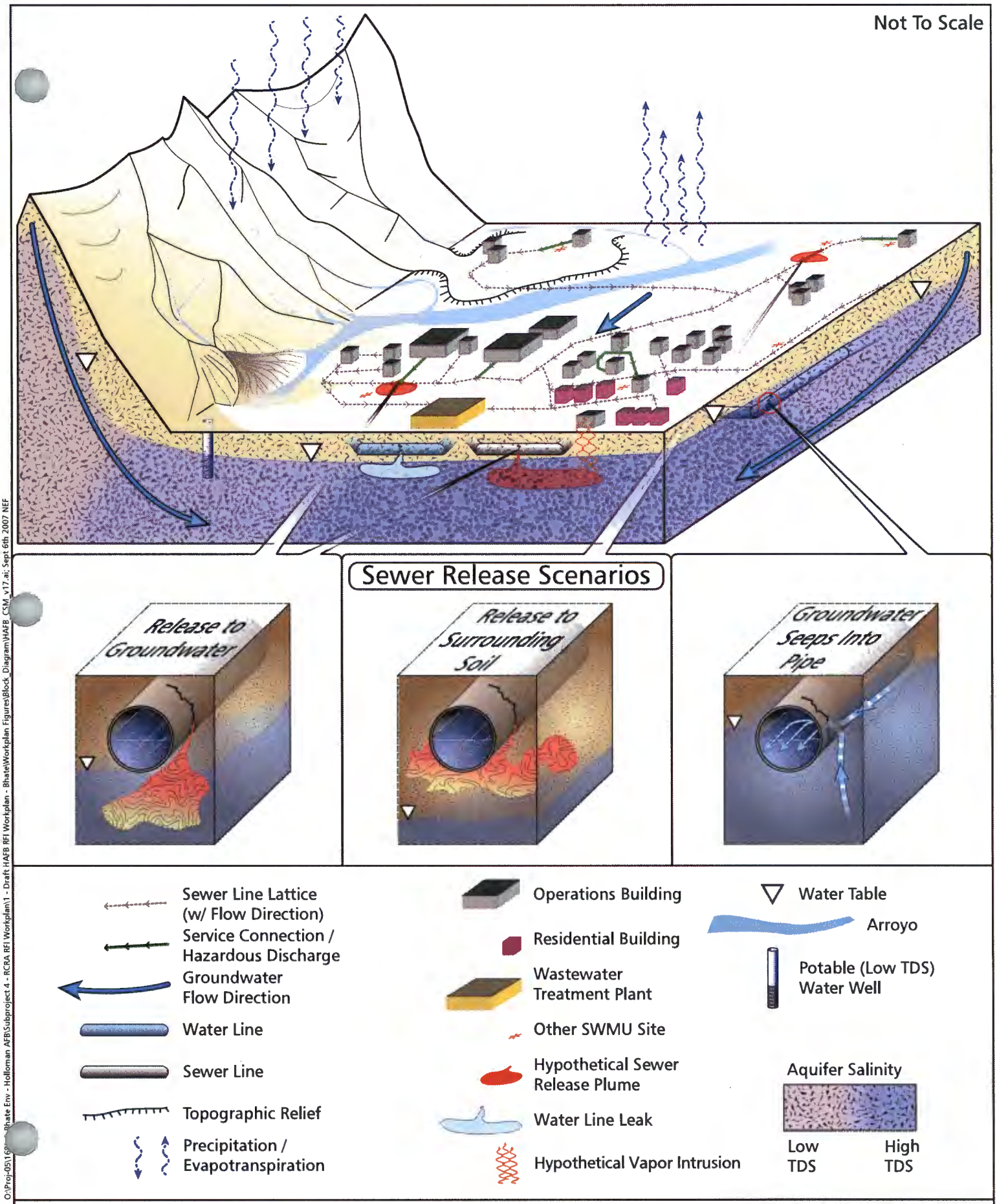

Figure 5-1: Initial Conceptual Site Model Diagram
SWMU 183, Holloman Air Force Base, New Mexico

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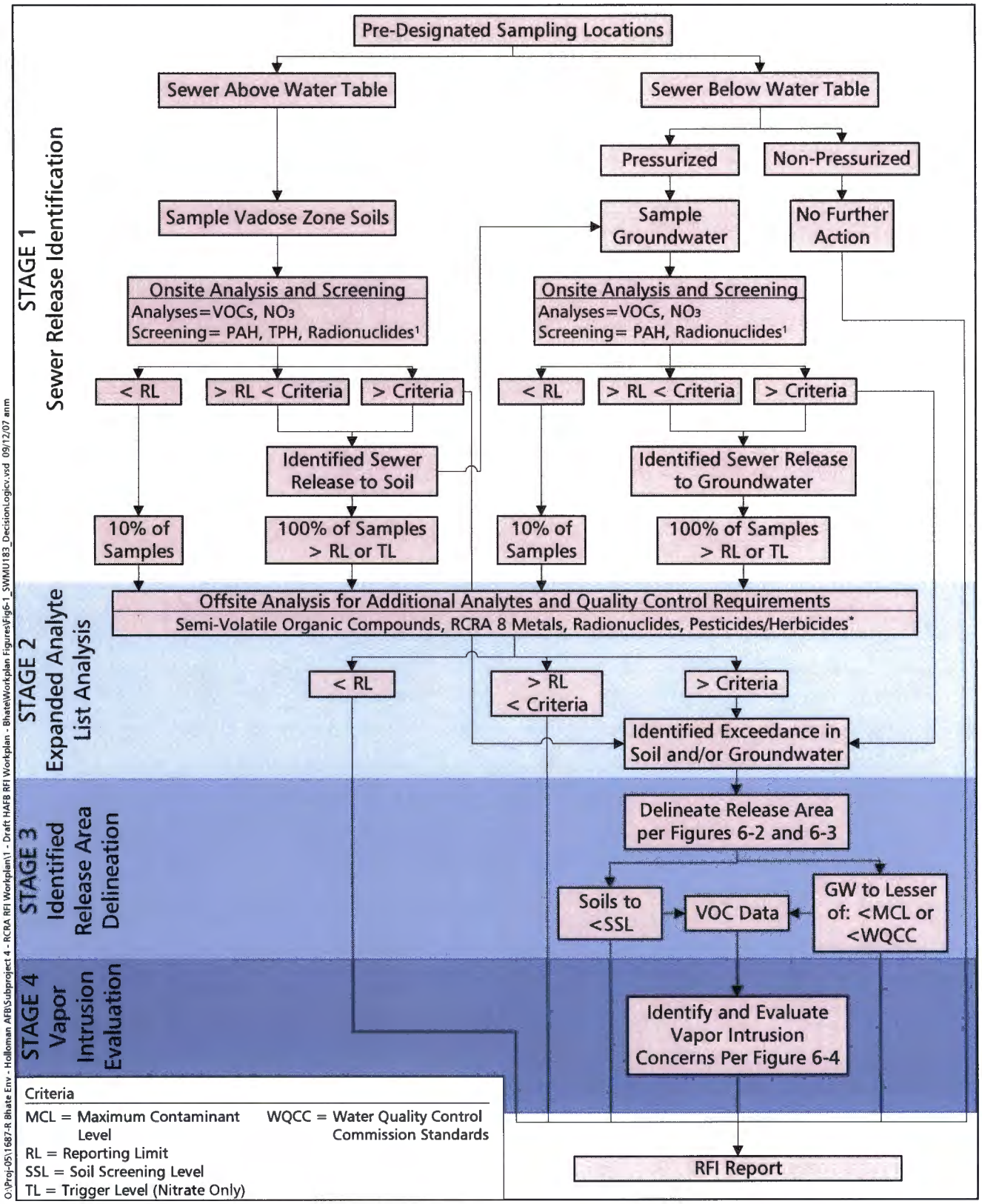

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Figure 6-1: Triad RFI Dynamic Decision Logic SWMU 183, Holloman Air Force Base, NM

Notes: * = Building 374 Only
1 = Screening via Ludlum 449 Scintillation Meter

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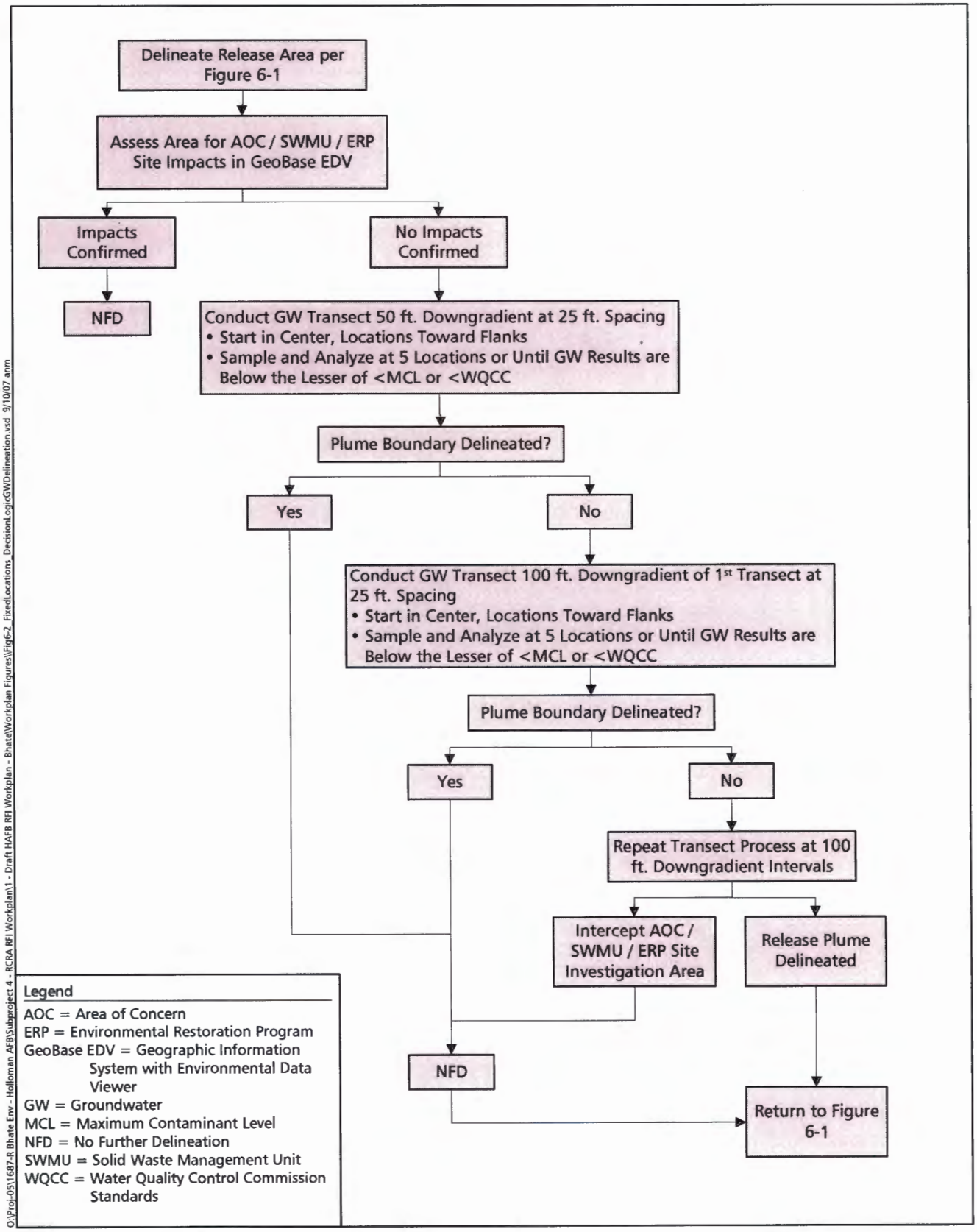

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Figure 6-2: Triad RFI Dynamic Decision Logic—Stage 3, Groundwater Delineation SWMU 183, Holloman Air Force Base, NM

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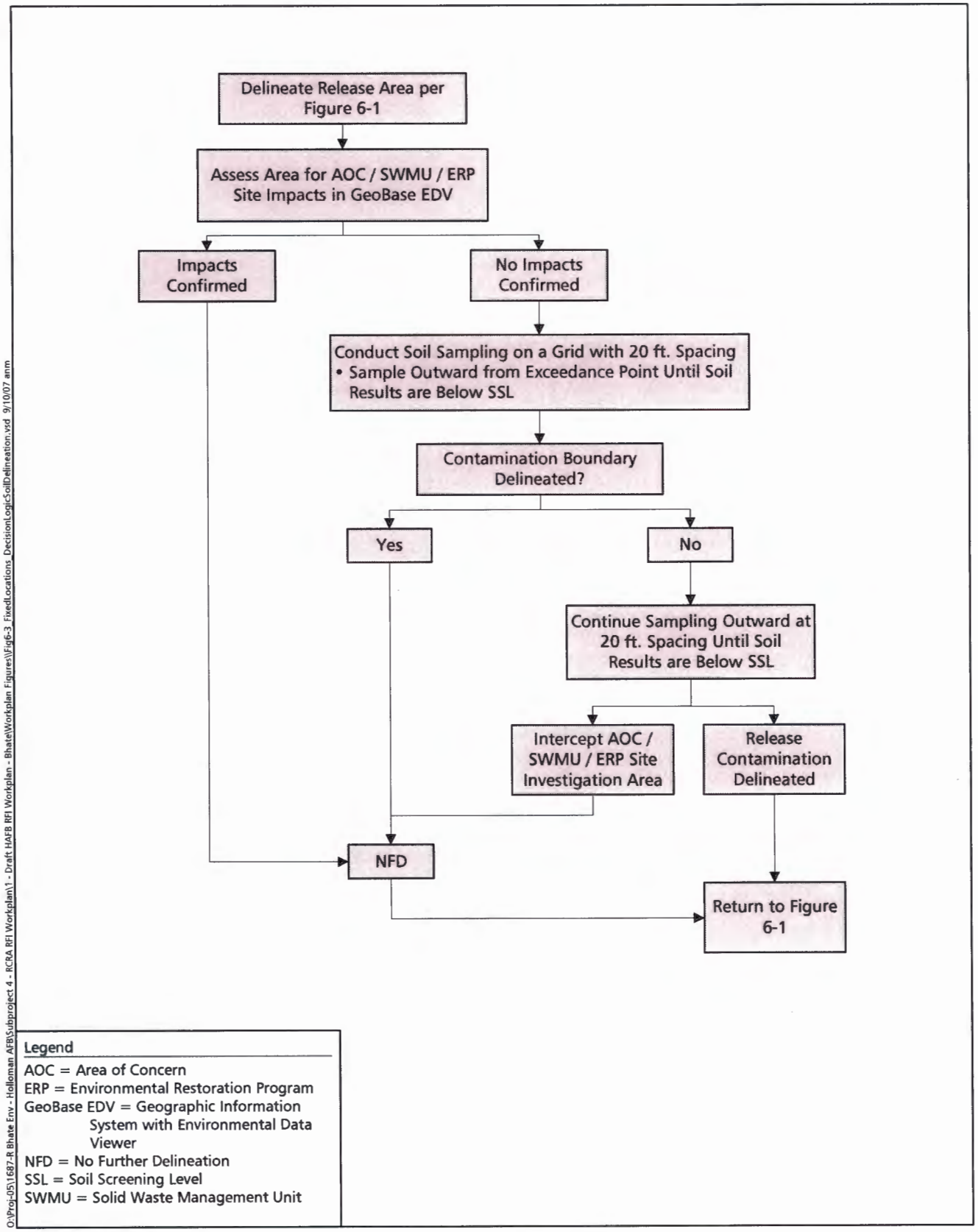

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Figure 6-3: Triad RFI Dynamic Decision Logic—Stage 3, Soil Delineation SWMU 183, Holloman Air Force Base, NM

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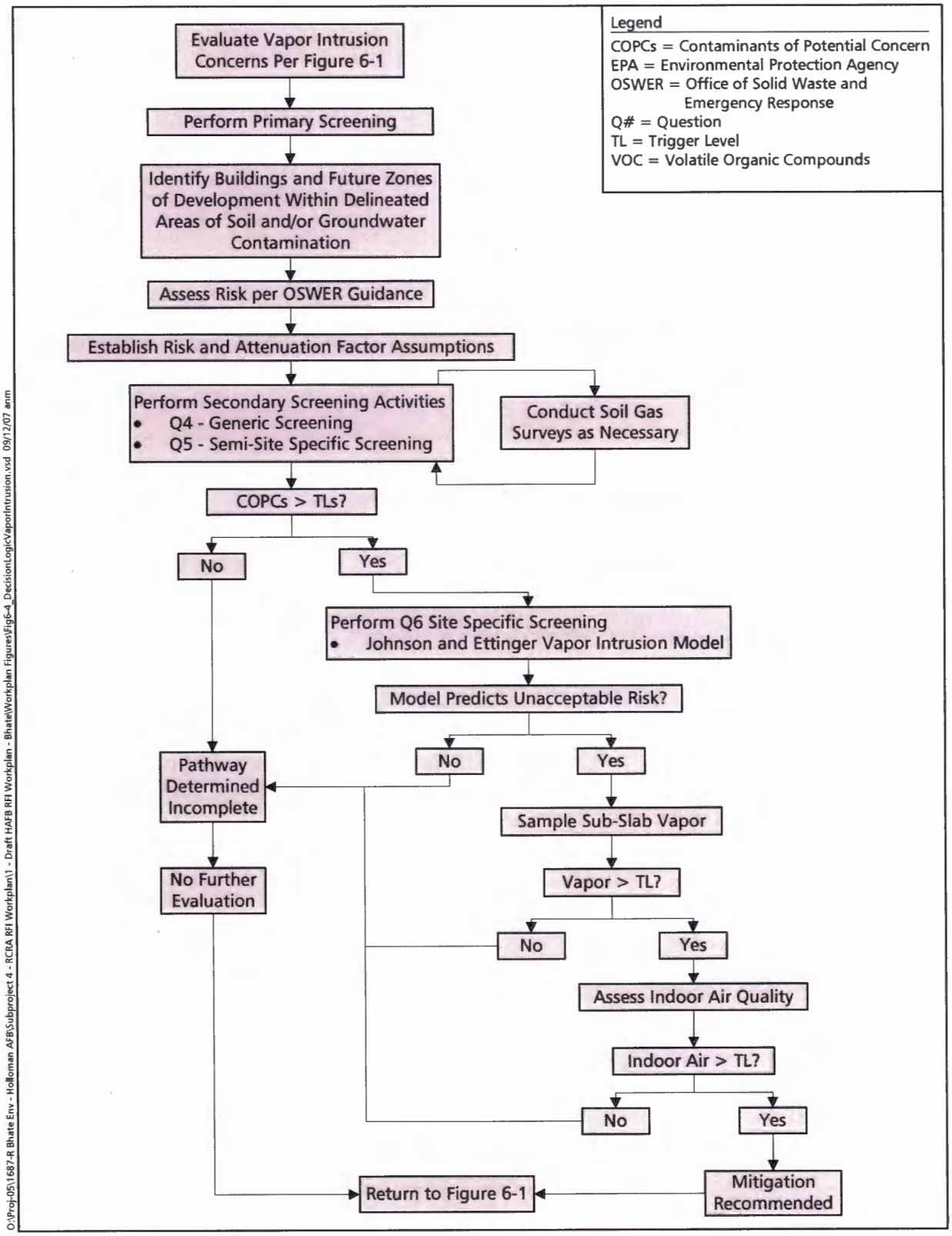

Figure 6-4: Triad RFI Dynamic Decision Logic—Stage 4, Vapor Intrusion Evaluation SWMU 183, Holloman Air Force Base, NM

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Figure 8-1: Triad RFI Project Organization Chart SWMU 183 – Holloman AFB, NM

Primary Triad Team Member = *
Field Team Leader = FTL

New Mexico Environmental Division
Albuquerque, NM

USAF
Air Combat Command
Langley AFB, VA

*Command Program Manager – Stanley Scott **

Holloman AFB
Environmental Flight 49 CES/CEV
Alamogordo, NM

Chief – Deborah Hartell
Environmental Restoration Program Project Manager – George Fish

US Army Corps of Engineers
Omaha District

*Service Program Manager – Thomas Zink, P.G. **
Geologist – Nick Geibel
Chemist – Adam Little
H&S, Risk Assessor – Judy Strawhecker

Bhate Environmental Associates, Inc.
Lakeland, CO

*Contract Program Manager – Frank Gardner, P.E.**
*Project Manager – James Moore **
Project Geologist / FTL – Katherine Thompson
Project Engineer / FTL – Bernard Wolf
GIS Specialist / FTL – Craig McGriff
Project Geologist - Zack Beck
Project Chemist - Marcia Olive
H&S Director - Brian Mueller
QA Officer - Corey Green

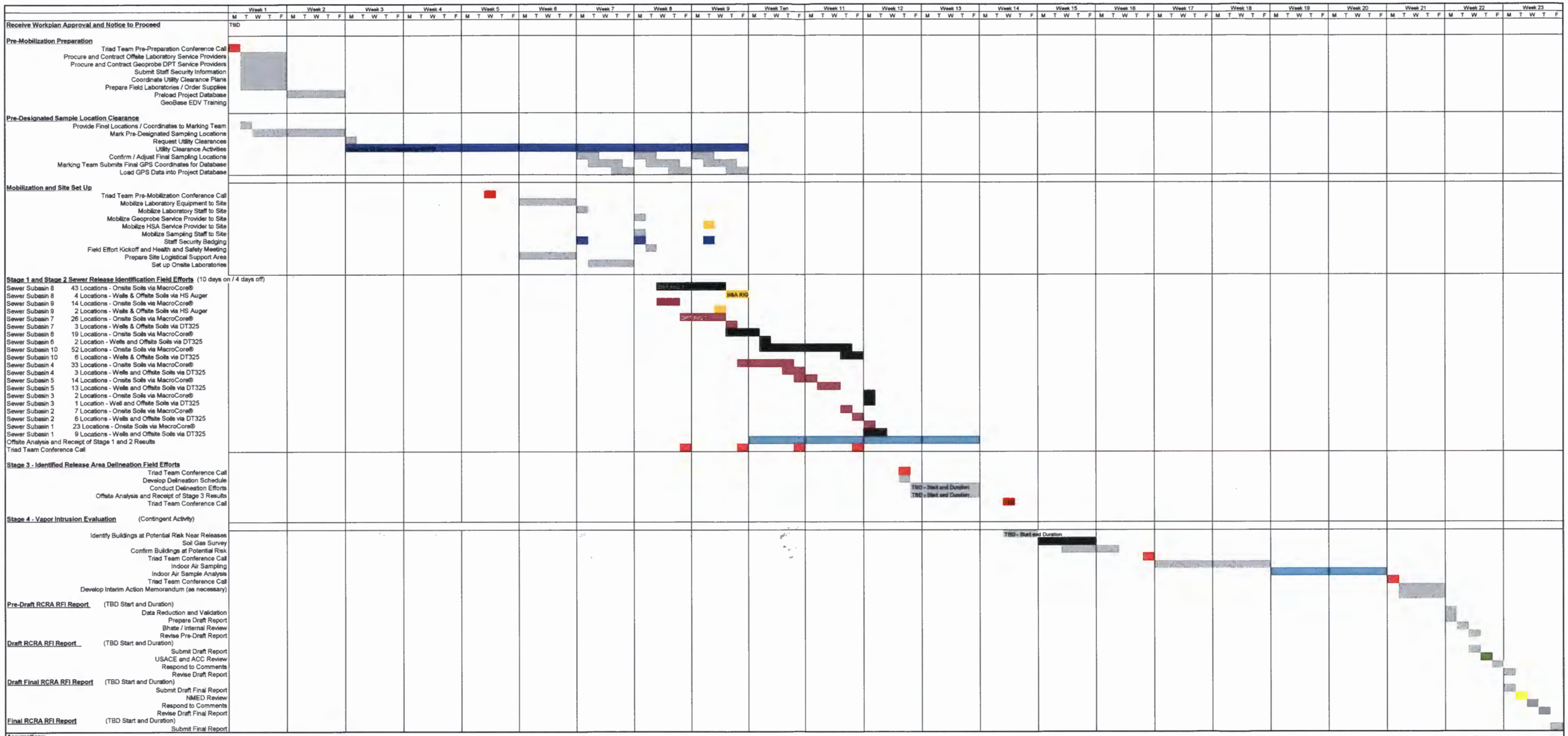
Stone Environmental, Inc.
Montpelier, VT

*Task Manager – Gerald Edwards, P.G.**
*Senior Hydrogeologist – Seth Pitkin, VP **
Onsite Laboratory Services Manager – Mike Rossi
QA Manager – Kim Watson
Database Specialist – Barbara Patterson
Web Developer – Nicholas Floersch

Support Subcontractors
New Mexico and Colorado

R&R Environmental
David Rizzuto – Logistical Support
David Lucero - Field Sampling Services
ESN Rocky Mountain – Direct Push Technologies
Test America, Denver and Los Angeles – Offsite Laboratories
General Environmental Laboratories, LLC– Offsite Laboratory

Figure 8-2: Triad RFI Project Schedule - SWMU 183 Triad RFI Project Schedule x 2 Rigs



Assumptions:

Soil core productivity = 8 cores x 12 ft bgs x 1 rig / day = 8 cores per day
Soil core productivity = 8 cores x 12 ft bgs x 2 rigs / day = 16 cores / day
1-inch prepack well installation = 1 hour / < 15 ft deep via DT-DPT
1-inch prepack well installation = 2.5 hours / 15 to 25 ft deep via DT-DPT
2-inch well installation = 4 hours / 25 to 40 ft deep via HS Auger
Duplicate soil and water samples = 10% of total locations
Matrix Spike / Matrix Spike Duplicate = 20% of total locations

DPT Rig 1
DPT Rig 2
HSA Rig

Contractor Activity
HAFB Staff Activity
Triad Team Activity
USACE Review Activity
NMED Review Activity

bhate associates

STONE ENVIRONMENTAL INC

TABLES

Table 1-1

Status of Oil Water Separator SWMU Sites

SWMU No.	Unit Name (ERP No.)	RCRA Permit Status
Table A - Sites Requiring Corrective Action		
SWMU 19	Building 638 O/WS	Table A
SWMU 20	Building 639 O/WS	Table A
SWMU 39	Building 1092 O/WS	Table A
SWMU 4	Building 131 O/WS (SD-08)	Source removal planned for 2008
SWMU 8	Building 231 O/WS	Source removal planned for 2008
Table B - Sites Requiring No Further Action		
SWMU 1	Building 55 O/WS	Table B
SWMU 1	Building 55 O/WS	
SWMU 2	Building 121 O/WS	Table B
SWMU 3	Building 130 O/WS	Table B
SWMU 6	Building 193 O/WS	Table B
SWMU 7	Building 198 O/WS	Table B
SWMU 7	Building 198 O/WS	
SWMU 9	Building 282 O/WS	Table B
SWMU 10	Building 283 O/WS	Table B
SWMU 11	Building 300 O/WS	Table B
SWMU 11	Building 300 O/WS	
SWMUs 12/13	Building 304/304A O/WS	Table B
SWMUs 12/13	Building 304/304A O/WS	
SWMU 13	Building 304A	Table B
SWMU 14	Building 306 O/WS	Table B
SWMU 14	Building 306 O/WS	
SWMU 15	Building 309 O/WS	Table B
SWMU 16	Building 315 O/WS	Table B
SWMU 16	Building 315 O/WS	
SWMU 17	Building 316 O/WS	Table B
SWMU 18	Building 500 O/WS	Table B
SWMU 21	Building 702 O/WS	Table B
SWMU 22	Building 704 O/WS	Table B
SWMU 23	Building 800 O/WS	Table B
SWMU 23	Building 800 O/WS	
SWMU 24	Building 801 O/WS	Table B
SWMU 25	Building 805 O/WS	Table B
SWMU 26	Building 809 O/WS	Table B
SWMU 27	Building 810 O/WS	Table B
SWMU 27	Building 810 O/WS	
SWMU 28	Building 822 O/WS	Table B
SWMU 28	Building 822 O/WS	
SWMU 29	Building 827 O/WS	Table B
SWMU 30	Building 830 O/WS	Table B
SWMU 31	Building 855 O/WS	Table B
SWMU 31	Building 855 O/WS	
SWMU 32	Building 868 O/WS	Table B
SWMU 33	Building 869 O/WS	Table B
SWMU 34	Building 902 O/WS	Table B
SWMU 34	Building 902 O/WS	
SWMU 35	Building 903 O/WS	Table B
SWMU 36	Building 1001 O/WS	Table B
SWMU 37	Building 1080 O/WS	Table B
SWMU 37	Building 1080 O/WS	
SWMU 38	Building 1080A O/WS	Table B
SWMU 38		
SWMU 40	Building 1166 O/WS	Table B
SWMU 41	Building 1266 O/WS	Table B
SWMU 41	Building 1266 O/WS	

Table 3 - 1
Pre-designated Triad RFI Sampling Locations
SWMU 183, Holloman Air Force Base, New Mexico

Subarea Area ID #	Location ID #	Planned Upgradient Manhole ID	Planned Downgradient Manhole ID	Segment Sequence #	Actual Upgradient Manhole ID	Actual Downgradient Manhole ID	Line Type Condition	Sampling Location Rationale	Upgradient / Nearby SWMUs / AOCs / ERP Sites	Initial Siting Latitude	Initial Siting Longitude	Actual Latitude	Actual Longitude
8	1	520	521	1			Poor	Segment Length	SWMU 71				
8	2	521	523E	2			Poor	Segment Length	SWMU 71				
8	3	Building 1178	523D				Unknown	Building 1178	SWMU 71				
8	4	Building 1178	523D				Unknown	Building 1178	SWMU 71				
8	5	Building 1178	523D				Unknown	Building 1178	SWMU 71				
8	6	Building 1185	523B				Unknown	Building 1185	No				
8	7	523E	523B	1			Poor	Segment Length	SWMU 71				
8	8	LS493V	493U	2			Force Main	LS and 1000 Ft	SWMU 71				
8	9	493T	493S	3			Good	LS and 1000 Ft	No				
8	10	LS493W	493Q	1			Force Main	LS and 1000 Ft	SWMUs 167 and 179				
8	11	LS493W	493Q	2			Force Main	LS and 1000 Ft	SWMUs 40, 128 and 138				
8	12	Test Track	SWMU 179				Unknown	Propellant Spill Drainage Pipe	SWMU 167 / SWMU 179				
8	13	Test Track	? Arroyo				Unknown	Oxidizer Spill Drainage Pipe	SWMU 167 / SWMU 179				
8	14	493Q	493P	1			Good	LS and 1000 Ft	SWMUs 40, 128 and 139				
8	15	LS493O	493N	2			Force Main	LS and 1000 Ft	No				
8	16	LS493O	493N	3			Force Main	LS and 1000 Ft	No				
8	17	LS493O	493N	4			Force Main	LS and 1000 Ft	No				
8	18	LS493L	493K	1			Force Main	LS and 1000 Ft	No				
8	19	LS493L	493K	2			Force Main	LS and 1000 Ft	No				
8	20	LS493L	493K	3			Force Main	LS and 1000 Ft	No				
8	21	LS493L	493K	4			Force Main	LS and 1000 Ft	No				
8	22	LS493L	493K	5			Force Main	LS and 1000 Ft	No				
8	23	493K	493J	6			Main	LS and 1000 Ft	No				
8	24	LS493I	493H	7			Force Main	LS and 1000 Ft	No				
8	25	LS493D	LS493C				Force Main	LS and Segment	No				
8	26	LS493C	493B	1			Force Main	PS and 1000 Ft	No				
8	27	LS493C	493B	2			Force Main	PS and 1000 Ft	No				
8	28	LS493C	493B	3			Force Main	PS and 1000 Ft	No				
8	29	LS493C	493B	4			Force Main	PS and 1000 Ft	No				
8	30	LS493C	493B	5			Force Main	PS and 1000 Ft	No				
8	31	LS493A	LS113715	1			Force Main	PS and 1000 Ft	No				
8	32	LS493A	LS113715	2			Force Main	PS and 1000 Ft	No				
8	33	LS493A	LS113715	3			Force Main	PS and 1000 Ft	No				
8	34	LS493A	LS113715	4			Force Main	PS and 1000 Ft - TO BE SAMPLED as PART of OT-32	No				
8	35	494D	494C	1			Poor	Segment Length - TO BE SAMPLED as PART of OT-32	No				
8	36	494B	494A	2			Good	1000 ft - TO BE SAMPLED as PART of OT-32	No				
8	37	492	491	1			Good	Suspected Sewer Pit Area #2 - TO BE SAMPLED as PART of OT-32	No				
8	38	490	489	2			Good	2000 ft - TO BE SAMPLED as PART of OT-32	No				
8	39	485	484	3			Good	2000 ft	No				
8	40	LS475D	475C	1			Force Main	LS and 1000 Ft	No				
8	41	LS475D	475C	2			Force Main	LS and 1000 Ft	No				
8	42	LS475D	475C	3			Force Main	LS and 1000 Ft	No				
8	43	LS475D	475C	4			Force Main	LS and 1000 Ft	No				
9	44	518	517	1			Fair	1000 ft / Segment	No				
9	45	513A	513	2			Good	1000 ft / Segment	No				
9	46	512	511	3			Good	1000 ft / Segment	No				
9	47	OWS510B	510B	1			Good	OWS / Segment	SWMU 41 / OWS 33B				
9	48	510A	510	2			Good	Segment Length	SWMU 41				
9	49	507I	507H	1			Good	1000 ft	No				
9	50	507F	507E	2			Good	1000 ft	No				
9	51	507C	507B	3			Good	1000 ft	No				
9	52	507A	507	4			Good	1000 ft	No				
9	53	505	504	1			Good	2000 ft and Suspected Sewer Pit Discharge Area #2	No				
9	54	500	499	2			Good	2000 ft	No				
9	55	495	494	3			Good	2000 ft	No				
9	56	Bldg 1226	113711	1			Unknown	Building 1226	No				
9	57	113716	113717	2			Unknown	1000 ft	No				

Table 3 - 1
Pre-designated Triad RFI Sampling Locations
SWMU 183, Holloman Air Force Base, New Mexico

Subarea Area ID #	Location ID #	Planned Upgradient Manhole ID	Planned Downgradient Manhole ID	Segment Sequence #	Actual Upgradient Manhole ID	Actual Downgradient Manhole ID	Line Type Condition	Sampling Location Rationale	Upgradient / Nearby SWMUs / AOCs / ERP Sites	Initial Siting Lattitude	Initial Siting Longitude	Actual Lattitude	Actual Longitude
7	58	701	702				Good	Line Segment	No				
7	59	708	706				Good	1000 ft	No				
7	60	OWS704	710				Good	OWS 49	No				
7	61	LS709	710	1			Force Main	Segment Length	No				
7	62	478D	478C	2			Good	1000 Ft	No				
7	63	478B	478A	3			Good	1000 Ft	No				
7	64	Bldg 1078/1080	479				Unknown	Building 1078/1080	SWMU 38				
7	65	113470	479				Unknown	OWS???	SWMU 38				
7	66	477A	477	1			Poor	Segment Length	SWMUs 36 and 126				
7	67	476	474A	2			Good	Segment Length	SWMUs 36 and 126				
7	68	483	482	1			Unknown	Segment Length	SWMUs 36 and 126				
7	69	482	474	2			Unknown	Segment Length	SWMUs 36 and 126				
7	70	472	471	3			Good	2000 ft	No				
7	71	463A	463	4			Good	2000 ft	No				
7	72	458	457	5			Fair	1000 ft / Segment	No				
7	73	457	456	6			Fair	1000 ft / Segment	No				
7	74	456	455	7			Fair	1000 ft / Segment	No				
7	75	456	455	8			Fair	1000 ft / Segment	No				
7	76	476	459				Abandoned	Line Segment	SWMUs 36 and 126				
7	77	476	459	1			Abandoned	Line Segment	No				
7	78	476	459	2			Abandoned	Line Segment	No				
7	79	476	459	3			Abandoned	Line Segment	No				
7	80	476	459	1			Abandoned	Line Segment	No				
7	81	476	459	2			Abandoned	Line Segment	No				
7	82	476	459	1			Abandoned	Line Segment	No				
7	83	476	459	2			Abandoned	Line Segment	No				
6	84	451	450				Poor	Building 866	SWMU 33				
6	85	SWMU 33	450				Good	Building 869	SWMU 33				
6	86	OWS44A-B	450				Good	Building 869 / OWS 44A and 44B	SWMU 33				
6	87	449	448	1			Good	1000 ft	No				
6	88	448	447	2			Good	Building 868	No				
6	89	446	445	3			Good	1000 ft and Building 883	No				
6	90	Bldg 877	445A				Good	Building 877 / OWS37A	No				
6	91	Bldg 898	443C				Good	Building 898	No				
6	92	443B	443A				Good	Building 898	No				
6	93	443	442A	1			Good	1000 ft and Building 898	No				
6	94	442	441	2			Good	1000 ft	No				
6	95	113683	409	1			Abandoned	1000 ft	No				
6	96	113683	409	2			Abandoned	1000 ft	No				
6	97	113683	409	3			Abandoned	1000 ft	No				
6	98	113683	409	4			Abandoned	1000 ft	No				
6	99	113683	409	5			Abandoned	1000 ft	No				
6	100	113683	409	6			Abandoned	1000 ft	No				
6	101	443C	LSX9X2	1			Abandoned	1000 ft	No				
6	102	443C	LSX9X3	2			Abandoned	1000 ft	No				
5	103	Bldg 11285	113642				Unknown	Building 11285	No				
5	104	LS 113510	LS113509				Force Main	LS	SWMU 14				
5	105	Bldg 306	113678 / 346				Unknown	Bldg 306 / OWS18	SWMU 14				
5	106	345D	345C	1			Fair	Segment Length	SWMU 11				
5	107	Bldg 301	345	2			Unknown	Building 301	SWMU 11				
5	108	Bldg 301	346A	3			Unknown	Building 301	SWMU 11				
5	109	Bldg 315	346B	4			Unknown	Building 315	SWMU 16				
5	110	LS 113510	347				Force Main	LS	SWMUs 229, 19, 20				
5	111	Bldg 332	369	1			Unknown	Building 332	No				
5	112	359	358	2			Lined	Segment Length	No				
5	113	113551	357	3			Lined	Segment Length	No				
5	114	Bldg 304	348	1			Unknown	Building 304 /OWS19B OWS40	SWMU 12, 13, 14 and 16				

Table 3 - 1
Pre-designated Triad RFI Sampling Locations
SWMU 183, Holloman Air Force Base, New Mexico

Subarea Area ID #	Location ID #	Planned Upgradient Manhole ID	Planned Downgradient Manhole ID	Segment Sequence #	Actual Upgradient Manhole ID	Actual Downgradient Manhole ID	Line Type Condition	Sampling Location Rationale	Upgradient / Nearby SWMUs / AOCs / ERP Sites	Initial Siting Lattitude	Initial Siting Longitude	Actual Lattitude	Actual Longitude
5	115	Bldg 304A	348	2			Good	Bldg 304A / OWS 19B	SWMU 12, 13, 14 and 16				
5	116	348	348A	3			Good	OWS Connection	SWMU 17 & 121				
5	117	350	349				Poor	OWS Connection	SWMU 18				
5	118	362	349	1			Poor	Segment Length	SWMU 18				
5	119	349	351	2			Good	Segment Length	Suspected Sewer / Nat Gas Leak Area				
5	120	Bldg 578	355F	1			Unknown	Building 578	No				
5	121	OWS355	355D	2			Unknown	Building 578 / OWS53	No				
5	122	LS355B	355				Force Main	Segment Length	No				
5	123	290	289	1			Good	Segment Length	No				
5	124	281	280A	2			Good	1000 ft	No				
5	125	280	11	3			Good	1000 ft	No				
5	126	375	380	1			Abandoned	Segment	No				
5	127	375	380	2			Abandoned	Segment	No				
5	128	380	6	3			Abandoned	Segment	No				
5	129	380	6	4			Abandoned	Segment	No				
4	130	OWS321E	321E				Good	Building 702 and 704 / OWS1 and OWS2	SWMUs 54, 55, 21, 22, 123				
4	131	OWS321H	321H				Good	Building 374 / OWS51	No				
4	132	LS321B	321				Force Main	Segment Length	No				
4	133	Bldg 195	324				Unknown	Building 195	No				
4	134	Bldg 195	SWMU 4				Unknown	Building 195 / OWS324	SWMU 4				
4	135	Bldg 198	324	1			Good	Building 198	SWMUs 4 and 7				
4	136	Bldg 193	323	2			Good	Building 193	SWMUs 4, 6 and 7				
4	137	325	326				Good	Segment	No				
4	138	Bldg 137	329				Good	Building 137	SWMU 5				
4	139	Bldg 55	315a				Unknown	Building 55	SWMU 1				
4	140	Bldg 308	334E				Unknown	Building 308	SWMU 15 and 120				
4	141	Bldg 309	334E	1			Unknown	Building 309	SWMU 15 and 120				
4	142	OWS113673	334E	2			Unknown	Building 309	SWMU 15 and 120				
4	143	Bldg 286	334F	1			Good	Building 286	SWMU 15 and 120				
4	144	Bldg 286	334G	2			Good	Building 286	SWMU 15 and 120				
4	145	OWS334L	LS334C	1			Unknown	OWS Connection	SWMU 15 and 120				
4	146	334I	LS334C	2			Good	Building 285	SWMU 15 and 120				
4	147	LS334C	334B	3			Force Main	Force Main	SWMU 15 and 120				
4	148	OWS337	337				Good	Building 282	SWMU 9				
4	149	336B	336				Fair	Segment Length	SWMUs 9 and 10				
4	150	340A	LS341B	1			Unknown	Building 300	SWMU 11				
4	151	LS341B	341A	2			Force Main	Force Main	SWMU 11				
4	152	340A	343	3			Abandoned	Abandoned Line	No				
4	153	Bldg 231	342A	4			Unknown	Building 231	SWMU 8				
4	154	Bldg 273	343	5			Good	Building 273	SWMU 8				
4	155	339	339A				Poor	Segment Length	SWMU 8				
4	156	344B	344				Poor	Segment Length	No				
4	157	297	296				Poor	Segment Length	No				
4	158	309C	292	1			Abandoned	Segment	No				
4	159	305A	292	2			Abandoned	Segment	No				
4	160	305A	292	3			Abandoned	Segment	No				
4	161	305A	292	4			Abandoned	Segment	No				
4	162	305A	292	5			Abandoned	Segment	No				
3	163	Bldg 15	247B	1			Unknown	Building 15	SWMUs 118, 132 and AOC-A				
3	164	Bldg 17	212	2			Fair	Building 17	No				
2	165	Bldg 18	209				Unknown	Building 18	SWMUs 118, 132 and AOC-A				
2	166	Bldg 16	200				Unknown	Building 16	SWMUs 118, 132 and AOC-A				
2	167	184	185	1			Good	Buildings 16 and 18	No				
2	168	122	118	2			Good	Buildings 16 and 18 and Segment	No				
2	169	114	114A				Good	Buildings 16 and 18 and Segment	No				
2	170	34	35	1			Pair	Buildings 15 and 17 and 2000 ft	No				

Table 3 - 1
Pre-designated Triad RFI Sampling Locations
SWMU 183, Holloman Air Force Base, New Mexico

Subarea Area ID #	Location ID #	Planned Upgradient Manhole ID	Planned Downgradient Manhole ID	Segment Sequence #	Actual Upgradient Manhole ID	Actual Downgradient Manhole ID	Line Type Condition	Sampling Location Rationale	Upgradient / Nearby SWMUs / AOCs / ERP Sites	Initial Siting Lattitude	Initial Siting Longitude	Actual Lattitude	Actual Longitude
2	171	26	25	2			Fair	Buildings 15 and 17 and 2000 ft	No				
2	172	22	21	3			Good	Buildings 15 and 17 and 2000 ft	No				
2	173	19	18	4			Good	Buildings 15 and 17 and 2000 ft	No				
2	174	LS17A	17	1			Force Main	Segment Length	No				
2	175	LS17A	17	2			Force Main	Segment Length	No				
2	176	17	X9X				Abandoned	1000 ft	No				
2	177	89	X9X				Abandoned	1000 ft	No				
1	178	439	438				Good	1000 ft	No				
1	179	OWS22	396	1			N/A	OWS22 / SWMU 27	SMWUs 27 & 56, AOC-B (ERP Site SS-65)				
1	180	Bldg 11649	396A	2			Unknown	Building 11649	SMWUs 27 & 56, AOC-B (ERP Site SS-65)				
1	181	LS395A	395	3			Force Main	Segment Length	SWMUs 27 & 56				
1	182	437	392				Good	1000 ft	No				
1	183	12	9	1			Good	2000 ft	No				
1	184	6	5	2			Good	2000 ft	No				
1	185	1	X9X	3			Good	2000 ft	No				
1	186	443	LSX9X2				Abandoned	1000 ft	No				
1	187	395	LSX9X2				Abandoned	1000 ft	No				
1	188	380	6				Abandoned	Segment	No				
1	189	280	6	1			Abandoned	Segment	No				
1	190	280	6	2			Abandoned	Segment	No				
1	191	17	X9X	1			Abandoned	1000 ft	No				
1	192	17	X9X	2			Abandoned	1000 ft	No				
1	193	17	X9X	3			Abandoned	1000 ft	No				
1	194	17	X9X	4			Abandoned	1000 ft	No				
1	195	17	X9X	5			Abandoned	1000 ft	No				
10	196	405Q	405R	1			Good	Building 21818	SWMUs 33 and 63				
10	197	113689	113688	2			No Line?	Buildings 21816 - 21814	No				
10	198	405T	405U	3			Good	Building 21812	SWMUs 32 and 125				
10	199	405W	405X	4			Good	Building 21820	No				
10	200	405Z	850	5			Unknown	Segment Length	No				
10	201	405J	405I	1			Good	Building 21819	Stealth Secure Area?				
10	202	405H	405G	2			Good	Building 21817 - 21815	Stealth Secure Area?				
10	203	405F	405E	3			Good	Building 21813 - 21811	Stealth Secure Area?				
10	204	405P	405O	1			Good	Building 21819	Stealth Secure Area?				
10	205	405N	405M	2			Good	Building 21817 - 21815	Stealth Secure Area?				
10	206	405L	853	3			Unknown	Building 21813 - 21811	Stealth Secure Area?				
10	207	OWS405B	405B	1			Unknown	OWS	No				
10	208	405B	405A	2			Good	Building 800	SWMU 23				
10	209	OWS405	405	3			Good	Building 800 / OWS23B	SWMU 23				
10	210	399	400	1			Abandoned	Abandoned / Adjacent New Line	SWMU 26 and 31				
10	211	399	400	2			Good	Building 830 / SWMU 30 / OWS27A	SWMU 30				
10	212	OWS400	400	3			Good	Building 830 / SWMU 30 / OWS27B	SWMU 30				
10	213	OWS402-2	402	4			Unknown	Building 822 / OWS25B	SWMUs 28, 29 and 230				
10	214	OWS402-1	113699	5			Unknown	Building 827 / OWS26	SWMU 28, 29 and 230				
10	215	OWS418	418				Unknown	Building 837 / OWS31	No				
10	216	417	417	1			Poor	OWS29B	SWMU 25 and 31				
10	217	416	415	2			Good	Segment Length	No				
10	218	415C	415				Good	Segment Length	No				
10	219	Bldg 851	415/415A	1			Abandoned	Building 851	No				
10	220	415A	414	2			Abandoned	Abandoned / Adjacent New Line	No				
10	221	OWS412	412				Unknown	Building 856 / OWS38	No				
10	222	OWS411A	411A	1			Good	Building 844 / OWS36B	No				
10	223	410A	410	2			Good	Building 897	No				
10	224	418A	419				Good	1000 ft - UST LEAK AREA	No				
10	225	422B	422B	1			Good	Building 918 / OWS39	No				
10	226	OWS422B	422B	2			Good	Building 918 / OWS39B and 39C	No				
10	227	422A	422	3			Good	Building 918	No				

Table 3 - 1
Pre-designated Triad RFI Sampling Locations
SWMU 183, Holloman Air Force Base, New Mexico

Subarea Area ID #	Location ID #	Planned Upgradient Manhole ID	Planned Downgradient Manhole ID	Segment Sequence #	Actual Upgradient Manhole ID	Actual Downgradient Manhole ID	Line Type Condition	Sampling Location Rationale	Upgradient / Nearby SWMUs / AOCs / ERP Sites	Initial Siting Lattitude	Initial Siting Longitude	Actual Lattitude	Actual Longitude
10	228	420	421	1			Good	Building 901	No				
10	229	422	423	2			Good	Building 901	No				
10	230	424	425	1			Good	Building 902	No				
10	231	425	426	2			Good	Building 902	No				
10	232	Bldg 907	426B	1			Unknown	Building 907 / OWS29A and 29B	SWMUs 34 and 35				
10	233	426B	426A	2			Good	Building 903 / OWS50	SWMUs 34 and 35				
10	234	426	427	3			Good	Building 907	SWMUs 34 and 35				
10	235	428	430A	1			Good	1000 ft	No				
10	236	430A	430	2			Poor	Segment Length	No				
10	237	431B	431A				Good	Segment Length	No				
10	238	431	432	1			Good	1000 ft	No				
10	239	433	434	2			Poor	Segment Length	No				
10	240	LS436A	LSX9X1	1			Force Main	LS and 1000 Ft	No				
10	241	LS436A	LSX9X1	2			Force Main	LS and 1000 Ft	No				
10	242	LS436A	LSX9X1	3			Force Main	LS and 1000 Ft	No				
10	243	LS436A	LSX9X1	4			Force Main	LS and 1000 Ft	No				
10	244	LS436A	LSX9X1	5			Force Main	LS and 1000 Ft	No				
10	245	113683	113511	1			Abandoned	1000 ft	SWMU 24				
10	246	Bldg 816	404	2			Good	OWS24A and 24B / Abandoned Line	SWMUs 24 and 91				
10	247	407	408	3			Abandoned	Abandoned / Adjacent New Line	No				
10	248	409	LS436A	4			Abandoned	1000 ft	No				
10	249	409	LS436A	5			Abandoned	1000 ft	No				
10	250	430A	LS436A	1			Abandoned	1000 ft	No				
10	251	409	LS436A	2			Abandoned	1000 ft	No				
10	252	409	LS436A	3			Abandoned	1000 ft	No				
Totals													

Bold boxes indicate unique lattice segments or long lengths without manholes

Table 3-2

Pollutants of Concern Known to Have Been Discharged to Sewer System

Name of Compound	Abbreviation
Petroleum, Oils, and Lubricants	POL
Biological Oxygen Demand	BOD
Chemical Oxygen Demand	COD
Metals / Heavy Metals	-
Volatile Organic Compounds	VOCs
Semi-Volatile Organic Compounds	SVOCs
Total Suspended Solids	TSS
Surfactants	-
Oil & Grease	O&G
Process / Developer Chemicals	-
Herbicides / Pesticides	-
Antifreeze	-
Phosphates	-
Sulfates	-
Chlorides	-
Phenol	
Radionuclides (Carbon-14, Tritium, Iodine 125, Radium 226 and 228)	-

Table 3-3

Types of Wastewater-Generating Processes

Bulk Washing Activities	Unique Process Activities
Rack Washing	X-ray Processing
Floor washing	Hospital Sterilization
Vehicle Washing	Hospital Sinks
Equipment Washing	Hospital Boiler/Chiller Systems
Aircraft Washing	Radiator test tanks
Ground Equipment Washing	Glass grinding coolant
Engine Washing	Aqueous Film-Forming Foam (AFFF)
Trench Drain Flushing	Photoprocessing
Trailer Washing	Laboratory Canister Rinsing
Mop Rinsing	Glassware Rinsing
	Non-Destructive Inspection (NDI) – Liquid Fluorescent Penetrant
	Tungsten inert gas (TIG) Welder coolant
	Heat Treatment Furnace Coolant
	Fuel-Contaminated Groundwater
	Reverse Osmosis Water Purification Unit (ROWPU) Purging

Table 4-1

Plant Species Observed at HAFB

Common Name	Scientific Name
Desert holly	*Acourtia nana*
Iodine bush (or pickleweed bush)	*Allenrolfea occidentalis*
Western ragweed	*Ambrosia psilostachya*
Fourwing saltbush	*Atriplex canescens*
Seep willow	*Baccharis salicifolia*
Thistle	*Cirsium undulatum*
Alkaliweed	*Cressa truxillensis*
Fluffgrass	*Dasyochloa pulchella*
Tansymustard	*Descurainia pinnata*
Desert saltgrass	*Distichlis spicata var. stricta*
Spectaclepod	*Dithyrea wislizeni*
Fendler's hedgehog	*Echinocereus fenderli*
Flaming torch hedgehog	*Echinocereus triglochidiatus*
Torrey's jointfir	*Ephedra torreyana*
Buckwheat	*Eriogonum spp.*
Coryphantha (or spinystar)	*Escobaria vivipara*
Tarbush	*Flourensia cernua*
Broom snakeweed	*Gutierrezia sarothrae*
Salt heliotrope	*Heliotropium curassavicum*
Tobosa	*Hilaria mutica*
Bushpea	*Hoffmanseggia glauca*
Hymonepappus	*Hymenopappus spp.*
Allthorn	*Koeberlinia spinosa*
Creosotebush	*Larrea tridentata*

Common Name	Scientific Name
Peppergrass	*Lepidium virginicum*
Bladderpod	*Lesquerella spp.*
Wolfberry	*Lycium berlandieri*
Blazingstar	*Mentzelia multiflora*
Bush muhly	*Muhlenbergia porteri*
Ring muhly	*Muhlenbergia torreyi*
Prickly pear	*Opuntia spp.*
Purple prickly pear	*Opuntia violacea*
Tulip prickly pear	*Opuntia phaeacantha*
Plains prickly pear	*Opuntia polycantha*
Walkingstick cholla	*Opuntia imbracata*
Tasajillo	*Opuntia leptocaulis*
Mariola	*Parthenium incanum*
Devil's claw	*Proboscidea parviflora*
Honey mesquite	*Prosopis glandulosa*
Curly dock	*Rumex crispus*
Russian thistle	*Salsola kali*
Burrograss	*Scleropogon brevifolius*
Silverleaf nightshade	*Solanum elaeagnifolium*
Globemallow	*Sphaeralcea spp.*
Spear globemallow	*Sphaeralcea subhastata*
Alkali sacaton	*Sporobolus airoides*
Neally dropseed	*Sporobolus nealleyi*
Saltcedar	*Tamarix ramosissima*
Grama grass cactus	*Toumeya papyracantha*
Soaptree yucca	*Yucca elata*

Table 4-2

Herpetofauna Species Observed at HAFB

Common Name	Scientific Name
Little striped whiptail	*Cnemidophorus inornatus*
New Mexico whiptail	*Cnemidophorus neomexicanus*
Checkered whiptail	*Cnemidophorus tesselatus*
Western diamondback rattlesnake	*Crotalus atrox*
Western prairie rattlesnake (or Western rattlesnake)	*Crotalus viridis*
Common collared lizard	*Crotaphytus collaris*
Long-nosed leopard lizard	*Gambelia wislizenii*
Lesser earless lizard	*Holbrookia maculata*
Coachwhip	*Masticophis flagellum*
Texas horned lizard	*Phrynosoma cornutum*
Short-horned lizard	*Phrynosoma modestum*
Gopher snake	*Pituophis melanoleucus*
Couch's spadefoot toad	*Scaphiopus couchii*
Desert spiny lizard	*Sceloporus magister*
Massasauga	*Sistrurus catenatus*
Ground snake	*Sonora semiannulata*
Side-blotched lizard	*Uta stansburiana*

Table 4-3

Bat Species Observed at HAFB

Common Name	Scientific Name
Pallid bat	*Antrozous pallidus pallidus*
Mexican free-tailed bat	*Tadarida brasiliensis*
Hoary bat	*Lasiurus cinereus*
Small-footed myotis	*Myotis ciliolabrum melanorhinus*
California myotis	*Myotis californicus*
Townsend's big-eared bat	*Corynorhinus townsendii*
Silver-haired bat	*Lasionycteris noctivagans*
Spotted bat	*Euderma maculatum*

Table 4-4

Rodent Species Observed at HAFB

Common Name	Scientific Name
Desert Pocket Mouse	*Chaetodipus penicillatus*
Merriam Kangaroo Rat	*Dipodomys merriami*
Ord's Kangaroo Rat	*Dipodomys ordii*
House Mouse	*Mus musculus*
Southern Plains Woodrat	*Neotoma micropus canescens*
Mearn's Grasshopper Mouse	*Onychomys arenicola*
Plains Pocket Mouse	*Perognathus flavescens*
Plains Pocket Mouse (lighter pelage)	*Perognathus flavescens gypsi*
Silky Pocket Mouse	*Perognathus flavus*
Cactus Mouse	*Peromyscus eremicus*
White-footed Mouse	*Peromyscus leucopus*
Deer Mouse	*Peromyscus maniculatus*
Western Harvest Mouse	*Reithrodontomys megalotis*
Spotted Ground Squirrel	*Spermophilus spilosoma*

Table 4-5

Bird Species Observed at HAFB

Common Name	Scientific Name
Raptors	
Turkey vulture	*Cathartes aura*
American kestrel	*Falco sparverius*
Red-tailed hawk	*Buteo jamaicensis*
Northern harrier	*Circus cyaneus*
Goatsuckers	
Lesser nighthawk	*Chordeiles acutipennis*
Perching Birds and Neotropical Shorebirds	
Horned lark	*Eremophila alpestris*
Cactus wren	*Campylorhynchus brunneicapillus*
Black-throated sparrow	*Amphispiza bilineata*
Western meadowlark	*Sturnella neglecta*
Scott's oriole	*Icterus parisorum*
American avocet	*Recurvirostra Americana*
Green heron	*Butorides virescens*
Western kingbird	*Tyrannus verticalis*
Blue grosbeak	*Guiraca caerulea*
Flycatchers	*Empidonax sp.*
Wilson's warbler	*Wilsonia Canadensis*
Shorebirds and Waterfowl	
Mallards	*Anas platyrhynchos*
Northern shoveler	*Anas clypeata*
Blue-winged teal	*Anas discors*

Common Name	Scientific Name
Lesser scaup	*Aythya affinis*
Ring-necked duck	*Aythya collaris*
Ruddy duck	*Oxyura jamaicensis*
Snowy plover	*Charadrius alexandrinus nivosus*
Wilson's phalarope	*Phalaropus tricolor*

Table 5-1: Initial Conceptual Site Model For SWMU 183, Holloman AFB, New Mexico				
Key Site Decisions				
Primary Decision	**Subsidiary Decision**	**Decision Information Requirements**	**Status**	**Required Action**
Can SWMU 183 be closed?	A. Are there ongoing sources of contamination from the sewer to the environment?	Either of the following: 1) Saturated soils between the sewer line and the water table, and 2) visual and/or olfactory evidence of a release in soil and/or groundwater samples, corroborated by analytical results indicating the presence of wastewater-borne contamination.	Previous studies of the sewer system indicate that releases have occurred in a limited number of known areas, and may have occurred in other areas based on the observed degraded condition of sewer lines.	Implement soil and groundwater sampling and analysis program along the sewer system.
	B. Is the quality of soils acceptable?	Soil sample analytical results at or near the sewer line are below New Mexico Environment Department (NMED) Soil Screening Levels (SSLs).	Soil analytical data along the sewer line does not exist, except for in areas where the sewer system transits other Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), or Environmental Restoration Program (ERP) sites.	Sample and analyze soils along the sewer line. Compare soil sampling and analysis results to SSLs.
	C. Is groundwater quality acceptable?	Groundwater sample analytical results at or near the sewer line are below New Mexico Water Quality Control Commission (WQCC) standards or Maximum Contaminant Levels (MCLs) (the lower of the two) if groundwater is potable (<10,000 milligrams per liter [mg/L] Total Dissolved Solids [TDS]).	Groundwater analytical data along the sewer line does not exist, except for in areas where the sewer system transits other SWMUs, AOCs, or ERP sites.	Sample and analyze groundwater where soil sampling and analyses results indicate a release, where pressurized sewer lines exist below the water table or where the water table is within 1 foot of the sewer line piping. Compare reported contaminant concentrations with WQCC standards and MCLs.
		Total Dissolved Solids (TDS) concentrations in groundwater are <10,000 mg/L. Groundwater of this quality is present in sufficient quantities to exploit for extraction and use.	Natural TDS levels exceed 10,000 mg/L. Local zones of lower TDS groundwater exist as related to releases from subsurface water supply systems.	Collect TDS sample wherever groundwater is sampled. Evaluate TDS level in context of regional TDS levels.
	D. Is measurable non-aqueous phase liquid (NAPL) present?	Visual evidence of light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) in soil and/or groundwater samples, or concentrations at or near the effective solubility limit.	Undefined	Determine if NAPL is present by soil sampling and, if indicated, groundwater sampling.
	E. Is there an unacceptable level of risk for indoor air quality?	Contaminants are present in soils and/or groundwater near a building at concentrations that could potentially result indoor air contamination.	Undefined	Conduct vapor intrusion evaluations per U.S. Environmental Protection Agency (USEPA) guidance where warranted.
Which parts of SWMU 183 can be broken out for closure?	Is contamination resulting from sewer line leakage pervasive or isolated?	Spatially distributed soil and/or groundwater analytical data.	Soil and groundwater analytical data along the sewer line does not exist, except for in areas where the sewer system transits other SWMUs, AOCs, or ERP sites.	Perform spatial analysis of soil and/or groundwater data in excess of regulatory criteria to determine extent of contamination.

Table 5-1: Initial Conceptual Site Model For SWMU 183, Holloman AFB, New Mexico			
Key Site Decisions			
CSM Element			
Facility	**Conceptual Understanding**	**Status**	**Required Action**
1) Current Structures	165,000 linear feet of active sewer line. 523 manholes, 20 lift stations and force mains, 17 wash racks. 42 oil water separators (OWS). 55 direct industrial discharges. Wastewater treatment plant (WWTP) located at the southern-central boundary of base.	Several reports on sewer line detail the condition of the majority of the sewer line. Data from these reports have been incorporated into GeoBase Environmental Data Viewer (GeoBase EDV), a geographic information system (GIS) which served as the basis for the SWMU Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) design.	None.
2) Historical / Inactive Structures	Approximately 50 OWS. Approximately 30,000 feet of abandoned lines.	Same as above. Environmental data are presently incorporated as relational files to fixed data sources.	None at present. Incorporate tabulated data into GeoBase EDV for advanced spatial analysis, as needed.
3) Process Types / Areas	WWTP 1.5 million gallons per day (MGD) design flow. Average flow 1 MGD, OWS contribute 0.01 MGD, non industrial buildings contribute 0.79 MGD, sanitary flows 0.427 MGD, industrial/commercial 0.58 MGD, infiltration/inflow (I/I) 0.542 MGD.	Process understood. Additional infiltration/inflow study being performed (as of September 2007).	None.
4) Waste Management Practices	Pollution prevention, Defense Reutilization Marketing Office (DRMO), Destroyed in Process, vendor recycling, industrial discharge to sewer.	Processes in place. Buildings with former or current discharge to sewer are identified within the GeoBase EDV.	None.
5) Adjacent Properties / Features	Miscellaneous base operations and facilities.	Operational buildings and facility locations are identified within the GeoBase EDV.	None.
6) Other Potential Sources Located Nearby	All SWMUs, AOCs, and ERP sites.	Other environmental site locations are identified within the GeoBase EDV.	None.
7) Utilities	Water lines, natural gas lines, fiber optic cables, some power service lines, base operations communication lines.	Defined.	Utility clearances required prior to subsurface investigation.
Land Use	**Conceptual Understanding**	**Status**	**Required Action**
1) Current and Future Land Uses	Current use as U.S. Air Force Base with mixed industrial and residential uses. NMED requires comparison of results to residential soil standards for current uses and future planned development uses.	Current land uses defined. Future land uses undefined.	None at present. Confirm future land use plans for areas where releases are identified.
2) Beneficial/Natural Resources	High TDS concentrations in groundwater precludes use of aquifer for potable water. Wide range of flora and fauna exist on site. Burrowing owl and oplimato falcon, both threatened or endangered species, known to exist on base.	TDS data exists for various areas within the Base property boundaries.	Collect TDS with any groundwater sample. Incorporate TDS data into GeoBase EDV.

Table 5-1: Initial Conceptual Site Model For SWMU 183, Holloman AFB, New Mexico			
Key Site Decisions			
3) Resource Use Locations	None.	Defined.	None.
4) Subpopulations	Schools, daycare, hospital, child development center.	Data are available.	Determine whether any sensitive subpopulations are present in proximity to identified sewer release areas.
5) Applicable Exposure Scenarios	Possible construction worker exposure. Possible indoor air exposure scenario for volatile organic compounds (VOCs.)	Undefined.	Undertake sampling & analysis program to determine if releases are present and if they pose a related risk at specific locations.
6) Exposure Pathways	Potential dermal, ingestion and/or inhalation exposure pathways for construction workers. Possible indoor air inhalation pathway via vapor intrusion.	Undefined.	Undertake sampling and analysis program to determine if releases are present and if they pose a related risk.
Physical Features	**Conceptual Understanding**	**Status**	**Required Action**
1) Topography	Regional topographic surface generally level. Arroyos trending from northeast to southwest.	Defined.	None.
2) Surface Water Features	Primary features include Lost River, Dillards Draw, and Rita's Draw.	Defined.	None.
3) Geology	Alluvial fans at basin edges (sands & gravels-limestone, dolomite, gypsum). In basin center (at the base) primarily lacustrine and eolian deposits of fine sand, silt and silty clay. Some caliche layers present.	Regionally defined. Site specific geology needs confirmation.	Evaluate and describe site specific geology during soil sampling activities.
4) Hydrogeology	Internally draining basin with flow inward from the mountains toward the center. Fresh water present in alluvial deposits at the basin edges with increasing TDS in the basin center. Water table aquifer at depths of 5 to 50 feet below ground surface (bgs). Hydraulic conductivities in the range of 10-4 to 10-6 centimeters per second (cm/sec).	Partially defined.	If plumes are detected, additional data on location-specific hydrogeology may be necessary and can be acquired during delineation step
5) Hydrology	Average annual rainfall is 8 inches. Average annual evapotranspiration (ET) rate is 67 inches. Intermittent storm flows in arroyos during storm events primarily in mid to late summer.	Defined.	None.
6) Water Resources	Groundwater transported from foot of Sacramento Mountains ranging from 6 to 30 miles east. No water resources on Base. Aqueduct from Lake Bonita, located 80 miles northeast of Base.	Defined.	None.
5) Soil Boring/Monitoring Well Locations	Soil borings and monitoring wells installed at other SWMU, AOC, and ERP sites, as well as 2 or 3 background wells.	Environmental data for former SWMUs are presently incorporated as relational files to fixed data sources.	None at present. Incorporate tabulated data into GeoBase EDV for advanced spatial analysis, as needed.
Release Information	**Conceptual Understanding**	**Status**	**Required Action**
1) Potential Source(s) of Release(s)	Existing sewer lines, manholes, and connection systems. Abandoned lines from former OWS SWMUs. Releases from non-sewer line sources adjacent to sewer lines.	Lengths of sewer line with potential for historical or current leaks are identified in previous I&I reports and incorporated into GeoBase EDV.	Implement sampling and analysis plan along sewer lines to identify potential sources of leaks.

Table 5-1: Initial Conceptual Site Model For SWMU 183, Holloman AFB, New Mexico			
Key Site Decisions			
2) Contaminants of Potential Concern (COPCs)	VOCs, semi-volatile organic compounds (SVOCs), metals, pesticides/herbicides, radionuclides.	Defined - Data available from previous I/I report.	Analyze for indicator Pollutants of Concern (POCs) in near real-time in every sample and extended list in 10% of samples
3) Potential Source Locations	Existing sewer lines, manholes, and connection systems. Abandoned lines from former OWS SWMUs.	Defined.	Analyze for indicator POCs in near real-time in every sample and extended list in 10% of samples
4) Confirmed Release Locations	OT32 Primate Research Institute (PRI) apparent release.	Defined – Data available from separate investigation effort.	Site is being characterized under separate investigation.
5) Potential Points of Entry to Subsurface	Likely points of entry are: Broken/cracked pipes in services, laterals, and/or mains; corroded pipes in services, laterals, and/or mains; defective joints in services, laterals, and/or mains; defective connections in services, laterals, and/or mains; defective OWS connections; defective manhole casings; heavily degraded segments of sewer line; clay tile lines.	Likely leak points identified in previous I/I report.	Implement sampling and analysis plan along sewer lines to identify potential sources of leaks.
6) Contaminated Media	None known from sewer line or manholes.	Defined in limited areas along sewer line.	Implement soil and groundwater sampling and analysis plan.
7) Potentially Contaminated Media	Soil, groundwater, and soil-gas.	Defined.	Implement soil and groundwater sampling and analysis plan with contingent delineation and vapor intrusion evaluation.
7) Delineation of Release Areas by COPC	No known contamination from the sewer line has been confirmed. Therefore, none has been delineated to date.	Undefined.	Implement soil and groundwater sampling and analysis plan with contingent delineation and vapor intrusion evaluation.
8) Transport Pathways	Groundwater and soil-gas are potential transport pathways. Nearby utility trenches may be preferential pathways for migration.	Undefined.	Implement soil and groundwater sampling and analysis plan with contingent delineation and vapor intrusion evaluation.
9) Other	Groundwater is below the elevation of the sewer line in northern areas. The sewer line is below the water table in some southern portions of the base. In these areas groundwater infiltrates the sewer line and releases are unlikely due to groundwater inflow.	Reliable and accurate data are not readily available regarding the relative elevations of sewer lines and the water table.	Prior to sampling, measure depth bgs to inverts in manholes located near sample locations. Measure depth to water in nearby monitoring wells.
Potential Receptors	**Conceptual Understanding**	**Status**	**Required Action**
1) HAFB Site Workers	Subsurface construction workers could be exposed to contaminants, if present, along the sewer line while working on subsurface utilities.	No known contamination from the sewer lines has been identified but the entirety of the system has not been investigated.	Implement sampling plan to determine if contaminants from sewer line are present in subsurface.
2) HAFB Residents	Residents may be exposed to contaminants via soil-gas transport to indoor air.	No known indoor air or soil-gas contamination from the sewer lines has been identified but the entirety of the system has not been investigated	Implement soil and groundwater sampling and analysis plan with contingent delineation and vapor intrusion evaluation.
3) Environmental Workers	Covered by Occupational Safety and Health Administration (OSHA) §1910.120 requirements.	Defined.	Perform subsurface work in accordance with 29 Code of Federal Regulations (CFR) §1910.120.
4) Terrestrial Flora / Fauna	None.	Defined.	None.

Table 5-1: Initial Conceptual Site Model For SWMU 183, Holloman AFB, New Mexico			
Key Site Decisions			
5) Aquatic Flora / Fauna	None.	Defined.	None.
6) Sensitive / Endangered Species	Endangered – Oplomado falcon. Threatened - Burrowing owl.	Defined.	Determine if contamination is present in the subsurface and determine if contamination and falcon and/or owl habitat are co-located.
7) Potentially Affected Wetlands	None.	Defined.	None.
8) Offsite Receptors	None.	Defined.	None.
Risk Management	**Conceptual Understanding**	**Status**	**Required Action**
1) Summary of Risks	Potential risks, if releases have occurred, include those to subsurface construction workers, burrowing owls, and residents/workers exposed to potentially contaminated indoor air.	Unknown	Implement investigation to develop data to determine if related risks exist.
2) Risk Management Impacts	No risk mitigation activities are contemplated.	Defined	None
3) Exceedance of Performance Monitoring Criteria	None	Undefined	Implement investigation to develop data to determine if risks exist.
Remediation	**Conceptual Understanding**	**Status**	**Required Action**
1) Study Options	Feasibility studies for remedy selection, design, and implementation will be planned as appropriate following identification of releases during the investigation step, including delineation.	To Be Determined	Complete investigation, identify areas requiring corrective action, develop feasibility plan for corrective action if required.
2) Study Requirements	Feasibility studies for remedy selection, design, and implementation will be planned as appropriate following identification of releases during the investigation step, including delineation.	To Be Determined	Complete investigation, identify areas requiring corrective action, develop feasibility plan for corrective action if required.
3) Remediation Options	Replace or slip line leaking sections of line or manholes, remove contaminated soil, risk-based closure.	To Be Determined	To Be Determined
4) Cleanup Requirements	Meet NMED SSLs for soil; WQCC or MCLs for groundwater, or risk-based action levels.	To Be Determined	To Be Determined

Notes: Defined = Primary information needed exists.

Partially Defined = Primary information needed partially exists.

Undefined = Primary information needed does not exist.

None = No action.

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Table 6-1

Onsite and Offsite Analytical Plan

Analyte(s)	Media	Method	Laboratory	Data Quality Level
Stage 1 - Sewer Release Identification				
Nitrate (NO_3)	Soil and Groundwater	IC via USEPA 300.0	Onsite	Definitive
VOCs	Soil and Groundwater	GC/MS and GC/FID via USEPA 8260B and ASTM D6520	Onsite	Definitive
PAHs	Soil	Field Fluorometer – SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening
PAHs	Groundwater	Rapid Assay Carcinogenic PAH Test – USEPA 4035	Onsite	Screening
TPH	Soil	Field Fluorometer – SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening
Radionuclides(2)	Soil and Groundwater	Ludlum 449 Scintillation Meter	Onsite	Screening
Stage 2 - Expanded Analyte List Analysis				
SVOCs	Soil and Groundwater	GC/MS via USEPA 8270C	Offsite	Definitive
RCRA 8 Metals	Soil and Groundwater	USEPA 6010B / 7471A / 7470A	Offsite	Definitive
Pesticides/ Herbicides (1)	Soil and Groundwater	USEPA 8081A / 8151A	Offsite	Definitive
Radionuclides(2)	Soil and Groundwater	Carbon-14: USEPA EERF C-O1 Mod Tritium: USEPA 906.0 Mod Radium 226: USEPA 903.1 Mod Radium 228: SW 9320	TBD	Definitive
Total Dissolved Solids(3)	Groundwater	USEPA 160.1 Gravimetric	Offsite	Definitive
Stage 3 - Identified Release Area Delineation (Analytes detected in Stage 1 and/or Stage 2 only)				
VOCs	Soil and Groundwater	GC/MS and GC/FID via USEPA 8260B and ASTM D6520	Onsite	Definitive
PAHs	Soil	Field Fluorometer – SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening

Analyte(s)	Media	Method	Laboratory	Data Quality Level
PAH	Groundwater	Rapid Assay Carcinogenic PAH Test	Onsite	Screening
SVOCs	Soil and Groundwater	GC/MS via USEPA 8270C	Offsite	Definitive
RCRA 8 Metals	Soil and Groundwater	USEPA 6010B / 7471A / 7470A	Offsite	Definitive
Pesticides/ Herbicides (1)	Soil and Groundwater	USEPA 8081A / 8151A	Offsite	Definitive
Radionuclides(2)	Soil and Groundwater	Carbon-14: USEPA EERF C-O1 Mod Tritium: EPA 906.0 Mod Radium 226: EPA 903.1 Mod Radium 228: SW 9320	TBD	Definitive
Stage 4 - Vapor Intrusion Evaluation				
VOCs	Soil Vapor	USEPA 8260B via GC/MS	Onsite	Definitive
VOCs	Indoor Air	SUMMA Canister via US EPA TO-15	Offsite	Definitive

Footnotes:
(1) Pesticides and herbicide analysis to be performed in vicinity of Building 374 only.
(2) Radionuclides will be passively screened with a hand-held Ludlum 449 scintillation meter.
(3) Detection of TDS < 10,000 mg/L will indicate a release only if found in conjunction with NO_3 and/or VOCs above applicable standards.

Abbreviations:

ASTM = American Society of Testing and Materials
FID = Flame Ionization Detector
GC/MS = Gas Chromatography / Mass Spectrometry
IA = Immunoassay
IC = Ion Chromatography
PAHs = Polycyclic Aromatic Hydrocarbons
RCRA = Resource Conservation and Recovery Act
SVOCs = Semi-Volatile Organic Compounds
TDS = Total Dissolved Solids
TPH = Total Petroleum Hydrocarbons
USEPA = U.S. Environmental Protection Agency
VOCs = Volatile Organic Compounds

Table 6-2

Field and Quality Control Sample Summary Table

Matrix	Analytical Parameter	Preparation Method	Analytical Method	Reporting Limit (RL)	Container/ Preservative	Holding Time	QC Sample Frequencies					
							MS/MSD	MS	Lab Duplicates	Trip Blanks	Field Duplicates	Equipment Blanks
Onsite Laboratory												
Soils												
	VOCs	ASTM D6520	SW8260B/Mod. 8021B	60 µg/kg	40-ml VOA/Methanol	7-days	5%	NA	NA	NA	10%	NA
	TPH	SiteLAB® Analytical Test Kit UVF-3100A		600 mg/kg	1 x 4 oz glass/4 °C	14-days	NA	3%	3%	NA	10%	NA
	PAH	SiteLAB® Analytical Test Kit UVF-3100A		0.5 mg/kg	1 x 4 oz glass/4 °C	7-days	NA	3%	3%	NA	10%	NA
	Nitrate	Ion Chromatrography EPA 300		6 mg/kgµµ	1 x 4 oz glass/4 °C	48-hours	NA	5%	NA	NA	10%	NA
Groundwater												
	VOCs	ASTM D6520	SW8260B/Mod. 8021B	2-5 µg/L	40-ml VOA/4 °C	7-days	5%	NA	NA	NA	10%	10%
	PAH	Immunoassay - EPA 4035		0.2 µg/L	40-ml VOA/4 °C	7-days	NA	3%	3%	NA	10%	NA
	Nitrate	Ion Chromatrography - EPA 300		2.0 mg/L	40-ml VOA/4 °C	48-hours	NA	5%	5%	NA	10%	NA
Soil Gas												
	VOCs	ASTM D6520	SW8260B	10-100 ppb (v/v)	Tedlar	1-day	NA	5%	5%	NA	10%	10%

Table 6-2

Field and Quality Control Sample Summary Table

Matrix	Analytical Parameter	Preparation Method	Analytical Method	Reporting Limit (RL)	Container / Preservative	Holding Time	QC Sample Frequencies					
							MS/MSD	MS	Lab Duplicates	Trip Blanks	Field Duplicates	Equipment Blanks
Offsite Laboratory												
Soils												
	SVOCs	SW3550	SW8270C	330 - 4000 µg/kg	1 x 4 oz glass/4 °C	7-days	5%	NA	NA	NA	10%	NA
	Pesticide / Herbicides	SW3520	SW8081A/ 8151	1.7 - 8000 µg/kg	1 x 4 oz glass/4 °C	7-days	5%	NA	NA	NA	10%	NA
	RCRA 8 Metals	SW3005	SW6010B / 7174A	0.5 - 300 mg/kg	1 x 4 oz glass/4 °C	28-Days	NA	5%	5%	NA	10%	NA
	Carbon-14	EPA EERF C-01 Mod		20 pCi/g	1 x 4 oz glass/4 °C for all radiochemical tests	6- months	NA	5%	5%	NA	10%	NA
	Tritium	EPA 906.0 Mod		6 pCi/g		6- months	NA	5%	5%	NA	10%	NA
	Radium 226	EPA 903.1 Mod		5 pCi/g		6- months	NA	5%	5%	NA	10%	NA
	Radium 228	SW 9320		5 pCi/g		6- months	NA	5%	5%	NA	10%	NA
Groundwater												
	SVOCs	SW3550	SW8270C	10 - 200 µg/L	2 x 1 L Amber Glass/4 °C	7-days	5%	NA	NA	NA	10%	NA
	Pesticide / Herbicides	SW3520	SW8081A/ 8151	0.05 - 500 µg/L	2 x 1 L Amber Glass/4 °C	7-days	5%	NA	NA	NA	10%	NA
	RCRA 8 Metals	SW3005	SW6010B / 7074A	1 - 5000 µg/L	1 x 500ml Plastic/HNO3	28-Days	NA	5%	5%	NA	10%	NA
	Carbon-14	EPA EERF C-01 Mod		20 pCi/L	3 x 1 L Glass/HNO3 for all radiochemical tests	6- months	NA	5%	5%	NA	10%	NA
	Tritium	EPA 906.0 Mod		1000 pCi/L		6- months	NA	5%	5%	NA	10%	NA
	Radium 226	EPA 903.1 Mod		5 pCi/L		6- months	NA	5%	5%	NA	10%	NA
	Radium 228	EPA 904.0 mod		5 pCi/L		6- months	NA	5%	5%	NA	10%	NA
Indoor Air												
	VOCs	SUMMA, TO-15		0.002 - 0.047 ppb (v/v)	Summa Canister	30-Days	NA	5%	5%	NA	10%	NA

Table 6-3

Onsite Analytical Quality Control Parameters

Parameter/ Data Level	QC type	Frequency	Control Limits	Corrective Action
VOCs/ Definitive	Method blank	1 per batch	Target analytes below RL, 10x exception for lab solvents	System check, reanalysis of affected samples
	Surrogate spike	Each sample, standard, blank	Limits listed in Appendix C of HAFB Basewide QAPP	Review, reanalyze based on technical judgment
	MS/MSD	Set per 20 samples per matrix	Limits listed in Appendix C of HAFB Basewide QAPP	Report results
	LCS	1 per batch	Limits listed in Appendix C of HAFB QAPP	Review, reanalyze LCS and associated samples, based on technical judgment.
	ICV (independent)	After initial calibration	%Recovery 70-130, unless otherwise listed in method	Review, reanalyze ICV, check standards, recalibrate if appropriate
TPH/PAH Screening	Method blank	1 per batch	Target analytes below RL, 10x exception for lab solvents	System check, reanalysis of affected samples
	MS/MSD	Set per 30 samples per matrix	% Recovery 60-140, unless otherwise listed in method	Report results
	LCS	1 per batch	%Recovery 70-130, unless otherwise listed in method	Review, reanalyze LCS and associated samples, based on technical judgment
	Laboratory reagent/prep blank	1 per 20 samples or batch	Target analytes below RL, 10x exception for lab solvents	System check, reanalysis of batch

Parameter/ Data Level	QC type	Frequency	Control Limits	Corrective Action
Nitrate / Definitive	LCS	1 per batch	80-120% recovery	System check, reanalysis of batch
	Replicates	1 per 20 samples per matrix	± 20%	Flag results
	MS	1 per 20 samples per matrix	70-130%	Flag results

MS/MSD = Matrix Spike / Matrix Spike Duplicate
LCS = Laboratory Control Sample
ICV = Independent Calibration Verification
RL = Reporting Limit

Table 7-1

SWMU Triad RFI Data Management Plan

Analyte(s)	Media	Method	Laboratory	Data Quality Level	Preliminary Field Data	Project Database	GeoBase EDV
Stage 1 - Sewer Release Identification							
Nitrate (NO_3)	Soil and Groundwater	IC via USEPA 300.0	Onsite	Definitive	Yes	Yes	Yes
VOCs	Soil and Groundwater	GC/MS and GC/FID via USEPA 8260B and ASTM D6520	Onsite	Definitive	Yes	Yes	Yes
PAHs	Soil	Field Fluorometer - SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening	Yes	Yes	Yes
PAHs	Groundwater	SiteLAB® RaPID Assay Carcinogenic PAH Test – USEPA 4035	Onsite	Screening	Yes	Yes	Yes
TPH	Soil	Field Fluorometer - SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening	Yes	Yes	Yes
Radionuclides	Soil and Groundwater	Ludlum 449 Scintillation Meter	Onsite	Screening	Yes	Yes	Yes
Stage 2 - Expanded Analyte List Analysis							
SVOCs	Soil and Groundwater	GC/MS via USEPA 8270C	10% Offsite	Definitive	As Requested	Yes	Yes
RCRA 8 Metals	Soil and Groundwater	USEPA 6010B / 7174A / 7074A	10% Offsite	Definitive	As Requested	Yes	Yes
Pesticides/ Herbicides	Soil and Groundwater	USEPA 8081A / 8151A	10% Offsite	Definitive	As Requested	Yes	Yes
Radionuclides	Soil and Groundwater	Carbon-14: EPA EERF C-O1 Mod Tritium: EPA 906.0 Mod	TBD	Definitive	As Requested	Yes	Yes

Analyte(s)	Media	Method	Laboratory	Data Quality Level	Preliminary Field Data	Project Database	GeoBase EDV
		Radium 226: EPA 903.1 Mod Radium 228: SW 9320					
Total Dissolved Solids	Groundwater	USEPA 160.1 Gravimetric	100% Offsite	Definitive	As Requested	Yes	Yes
Stage 3 - Identified Release Area Delineation (Analytes detected in Stage 1 and/or Stage 2 only)							
VOCs	Soil and Groundwater	GC/MS and GC/FID via USEPA 8260B and ASTM D6520	Onsite	Definitive	Yes	Yes	Yes
PAHs	Soil	Field Fluorometer - SiteLAB® Analytical Test Kit UVF-3100A	Onsite	Screening	Yes	Yes	Yes
PAH	Groundwater	SiteLAB® RaPID Assay Carcinogenic PAH Test	Onsite	Screening	Yes	Yes	Yes
SVOCs	Soil and Groundwater	GC/MS via USEPA 8270C	Offsite	Definitive	As Requested	Yes	Yes
RCRA 8 Metals	Soil and Groundwater	USEPA 6010B 7471A / 7470A	Offsite	Definitive	As Requested	Yes	Yes
Pesticides/ Herbicides	Soil and Groundwater	USEPA 8081A / 8151A	Offsite	Definitive	As Requested	Yes	Yes
Radionuclide s	Soil and Groundwater	Carbon-14: EPA EERF C-O1 Mod Tritium: EPA 906.0 Mod Radium 226: EPA 903.1 Mod Radium 228: SW 9320	TBD	Definitive	As Requested	Yes	Yes
Stage 4 - Vapor Intrusion Evaluation							
VOCs	Soil Vapor	USEPA 8260B via GC/MS	Onsite	Definitive	Yes	Yes	Yes

Analyte(s)	Media	Method	Laboratory	Data Quality Level	Preliminary Field Data	Project Database	GeoBase EDV
VOCs	Indoor Air	SUMMA Canister via USEPA TO-15	Offsite	Definitive	Yes	Yes	Yes
All Stages							
Survey Data	N/A	GPS	N/A	Sub-meter	N/A	Yes	Yes
Soil Logging	Soil	Per HAFB Basewide QAPP	N/A	Visual	Yes	N/A	N/A
GW Elevations	GW	Electronic water level meter	N/A	0.01 inch	Yes	Yes	Yes

Abbreviations:

ASTM = American Society for Testing and Materials
EDV= Environmental Data Viewer
GC/FID = Gas Chromatograph/Flame Ionization Detector
GC/MS = Gas Chromatography / Mass Spectrometry
GPS = Global Positioning System
GW = Groundwater
HAFB = Holloman Air Force Base
IA = Immunoassay
IC = Ion Chromatography
PAHs = Polycyclic Aromatic Hydrocarbons
QAPP = Quality Assurance Project Plan
RCRA = Resource Conservation and Recovery Act
SVOCs = Semi-Volatile Organic Compounds
TPH = Total Petroleum Hydrocarbons
USEPA = U.S. Environmental Protection Agency
VOCs = Volatile Organic Compounds
Y = Yes

Table 7-2

List of Analytical QC Extensions

Listing Order	Basewide QAPP QC Extensions	Program-Specific QC Extensions	Description
1	Dis	N/A	Dissolved phase (field filtered)
1	S	N/A	Field screening
2	A	FD	Field duplicate
2	B	SPLT	Field split (to quality assurance lab)
2	C	TB	Trip blank
2	D	EB	Rinsate or equipment blank
2	E	FB	Field blank
3	MS	MS	Matrix spike
3	MSD	MSD	Matrix spike duplicate
3	F	RD	Blind regulatory performance evaluation sample
3	G	EB	Water used for decontamination, blank collection, etc.

Table 8-1. Roles and Responsibilities of Project Team Members

Organization	Project Role	Name	Responsibilities
HAFB	HAFB Representative	Mr. George Fish	NMED Point of Contact
USAF Air Combat Command	Directing Authority	Mr. Stanley Scott	USAF Command-level authority and support
USACE Omaha District	Service Agency Program Manager	Mr. Thomas Zink, PG *	Directs prime environmental contractor Provides management support to USAF
USACE Omaha District	Project Hydrogeologist	Mr. Nick Geibel *	Provides technical guidance and oversight Reviews formal technical deliverables
USACE Omaha District	Project Chemist	Mr. Adam Little *	Provides technical guidance and oversight Reviews formal technical deliverables
Bhate	AE Program Manager	Mr. Frank Gardner, PG*	Manages prime contract with USACE Procures subcontractors Reviews formal technical deliverables
Bhate	Project Manager	Mr. James Moore, PG *	Manages project technical activities Manages subcontractors Manages and reviews technical deliverables
Bhate	Project Geologist Field Team Leader	Ms. Katherine Thompson	Manages field sampling effort Develops technical deliverables
Bhate	Project Engineer Field Team Leader	Mr. Bernard Wolfe	Manages field sampling effort Develops technical deliverables
Bhate	Project GIS Specialist Field Team Leader	Mr. Craig McGruff	Manages field sampling effort and provides GIS support for technical deliverable development
Bhate	Project Geologist	Mr. Zack Beck	Performs field technical activities Develops technical deliverables
Bhate	Project Chemist	Ms. Marcia Olive	Chemistry and technical deliverable review
Bhate	H&S Manager	Mr. Brian Mueller	Health and Safety Officer Health and Safety Plan Review
Bhate	QA/QC Manager	Ms. Corey Green	Quality Assurance Project Plan Review
Stone	Subcontractor Task Manager	Mr. Gerald Edwards, PG*	Manages subcontracted project activities Senior technical support

Organization	Project Role	Name	Responsibilities
Stone	Senior Hydrogeologist	Mr. Seth Pitkin *	Oversees technical project activities Senior technical support
Stone	Onsite Laboratories Services Manager	Mr. Michael Rossi *	Manages onsite laboratory activities Manages subcontracted offsite laboratories
Stone	QA Manager	Ms. Kim Watson	Performs daily data QC and validation
Stone	Database Specialist	Ms. Barbara Patterson	Manages environmental database
Stone	Web Developer	Mr. Nicholas Floersch	Manages web-accessible GeoBase EDV

* = Primary Triad Team Member

Abbreviations:

AE = Architect-Engineer

EDV = Environmental Data Viewer

GIS = Geographic Information System

HAFB = Holloman Air Force Base

H&S = Health and Safety

NMED = New Mexico Environmental Division

PE = Professional Engineer

PG = Professional Geologist

QA = Quality Assurance

QA/QC = Quality Assurance / Quality Control

QC = Quality Control

USAF = United States Air Force

USACE = United States Army Corps of Engineers

Table 8-2

Summary of Anticipated Triad Team Decision Making

Decision Level	Decision	Action / Data Level Required	Final Decision Maker
Planning	Determine Pre-Designated Sample Locations	Site Historical Information HAFB Geobase Map Information Conceptual Site Model	Agency, Prime, Subcontractor Triad Team
Agency and Regulatory	Approve Sample Locations	Triad Dynamic Work Plan & QAPP	Agencies and NMED
Stage 1- Sewer Release Identification			
Field	Should soil or direct groundwater sampling be conducted at a location?	Sample location on Plates 1 or 2 Basewide groundwater elevation map Local manhole invert measurement	Field Crew
Field	Do soil data indicate a release?	Preliminary onsite analytical data	Field Crew
Field	Does groundwater require sampling?	Preliminary onsite analytical data	Field Crew
Field	Do groundwater data indicate release?	Preliminary onsite analytical data	Field Crew
Field	Is a release confirmed?	Preliminary onsite analytical data	Field Crew
Project Mgmt.	Should location be earmarked for Stage 3 delineation?	Preliminary onsite analytical data indicate high levels of contamination	Field Crew & Project Mgrs
Stage 2 - Expanded Analyte List Analysis			
Field	Which samples should be submitted for offsite analysis?	Preliminary onsite analytical data Pre-determined 10% confirmation	Field Crew Project Mgrs
Prj Mgmt	Is a release confirmed?	Offsite analytical data	Project Mgrs
Prj Mgmt	Should location be earmarked for Stage 3 delineation?	Offsite analytical data confirm high levels of contamination	Project Mgrs

Stage 3 - Identified Release Area Delineation			
Technical Support	Is the confirmed release in an area of existing investigation?	Offsite analytical data compared against other site(s) data / locations	Technical Support Staff
Triad	Should delineation be performed at the location?	Yes / No, based on results of above comparison	Triad Team
Field and Senior Technical	If Yes, where should delineation transects be located?	Work Plan decision logic diagram Utility clearance data	Field Crew Senior Techs
Field	Where should transect samples be collected?	Work Plan decision logic diagram Utility clearance data	Field Crew
Field	Do additional transects need to be performed?	Preliminary onsite analytical data Work Plan decision logic diagram	Field Crew
Field and Senior Technical	If Yes, where should additional delineation transects be located?	Work Plan decision logic diagram Utility clearance data	Field Crew Senior Tech
Senior Technical	Is contamination delineated?	Preliminary onsite analytical data Senior Technical evaluations	Senior Tech
Triad	Continue or stop delineation?	Joint decisions based on the above	Triad Team
Stage 4 – Vapor Intrusion Evaluation			
Senior Technical	Are any buildings or to-be-developed zones potentially at risk?	Validated onsite and offsite data GeoBase EDV spatial analysis	Senior Tech Support Staff
Senior Technical	Does potential for vapor intrusion exist?	Spatial analysis results Work Plan decision logic diagram	Senior Tech
Triad	Should soil-gas survey(s) be conducted?	Senior Technical evaluation and recommendations	Triad Team
Senior Technical	Does potential for indoor air quality impacts exist?	Onsite analytical results Work Plan decision logic diagram	Senior Tech
Triad	Should indoor air sampling be conducted?	Senior Technical evaluation and recommendations	Triad Team

Senior Technical	If Yes, do results indicate indoor air quality concerns?	Offsite analytical results	Senior Technical
Triad, Agency & Regulatory	If concern confirmed, what steps should be taken to protect public health?	Work Plan decision logic diagram Senior Technical evaluation and recommendations	Agencies and NMED
Reporting			
Triad and Agency	Are major project objectives satisfied?	Validated and tabulated data 2 and 3-dimensional presentation GeoBase EDV	Triad Team and Agencies
Regulatory	Can delineation areas receive NFAs?	RCRA RFI Report	NMED
Regulatory	Can SWMU 183 receive NFA?	NFA approval	NMED
Regulatory	Can specifically identified and delineated release areas receive NFA?	NFA approval	NMED

PLATES

TO VIEW THE MAP AND/OR MAPS WITH THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT

APPENDIX A

HAFB BASEWIDE QUALITY ASSURANCE PROJECT PLAN (QAPP) ADDENDUM

FINAL

BASEWIDE QUALITY ASSURANCE PROJECT PLAN (QAPP) ADDENDUM

TRIAD APPROACH DYNAMIC WORK PLAN RCRA FACILITY INVESTIGATION SWMU 183 - BASEWIDE SEWER SYSTEM HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska
Contract No. DACA45-03-D-0023
Task Order No. 0006

February 2008

Prepared By:

Stone Environmental, Inc.
535 Stone Cutters Way
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Under Subcontract To:

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Birmingham, Alabama 35205

Bhate Project No. 9040238.11.02

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FINAL

BASEWIDE QUALITY ASSURANCE PROJECT PLAN (QAPP) ADDENDUM

TRIAD APPROACH DYNAMIC WORK PLAN RCRA FACILITY INVESTIGATION SWMU 183 - BASEWIDE SEWER SYSTEM HOLLOMAN AIR FORCE BASE, NEW MEXICO

REVIEW SHEET

This QAPP Addendum has been reviewed and approved by:

	Gerald Edwards	2/5/08
Gerald Edwards, PG Subcontractor Task Manager Stone Environmental, Inc.	Signature	Date
	J H Moore	2/5/08
Jim Moore, P.G. Project Manager Bhate Environmental Associates, Inc.	Signature	Date
	Frank Gardner	2/5/08
Frank Gardner, P.G. Program Manager Bhate Environmental Associates, Inc.	Signature	Date

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INTRODUCTION

Bhate Environmental Associates, Inc., (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contract DACA45-03-D-0023, Task Order No. 0006, to conduct a Triad Approach-Based Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of Solid Waste Management Unit (SWMU) 183, the basewide sewer system at Holloman Air Force Base (HAFB), New Mexico.

The SWMU 183 RFI is being performed according to the requirements set forth in the HAFB Hazardous Waste Facility Permit No. NM6572124422; Appendix 4-B RCRA Facility Investigation (RFI) Outline, dated February 2004 (HAFB RCRA Permit).

Stone Environmental, Inc., (Stone) was retained by Bhate to provide support for the project and accordingly, was assigned the role of developing the Triad Approach Dynamic Work Plan (Triad Work Plan) and associated documents.

This document is an appendix to the Triad RFI Work Plan and an addendum to the HAFB Basewide QAPP (Bhate, November 2003).

TABLE OF CONTENTS

Document Name (in chronological order of text reference)

1. Field Sampling Procedures

   a. QA1 - SEI-6.34.0 - *Procedure for Sampling Groundwater Monitoring Wells Using Low Stress (Low Flow) Technique*

   b. QA2 - SEI-6.36.0 - *Procedure for Collection of Soil Gas Samples Using the GeoProbe ® PRT system and Vacuum Lung Box*

   c. QA3 - SSP SEI-051687.1.0 - *Indoor Air Quality Sampling with SUMMA® Canisters*

2. Analytical Procedures

   a. QA4 - Stone SOP SEI-10.15.3 - *The Determination of Volatile Organic Compounds By Gas Chromatography/Mass Spectrometry (SW846 EPA Method 8260) (includes water, soil and air)*

   b. QA5 - Stone SOP SEI-10.1.3 - *Determination of Aromatic and Chlorinated Volatile Organics and Light Weight Petroleum Hydrocarbon Compounds Using Solid Phase Micro-extraction (SPME) and A Gas Chromatograph in Soil and Water Samples (Modified SW846 Methods 8021 & ASTM D6520)*

   c. QA6 - Stone NELAP Certificate

   d. QA7 - IA Carc PAH SOP Users Guide September 2005

   e. QA8 - Site LAB UVF-3100D_Components_CheckList

   f. QA9 - Site LAB Target PAH Instructions Manual

   g. QA10 - Site LAB Manual - TPH Instruction 2007

   h. QA11 - SOP for IC via EPA Method 300.0

   i. QA12 - HAFB Onsite Lab Sample Log-in Sheet

   j. QA13 - Stone Laboratory Quality Manual (LQM), September 05, 2006

   k. QA14 - SEI MDL Lab1 MS SIM 8260 2006.10.04 using response factor

   l. QA15 - SEI MDL Lab 1 FID PDMS.xls

m. QA16 - USACE Candidate Environmental Laboratory Self-Declaration Form; GEL Laboratories, LLC, June 4, 2007

n. QA17 - Introductory Statement for STL Denver Self Declaration Submittal, November 2, 2005 (Note: STL Denver is now owned by TestAmerica Laboratories)

o. QA18 - SOP No.: SANA-QA-0020 Supplemental Requirements for Navy Air Projects Under the Department of Defense Quality Systems Manual, Rev. 3, January 2006; June 14, 2007 (Note: STL Los Angeles is now owned by TestAmerica Laboratories)

FIELD SAMPLING PROCEDURES

STANDARD OPERATING PROCEDURE

SEI-6.34.0

PROCEDURE FOR SAMPLING GROUNDWATER MONITORING WELLS USING LOW STRESS (LOW FLOW) TECHNIQUE

SOP Number: SEI-6.34.0 | Date Issued: 01/21/05
Revision Number: NA | Date of Revision: NA

1.0 OBJECTIVE

This Standard Operating Procedure (SOP) provides a framework for collecting groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level draw downs, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes..

2.0 POLICIES

It is the policy of Stone Environmental Inc. (Stone) that all field staff conducting this sampling read this SOP prior to acquiring samples. Refer to SEI 6.16.4 for sample handling, preservation and transportation procedures.

Stone personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted. Field personnel will use a field logbook, observation and remark form or other designated field form to record activities, measurements, and observations made in the field.

3.0 SAFETY ISSUES

The corporate Health and Safety Plan and the Site Health and Safety Plan specify the procedures to be followed and equipment to be used during site activities. The following is a brief and general overview of safety issues.

- Potential Safety Issues include:
    - Heavy equipment (drill rigs or direct push rigs) hazards
    - Overhead utility hazards

- Underground utility hazards
- Traffic/ motor vehicle hazards
- Hazards associated with exposure to various chemicals
- Slip, trip and fall hazards
- Pinch point hazards
- Compressed gas hazards
- Fire hazards from hot work (e.g., grinding)
- Gasoline hazards (filling generator)

- SEI staff and others under contract with SEI that may be present on-site will wear a hardhat whenever overhead hazards are present.
- Appropriate eye protection should be worn
- Hearing protection shall be worn whenever the drill rig is actively advancing profiling equipment.
- Steel toed boots will be worn
- SEI staff will read the site health and safety plan (HASP) prior to beginning a project.

Additional personal protective equipment shall be worn in accordance to the health and safety document.

4.0 PROCEDURES

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable draw-downs of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after four (4) hours of purging, indicator field parameters have not stabilized, one of the following three courses of action may be taken: a) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analyses, may not meet the sampling objectives), b) continue purging until stabilization is achieved, c) discontinue purging, do not collect any samples, and record in study or project records that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

4.1 Equipment

1. Extraction device. Adjustable rate, submersible pumps should be used (for example, centrifugal or bladder pump constructed of stainless steel or Teflon
2. Tubing. Fluorinated Ethyl Propylene (FEP) will be used when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when

sampling for metals. The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping

3. Slope Indicator or other water level measuring device. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record
4. Graduated cylinder or other volumetric lab ware to determine purge volume.
5. Power source (generator, nitrogen tank, etc.) appropriate for pump. If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples
6. Indicator field parameter monitoring instruments (pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), turbidity, specific conductance, and temperature). Use of a flow-through cell is required when measuring all listed parameters. Standards to calibrate the water quality instrument should be brought to the site for calibration prior to use. Refer to the manufacturer's operation manual for maintenance and calibration procedures for the water quality instrument and to SEI 10.7.1 operation of the YSI 600 XL.

4.2 Preliminary Site Activities

1. Check for security damage or evidence of tampering on each well, record pertinent observations
2. Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the logbook
3. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.
4. Check newly constructed wells for the presence of NAPL before the initial sampling round. Note: Procedures for collection of LNAPL or DNAPL samples are not addressed in this SOP.

4.3 Purging and sampling procedures

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred. If applicable, refer to the site Quality Assurance Project Plant (QAPP) for additional sample information including frequency, preservation methods, containers, and specific analytical methods.

4.3.1 Install Pump

Lower pump and any safety cables, tubing and/or electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. In most instances, the pump will be positioned in the middle of the well screen. For cases where the well screen straddles the water table, the pump should be position 2 feet above the bottom of the well.

4.3.2 Measure Water Level

Before starting pump, measure water level. If a recording pressure transducer is used, initialize starting condition. After recording the height of the water column in the well, determine the volume in gallons by the following formula:

Volume in gallons = (Height of water column * π*Radius^2)*7.4805

When using the above formula, all measurements (height <u>and</u> radius) must be in feet.

4.3.3 Purge Well

4.3.3.1 Initial Low Stress Sampling Event

Start pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water draw-down (less than 0.3 feet). If the minimal draw-down that can be achieved is greater than 0.3 feet, continue purging until indicator field parameters stabilize

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover' as pump flow adjustments are made.

Using the appropriate volumetric container (one that is scalable relative to the volume to be purged), measure the volume of water purged at the same interval as field parameters are recorded (Section 4.3.4). If water is or believed to be contaminated, purge water must be containerized as specified in the site work plan. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume should be greater than the stabilized drawdown volume plus the extraction tubing volume. This may not be possible in wells with low recharge rates.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic) and/or the use of special techniques. If the recharge rate of the well is lower than the pump's minimum extraction rate, then continue to purge until the drawdown is near (but not below) the top of the well screen. Once the drawdown is within six (6) inches of the top of the well screen, discontinue purging. The well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all

anticipated samples (the intake should not be moved during this recovery period). In this case only, samples may be collected even if the well was not purged for four (4) hours and the indicated field parameters did not stabilize (as instructed in Section 4.0).

4.3.3.2 Subsequent Low Stress Sampling Events

Prior to sampling, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use the final pump dial setting information) from previous event(s). Perform purging operations as above

4.3.4 Monitor Indicator Field Parameter

During well purging, monitor indicator field parameters (turbidity, specific conductance, pH, ORP, DO) every 3 to 5 minutes. Values are to be recorded on appropriate field forms or on Observation and Remark (O&R) forms. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three (3) consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

- Turbidity – 10% (if values are greater than 1 NTU)
- DO – 10%
- Specific conductance – 3%
- Temperature – 3%
- pH - +/- 0.1 units
- ORP - +/- 10 millivolts

Percentage difference should be calculated using the following formula:

(Absolute Value (Previous Value – Updated Value)/ Previous Value) * 100

All measurements should be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump),

water in the cell must not drain out. Monitoring probes must be submerged in the water at all times. If two flow-through-cells are used in series, the one with the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

4.3.5 Collect Water Sample

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain the sample).

VOC samples should be collected first and directly into the sample containers. Sample water should be allowed to fill sample containers gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: 1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; 2) insert small diameter Teflon tubing into water filled portion of pump tubing, allowing the end to protrude beyond the end of the pump tubing, collect samples from small diameter tubing; 3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator parameter values. This third technique (least favorable because VOC samples should be collected first) allows the drawdown in the well to remain constant while all other samples are being collected. If flow is increased to collect VOC samples, do not allow the drawdown in the well to drop below the top of the well screen. Note that any two, or all three, techniques may be used in conjunction to achieve the desired results.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved.

Label each sample as collected. Samples requiring cooling (VOCs, organics, cyanide etc.) will be placed in a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

4.3.6 Posting Sampling Activites

After collection of the samples, the pump tubing may be dedicated to the well for re sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.01 feet), if not measured during the monthly water level measurements. Note: measurement of total well depth is

optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

4.4 Decontamination

Refer to SEI -5.1.5 *Maintenance and Decontamination of Field Equipment* for further information regarding the decontamination of field equipment. Decontamination procedures specific to low stress sampling are described below.

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. The pump will not be removed between purging and sampling operations. The pump and tubing (including support cable and/or electrical wires which are in contact with the well and/or groundwater) will be decontaminated by the procedure described below.

4.4.1 Procedure

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with decontaminating solutions. It is recommended that detergents and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior, safety cables, electrical wires and other re-usable parts must be rinsed with the decontaminating solutions, as well. The procedure is as follows.

1. Flush the equipment with potable water.
2. Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.
3. Flush with potable or distilled/deionized water to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.
4. Flush with methanol (pesticide grade). If equipment blank data from previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with analyte-free water. The final water rinse must not be re-used for additional decontamination procedures.

4.5 Quality Assurance/Quality Control

QA/QC samples (i.e. trip and equipment blanks and field duplicates) will be collected in accordance to the site Quality Assurance Project Plan, if appropriate or as specified in the site work plan.

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation.

Collect samples in order from wells with lowest contaminant concentration to the highest. Collect equipment blanks after sampling contaminated wells and not after background wells.

4.6 Documentation

A record of the sample collection must be made in the field at the time the sample is collected. The record should be made in a field notebook, a sample collection form, or other medium acceptable according to the study protocol. The information to be recorded must, at a minimum, include the following:

- Date and time of sample collection;
- Name(s) of the personnel performing the sampling;
- Weather;
- Sample location, well identification, and / or sample identification;
- Project/study designation;
- Water level prior to purging (equilibrium level);
- Total Well Depth;
- Well volume calculations;
- Volume purged from the well prior to sampling;
- Observations (I.E. PID reading or presence of NAPL); and
- Equilibrated chemical parameters monitored in the field

5.0 RESPONSIBILITIES

Stone staff are required to take accurate and descriptive notes. Variations from this SOP should be noted on observations and remarks (O&R) forms along with data and personnel.

Field staff members are responsible for following and implementing all procedures outline within this SOP. Care shall be taken to avoid compromising sample and data integrity.

6.0 DEFINITIONS

1. *pH-* The log-normal activity (concentration) of Hydrogen Ion (H^+) and Hydroxide Ion (OH^-) in solution. Ranges from 0 (acidic) to 7 (neutral) to 14 (basic).
2. *Conductivity-* The ability of water to conduct electricity as a function of dissolve ionic species, suspended solids, and organic content. Usually measured in Siemans (S).
3. *Turbidity-* The amount of suspended solids in a liquid.

4. *EPA*- The United States Environmental Protection Agency
5. *VOC*-Volatile Organic Compound.
6. *SVOC*-Semi-volatile Organic Compound.

7.0 REFERENCES

U.S. Environmental Protection Agency, Region 1, 1996, *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells,* p-13

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by:_____ Date:_____

Michael D. Rossi, Senior Scientist

Approved by:_____ Date:_____

Christopher T. Stone, President

10.0 REVISION HISTORY

None

STANDARD OPERATING PROCEDURE

SEI-6.36.0

PROCEDURE FOR COLLECTION OF SOIL GAS SAMPLES USING THE GEOPROBE PRT SYSTEM AND VACUUM "LUNG" BOX

SOP Number: SEI-6.36.0 | Date Issued: 06/22/07
Revision Number: N.A. | Date of Revision: N.A.

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to provide reference for collecting soil gas samples that are representative of Volatile Organic Compounds (VOCs) within the vadose zone. Sampling locations must be chosen in line with the objectives of the data required, with care taken to ensure sample integrity. Health and safety of the sampling personnel is of utmost importance.

2.0 POLICIES

1. According to 40 CFR Part 160, Subpart E, Section 160.81, a testing facility shall have standard operating procedures in writing setting forth study methods that management is satisfied are adequate to insure the quality and integrity of the data generated in the course of a study.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. A site-specific health and safety plan (HASP) shall be created for the site. A template for creating a proper health and safety plan is provided on the Stone network.
2. All locations proposed for collecting soil gas samples will be pre-marked and cleared for utilities by Digsafe.
3. Care must always be taken when approaching a sampling location. Do not, under any circumstances, place yourself in danger to collect a sample.

4.0 PROCEDURES

4.1 Equipment and Materials

1. Photoionization detector (PID) equipped with a 10.6 eV bulb to determine risk of exposure to sampling personnel, as required in the HASP.

2. Appropriate personnel protective equipment as specified in the HASP.

3. Certified pre-cleaned, 1.6 liter Tedlar bags complete with influent fitting and extraction septa.

4. One, 4-liter Pelican® case ("lung box") with barbed fittings to attach to two Tedlar bags and the effluent line to the pump (for splits).

5. One, low flow air sampling pump capable of pumping rates between 100 and 200 ml/minute. Recommended pumps are SKC 224 Series or Buck VSS Series.

6. One, 12-volt deep cycle battery

7. Soil Gas probe (Geoprobe Post Run Tubing (PRT) soil gas sampling tool)

    a. 2, 5-foot 1.5" outer diameter direct push rod

    b. PRT expendable points

    c. PRT expendable point holder

    d. PRT expendable point holder o-rings

    e. PRT adapter

    f. PRT adapter o-rings

    g. Drive cap for 1.5" direct push rod

8. 1-1.5" rubber stopper

9. Silicon tubing and clamp.

10. 1/4" Outer diameter fluorinated ethylene propylene (FEP) tubing of sufficient length to reach between the target depth and surface equipment.

11. ¼" Inner diameter braided, Tygon tubing

12. ¼" NPT to ¼" barb fittings (6)

13. 3-way, ¼" NPT stainless steel valve (bypass valve) (2)

14. Field notebook, sample collection form, or other acceptable medium for recording field data. Ball point pens.

15. Percussion implement based on local geology and desired depth (i.e. sledge hammer, jackhammer, Geoprobe)

16. Coring device, jackhammer, or other device to gain access to subsurface soils as warranted by the surface material (i.e. concrete or asphalt).

17. Granular Bentonite (for making seal between soil gas probe and ground)

18. Spring Water

19. Decontamination equipment (Alconox, scrub brushes and containment pails)

20. Bentonite chips for backfilling

21. Surface patch (sand, asphalt or concrete)

22. Thales Mobile Mapper Pro – sub meter resolution GPS unit

4.2 Calculate Flow Rate

To calculate flow rate for the pump, affix a calibrated bubble-flow meter to the effluent (positive) side of the pump and turn on the pump. Using a stopwatch, record the time in seconds required for a bubble to reach the 100 mL mark on the bubble flow meter. Divide this time by 100, and take the inverse. This will result in the pump flow rate in milliliters per second.

Using the calculated flow rate, determine the time needed to fill the 1.6 Liter Tedlar bags.

It is important to continuously check the flow rate during each of the sampling events; although the pump may be calibrated to a certain flow rate, the variable resistance (depending on soil types) can cause a change in the actual flow rate. The pumps can be adjusted during the sampling event to provide the desired flow rate.

4.3 Leak Testing

A leak testing procedure will be conducted at each of the sampling locations to demonstrate that the sampling system does not allow for short circuiting to occur between the ambient air and the sampling train.

The leak test procedure involves saturating the air above the sample location with acetone during the sampling process followed by the analysis of the gas sample for acetone along with the target compounds.

To saturate the air with acetone, an acetone-soaked cleaning sponge will be positioned over the sampling location within an up-side-down 5-gallon pail for at least 5 minutes prior to sample collection. Prior to this saturation step, the PRT sampling system should be placed through a 1.5-inch (same diameter as drill rod) hole that is present in the 5-gallon bucket. After the 5-minute saturation period, the sample collection process detailed below can begin.

If no acetone is present in the gas sample's analytical results, it can be concluded that no short circuiting has occurred. If acetone is found in the gas sample, the sample should be discarded and the sampling procedure repeated to demonstrate that no short circuiting has occurred.

4.4 Sample Collection Procedure

Prior to arrival in the field, sampling locations should be located and identified to meet the objectives of the study or project. If possible, these locations should be identified on a preliminary site map or drawing. Final locations will be verified for horizontal location using the Thales Mobile Mapper Pro.

Put on clean protective gloves. Clean and decontaminate any sampling equipment to be used using methods appropriate to the contaminants of concern (see SEI SOP 5.1.5).

Using appropriate method, prepare sample location for the soil gas probe.

- Concrete coring: Don dust mask prior to beginning concrete coring. Set-up diamond-core drilling rig per manufacturer's instructions and create a hole in the concrete slab.
- Asphalt coring: Punch a hole through asphalt to substrate using jackhammer per manufacturer's instructions.

Screen hole using PID per HASP.

Advance PRT to desired depth using percussion implement. Insert stopper into the direct push rod.

Set-up soil gas probe according to the following methodology:

1. Connect ¼" FEP tubing to PRT adapter, cap other end using a clamped piece of silicon tubing.
2. Pull back on direct push rod.
3. Seal void between rod and surface material using wetted bentonite.

4. Insert expendable tip knock out rod to ensure tip has fallen out of tip.

5. Remove stopper from direct push rod.

6. Slide PRT adapter and tubing into the direct push rod. While applying down-ward pressure, rotate tubing clockwise (reverse thread) to tighten adapter to PRT knock out tip holder.

Set up soil gas sampling apparatus according to the following methodology:

1. Insert new, pre-labeled Tedlar bag into Pelican case "lung box" and attach fill valve to influent fitting. Open Tedlar bag by making a ½ turn of the septa valve.

2. Connect influent fitting on Pelican case to a three-way bypass valve using ¼" Tygon tubing.

3. Connect gas pump to second 3-way valve

4. Connect bypass valve to valve adjacent vacuum pump

5. Plumb second three way to Pelican case "lung box"

Set three way valve positions to bypass lung box

Purge system of non-formation gas based on the flow rate and volume of the system (assume 2 ml per foot of tubing and 50 ml for the annulus below tip. itself).

Reset 3-way valves to include Pelican case in sample train.

Turn pump on and allow for enough time to fill the Tedlar bag based on flow rate.

Once filled, open lung box, close septa valve and remove the sample bag. Collection of each sample will be recorded in a field logbook or on a specified sample collection form. Information recorded will include the following but may not be limited to:

1. Stone project number

2. Date and time of sample collection.

3. Name of personnel collecting the sample.

4. Sample identification.

5. General Sample location.

6. Sample depth.

7. Sample type (SG: soil gas)

8. Additional comments/observations

Retract sample tooling and back fill hole with bentonite chips. Bring hole to grade using applicable surface material (sand, asphalt, concrete).

Decontaminate equipment prior to moving to next location.

4.5 Retrieving Quality Control Samples

Duplicate samples for either split confirmation analyses or field duplicates will be collected using two Tedlar bags filled simultaneously within the 4-liter Pelican Case. Sample influent is split prior to enter the Pelican case using a "T" fitting. All other plumbing is identical to that described in Section 4.3.

Field blanks to determine background contamination levels are collected through all sampling apparatus at the ground surface.

4.6 Sample Packing and Transportation

Pack samples in an insulated cooler or other sturdy container with refrigerant, if required. Samples for onsite analyses should be sent to the onsite laboratory as soon as possible. Samples for offsite analyses should be sent to the laboratory as soon as is reasonable, but within the maximum holding time for the sample. Chain of custody forms will be filled out and signed prior to shipment to the laboratory and included in the shipping container with the samples, according to standard operating procedures (SEI-4.2.n) and/or protocol and work plan instructions.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SSP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

6.0 DEFINITIONS

1. *Soil Gas* – Interstitial air within the vadose zone.
2. *Decontamination* – Procedures followed to ensure cross contamination does not occur between sampling points or that potential contamination of equipment does not pose a hazard to sampling personnel.
3. *EPA* the U.S. Environmental Protection Agency.
4. *Maintenance* – Actions performed on equipment to standardize and/or correct the accuracy and precision of a piece of equipment to ensure that the equipment is operating within the manufacturer's specifications and standard values.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by:_____ Date:_____

Daniel Voisin, Staff Geoscientist

Approved by:_____ Date:_____

Christopher T. Stone, President, Management

10.0 REVISION HISTORY

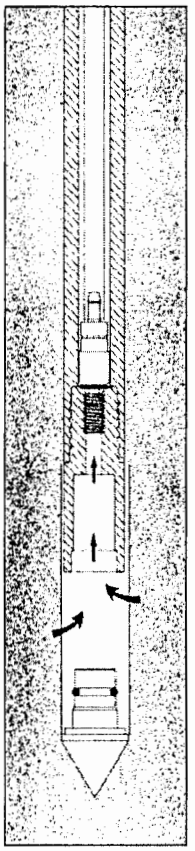
6/22/07 – Leak test procedure added.

ATTACHMENT 1: SOIL GAS SAMPLING – PRT SYSTEM OPERATION (FROM GEOPROBE SYSTEMS®)

Soil Gas Sampling – PRT System Operation

from Geoprobe Systems®

www.geoprobe.com
1-800-436-7762



Soil Gas Sampling using the Post-Run Tubing (PRT) System.

Soil Gas Sampling — PRT System Operation

Basics

Using the Post-Run Tubing System, one can drive probe rods to the desired sampling depth, then insert and seal an internal tubing for soil gas sampling. The usual Geoprobe probe rods and driving accessories and the following tools are required:

- PRT Expendable Point Holder
- PRT Adapter
- Selected PRT Tubing

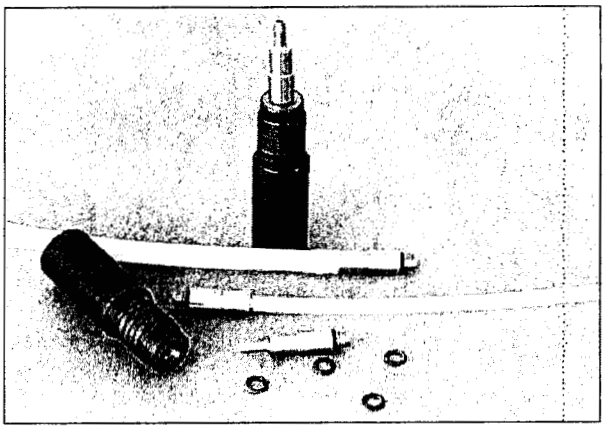
Preparation

1. Clean all parts prior to use. Install O-rings on the PRT Expendable Point Holder and the PRT adapter.
2. Inspect the probe rods and clear them of all obstructions.
3. TEST FIT the adapter with the PRT fitting on the expendable point holder to assure that the threads are compatible and fit together smoothly.

   NOTE: PRT fittings are left-hand threaded.

4. Push the adapter into the end of the selected tubing. Tape may be used on the outside of the adapter and tubing to prevent the tubing from spinning freely around the adapter during connection – especially when using Teflon tubing **(Figure 1)**.

   REMEMBER: The sample will not contact the outside of the tubing or adapter.



PRT SYSTEM PARTS
PRT Expendable Point Holder, PRT Adapters, Tubing, and O-rings.

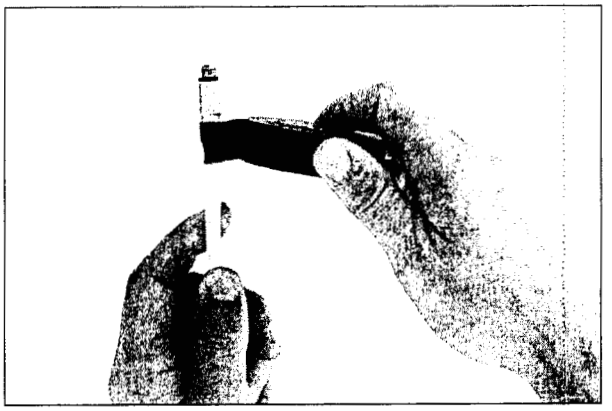


Figure 1. Securing adapter to tubing with tape. NOTE: Tape does not contact soil gas sample.

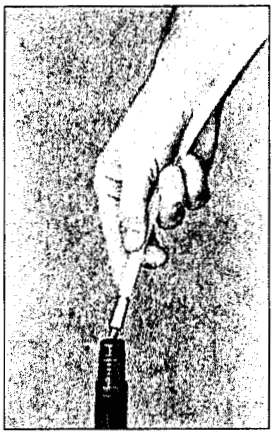
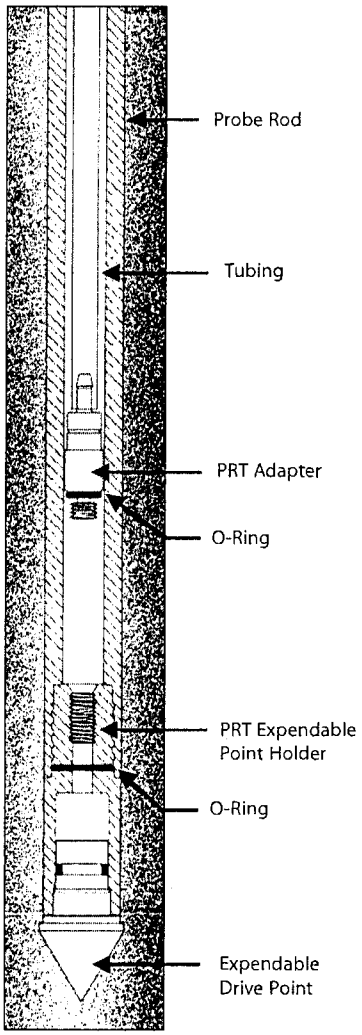


Figure 2. Insertion of tubing and PRT adapter.

Figure 3. Engaging threads by rotating tubing.

Soil Gas Sampling — PRT System Operation



A cross section of probe rods driven to depth and then retracted to allow for soil gas sampling. The PRT adapter and tubing are now fed through the rods and rotated to form a vacuum-tight connection at the point holder. The result is a continuous run of tubing from the sample level to the surface.

Probing

Drive the PRT tip configuration into the ground. Connect probe rods as necessary to reach the desired depth. After depth has been reached, disengage the expendable point by pulling up on the probe rods. Remove the pull cap from the top probe rod, and position the Geoprobe unit to allow room to work.

Connection

1. Insert the adapter end of the tubing down the inside diameter of the probe rods **(Figure 2)**.

2. Feed the tubing down the rod bore until it hits bottom on the expendable point holder. Allow about 2 ft. (610 mm) of tubing to extend out of the hole before cutting it.

3. Grasp the excess tubing and apply some downward pressure while turning it in a counterclockwise motion to engage the adapter threads with the expendable point holder **(Figure 3)**.

4. Pull up lightly on the tubing to test engagement of the threads. (Failure of adapter to thread could mean that intrusion of soil may have occurred during driving of probe rods or disengagement of drive point.)

Soil Gas Sampling — PRT System Operation

Sampling

1. Connect the outer end of the tubing to the Silicone Tubing Adapter and vacuum hose (or other sampling apparatus).

2. Follow the appropriate sampling procedure for collecting a soil gas sample **(Figure 1)**.

Removal

1. After collecting a sample, disconnect the tubing from the vacuum hose or sampling system.

2. Pull up firmly on the tubing until it releases from the adapter at the bottom of the hole. (Taped tubing requires a stronger pull.)

3. Remove the tubing from the probe rods. Dispose of polyethylene tubing or decontaminate Teflon tubing as protocol dictates.

4. Retrieve the probe rods from the ground and recover the expendable point holder with the attached PRT adapter.

5. Inspect the O-ring at the base of the PRT adapter to verify that proper sealing was achieved during sampling. The O-ring should be compressed. This seal can be tested by capping the open end of the point holder applying vacuum to the PRT adapter.

6. Prepare for the next sample.

Figure 1. Taking a soil gas sample for direct injection into a GC with the PRT system.

SITE SPECIFIC PROCEDURE

SSP SEI-051687.1.0

INDOOR AIR QUALITY SAMPLING WITH SUMMA® CANISTERS

SSP Number: SSP SEI-051687.1.0 Date Issued: 09/21/2007
Revision Number: N.A. Date of Revision: N.A.

1.0 OBJECTIVE

The objective of this site specific procedure (SSP) is to provide reference for collecting indoor air quality samples that are representative of Volatile Organic Compounds (VOCs) within each area of interest (basement and ground floor). Sampling locations must be chosen in line with the objectives of the data required, with care taken to ensure sample integrity. Health and safety of the sampling personnel is of utmost importance.

2.0 POLICIES

1. According to 40 CFR Part 160, Subpart E, Section 160.81, a testing facility shall have standard operating procedures in writing setting forth study methods that management is satisfied are adequate to insure the quality and integrity of the data generated in the course of a study.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. A site-specific health and safety plan (HASP) shall be created for the site. A template for creating a proper health and safety plan is provided on the Stone network.

4.0 PROCEDURES

4.1 Equipment and Materials

1. Photoionization detector (PID) equipped with a 10.6 eV bulb to determine risk of exposure to sampling personnel, as required in the HASP.
2. Appropriate personnel protective equipment as specified in the HASP.
3. Site map and sampling forms.

4. Sample inlet line – chromatographic-grade stainless steel tubing.

5. Sample Canister(s) – Certified clean and leak free stainless steel SUMMA® polished or silica lined passivated air sampling canisters, typically available in 6 and 15 liter sizes.

6. Vacuum/Pressure gauge – Configured with appropriate fitting to attach to canister to measure vacuum before and after collection of sample.

7. Particulate Matter Filter - 2 μm pore size in-line stainless steel filter to be attached to sample inlet line.

8. Flow controller – Adjustable mechanical flow controller, fixed orifice flow controller or electronic flow controller capable of reliably controlling flowrate under vacuum (-30 inches Hg to -5 inches Hg) and under flowrates between 5 and 100 cubic centimeters per minute depending on the event duration. The flow controller must be constructed of non-contaminating materials.

4.2 Sample Collection Procedure

This procedure outlines methodology to be used to collect time-integrated samples from the breathing zones of potentially impacted structures or in a manner otherwise consistent with the sampling and data quality objectives.

To start the sampling event, properly site the canister and verify the vacuum (-30 inches of Hg) with a vacuum gauge. Next, attach the flow controller device and in-line filter. Open the canister bellows and record the start time. Start co-located canisters at the same time if possible. Immediately check the flowrate and adjust to the set point, if necessary. Record the initial flowrate.

To complete the sampling event, check and record the final flowrate. Close the canister bellows and record the ending time. Next, detach the flow controller and check the remaining vacuum with the gauge. The vacuum should measure some amount of reserve (-5 inches of Hg). Gauge readings of ambient indicate that the flow rate was set too high or there is a leak in the canister. This observation compromises the time-integrated aspect of the sample.

Collection of each sample will be recorded in a field logbook or on a specified sample collection form. Information recorded will include the following but may not be limited to:

1. Stone project number

2. Date and time of initiating sample collection.

3. Date and time of terminating sample collection.

4. Name of personnel collecting the sample.

5. Sample Number.
6. General Sample location.
7. Sample Height.
8. Additional comments/observations

Decontaminate equipment prior to moving to next location.

4.3 Retrieving Quality Control Samples

Duplicate samples for field duplicates will be collected by using two Summa canisters co-located and opened at the same time.

Field blanks to determine background contamination levels are collected through all sampling apparatus in an outdoor setting up wind of the study area.

4.4 Sample Packing and Transportation

Pack samples in an insulated cooler or other sturdy container with refrigerant, if required. Samples for offsite analyses should be sent to the laboratory as soon as is reasonable, but within the maximum holding time for the sample. Chain of custody forms will be filled out and signed prior to shipment to the laboratory and included in the shipping container with the samples, according to standard operating procedures (SEI-4.2.n) and/or protocol and work plan instructions. All samples for offsite analyses will be accompanied by a lab-supplied trip blank.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SSP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

6.0 DEFINITIONS

1. *EPA* the U.S. Environmental Protection Agency.
2. *Maintenance* – Actions performed on equipment to standardize and/or correct the accuracy and precision of a piece of equipment to ensure that the equipment is operating within the manufacturer's specifications and standard values.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

MaDEP WSC Policy #02-430 *Indoor Air Sampling and Evaluation Guide*, Office of Research and Standards, Massachusetts Department of Environmental Protection, 1 Winter Street, Boston, MA 02108.

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by:_____ Date:_____

Daniel Voisin, Staff Geoscientist

Approved by:_____ Date:_____

Mike Rossi, Laboratory Manager, Senior Scientist

10.0 REVISION HISTORY

Not Applicable

ANALYTICAL PROCEDURES

STANDARD OPERATING PROCEDURE

SEI-10.15.3

THE DETERMINATION OF VOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY / MASS SPECTROMETRY (SW846 EPA METHOD 8260B)

SOP Number: SEI-10.15.3
Revision Number: 3

Date Issued: 08/19/04
Date of Revision: 09/05/06

1.0 OBJECTIVE

This method, based on SW846 EPA Method 8260B for the analyses of volatile organic compounds, is designed to measure the concentration of specified volatiles organic compounds (VOCs) in water, soil and air samples using solid phase microextraction (SPME) and a Gas Chromatograph equipped with a capillary column and mass spectrometer. Specific VOCs of interest are outlined in Table 1.

2.0 SUMMARY OF METHOD

This method provides gas chromatographic conditions for the detection of certain aromatic and chlorinated VOCs. Soil and water samples are prepared in 24 mL extraction vials. The SPME fiber is then exposed to the headspace above the sample for a set number of minutes while the sample is rapidly stirred. Air samples are collected in Tedlar bags and the SPME fiber is exposed directly to the sample through the Teflon®-lined syringe septum. The exposure time must be consistent for all standards and samples (typically eight minutes). The absorbed analytes are thermally desorbed from the SPME fiber in the injection port of a Gas Chromatograph and transferred to a narrow bore capillary column. A temperature program is used to enhance separation as the analytes are carried through the column to the ion source of the mass spectrometer. The ionized molecules are focused and separated according to their mass/charge (m/z) ratio by a quadrupole analyzer. The signal is amplified by an electron multiplier and interpreted by the mass spectrometer data system to produce a total ion chromatogram and mass spectra for every point on the chromatogram.

This method is suitable for analysis of air, water, soils, and wastes.

Soil and waste samples are collected in approximately 10-12 gram cores preserved in methanol (10 mLs) in 40 mL VOA vials and water samples are collected in 40 mL VOA vials with no headspace. All samples are analyzed as waters on the GCMS

This method is based on EPA 8260B and ASTM Method D6520.

3.0 DEFINITIONS

Accuracy: the degree of agreement between a measurement and true or expected value, or between the average of a number of measurements and the true or expected value.

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of a similar matrix, meeting the above-mentioned criteria.

Corrective Action: action taken to eliminate the causes of an existing non-conformance, defect or other undesirable situation in order to prevent recurrence.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Instrument Blank: a blank matrix that is the same as the processed sample matrix (i.e. extract, digestate, condensate) and introduced onto the instrument for analysis.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Matrix: the substrate of a test sample.

Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate; Laboratory Duplicate.

Matrix Spike (MS): field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a replicate matrix spike.

Method Blank: a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Precision: an estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions.

Quality Assurance (QA): an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Control (QC): the overall system of technical activities, the purpose of which is to measure and control the quality of a product or service.

Quality Control Sample: a control sample, generated at the laboratory or in the field, or obtained from an independent source, used to monitor a specific element in the sampling and/or testing process.

Quantitation Limit (QL): the minimum amount of a substance that can be quantitatively measured with a specified degree of confidence and within the accuracy and precision guidelines of a specific measurement system. The QL can be based on the MDL, and is generally calculated as 3-5 times the MDL, however, there are analytical techniques and methods where this relationship is not applicable. Also referred to as Practical Quantitation Level (PQL), Estimated Quantitation Level (EQL), Limit of Quantitation (LOQ).

Reporting Limit (RL): The level to which data is reported for a specific test method and/or sample. The RL is generally related to the QL. The RL must be minimally at or above the MDL.

Spike: a known amount of an analyte added to a blank, sample or sub-sample.

Standard Operating Procedure (SOP): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

SPME – Solid Phase Microextraction

Tedlar Bag – Inflatable sample container, used to trap air samples for analysis, equipped with a Teflon®-lined syringe septum that allows a SPME fiber to come in contact with the air sample.

VOC – Volatile Organic Compounds

QA/QC – Quality Assurance/Quality Control

4.0 INTERFERENCES

When analyzing for VOCs, samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride), through the sample container septum during shipment and storage. A trip blank prepared from organic-free reagent water and carried through sampling and subsequent storage and handling must serve as a check on such interferences.

Contamination by carryover can occur whenever high-concentration and low-concentration samples are analyzed in sequence. To reduce the potential for carryover, the sample syringe or purging device must be rinsed out between samples with an appropriate solvent. Whenever an unusually concentrated sample is encountered, it should be followed by injection of a method blank to check for cross contamination.

Purging vessels and syringes should be adequately cleaned and flushed prior to use. All glassware must be kept scrupulously cleaned. Clean all glassware as soon as possible after use by rinsing with the last solvent used or analyte-free water. Store clean dry glassware in a clean environment.

5.0 SAFETY ISSUES

1. Laboratory personnel should take extra care when working with standards. When working with neat standards, make certain that there is adequate ventilation and that Nitrile or Latex gloves are worn and if necessary safety glasses.
2. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site and followed.
3. Field visits may involve accessing remote areas. Health and safety concerns regarding these field visits are minimal, however, hazards such as slip, trip and falls, poisonous plant and dangerous animals, as well as getting vehicles stuck in remote areas, do present considerable health and safety issues. To help ensure field staff's health and safety in remote areas, all field staff are to have daily communication with the project manager or another appropriate SEI employee.
4. All chemicals are required to be received with a Material Safety Data Sheets (MSDS). MSDSs shall be made available to all personnel involved in the sampling and testing.

6.0 EQUIPMENT AND SUPPLIES

1. Gas Chromatograph: Analytical system complete with gas chromatograph and all required accessories, column supplies, gases, syringes and data system to determine peak areas and perform integrations. Hewlett Packard 5890 Series II.
2. Mass Spectrometer: Hewlett Packard 5971 MSD.
3. Analytical Column: SPB-624 10m x 0.20mm ID, 1.1 um film or equivalent
4. Array of Microsyringes: range 5-1000 uL.
5. Balance: Top loading, capable of weighing accurately to 0.01 grams (soil samples only).
6. Sample introduction and preparation apparatus: SPME Fiber type 100 µm polydimethylsiloxane (PDMS) and/or 85 µm Carboxen/PDMS fiber, magnetic hot plate and magnetic stirrers, tube clamp and stand.
7. VOA vials: 40 mL collection containers with Teflon®-lined septum and 24 mL extraction vials

7.0 REAGENTS AND STANDARDS

Reagents: Organic-free reagent water demonstrated to be free of compounds of interest (spring water, carbon filtered and/or deionized). Purge and Trap Grade or equivalent grade methanol (demonstrated to be free of analytes and stored away from other solvents).

Stock standards – Stock standards may either be prepared from pure standard materials or purchased as certified solutions. Secondary dilution standards are prepared accordingly using stock standard solutions, which contain the compounds of interest, either as single compounds or mixed together. The aqueous standards are prepared at concentrations as listed in Section 9.0. Gas standards are purchased in mixtures of site-specific target analytes. Calibration standards are prepared at a minimum of five different concentrations levels for VOC analytes.

8.0 SAMPLE COLLECTION AND HANDLING

8.1 Sample Collection

1. Aqueous samples are collected in 40 mL Teflon®-lined septum VOA vials filled to ensure that no headspace is present. If storage of these samples is expected to exceed seven days, aqueous samples should be preserved with hydrochloric acid (HCL) to a pH of < 2.
2. Soil and waste samples are collected in approximately 10-12 gram cores, and placed in 40 mL vials. A solid aliquot of approximately 10-12 grams of sample is placed in a VOA vial with 10 mL of methanol.
3. Air samples are collected in Tedlar bags. The target analytes shall be concentrated on the SPME fiber by exposing the fiber directly to sample through the Teflon®-lined septum. Air samples must be analyzed within 3 days of collection.

8.2 Handling and Holding Times

Unpreserved water samples must be analyzed within 7 days of collection. Preserved (preserved with HCl to a pH of < 2) water samples must be analyzed within 14 days of collection. Soil samples collected in methanol must be analyzed within 14 days from collection. Water and soil samples shall be stored at 4 ° Ç ± 2 ° C. Samples are allowed to come to room temperature just prior to analysis. All samples for this program are typically analyzed within one or two days from collection, therefore, holding times should not be a concern.

9.0 PROCEDURES

9.1 Typical GC Program

Oven Temp: 45°C (1.00 min) to 140°C at 25°C/min to 180°C at 35°C/min, hold for 1 min.

Flow Rate: Helium, 0.8 mL/min, 8 PSI, set at 45°C

Detector: MSD, scan mode, 40-260 amu, (or as necessary to 35-300 amu)

Injector: 240°C, splitless (close 1.5 min)

Liner: 0.75 mm ID splitless/split injection port

9.2 GC Column

Column: SPB-624 16m x 0.20mm ID, 1.1 um film, equivalent

9.3 Material Preparation:

SPME: Fiber Type: 100 µm polydimethylsiloxane (PDMS) and/or 85 µm Carboxen/PDMS fiber

Extraction: The fiber is exposed to the headspace above a water sample for 8 minutes while the sample is rapidly stirred on a magnetic stirring plate. Each magnetic stirrer is rinsed three times with methanol and a final rinse with volatile free water prior to use. For air samples, the SPME fiber is exposed directly to the same through the Teflon-line septum located on the Tedlar bag. Exposure time of the fiber to the air sample will be the same for all samples and calibration standards. Prior to use, each fiber must be conditioned for at least one hour in the GC inlet at 240°C. The fibers are very fragile and should not be exposed to hard surfaces, as they will damage easily.

9.4 Operating Procedure

9.4.1 4-Bromofluorobenzene

The following ion abundances must be met before analysis of calibration standards, environmental samples and at the beginning of a 12-hour analytical sequence by analyzing BFB in a check standard, method blank or as a single injection:

BFB Key Ions and Ion Abundance Criteria	
Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	less than 2.0 percent of mass 174
174	>50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	95.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

9.4.2 Calibration Criteria

9.4.2.1 Initial Calibration (ICAL):

1. Five-point calibration for VOC compounds: 5, 20, 50, 100, and 200 ppb (ketones: 50, 100, 200, 500, 1000 ppb). The low standard must be set at the practical quantitation

limit (PQL). A typical calibration range for air (ppb_v/v) will be similar to that of water and will be chosen on a site specific basis.

2. Calibration range must encompass the expected sample concentration; therefore, if site samples are expected to be higher in concentration than the calibration range, adjustments to the calibration range and samples will be documented and made accordingly.

3. The linearity of the calibration curves must be assessed and are used for all quantitation. Volatile organic compounds in soil and water use an internal standard procedure (internal standard; fluorobenzene). Average response factors are used for quantitation and the average relative standard deviation (%RSD) of each compound must be less than 15%. Depending upon the on-site program, 25% RSD may be acceptable.

4. Volatile organic carbons in air use an external calibration procedure. Linear regression is used for quantitation and the correlation coefficient (r) of each compound must be greater than 0.995 (r^2 = 0.990). Depending upon the on-site program acceptable correlation coefficient may be set at 0.99 in accordance with SW846 8000.

9.4.2.2 System Performance Check Compounds (SPCC) and Calibration Check Compounds (CCC):

SPCC's must meet the minimum average response factor given in Table 1. CCC's should have a %RSD less than or equal to 15% if they are target compounds. Otherwise, CCC's must be equal to or less than 30%.

9.4.2.3 Continuing Calibration (CCV):

1. A mid-point continuing calibration verification standard for VOC compounds at 50 ppb (ketones 200 ppb) must be analyzed every 12 hours, prior to sample analysis in order to verify the initial calibration. A percent difference of the expected concentration is compared to the actual concentration. The percent difference values for each compound must be less than or equal to 20%.

$$\%D = \frac{ExpectedConcentration - ActualConcentration}{ExpectedConcentration}$$

The CCV may also be used to demonstrate that the BFB criteria shown in 10.4.1 have been met.

9.4.2.4 Initial Calibration Verification Standard (ICV):

A QC sample from a second (independent) source will be analyzed directly after the ICAL. The ICV sample will contain all the VOC compounds of interest at the mid-point (50 ppb or 200 ppb for ketones). Recovery Limits for the ICV will be 70-130%. This QC sample may

also be used daily as the ICV/LCS with recovery limits less than or equal to 25% for all compounds including the Bromofluorobenzene surrogate.

$$\%\,\mathrm{Recovery} = \frac{ActualConcentration}{ExpectedConcentration}$$

9.4.3 Retention Time Windows and Pattern Recognition

The laboratory shall identify single component target analytes by comparison of its mass spectrum to a reference spectrum. The retention time for each analyte should be within ± 0.02 minutes from the ICAL or daily CCV.

9.4.4 Sample Preparation:

Water samples: An aliquot of sample, sufficient to get the highest concentration constituents into the upper half of the linear range, is transferred to a 24 mL extraction vial and spiked with the surrogate (bromofluorobenzene between 8.33 and 16.67 ppb) and internal standard (fluorobenzene between 8.33 and 16.67 ppb). The SPME fiber is then exposed to the headspace above the sample for eight minutes while the sample is rapidly stirred with a magnetic stirrer on a magnetic plate. The eight minutes is measured using a bench-top timer. Extraction time may be modified depending on the anticipated equilibration response of the target analytes at given concentrations.

Soil samples: Preserved in methanol; 10-12 g core of soil is added to 10 mL of methanol containing an appropriate amount of bromofluorobenzene. After addition of the site soil and prior to analysis, the vial is mixed for five minutes. An aliquot of methanol, sufficient to get the highest concentration constituents into the upper half of the linear range but not to exceed 2 mL, is diluted to volume with analyte free water and ¼ tsp. salt in a 24 mL vial, and analyzed using SPME in the same manner as a water sample.

Air samples: Exposure of the SPME fiber to the air sample occurs directly through the Teflon®-lined septum in the Tedlar bag. Exposure time, measured using a bench-top timer, may be modified depending on the anticipated equilibration response of the target analytes at given concentrations. There is no surrogate or internal standard for air sampling.

9.4.5 Analysis of Samples:

Analysis of samples is performed using SPME followed by analysis on a GC equipped with a narrow bore capillary column and a MSD. For this program the fiber is exposed to the headspace above the sample. Therefore a small portion is discarded from the 24 ml vial prior to exposure. The exposure time needs to be consistent (8 minutes for this method). To facilitate the release of the analytes from their respective media, the sample is rapidly stirred throughout the extraction. The adsorbed analytes are thermally desorbed in the injection port of the GC and transferred to the capillary column.

9.4.6 Surrogate (SS) and Internal Standard (ISTD) Compounds for VOC compounds

Compound	Amount Spiked
Bromofluorobenzene (SS)	Range: 8.33 to 16.67 ppb
Fluorobenzene (ISTD)	Range: 8.33 to 16.67 ppb

9.4.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD) Compounds:

Compounds and spike amounts are on Table 1. For water samples the MS will be spiked at 50 ppb; the amount may change to account for the concentration of a particular analyte found in the sample being analyzed as a MS. For soil samples, an appropriate amount of the target analytes are spiked into the 10 mL of methanol. Matrix Spike Analyses will contain only the VOC compounds of interest. For air, MS/MSD are performed by spiking air standards into the Tedlar bag prior to sampling.

9.4.8 Target Compound List Compounds

A Target Compound List with Practical Quantitation Limits can be found on Table 1.

10.0 CALCULATIONS

Identification of the project specific VOCs in the sample chromatogram is based on retention time and on comparison of the sample mass spectrum with characteristic ions in a reference mass spectrum. Retention times must be within ± 0.02 minutes from the ICAL. If a retention time shift is observed in the CCV or daily ICV, then adjustments to the daily retention time windows will be made accordingly. The relative intensities of the characteristic ions must agree within 30% of these ions in the reference spectrum. Quantification of the VOCs is determined by comparison to the internal standard and average response factor for the target ion of the analyte.

The concentration of each analyte in the sample may be determined by calculating the amount of standard injected, from the target ion peak response, using the calibration curve. The calculations are as noted below.

Concentrations of Unknowns

Method 8260B does not include reporting of tentatively identified compounds (TIC). However, reporting of up to 10 TIC's whose peak heights are ≥ 10% of the nearest internal standard may be requested or ≥ 40% of the nearest internal standard may be requested for low concentration analyses. Concentrations are calculated using the following formula using an assumed response factor (RF) of 1:

$$C_{(x)} = \frac{C_{(IS)} * A_{(x)}}{A_{(IS)}} * DF$$

Where:

$C_{(x)}$= Concentration of Unknown (µg/L).

$C_{(IS)}$= Concentration of internal standard (µg/L).

DF = Dilution Factor

$A_{(x)}$ = Area of Unknown

$A_{(IS)}$= Area of associated internal standard.

Concentrations of Calibrated Compounds:

$$C_{(x)} = \frac{A_{(x)} * C_{(IS)}}{A_{(IS)} * \overline{RRF}} * DF$$

Where:

$C_{(x)}$ = Concentration of compound (µg/L)

$C_{(IS)}$ = Concentration of associated internal standard (µg/L).

DF = Dilution Factor.

$A_{(IS)}$ = Area of quantitation ion for associated internal standard.

$A_{(x)}$ = Area of quantitation ion for compound.

RRF = Average Relative Response Factor from five-point initial calibration.

Data Reporting - Based on the mass spectra, it is appropriate to report values between the MDL and the RL. In this region, an analyte can be qualitatively detected, but not accurately quantified. Any data point reported in this region is flagged with a "J" qualifier. Stone reports sample specific RL's. Sample specific RL's are derived by taking into account various sample specific data, which can include the amount of the sample subject to testing, % moisture, dilution factor, interferences and the base RL's for the analysis.

Typical Reporting qualifiers are as follows:

B = Analyte is found in the associated method blank as well as the sample.

D = Compound is identified in an analysis at a secondary dilution factor.

E = Compound quantitation is above the instrument's calibration range for this analysis.

J = Indicates an estimated quantitation value.

U = Compound was analyzed for but not detected. Value reported is the method reporting limit.

11.0 QUALITY CONTROL AND CORRECTIVE ACTION

11.1 Instrument Blank (SPME Fiber Blank)

To be performed once daily at the start of the analytical day. All target analyte areas detected in the instrument blank must be less than one-third the area of the analyte at the PQL value prior to continuing.

11.2 4-Bromofluorobenzene

To be performed every 12 hours, at the start of the analytical day and before beginning acquisition of a calibration curve. Criteria can be found in section 9.4.1.

11.3 Continuing Calibration Verification

To be performed every 12 hours, at the start of the analytical day. Percent differences must be less than or equal to 20%

11.4 Method Blank

One per analytical batch (12 hours or 20 samples) directly after the calibration standard and after highly contaminated samples to demonstrate that there is no carry over into subsequent samples. All target analyte concentrations detected in the method blank must be less than one-half the PQL value prior to continuing.

11.5 Surrogate Standards

Surrogate recoveries should be 75-125% for water and soil samples. Samples with surrogate recoveries falling outside of quality control limits should be reanalyzed once. If the reanalysis of the sample is also outside the quality control limits, then it will be determined that the problem may be associated with the sample matrix and noted as such.

11.6 Matrix Spike and Matrix Spike Duplicate (MS/MSD) Analysis

An MS/MSD analysis is required every set of twenty samples or as specified by the client. A sample will be chosen by client to perform a matrix spike analysis. The control limits for the matrix spike recoveries will be derived empirically using the most recently acquired group of data. If no data is available, advisory recovery limits (set forth by the EPA, SW 846 Methodologies) of 70-130% will be used.

$$\%\text{Recovery} = \frac{\text{Sample Spiked Concentration} - \text{Un-Spiked Sample Concentration}}{\text{Spiked Concentration}}$$

11.7 Initial Calibration Verification Standard (ICV)

A QC sample from a second (independent) source than that of the initial calibration will be analyzed directly after the ICAL. The ICV sample will contain all the VOC compounds of interest at 100 ppb. Recovery Limits for the ICV will be 70-130%. This sample may also be used as the laboratory control sample (LCS). Daily LCS range 80-120%.

11.8 CORRECTIVE ACTION

Quality Control Check	*Minimum Frequency*	*Acceptance Criteria*	*Corrective Action*
Initial Calibration (ICAL)	As necessary.	Minimum of five points for VOCs. Minimum RRF and Maximum %RSD on Table 1 or a correlation factor (r) of 0.99 for linear regression.	Verify solution integrity and check instrument performance. Perform necessary maintenance and recalibrate instrument. Reanalyze all affected samples.
Initial Calibration Verification (ICV)	One per calibration (following acceptable ICAL)	QC limits are 70 to 130% for target compounds	Reanalyze once; if still out verify solution integrity or ICAL solution integrity, and instrument performance. Re-prepare and reanalyze all associated samples.
Retention Time (RT) Window Study	Every new column installation	All target compounds and surrogates in all standards must fall within the established window of ± 0.02 minutes from ICAL	Perform system maintenance. Reanalyze affected samples.
Continuing Calibration Verification (CCV)	To be performed every 12 hours, at the start of the analytical day	See Section 9.0. ≤ ± 20% for VOCs	Verify solution integrity and instrument performance. Reanalyze standard once, if still out, recalibrate and reanalyze affected samples.
Method Blanks	One per preparation batch	Target Compounds < one-third reporting limit	Investigate source of contamination. Re-prepare and reanalyze all associated samples.
Matrix Spike (MS) and Matrix Spike Duplicate (MSD)	One set per 20 samples of a similar matrix	QC limits are 70-130%. RPD not to exceed 30%. In air, QC limits are 60-140%. RPD not to exceed 40%	Reanalyze once; if still out, verify solution integrity and instrument performance. If necessary analyze a LCS or ICV and if acceptable, narrate as possible matrix effect.
4-Bromofluorobenzene	every 12 hours or at the start of a new analytical day, and before acquisition of a new calibration curve	See section 9.4.1.	Reanalyze once, if still out, MS should be retuned and adjusted to meet all criteria before continuing

11.9 Data Review

The analyst is responsible for primary data review of data generated from the sample analysis. Analyses will be documented in the instrument run log. Maintenance is documented in the Instrument Maintenance Logbook. Instrument calibrations and recoveries of all QC samples must be within specified control limits. If instrument calibration or the recoveries of any QC sample exceed specified tolerances, then the affected sample results are evaluated and generally the samples are submitted for re-analysis. To determine if analytical results are acceptable, a qualified and

independent QA/QC program shall conduct a secondary review on a weekly basis. A QA/QC Checklist (Attachment 1) is used to indicate any problems with the referenced analytical batches. The QA/QC checklist will also address any corrective action taken. All calibrations, calculations, and transcriptions are checked for accuracy and QC sample results are evaluated against specified limits. If instrument calibration and recoveries of all QC samples are within the specified criteria, then the data reports will be submitted to the Project Manager as final results with no qualifiers. If recoveries of any QC samples exceed specified limits and re-analysis is not an option, then the samples will be qualified as estimated with a "J" qualifier (J= The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.). Data will not be reported if significant QC issues affect the batch analyses.

12.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The United States Environmental Protection Agency (USEPA) has established a prevention hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the agency recommends recycling as the next best option.

The quantity of chemical purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

The USEPA requires that laboratory waste management practices conducted be consistent with all applicable rules and regulations. Excess reagents, samples, and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel", available from the American Chemical Society.

13.0 REFERENCES

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Lee, Jae-Hwan, Seung Man Hwang, Dai Woon Lee, and Gwi Suk Heo, 2002, Determination of Volatile Organic Compounds (VOCs) Using Tedlar Bag/Solid-phase Microextraction/Gas Chromatography/Mass Spectrometry (SPME/GC/MS) in Ambient Workplace Air. Bull. Korean Chem. Soc., Vol 23, No. 3 pp. 488-496.

"Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

http://www.epa.gov/epaoswer/hazwaste/test/pdfs/8260b.pdf

National Environmental Laboratory Accreditation Conference (NELAC), Quality Assurance Systems Standards, Chapter 5, Approved May 2001, Effective July 2003

ASTM6520, Solid Phase Micro-extraction of water and its headspace for analysis of Volatile and Semi-volatile Organic Compounds

14.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

Attachment 1: Sample GC Laboratory QA/QC Checklist

Table 1: Analyte Details

Analyte	CAS #	Minimum RRF	Maximum %RSD	PQL Water (ug/L)	PQL Air (ppbv/v)	PQL Soil (ug/Kg)	MS/MSD amount (ppb)
Chloromethane (SPCC)	74-873	0.01	15%	2	1-50	120	50
Vinyl Chloride (CCC)	75-014	0.01	15% (30%)	2	1-50	60	50
Bromomethane	74-839	0.01	15%	10	1-50	120	50
Chloroethane	75-003	0.01	15%	5	1-50	120	50
1,1,2-Trichloro-1,2,2-trifluoroethane	76-131	0.01	15%	5	1-50	60	50
1,1-Dichloroethene (CCC)	75-354	0.01	15% (30%)	2	1-50	120	50
Acetone	67-641	0.01	15%	50	1-50	1200	200
Carbon Disulfide	75-150	0.01	15%	2	1-50	60	50
Methyl Acetate	79-209	0.01	15%	2	1-50	60	50
Methylene Chloride	75-902	0.01	15%	2	1-50	60	50
t-Butyl-methyl ether	1634-044	0.01	15%	2	1-50	60	50
trans-1,2-Dichloroethene	156-605	0.01	15%	2	1-50	60	50
1,1-Dichloroethane (SPCC)	75-343	0.10	15%	2	1-50	60	50
cis-1,2-Dichloroethene	156-592	0.01	15%	2	1-50	60	50
2-Butanone	78-933	0.01	15%	50	1-50	1200	200
Chloroform (CCC)	67-663	0.01	15% (30%)	2	1-50	60	50
1,1,1-Trichloroethane	71-556	0.01	15%	2	1-50	60	50
Cylcohexane	110-827	0.01	15%	2	1-50	60	50
Carbon Tetrachloride	56-235	0.01	15%	2	1-50	120	50
Benzene	71-432	0.01	15%	2	1-50	60	50
1,2-Dichloroethane	107-062	0.01	15%	2	1-50	60	50
Trichloroethene	79-016	0.01	15%	2	1-50	60	50

Analyte	CAS #	Minimum RRF	Maximum %RSD	PQL Water (ug/L)	PQL Air (ppbv/v)	PQL Soil (ug/Kg)	MS/MSD amount (ppb)
Methyl Cyclohexane	108-872	0.01	15%	2	1-50	60	50
1,2-Dichloropropane (CCC)	78-875	0.01	15% (30%)	2	1-50	60	50
Bromodichloromethane	75-274	0.01	15%	2	1-50	60	50
cis-1,3-Dichloropropene	10061-015	0.01	15%	2	1-50	60	50
4-Methyl-2-pentanone	108-101	0.01	15%	50	1-50	1200	200
Toluene (CCC)	108-883	0.01	15% (30%)	2	1-50	60	50
trans-1,3-Dichloropropene	10061-026	0.01	15%	2	1-50	60	50
1,1,2-Trichloroethane	79-005	0.01	15%	2	1-50	60	50
Tetrachloroethene	127-184	0.01	15%	2	1-50	60	50
2-Hexanone	591-786	0.01	15%	50	1-50	1200	200
Dibromochloromethane	124-481	0.01	15%	2	1-50	60	50
1,2-Dibromoethane	106-934	0.01	15%	2	1-50	60	50
Chlorobenzene (SPCC)	108-907	0.30	15%	2	1-50	60	50
Ethylbenzene	100-414	0.01	15% (30%)	2	1-50	60	50
m+p-Xylenes	108-383 106-423	0.01	15%	2	1-50	120	50
o-Xylene	95-476	0.01	15%	2	1-50	60	50
Styrene	100-425	0.01	15%	2	1-50	60	50
Bromoform (SPCC)	75-252	0.10	15%	2	1-50	60	50
Isopropylbenzene	98-828	0.01	15%	2	1-50	120	50
Bromofluorobenzene	460-004	0.01	15%	2	1-50	60	50
1,1,2,2-Tetrachloroethane (SPCC)	79-345	0.30	15%	2	1-50	60	50
1,3-Dichlorobenzene	541-731	0.01	15%	2	1-50	60	50
1,4-Dichlorobenzene	106-467	0.01	15%	2	1-50	60	50
1,2-Dichlorobenzene	95-501	0.01	15%	2	1-50	60	50
1,2-Dibromo-3-chloropropan	96-128	0.01	15%	2	1-50	60	50
1,2,4-Trichlorobenzene	120-821	0.01	15%	2	1-50	60	50

15.0 AUTHORIZATION

Authored by: _____ Date: _____

David Crosby, Staff Scientist

Approved by: _____ Date: _____

Seth Pitkin, Vice President

16.0 REVISIONS

Revision 1:

1. Included the analytical process to analyze air in a tedlar bag using SPME and SW846 Method 8260.

Revision 2:

1. Allow a range for the concentration of the internal standard from 8.33 to 16.67 ppb.
2. Section 9.4. Included text to allow for the BFB tune evaluation to be performed as part of a check standard prior to running calibration standards and environmental samples.
3. Table 1. Adjust chloromethane and bromomethane reporting limits to 10 ppb for waters and 120 ppb for soils.
4. Include calibration by linear regression in Section 11.9.

Revision 3:

1. Adjust frequency for continuing calibration check standard from one per 15 analytical runs to one at the beginning of each analytical day.
2. Adjustment of reporting limits to reflect latest method detection limit study.

Attachment I

SAMPLE GC LABORATORY QA/QC CHECKLIST

GC LABORATORY QA/QC CHECKLIST

Date:_____

QC Analysis	Criteria	Filename(s):
IC Calibration:	%RSD ± 15/20% VOCs, >0.99 (other)	
CC Calibration:	%D ± 20 % VOCs, ± 30% (Other)	
SPME Fiber Blank:	< 1/3 reporting limit	
Method Blank:	< 1/2 reporting limit	
ICV Standard:	70-130%	
ICV/LCS:	70-130%	
MS/MSD Analysis:	70-130%	
Surrogate Standards:	75-125%	
Other (describe):		

Comments/Corrective Action:

Prepared By: _____

Reviewed By:_____

NA = None Available

STANDARD OPERATING PROCEDURE

SEI-10.1.3

DETERMINATION OF AROMATIC AND CHLORINATED VOLATILE ORGANICS AND LIGHTWEIGHT PETROLEUM HYDROCARBONS (TYPICAL RANGE C4-C16) COMPOUNDS USING SOLID PHASE MICROEXTRACTION (SPME) AND A GAS CHROMATOGRAPH IN SOIL AND WATER SAMPLES (MODIFIED SW846 METHODS 8021/8015& ASTM D6520)

SOP Number: SEI-10.1.3
Revision Number: 3

Date Issued: 02/21/03
Date of Revision: 08/17/04

1.0 OBJECTIVE

This method is designed to measure the concentration of specified volatiles organic compounds (VOCs) and various classes of petroleum hydrocarbon compounds in water and soil samples using solid phase microextraction (SPME) and a Gas Chromatograph equipped with a capillary column. Specific VOCs of interest may include but are not limited to vinyl chloride, cis-1, 2-dichloroethene, trans-1, 2-dichloroethene, trichloroethene, tetrachloroethene, benzene, toluene, ethylbenzene, m & p xylene, and o-xylene (typically reported as total xylene). The petroleum hydrocarbon compounds of interest include: gasoline, kerosene, No. 2 Fuel Oil, and diesel fuel (specifically hydrocarbons between the range of C4-C16).

2.0 SUMMARY OF METHOD

This method provides gas chromatographic conditions for the detection of certain aromatic and chlorinated VOCs and petroleum hydrocarbons (typical range C4-C16). The Gas Chromatograph is equipped with a narrow bore capillary column and a Flame Ionization Detector (FID). Samples are prepared in 24 mL extraction vials. The SPME fiber is then exposed to the headspace above the sample for a set number of minutes while the sample is rapidly stirred. The exposure time must be consistent for all standards and samples (typically eight minutes). The absorbed analytes are thermally desorbed from the SPME fiber in the injection port of a Gas Chromatograph and transferred to the capillary column.

This method is suitable for analysis of water, soils, and wastes.

Soil samples are collected in approximately 10-12 gram cores preserved in methanol (10 mLs) in 40 mL VOA vials and water samples are collected in 40 mL VOA vials with no headspace.

This method is based on EPA SW-846 Methods 8000, 8021B and 8015 and ASTM Method D6520.

3.0 DEFINITIONS

SPME – Solid Phase Microextraction

VOC – Volatile Organic Compounds

QA/QC – Quality Assurance/Quality Control

Lightweight petroleum hydrocarbons- typically gasoline range organic petroleum hydrocarbons in the carbon range of C4-C16.

Laboratory Control Sample (LCS) - A reagent water or method blank matrix spiked with the analytes of interest. The spike recovery is used to evaluate method accuracy and control.

Instrument Blank – Involves only the SPME fiber. The fiber is exposed to laboratory room air (for a time equal to the exposure time for the samples and calibration standards) prior to analysis. The instrument blank is used to measure contamination associated with laboratory room air, the fiber, and the GC.

Method Blank - A reagent water or soil sample spiked with surrogates and subjected to the same preparation procedures as the associated samples. The method blank is used to measure contamination associated with that of the instrument blank and the reagents (dilution water and solvents that contain QC standards) used as part of the program. The surrogate recoveries of the method blank are used as matrix-free laboratory controls.

EPA - U.S. Environmental Protection Agency.

4.0 INTERFERENCES

When analyzing for VOCs, samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride), through the sample container septum during shipment and storage. A trip blank prepared from organic-free reagent water and carried through sampling and subsequent storage and handling must serve as a check on such interferences.

Sulfur dioxide is a potential interferant in the analysis for vinyl chloride.

Contamination by carryover can occur whenever high-concentration and low-concentration samples are analyzed in sequence. To reduce the potential for carryover, the sample syringe or purging device must be rinsed out between samples with an appropriate solvent. Whenever an unusually concentrated sample is encountered, it should be followed by injection of a method blank to check for cross contamination.

Purging vessels and syringes should be adequately cleaned and flushed prior to use. All glassware must be kept scrupulously cleaned. Clean all glassware as soon as possible after use by rinsing with the last solvent used or analyte-free water. Store clean dry glassware in a clean environment.

The flame ionization detector (FID) is a non-selective detector. There is a potential for many non-target compounds present in samples to interfere with this analysis.

5.0 SAFETY ISSUES

1. Laboratory personnel should take extra care when working with standards. When working with neat standards, make certain that there is adequate ventilation and that Nitrile or Latex gloves are worn and if necessary safety glasses.
2. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site and followed.
3. Field visits may involve accessing remote areas. Health and safety concerns regarding these field visits are minimal, however, hazards such as slip, trip and falls, poisonous plant and dangerous animals, as well as getting vehicles stuck in remote areas, do present considerable health and safety issues. To help ensure field staff's health and safety in remote areas, all field staff are to have daily communication with the project manager or another appropriate SEI employee.
4. All chemicals are required to be received with a Material Safety Data Sheets (MSDS). MSDSs shall be made available to all personnel involved in the sampling and testing.

6.0 EQUIPMENT AND SUPPLIES

1. Gas Chromatograph: Analytical system complete with gas chromatograph and all required accessories, including a detector, column supplies, gases, syringes and data system to determine peak areas and perform integrations. Hewlett Packard 5890 Series II.
2. Analytical Column: SPB-624 10m x 0.20mm ID, 1.1 um film.
3. Detector: Flame ionization detector (FID).
4. Array of Microsyringes: range 5-1000 uL.
5. Balance: Top loading, capable of weighing accurately to 0.01 grams (soil samples only).
6. Sample introduction and preparation apparatus: SPME Fiber type 100 µm polydimethylsiloxane (PDMS) and/or 85 µm Carboxen/PDMS fiber, magnetic hot plate and magnetic stirrers, tube clamp and stand.
7. VOA vials: 40 mL collection containers with Teflon®-lined septum and 24 mL extraction vials

7.0 REAGENTS AND STANDARDS

1. Reagents: Organic-free reagent water demonstrated to be free of compounds of interest (spring water, carbon filtered and/or deionized). Purge and Trap Grade or equivalent grade methanol (demonstrated to be free of analytes and stored away from other solvents).
2. Stock standards – Stock standards may either be prepared from pure standard materials or purchased as certified solutions. Secondary dilution standards are prepared accordingly using stock standard solutions, which contain the compounds of interest, either singly or mixed together. The aqueous standards are prepared at concentrations as listed in Section 9.0. Calibration standards at a minimum of

five different concentrations for VOC analytes and at a minimum of three for petroleum hydrocarbon compounds are prepared in water.

8.0 SAMPLE COLLECTION AND HANDLING

8.1 Sample Collection

1. Aqueous samples are collected in 40 mL Teflon®-lined septum VOA vials filled to ensure that no headspace is present. If storage of these samples is expected to exceed seven days, aqueous samples should be preserved with hydrochloric acid (HCL) to a pH of < 2.
2. Soil samples are collected in approximately 10-12 gram cores, and placed in 40 mL vials. A soil aliquot of approximately 10-12 grams of sample is placed in a VOA vial with 10 mL of methanol.

8.2 Handling and Holding Times

Unpreserved water samples must be analyzed within 7 days of collection. Preserved (preserved with HCl to a pH of < 2) water samples must be analyzed within 14 days of collection. Soil samples collected in methanol must be analyzed within 14 days from collection. All samples shall be stored at 4 ° C ± 2 ° C. Samples are allowed to come to room temperature just prior to analysis. All samples for this program are typically analyzed within one or two days from collection, therefore, holding times should not be a concern.

9.0 PROCEDURES

9.1 Typical GC Program

Oven Temp: 35°C (0.5 min) to 160°C at 30°C/min.

Carrier Gas: Helium, 40 cm/sec (set at 40°C)

Detector: FID

Injector: 240°C, splitless (close 3 min)

Liner: 0.75 mm ID splitless/split injection port

Flow rates: Helium 1.0 ml/min

Air 450 ml/min

Hydrogen 33 ml/min

Helium makeup 30 ml/min

9.2 GC Column

Column: SPB-624 10m x 0.20mm ID, 1.1 um film

9.3 Material Preparation:

SPME: Fiber Type: 100 µm polydimethylsiloxane (PDMS).

SPME Fiber Type for low level waters: 85 µm Carboxen/PDMS

Extraction: The fiber is exposed to the headspace above a sample for 8 minutes while the sample is rapidly stirred on a magnetic stirring plate. Each magnetic stirrer is rinsed three times with methanol and a final rinse with volatile free water prior to use. Prior to use, each fiber must be conditioned for at least one hour in the GC inlet at 240°C. The fibers are very fragile and should not be exposed to hard surfaces, as they will damage easily.

9.4 Operating Procedure

9.4.1 Calibration Criteria

9.4.1.1 Initial Calibration (ICAL):

1. Five-point calibration for VOC compounds (10, 40, 100, 200, 500 ppb). The low standard must be set at the practical quantitation limit (PQL). Low level standards (1,2,5,10, 20 ppb)
2. Three-point calibration for petroleum hydrocarbon standards (200, 500, 2,000 ppb of Number 2 Fuel Oil). If appropriate and necessary based on the observed chromatographic pattern of the petroleum hydrocarbons detected in site samples, a three-point calibration for Diesel and No. 6 Fuel Oil (200, 500, 2000 ppb) will be prepared. It should be noted that this headspace methodology will only detect the lightweight petroleum hydrocarbons associated with these fuel oils.
3. Calibration range must encompass the expected sample concentration; therefore, if site samples are expected to be higher in concentration than the calibration range, adjustments to the calibration range and samples will be documented and made accordingly.
4. The linearity of the calibration curves must be assessed and are used for all quantitation. Volatile organic compounds use an internal standard procedure (internal standard; fluorobenzene). Linear regression is used for quantitation and the correlation coefficient (r) of each compound must be greater than 0.995 ($r^2 = 0.990$). Depending upon the on-site program acceptable correlation coefficient may be set at at 0.99 in accordance with SW846 8000.

5. For the petroleum hydrocarbon compounds external standard calibration will be performed using a specific window (specifically all peaks encompassing approximately (C4-C16) at approximately 3.0 to 9.0 minutes. The correlation coefficient of the calibration must be greater than 0.99 (> 0.99).

9.4.1.2 Continuing Calibration (CCV):

1. A mid-point continuing calibration verification standard for VOC compounds at 100 ppb (low level: 5 ppb) must be analyzed daily: prior to sample analysis in order to verify the initial calibration; after every 15 analytical runs which include environmental and QC samples; and at the close of an analytical sequence. A percent difference of the expected concentration is compared to the actual concentration. The percent difference values for each compound must be less than or equal to 20%.

$$\%D = \frac{\text{Expected Conc. - Actual Conc.}}{\text{Expected Conc.}}$$

2. A mid-point CCV standard for petroleum hydrocarbons (500 ppb for diesel or No. 2) must be analyzed daily; prior to sample analysis in order to verify the initial calibration; and if necessary, at the close of an analytical sequence. A percent difference of the daily concentration gasoline range petroleum hydrocarbons found compared to the nominal concentration is calculated. The percent difference values for petroleum hydrocarbons must be less than or equal to ± 30%.

$$\%D = \frac{\text{Expected Conc. - Actual Conc.}}{\text{Expected Conc.}}$$

9.4.1.3 Initial Calibration Verification Standard (ICV):

A QC sample from a second (independent) source will be analyzed directly after the ICAL. The ICV sample will contain all the VOC compounds of interest at the mid-point (100 ppb or 5 ppb for low level waters). Recovery Limits for the ICV will be 70-130%. This QC sample may also be used daily as the ICV/LCS with recovery limits less than or equal to 20% for all compounds including the Bromofluorobenzene surrogate.

$$\%Rec. = \frac{\text{Actual Conc.}}{\text{Expected Conc.}}$$

9.4.2 Retention Time Windows and Pattern Recognition

The laboratory shall identify single component target analytes on the basis of retention time windows (± 0.02 minutes from the ICAL or daily CCV). Petroleum hydrocarbons are distinguished on the basis of the ranges of retention times for characteristic components in each type of fuel. During the initial calibration, the retention time window of these components is established and documented. Once the range and retention time window is established, they will be used for the identification of the compounds of interest.

9.4.3 Sample Preparation:

Water samples: An aliquot of sample, sufficient to get the highest concentration constituents into the upper half of the linear range, is transferred to a 24 mL extraction vial and spiked with the surrogate (bromofluorobenzene at 100 ppb) and internal standard (fluorobenzene at 104 ppb). The SPME fiber is then exposed to the headspace above the sample for eight minutes while the sample is rapidly stirred with a magnetic stirrer on a magnetic plate. The eight minutes is measured using a bench-top timer. Extraction time may be modified depending on the anticipated equilibration response of the target analytes at given concentrations.

Soil samples: Preserved in methanol; 10-12 g core of soil is added to 10 mL of methanol containing an appropriate amount of bromofluorobenzene. After addition of the site soil and prior to analysis, the vial is mixed for five minutes. An aliquot of methanol, sufficient to get the highest concentration constituents into the upper half of the linear range but not to exceed 2 mL, is diluted to volume with analyte free water and ¼ tsp. salt in a 24 mL vial, and analyzed using SPME in the same manner as a water sample.

9.4.4 Analysis of Samples:

Analysis of samples is performed using SPME followed by analysis on a GC equipped with a narrow bore capillary column and a FID. For this program the fiber is exposed to the headspace above the sample. Therefore a small portion is discarded from the 24 ml vial prior to exposure. The exposure time needs to be consistent (8 minutes for this method). To facilitate the release of the analytes from their respective media, the sample is rapidly stirred throughout the extraction. The adsorbed analytes are thermally desorbed in the injection port of the GC and transferred to the capillary column.

9.4.5 Surrogate (SS) and Internal Standard (ISTD) Compounds for VOC compounds

Compound	Amount Spiked (Low level, Carboxen)
Bromofluorobenzene (SS)	100 ppb (12.48 ppb)

Fluorobenzene (ISTD)	104 ppb (4.16 ppb)

9.4.6 Surrogate Spike Compound for Petroleum Hydrocarbons Compounds

Compound	**Amount Spiked**
Fluorobenzene	104 ppb (4.16 ppb)

9.4.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD) Compounds:

Compound	*Amount Spiked**
Vinyl Chloride	100
cis-1,2-Dichloroethene	100
trans-1,2-Dichloroethene	100
Trichloroethene	100
Benzene	100
Toluene	100
Ethylbenzene	100
m+p Xylenes	200
o Xylene	100

Note: For water samples the MS will be spiked at 50 ppb or at 5 ppb depending upon the program; the amount may change to account for the concentration of a particular analyte found in the sample being analyzed as a MS. For soil samples, an appropriate amount of the target analytes are spiked into the 10 mL of methanol. Matrix Spike Analyses will contain only the VOC compounds of interest.

9.4.8 Target Compound List Compounds

Compounds	**Practical Quantitation Limits ***	
	Water (ug/L)	Soils (ug/kg)
Vinyl Chloride	20	400
cis-1,2-Dichloroethene	5	100

trans-1,2-Dichloroethene	5	100
Trichloroethene	5	100
Tetrachloroethene	5	100
Benzene	5	100
Toluene	5	100
Ethylbenzene	5	100
Total Xylene	5	100
Petroleum Hydrocarbon Compounds**	50	500

* Low Level PQLs can be achieved for all compounds at 1 ppb using the Carboxen Fiber.

**Note: If upon visual inspection of the chromatogram the petroleum hydrocarbon compounds are suspected to be that of No. 6 Fuel Oil or heavier weight hydrocarbons, the PQL will be higher; approximately 200 ug/L for waters and 2400 ug/kg for soils. PQLs are sample dependent and may change based on sample dilution used during the analysis; adjustments to the PQLs will be made accordingly.

10.0 CALCULATIONS

Identification of the project- specific VOCs in the sample chromatogram is achieved by comparing the retention times generated by the calibration standards, continuing calibration standard and other fortified QC samples. Retention times must be within ± 0.04 minutes from the ICAL. If a retention time shift is observed in the CCV or daily ICV, then adjustments to the daily retention time windows will be made accordingly. Quantification of the VOCs is determined by comparison to the internal standard and linear regression for that analyte from the initial calibration curve.

Quantification of the lightweight petroleum hydrocarbon compounds is determined by summing the peak areas found in the chromatographic window of the sample and using a linear regression of the calibration curve. The SPME gas chromatograph (GC) headspace method will detect only those petroleum hydrocarbon compounds that are lightweight, i.e., those that are typically found in gasoline, kerosene, a portion of No. 2 Fuel Oil and diesel. Therefore, the petroleum hydrocarbon results will be used on a be semi-quantitative basis.

The concentration of each analyte in the sample may be determined by calculating the amount of standard injected, from the peak response, using the calibration curve as noted above.

For the analysis of the petroleum hydrocarbons, sum the area of all peaks eluting between approximately 3.0-9.0minutes (set range should be used for both standards and samples). This area is used to calculate petroleum hydrocarbons.

Range concentration = Dilution x (Total FID Area – Surrogate Area).

Use the HP Chemstation software to calculate sample hydrocarbon range concentrations for water in ug/L and soil in ug/Kg.

11.0 QUALITY CONTROL AND CORRECTIVE ACTION

11.1 Instrument Blank (SPME Fiber Blank)

To be performed once daily at the start of the analytical day. All target analyte concentrations detected in the instrument blank must be less than one-half the PQL value prior to continuing.

11.2 Method Blank

One per analytical batch (15 samples) directly after the calibration standard and after highly contaminated samples to demonstrate that there is no carry over into subsequent samples. All target analyte concentrations detected in the method blank must be less than one-half the PQL value prior to continuing.

11.3 Surrogate Standards

Surrogate recoveries should be 75-125% for water and soil samples. Surrogate recoveries for QC samples should be 80-120%. Samples with surrogate recoveries falling outside of quality control limits should be reanalyzed once. If the reanalysis of the sample is also outside the quality control limits, then it will be determined that the problem may be associated with the sample matrix and noted as such.

11.4 Matrix Spike and Matrix Spike Duplicate (MS/MSD) Analysis

An MS/MSD analysis is required every set of twenty samples or as specified by the client. A sample will be chosen by client to perform a matrix spike analysis. The control limits for the matrix spike recoveries will be derived empirically using the most recently acquired group of data. If no data is available, advisory recovery limits (set forth by the USEPA, SW 846 Methodologies) of 70-130% will be used.

$$\%\text{Recovery} = \frac{\text{Sample Spiked Concentration} - \text{Un-Spiked Sample Concentration}}{\text{Spiked Concentration}}$$

11.5 Initial Calibration Verification Standard (ICV)

A QC sample from a second (independent) source than that of the initial calibration will be analyzed directly after the ICAL. The ICV sample will contain all the VOC compounds of interest at 100 ppb.

Recovery Limits for the ICV will be 70-130%. This sample may also be used as the laboratory control sample (LCS). Daily LCS range 80-120%.

11.6 Lab Duplicate

A random sample is run in duplicate and the results are compared. The relative percent difference (RPD) should not exceed 30%.

11.7 CORRECTIVE ACTION

Quality Control Check	*Minimum Frequency*	*Acceptance Criteria*	*Corrective Action*
Initial Calibration (ICAL)	As necessary.	Minimum of five points for VOCs. Correlation coefficient must be > 0.995. (some programs >0.99) Minimum of three points for petroleum hydrocarbon. Low standard must not exceed reporting limit. Petroleum hydrocarbon > 0.99.	Verify solution integrity and check instrument performance. Perform necessary maintenance and recalibrate instrument. Reanalyze all affected samples.
Initial Calibration Verification (ICV)	One per calibration (following acceptable ICAL)	QC limits are 70 to 130% for target compounds	Reanalyze once; if still out verify solution integrity or ICAL solution integrity, and instrument performance. Re-prepare and reanalyze all associated samples.
Retention Time (RT) Window Study	Every new column installation	All target compounds and surrogates in all standards must fall within the established window of ± 0.04 minutes from ICAL	Perform system maintenance. Reanalyze affected samples.
Continuing Calibration Verification (CCV)	One after each 15 samples window and must be followed by a method blank if more samples are to be analyzed	See Section 9.0. ≤ ± 20% for VOCs ≤ ±30 % for petroleum hydrocarbons	Verify solution integrity and instrument performance. Reanalyze standard once, if still out, recalibrate and reanalyze affected samples.
Method Blanks	One per preparation batch	Target Compounds < one-half reporting limit	Investigate source of contamination. Re-prepare and reanalyze all associated samples.
Matrix Spike (MS) and Matrix Spike Duplicate (MSD)	One set per 20 samples of a similar matrix	QC limits are 70-130%. RPD not to exceed 30%.	Reanalyze once; if still out, verify solution integrity and instrument performance. If necessary analyze a LCS or ICV and if acceptable, narrate as possible matrix effect.

11.8 Data Review

The analyst is responsible for primary data review of data generated from the sample analysis. Analyses will be documented in the instrument run log. Maintenance is documented in the Instrument Maintenance Logbook. Instrument calibrations and recoveries of all QC samples must be within specified control limits. If instrument calibration or the recoveries of any QC sample exceed specified tolerances, then the affected sample results are evaluated and generally the samples are submitted for re-analysis. To determine if analytical results are acceptable, a qualified and independent QA/QC program shall conduct a secondary review on a weekly basis. A QA/QC Checklist (Attachment 1) is used to indicate any problems with the referenced analytical batches. The QA/QC checklist will also address any corrective action taken. All calibrations, calculations, and transcriptions are checked for accuracy and QC sample results are evaluated against specified limits. If instrument calibration and recoveries of all QC samples are within the specified criteria, then the data reports will be submitted to the Project Manager as final results with no qualifiers. If recoveries of any QC samples exceed specified limits and re-analysis is not an option, then the samples will be qualified as estimated with a "J" qualifier (J= The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.). Data will not be reported if significant QC issues affect the batch analyses.

12.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The United States Environmental Protection Agency (USEPA) has established a prevention hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the agency recommends recycling as the next best option.

The quantity of chemical purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

The USEPA requires that laboratory waste management practices conducted be consistent with all applicable rules and regulations. Excess reagents, samples, and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water and land by minimizing and controlling all releases from hoods and bench operations,

complying with the letter and spirit of any waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel", available from the American Chemical Society.

13.0 REFERENCES

Pawliszyn, Janusz, 1999, Applications of Solid Phase Microextraction, *in* RSC Chromatography Monographs; Smith, Roger S., Series Editor, Royal Society of Chemistry, Cambridge, UK, 655 p.

SW846. ASTM D6520.

"Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

14.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

Attachment 1: Sample GC Laboratory QA/QC Checklist

15.0 AUTHORIZATION

Authored by: _____ Date: _____

Michael D. Rossi, Project Scientist

Approved by: _____ Date: _____

Christopher T. Stone, President

16.0 REVISION HISTORY

Revision Number 1

1. Minor wording edits

Revision Number 2

Unknown

Revision Number 3

1. Added Section 12.0 Pollution Prevention
2. Added Section 16.0 Revision History

Attachment I

SAMPLE GC LABORATORY QA/QC CHECKLIST

GC LABORATORY QA/QC CHECKLIST

Date:_____

QC Analysis	Criteria	Filename(s):
IC Calibration:	%RSD ± 30% VOCs, >0.99 (other)	
CC Calibration:	%D ± 20 % VOCs, ± 30% (Other)	
SPME Fiber Blank:	< 1/3 reporting limit	
Method Blank:	< 1/2 reporting limit	
ICV Standard:	70-130%	
ICV/LCS:	80-120%	
MS/MSD Analysis:	70-130%	
Surrogate Standards:	75-125%	
Other (describe):		

Comments/Corrective Action:

Prepared By: _____

Reviewed By:_____

NA = None Available

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State of Florida
Department of Health, Bureau of Laboratories
This is to certify that

E97932
STONE ENVIRONMENTAL, INC.
535 STONE CUTTERS WAY MOBILE LAB - IUK500F2541047129
MONTPELIER, VT 05602

has complied with Florida Administrative Code 64E-1,
for the examination of Environmental samples in the following categories

NON-POTABLE WATER - VOLATILE ORGANICS, SOLID AND CHEMICAL MATERIALS - VOLATILE ORGANICS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

EFFECTIVE July 01, 2007 THROUGH June 30, 2008

Max Salfinger, M.D.
Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1697, 7/04
NON-TRANSFERABLE E97932-04-7/1/2007
Supersedes all previously issued certificates

Charlie Crist
Governor

FLORIDA DEPARTMENT OF HEALTH

Ana M. Viamonte Ros, M.D., M.P.H.
Secretary of Health

Laboratory Scope of Accreditation

Attachment to Certificate #: E97932-04, expiration date June 30, 2008. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E97932 **EPA Lab Code: VT00974** **(802) 229-2194**

E97932
Stone Environmental, Inc.
535 Stone Cutters Way
Mobile Lab - IUK500F2541047129
Montpelier, VT 05602

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1-Trichloroethane	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	6/23/2004
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,3-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,4-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Benzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Benzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Bromoform	EPA 8260	Volatile Organics	NELAP	6/23/2004
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	6/23/2004
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	6/23/2004
Chlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Chloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
Chloroform	EPA 8260	Volatile Organics	NELAP	6/23/2004
cis-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/23/2004
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	6/23/2004
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	6/23/2004
Ethylbenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	6/23/2004
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	9/29/2006
Methylene chloride	EPA 8260	Volatile Organics	NELAP	4/27/2005
m-Xylene	EPA 8260	Volatile Organics	NELAP	9/29/2006

Clients and Customers are urged to verify the laboratory's current certification status with the Environmental Laboratory Certification Program. **Issue Date: 7/1/2007** **Expiration Date: 6/30/2008**

Laboratory Scope of Accreditation

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Montpelier, VT 05602

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
o-Xylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
p-Xylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Styrene	EPA 8260	Volatile Organics	NELAP	4/27/2005
Tetrachloroethylene (Perchloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	9/23/2004
Toluene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Toluene	EPA 8260	Volatile Organics	NELAP	9/23/2004
trans-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/23/2004
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	4/27/2005
Trichloroethene (Trichloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	9/23/2004
Vinyl chloride	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	9/23/2004
Xylene (total)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Xylene (total)	EPA 8260	Volatile Organics	NELAP	9/23/2004

Laboratory Scope of Accreditation

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1-Trichloroethane	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,2-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,3-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
1,4-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Benzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Benzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Bromoform	EPA 8260	Volatile Organics	NELAP	9/29/2006
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	9/29/2006
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	9/29/2006
Chlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Chloroethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
Chloroform	EPA 8260	Volatile Organics	NELAP	9/29/2006
cis-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	9/29/2006
Ethylbenzene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	9/29/2006
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	9/29/2006
Methylene chloride	EPA 8260	Volatile Organics	NELAP	9/29/2006
Styrene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Tetrachloroethylene (Perchloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006

Charlie Crist
Governor

Ana M. Viamonte Ros, M.D., M.P.H.
Secretary of Health

Laboratory Scope of Accreditation

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	9/29/2006
Toluene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Toluene	EPA 8260	Volatile Organics	NELAP	9/29/2006
trans-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	9/29/2006
Trichloroethene (Trichloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	9/29/2006
Vinyl chloride	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	9/29/2006
Xylene (total)	ASTM D6520-00	Volatile Organics	NELAP	9/29/2006
Xylene (total)	EPA 8260	Volatile Organics	NELAP	9/29/2006

Clients and Customers are urged to verify the laboratory's current certification status with the Environmental Laboratory Certification Program. **Issue Date: 7/1/2007** **Expiration Date: 6/30/2008**

STRATEGIC DIAGNOSTICS INC.

RaPID Assay® Carcinogenic PAH Test Kit
A00200/A00201

Intended Use

The RaPID Assay® Carcinogenic PAH Test Kit can be used as a quantitative, semi-quantitative or qualitative enzyme immunoassay (EIA) for the analysis of Carcinogenic PAH (as benzo(a)pyrene) in water (groundwater, surface water, well water). For applications in other matrices please contact our Technical Service department. The RaPID Assay® Carcinogenic PAH Test Kit allows reliable and rapid screening for Carcinogenic PAH (measured and reported as benzo(a)pyrene) and related compounds, with quantitation between 0.1 ppb and 5.0 ppb (as benzo(a)pyrene). The minimum detection level of the kit is 0.04 (as benzo(a)pyrene.)

Test Principles

The Carcinogenic PAH RaPID Assay® kit applies the principles of enzyme linked immunosorbent assay (ELISA) to the determination of Carcinogenic PAH and related compounds. The sample to be tested is added, along with an enzyme conjugate, to a disposable test tube, followed by paramagnetic particles with antibodies specific to Carcinogenic PAH attached. Both the Carcinogenic PAH (which may be in the sample) and the enzyme labeled Carcinogenic PAH (the enzyme conjugate) compete for antibody binding sites on the magnetic particles. At the end of an incubation period, a magnetic field is applied to hold the paramagnetic particles (with Carcinogenic PAH and labeled Carcinogenic PAH analog bound to the antibodies on the particles, in proportion to their original concentration) in the tube and allow the unbound reagents to be decanted. After decanting, the particles are washed with Washing Solution.

The presence of Carcinogenic PAH is detected by adding the enzyme substrate (hydrogen peroxide) and the chromogen (3,3',5,5' – tetramethylbenzidine). The enzyme labeled Carcinogenic PAH analog bound to the Carcinogenic PAH antibody catalyzes the conversion of the substrate/chromogen mixture to a colored product. After an incubation period, the reaction is stopped and stabilized by the addition of acid. Since the labeled Carcinogenic PAH (conjugate) was in competition with the unlabeled Carcinogenic PAH (sample) for the antibody sites, the color developed is inversely proportional to the concentration of Carcinogenic PAH in the sample.

NOTE: Color development is inversely proportional to the Carcinogenic PAH concentration.

Darker color = lower concentration
Lighter color = higher concentration

The determination of the Carcinogenic PAH level in an unknown sample is interpreted relative to the standard curve generated from kit standards after reading with a spectrophotometer.

Performance Characteristics

The Carcinogenic PAH RaPID Assay® will detect Carcinogenic PAH and related compounds to different degrees. Refer to the table below for data on several of these compounds. The Carcinogenic PAH RaPID Assay® kit provides screening results. As with any analytical technique (GC, HPLC, etc.) positive results requiring some action should be confirmed by an alternative method.

The Carcinogenic PAH RaPID Assay® immunoassay test does not differentiate between Carcinogenic PAH and other related compounds. The table below shows compounds at the method detection limit (MDL) which is the lowest concentration of the compound that can be picked up in the assay. The limit of quantitation (LOQ) is an approximate concentration required to yield a positive result at the lowest standard, this is the lowest concentration of the compound that can be quantified in the assay. The IC50 is the concentration required to inhibit one half of the color produced by the negative control. It is also used to calculate cross-reactivity values to similar compounds.

Compound	MDL (ppb)	LOQ (ppb)	IC50 (ppb)

Benzo(a)pyrene	0.08	0.2	3.2
Benzo(a)anthracene	0.02	0.06	0.96
Benzo(k)fluoranthene	0.02	0.08	1.26
Chrysene	0.04	0.09	1.38
Benzo(b)fluoranthene	0.04	0.16	2.60
Indeno(1,2,3-c,d)pyrene	0.02	0.254	4.06
Dibenzo(a,h)anthracene	0.14	0.30	4.82
Anthracene	0.44	2.56	41
Phenanthrene	2.70	8.4	134.4
Fluoranthene	2.00	8.56	137
Benzo(g,h,i)perylene	0.30	>12.5	>200
Pyrene	2.00	29.1	466
Fluorene	37.0	42.8	684
Naphthalene	376	625	10000
Acenaphthylene	148	721	11540
Acenaphthalene	1078	>1250	>20000
Heating Oil	20.0	81.6	1306
Gasoline	200	>1250	>20000
Kerosene	2800	>2800	>20000
Jet A Fuel	>20000	>20000	>20000

The total Carcinogenic PAH concentrations (sum of seven Carcinogenic PAH compounds) of the indicated contaminant types in soil and water samples are expressed below, at each of the three kit calibrator (standard) levels.

Carcinogenic PAH RaPID Assay®
Total Carcinogenic PAH in Water (in ppb)

Contaminant	S1 Equivalent	S2 Equivalent	S3 Equivalent
Creosote	0.01	0.2	2
Coal Tar Oil	0.01	0.2	2
Diesel	0.01	0.1	0.7
Fuel Oil #4,6	0.02	0.15	0.7
Fuel Oil #5	0.01	0.1	0.5

The presence of the following substances up to 250 ppm were found to have no significant effect on Carcinogenic PAH RaPID Assay® results: copper, manganese, magnesium, mercury, nickel, nitrate, peroxide, phosphate, sulfite, thiosulfate and zinc. In addition, calcium up to 500 ppm, sodium chloride up to 1.0M, sulfate to 10,000 ppm, and iron to 100 ppm, showed no significant effect on results.

Precautions

- Training is strongly recommended prior to using the RaPID Assay® test system. Contact Strategic Diagnostics for additional information.
- Treat Carcinogenic PAH solutions that contain Carcinogenic PAH, and potentially contaminated samples as hazardous materials.
- Use gloves, proper protective clothing, and methods to contain and handle hazardous material where appropriate.
- Reagents must be added in a consistent manner to the entire rack. A consistent technique is the key to optimal performance. Be sure to treat each tube in an identical manner.
- Water samples should be at a neutral pH prior to analysis. Samples containing gross particulate should be filtered (e.g. 0.2 um Anotop™ 25 Plus, Whatman, Inc.) to remove particles.
- Store all test kit components at 2°C to 8°C (36°F to 46°F). Storage at ambient temperature (18°C to 27°C or 64°F to 81°F) on the day of use is acceptable. *Test tubes require no special storage and may be stored separately to conserve refrigerator space.*
- Allow all reagents to reach ambient temperature (18°C to 27°C or 64°F to 81°F) before beginning the test. This typically requires at <u>least</u> 1 hour to warm from recommended storage conditions.

- Do not freeze test kit components or expose them to temperatures above 100°F (39°C).
- Do not use test kit components after the expiration date.
- Do not use reagents or test tubes from one test kit with reagents or test tubes from a different test kit.
- Do not mix reagents from kits of different lot numbers.
- Use approved methodologies to confirm any positive results.
- Do not under any circumstances attempt to disassemble the base of the magnetic rack. Magnets will be violently attracted to each other.
- Adequate sample number and distribution are the responsibility of the analyst.
- The photometer provided in the accessory kit requires electricity and comes with a 110V adapter. Adapters for 220V are available.
- Do not expose color solution to direct sunlight.
- Do not dilute or adulterate test reagents or use samples not called for in the test procedure; this may give inaccurate results.
- Tightly recap the standard vials when not in use to prevent evaporative loss.

Materials Provided

- Antibody Coupled Paramagnetic Particles in buffered saline containing preservative and stabilizers.

  30 test kit: one 20 mL vial
  100 test kit: one 65 mL vial

- Enzyme Conjugate.

  30 test kit: one 10 mL vial
  100 test kit: one 35 mL vial

- Standards

  Three concentrations (0.1, 1.0, 5.0 ppb) of Carcinogenic PAH (as benzo(a)pyrene) standards in buffered saline containing preservative and stabilizers are supplied. Each vial contains 4 mL.

- Control

  A concentration (approximately 2.0 ppb) of Carcinogenic PAH (as benzo(a)pyrene) in buffered saline containing preservative and stabilizers. A 4 mL volume is supplied in one vial.

- Diluent/Zero Standard

  Buffered saline containing preservative and stabilizers without any detectable Carcinogenic PAH.

  30 test kit: one 10 mL vial
  100 test kit: one 35 mL vial

- Color Solution containing hydrogen peroxide and 3,3',5,5'-tetramethylbenzidine in an organic base.

  30 test kit: one 20 mL vial
  100 test kit: one 65 mL vial

- Stop Solution containing a solution of 2M sulfuric acid.

  30 test kit: one 20 mL vial
  100 test kit: one 60 mL vial

- Washing Solution containing preserved deionized water, with preservatives and stabilizers.

  30 test kit: one 70 mL vial
  100 test kit: one 250 mL vial

- Polystyrene test tubes

  30 test kit: one 36 tube box
  100 test kit: three 36 tube boxes

- User's Guide

Materials Required and Ordered Separately

See "Ordering Information" for the appropriate catalogue numbers.

Rapid Assay® Accessory Kit

Accessory equipment may be rented or purchased from Strategic Diagnostics. See "Ordering Information" for the appropriate catalogue numbers.

The accessory kit contains the following items:

- Adjustable Volume Pipet
- Eppendorf™ Repeater® Pipettor

- Electronic timer
- Portable balance capable of weighing 10 g (for soil samples)
- Vortex mixer
- Magnetic separation rack
- RPA-I RaPID Analyzer (or equivalent spectrophotometer capable of reading 450 nm in a 1 mL sample size).

Other Items

- 12.5 mL Combitips® for the Repeater pipettor - for 0.25 mL to 1.25 mL dispensing volumes (5)
- Pipet tips for adjustable volume pipet (100-1000 uL)

NOTE: Order replacement Combitips® and pipet tips separately. See the "Ordering Information" section.

Materials Required but Not Provided

- Protective clothing (e.g., latex gloves)
- Absorbent paper for blotting test tubes
- Liquid and solid waste containers
- Marking pen
- Instructional video (optional)
- Methanol (HPLC Grade or equivalent) for water samples

Suggestions for Pipettor Use

- Practice using both pipettes (adjustable volume and Repeater pipettor) with water and extra tips before you analyze your samples.
- Use a new tip each time you use the Repeater pipettor to pipette a different reagent to avoid reagent cross-contamination. Tips can be rinsed thoroughly, dried completely and reused. By using the same tip to dispense the same reagent each time you can avoid cross contamination.

NOTE: Repeator tips should be changed periodically (after ~10 uses) since precision deteriorates with use.

- Draw the desired reagent volume into the Repeater pipettor and dispense one portion of the reagent back into the container to properly engage the ratchet mechanism. If you do not do this, the first volume delivered may be inaccurate.
- To add reagents using the Repeater pipettor, pipette down the side of the test tube just below the rim.
- When adding samples and standard using the positive displacement pipettor, always pipette into the bottom of the tube without touching the sides or bottom of the tube.
- Use a new adjustable volume pipet tip each time you pipette a new unknown.

Assay Procedure

Prior to performing your first Rapid Assay®, please take time to read the package inserts in their entirety and review the videotape if available. **On site training is strongly recommended for new users of this test system.** Please contact your account manager for further information.

Collect/Store the Sample

The following steps explain how to properly collect and store your samples.

1. Water samples should be collected in glass vessels with teflon cap liners. **Immediately upon collection, water samples should be diluted with and equal volume (1:1) of methanol (HPLC grade) to prevent adsorptive losses to the glass containers.** This is a 2x dilution, which must be accounted for when interpreting the results. See "Results Interpretation", Section 3a for further details. Use this diluted sample as "sample" in "Perform the Test".

NOTE: This 2x dilution is <u>not</u> required for soil samples.

2. Samples should be collected in appropriately sized and labeled containers.
3. If testing soil samples, follow the SDI Sample Extraction Kit User's Guide or the appropriate technical bulletin to properly collect and store your sample.
4. Samples should be tested as soon as possible after collection. If this is not possible, storage at 4°C (39°F) is recommended to minimize evaporative losses.

Set Up

1. Remove kits from refrigerator. All reagents must be allowed to come to room temperature prior to analysis. Remove reagents from packaging and place at room temperature at least 1 hour prior to testing.
2. Turn on the RPA-1 or other spectrophotometer. The RPA-1 should be warmed up for at least 30 minutes prior to the run.
3. Label five 12.5 mL Combitips "Conjugate", "Particles", "Wash", "Color" and "Stop". In addition, add the name of the compound you are testing for to each Combitip.
4. Remove nine clean blank test tubes for standards and control and one test tube for each sample (if testing in singlicate). Label the test tubes according to contents as follows.

Tube #	Contents
1	Negative control(replicate 1)
2	Negative control (replicate 2)
3	Standard 1 (replicate 1)
4	Standard 1 (replicate 2)
5	Standard 2 (replicate 1)
6	Standard 2 (replicate 2)
7	Standard 3 (replicate 1)
8	Standard 3 (replicate 2)
9	Control
10	Sample 1
11	Etc.

***Label at top of tubes to avoid interference with reading of tubes in photometer**

Sample Extraction and Dilution

Filtration may be necessary to remove gross particulate from the sample. If testing at levels higher than standard kit levels is desired, contact SDI for special instructions. Please follow the instructions from the SDI Sample Extraction Kit to prepare and dilute the soil extract prior to running the assay. Dilute water samples as described in "Collect/Store the Sample."

Perform the Test

1. Separate the upper rack from the magnetic base. Place labeled test tubes into the rack.
2. Add **200 uL** of standards, control or samples to the appropriate tubes using the adjustable volume pipet with the dial set on **0200**. The negative control, standards and control must be run with each batch of samples.

NOTE: Sample should be added to the bottom of the tube by inserting the pipet tip into the tube without touching the sides or the bottom of the tube. Take care not to contact sample with pipette tip once dispensed into bottom of the tube.

3. Using the Repeater Pipettor with the "Conjugate" tip attached and the dial set on **"1"**, add **250 uL** of Enzyme conjugate down the **inside wall** of each tube. (Aim the pipet tip ¼" to ½" below the tube rim or tube wall; deliver liquid gently to avoid splashback.)
4. Thoroughly mix the magnetic particles by swirling (avoid vigorous shaking) and attach the "Particles" tip to the Repeater Pipettor. With the dial set on **"2"** add **500 uL** of magnetic particles to each tube, aiming down the side of the tube as described above. Vortex, mixing each tube 1 to 2 seconds at low speed to minimize foaming. Pipetting of magnetic particles should be kept to 2 minutes or less.
5. Incubate 20 minutes at room temperature.
6. After the incubation, combine the upper rack with the magnetic base and press all tubes into the base; allow 2 minutes for the particles to separate.
7. With the upper rack and magnetic base combined, use a smooth motion to invert the combined rack assembly over a sink and pour out the tube contents.

NOTE: If the rack assembly inadvertently comes apart when lifting to pour out tube contents, re-combine and wait an additional 2 minutes to allow particles to separate.

8. **Keep the rack inverted** and gently blot the test tube rims on several layers of paper towels. It is important to remove as much liquid as possible but **do not bang** the rack or you may dislodge the magnetic particles and affect the results.
9. Set the Repeater Pipettor dial to **"4"** and put on the tip labeled "Wash". Add **1 mL** of Washing Solution down the inside wall of each tube by using the technique described earlier. Wait 2 minutes and pour

out the tube contents as described previously. **Repeat this step one more time.**

NOTE: The number of washes and wash volume are important in ensuring accurate results.

10. Remove the upper rack (with its tubes) from the magnetic base. With the "Color" tip attached to the Repeater Pipet and the dial set to **"2"** add **500 uL** of Color Reagent down the inside wall of each tube as described previously. Vortex 1 to 2 seconds (at low speed).

11. Incubate 20 minutes at room temperature. During this period, add approximately 1 mL of Washing solution to a clean tube for use as an instrument blank for "Results Interpretation".

12. After the incubation, position the Repeater pipettor at Setting **"2"** and use the "Stop" tip to add **500 uL** of Stop solution to all test tubes.

13. Proceed with results interpretation.

WARNING: Stop solution contains 2M sulfuric acid. Handle carefully.

Results Interpretation

1. After addition of Stop Solution to the test tubes, results should be read within 15 minutes.

2. Wipe the outside of all antibody coated tubes prior to photometric analysis to remove fingerprints and smudges.

Photometric Interpretation Using the RPA-I

1. The RPA-I photometer (provided in the Rapid Assay® Accessory kit) can be used to calculate and store calibration curves. It is preprogrammed with various RaPID Assay® protocols. For the Carcinogenic PAH Rapid Assay® test kit parameter settings are as follows:

Data Reduct:		Lin. Regression
Xformation	:	Ln/LogitB
Read Mode	:	Absorbance
Wavelength	:	450 nm
Units	:	PPB
# Rgt Blk	:	0

Calibrators:

# of Cals	:	4
# of Reps	:	2

Concentrations:

#1	:	0.00 ppb
#2	:	0.10 ppb
#3	:	1.00 ppb
#4	:	5.00 ppb
Range	:	0.04 – 5.00
Correlation	:	0.990
Rep. %CV	:	10%

NOTE: Prior to analysis the RPA-I User's Manual should be thoroughly reviewed for more detailed operation instructions.

2. Follow the instrument prompts to read the absorbance of all tubes:

Instrument Display	Operator Response
SELECT COMMAND RUN PROTOCOL	Press RUN Scroll using the YES [] or NO [] keys until the desired protocol appears. Then press ENTER
SPL. REPLICATES (1-5)	Press 1 (for analysis of samples in singlicate.) Press ENTER
BLANK TUBE, INSERT TUBE, EVALUATING TUBE, REMOVE TUBE (Beep)	Insert blank tube containing 1mL wash solution. Remove tube
CAL #1, REP. #1, INSERT TUBE, EVALUATING TUBE, REMOVE TUBE (Beep)	Insert Tube #1 Remove tube

Follow prompts to read tubes.

NOTE: Tube order is important. The RPA-I expects to see the standards in ascending order, in duplicate, starting with the negative control.

Following evaluation of all standards, the instrument will display:

PRINTING DATA,	Data will print
PRINTING CURVE	Curve will print only if programmed to print (See RPA1 User's Manual).
CTRL #1 REP #1, INSERT TUBE, EVALUATING TUBE,	Insert Control Tube
REMOVE TUBE (Beep)	Remove Tube
EDIT CALIBRATORS YES/NO	Press NO (if editing is necessary press YES and refer to the RPA1 User's Manual).
SPL #1 REP#1 INSERT TUBE EVALUATING TUBE	Insert first sample tube
REMOVE TUBE (Beep)	Remove tube

Continue to follow prompts. After all samples have been read, press STOP.

Expected Results:

- **%CV (coefficient of variation) between standard duplicates of 10% or less.**
- **Absorbance reading for the 0 ppb standard should be between 0.8 and 2.0 for all assays.**
- **Correlation (r) of 0.990 or greater for all assays.**
- **Kit control within range specified on vial.**
- **Absorbance of negative control and standards should be as follows:**

  Negative Control>Std. 1>Std. 2>Std. 3.

3. Concentrations will be indicated for all samples on the RPA-I printout.

a) The concentration indicated on the printout, is multiplied by the appropriate dilution factor (if applicable) introduced in the procedure. The quantitation range of the kit is also multiplied by this factor.

EXAMPLE: Water samples were diluted 2-fold with methanol upon collection (see "Collect/Store the Sample" in this User's Guide). As a result, the concentrations listed on the printout should be multiplied by 2 to determine the sample concentration. The standard concentrations are also multiplied by 2 to give a quantitation range in water for this test kit of 0.2 to 10 ppb.

b) Samples with an "nd" and no concentration listed have an absorbance greater than the negative control; therefore, no concentration can be computed for these samples. Results must be reported as <0.2 ppb (or Standard 1 multiplied by the dilution factor).

c) Samples with an "nd" next to a listed concentration have an estimated concentration below the minimum detection level of the test kit. Results must be reported as <0.2 ppb (or Standard 1 multiplied by the dilution factor).

NOTE: Any samples with concentrations determined to be lower than Standard 1 (the limit of quantitation) must be reported as <0.2 ppb (or Standard 1 multiplied by the dilution factor.) Quantitation is not possible below this standard as this is outside the linear range of the assay.

d) Similarly, samples with a "hi" next to a listed concentration have an estimated concentration higher than Standard 3 and must be reported as >10.0 ppb (or Standard 3 multiplied by the dilution factor.)

NOTE: In order to determine the concentration of samples with concentrations greater than Standard 3, they must be subjected to repeat testing using a diluted sample. A ten-fold or greater dilution of the sample is recommended with an appropriate amount of Carcinogenic PAH diluent. This additional dilution must then be taken into account when calculating the concentration.

Photometric Interpretation Using Other Photometers

Other photometers may also be used to interpret results obtained from the RPA-I photometer. It is important that the photometer be able to read absorbance at 450nm and that the instrument can read at a 1 mL fill volume. Absorbances obtained from other spectrophotometers (reading at 450 nm) may be used to manually calculate sample concentrations as outlined below.

1. Calculate the mean absorbance for each of the three standards and the negative control.

2. Determine the standard deviation and %CV (coefficient of variation) of each standard and ensure %CV is less than 10% for each.

3. Calculate the %B/Bo for each standard by dividing the mean absorbance value for the standard by the mean absorbance value for the negative control and multiplying the results by 100.

4. Construct a standard curve by plotting the %B/Bo for each standard, on the vertical logit (y) axis versus the corresponding analyte concentration on the horizontal logarithmic (x) axis on the graph paper provided in the test kit. **Graph papers are specific for each method. Use only the graph paper supplied with each kit.**

5. Draw the best straight line through all points. Using the %B/Bo of the sample, the concentration can be interpolated from the standard curve.

6. Multiply results by the appropriate dilution factor (if applicable) introduced in the procedure. For example, if the sample was diluted 10-fold to increase the detection levels of the kit then the results, must be multiplied by 10. This dilution also changes the range of the assay (standards) by the same factor.

NOTE: Do not forget to account for the 2x dilution introduced in the "Collect/Store the Sample" procedure for the water samples.

Limitations of the Procedure

The Rapid Assay® Carcinogenic PAH Test Kit is a screening test **only**. Sampling error may significantly affect testing reliability. Adequate sample number and distribution are the responsibility of the analyst.

Ordering Information

Description	Catalogue Number
Rapid Assay® Carcinogenic PAH Kit	A00200/A00201
Rapid Assay® Accessory Kit**	6050100
Adjustable Volume Pipet Tips (100-1000 uL)	A00013
12.5 mL Combitip for Repeating Pipette (1 each)	A00009
CarcinogenicPAH Diluent	A00203
Rapid Assay® Accessory Kit Rental	6997010
**** To obtain part numbers and pricing for individual items in the Accessory Kit contact SDI at the number below.**	

Ordering/Technical Assistance

Should you have any questions regarding this procedure prior to analysis contact Technical Service to avoid costly mistakes.

To Place an Order or Receive Technical Assistance, please call Strategic Diagnostics Inc. at:

Call toll-free **800-544-8881**`

Or 302-456-6789 Phone
302-456-6782 Fax
Web site: www.sdix.com
E-mail: techservice@sdix.com

General Limited Warranty

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Safety

To receive an MSDS for this product, visit our web site at www.sdix.com.

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Z00361.1, Rev 4/5/00

Operation of the Repeater Pipet

To Set or Adjust Volume

To determine the pipetting volume, the dial setting (1-5) is multiplied by the minimum pipetting volume of the tip (indicated on the side of the Combitip, e.g. 1~100 uL.)

To Assemble Pipet Tip

Slide filling lever down until it stops. Then raise the locking clamp and insert the tip until it clicks into position. Be sure the tip plunger is fully inserted into the barrel before lowering the locking clamp to affix the tip in place.

To Fill Tip

With tip mounted in position on pipet, immerse end of tip into solution. Slide filling lever upward slowly. Combitip will fill with liquid.

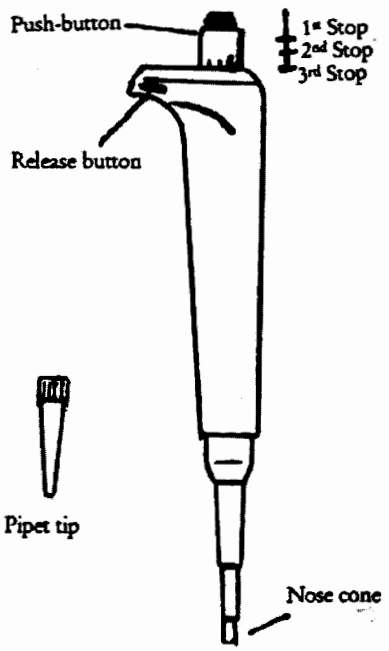
To Dispense Sample

Check the volume selection dial to ensure pipetting volume. Place tip inside test tube so that tip touches the inner wall of tube. Completely depress the pipetting lever to deliver sample. NOTE: Dispense one portion of reagent back into the container to engage the ratchet mechanism and ensure accuracy.

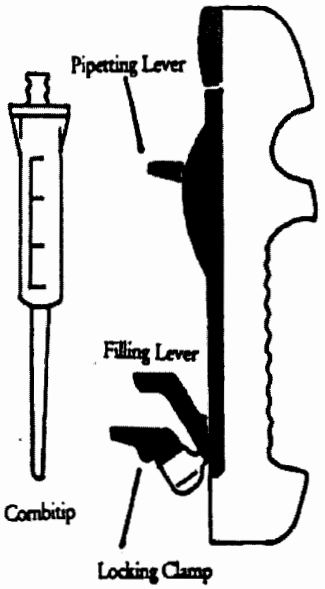
To Eject Tip

Empty tip of any remaining solution into appropriate container by pushing filling lever down. Raise locking clamp upward, and remove the Combitip.

Adjustable Volume Pipet



Repeater Pipet



Operation of the Adjustable Volume Pipet

To Set or Adjust Volume

Press release button on side of pipette and turn the push-button to adjust volume up or down. Volume setting is displayed on top of pipet. See kit instructions for appropriate setting. Pipet will accurately dispense volumes between 100 and 1000 uL.

To Assemble Pipet Tip

Gently push nose cone of pipet firmly into a pipet tip contained in the pipet tip rack.

To Withdraw Sample

Keep pipet almost vertical. With tip mounted in position on pipet, press push-button to 1st stop and hold it. Place tip at bottom of liquid sample and slowly release push-button to withdraw measured sample. Ensure that no air bubbles exist in the pipette tip. If bubbles exist, dispense sample and re-withdraw. Slide tip out along the inside of the vessel.

To Dispense Sample

Wipe any liquid from outside of tip taking care not to touch orifice. Place tip into tube, almost to the bottom, and slowly press push-button to 2nd stop. Hold push-button at 2nd stop when removing tip from tube.

To Eject Tip

Press push-button to 3rd stop. Tip is ejected.

STRATEGIC DIAGNOSTICS INC.

RaPID Assay® Carcinogenic PAHs In Soil Application

Intended Use

For detection of Carcinogenic PAHs (as benzo(a)pyrene) in soil. For testing in other matrices, please contact our technical support department at 1-800-544-8881.

Materials Required but Not Provided

SDI Sample Extraction Kit
(Part Number: A00204EA/A00204EB)

Procedural Notes and Precautions

- Prepare soil samples for analysis according to the procedure in the SDI Sample Extraction Kit Users Guide.
- After extraction and dilution of samples, follow the immunoassay procedure as described in the Rapid Assay ® Carcinogenic PAHs Test Kit User's Guide.
- The initial 2x dilution described for water samples in Step 1 of "Collect/Store the Sample" does not need to be performed for soil samples.

Quality Control

A control solution at approximately 2.0 ppb (as benzo(a)pyrene) is provided with the Carcinogenic PAHs RaPID Assay® Kit. It is recommended that it be included in every run and treated in the same manner as unknown samples. If running standard soil procedures an acceptable result should be 100 times the value stated on the control vial (i.e. 200 + or – 40 ppb) when the control results are corrected for the dilution factors (see Results section below).

Results Interpretation

Interpret soil sample results as described in the RaPID Assay® Carcinogenic PAHs Test Kit procedure, accounting for the total dilution factor indicated in the table of the SDI Sample Extraction Kit Users Guide. Alternatively, program the RPA-1 Analyzer as listed below to automatically correct for this dilution factor.

1. The RPA-I photometer (provided in the Rapid Assay® Accessory kit) can be used to calculate and store calibration curves. To obtain soil results from the Carcinogenic PAHs Rapid Assay® test kit on the RPA-I the following parameter settings are recommended:

Data Reduct:	Lin. Regression
Xformation :	Ln/LogitB
Read Mode :	Absorbance
Wavelength :	450 nm
Units :	PPB
# Rgt Blk :	0

Calibrators:

# of Cals :	4
# of Reps :	2

Concentrations:

#1 :	0.00 PPB
#2 :	10.0 PPB
#3 :	100.0 PPB
#4 :	500.0 PPB
Range :	10 - 500
Correlation :	0.990
Rep. %CV :	10%

Performance Data

The Carcinogenic PAHs RaPID Assay® does not differentiate between Carcinogenic PAHs and other related compounds. The table below shows compounds at the method detection limit (MDL) which is the lowest concentration of the compound in soil that can be picked

up in the assay. The limit of quantitation (LOQ) is an approximate concentration required to yield a positive result at the lowest standard, this is the lowest concentration of the compound in soil that can be quantified in the assay. The IC50 is the concentration in soil required to inhibit one half of the color produced by the negative control. It is also used to calculate cross-reactivity values to similar compounds.

Compound	MDL (ppb)	LOQ (ppb)	IC50 (ppb)
Benzo(a)pyrene	8.0	20.0	320
Benzo(a)anthracene	2.0	6.0	96
Benzo(k)fluoranthene	2.0	8.0	126
Chrysene	4.0	8.0	138
Benzo(b)fluoranthene	4.0	16.0	260
Indeno(1,2,3-c,d)pyrene	2.0	24.6	406
Dibenzo(a,h)anthracene	14.0	30.0	482
Anthracene	44.0	256	44.0
Phenanthrene	270	840	13440
Fluoranthene	200	856	46600
Benzo(g,h,i)perylene	30.0	>1250	>20000
Pyrene	200	2920	46600
Fluorene	3700	4280	68400
Naphthalene	18800	61500	10000000
Acenaphthylene	14800	72200	1154000
Acenaphthalene	107800	>125000	>2000000

The total Carcinogenic PAH concentrations (sum of seven Carcinogenic PAH compounds) of the indicated contaminant types in soil and water samples are expressed below, at each of the three kit calibrator (standard) levels, in units comparable to results from GC Method 8270 or HPLC Method 8310.

Carcinogenic PAHs RaPID Assay®
Total Carcinogenic PAHs in Soil (in ppb)

Contaminant	S1 equivalent	S2 equivalent	S3 equivalent
Creosote	0.5	10	100
Coal Tar Oil	0.5	10	100
Diesel	0.5	5	35
Fuel Oil #4,6	1.0	7.5	35
Fuel Oil #5	0.5	5	25

Range of Detection

The Carcinogenic PAHs RaPID Assay® has a range of detection in soil of 10.0 to 500 ppb (as Benzo(a)pyrene) when used in conjunction with the SDI Sample Extraction Kit.

Recovery

Carcinogenic PAH recoveries will vary depending on soil type, retention mechanism, solvent and extraction apparatus used, length of extraction period and levels of potentially interfering substances in the soil.

Z00366.1, Revised 4/4/00

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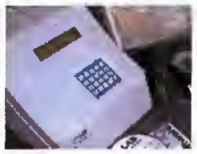

Polyaromatic Hydrocarbons

Instructions for Sitelab UVF-3100D Target PAH Applications

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Model UVF-3100D

Testing soil, water or sediments for Polyaromatic Hydrocarbons (PAHs) has improved using Sitelab's UVF-3100D analyzer, fitted with excitation and emission optical filters that are more sensitive and selective to the target PAH compounds reported by U.S. EPA Method 8270 performed using GC/MS instrumentation. Applications include coal tars, coal ash and weathered fuel oils typically encountered during site assessment or cleanup activities.

Components Required:

- Sitelab UVF-3100A Analyzer with sample preparation tools.
- PAH Optical Filters (3100D-EXEM)
- Sitelab EPH or PAH Calibration Kit (CAL-010 or CAL-060).
- Sitelab Manual with Standard Operating Procedures.

Install PAH Optical Filters into Analyzer...

1. Remove Cylinder

- Open the lid on the UVF-3100 and pull out the black cuvette holder.
- Next, slide/pull out the optical filter cylinder from the analyzer.
- Locate the empty Slot D filter sockets. Turn the cylinder upside down to find them, if necessary.

2. Inspect Filters

- The thinner filter is to be used for Excitation. It has a shinny reflective front side and a dark, black colored back side.
- The thicker filter is to be used for Emission. It has a shinny reflective front side and a blue colored back side (above)
- Use tissue wipe to clean

3. Install Filters into EX and EM Sockets

- Place the thinner Excitation filter into the socket labeled "D EX" and secure into place using the rubber o-ring provided. The filter's reflective front side must face outward, while the darker back side is to face inward, toward the cuvette.
- Place the thicker Emission filter into the socket labeled "D EM" and secure into place using the rubber o-ring provided. The filter's reflective front side must face outward, while the bluish back side is to face inward, toward the cuvette.

Check Optical Alignment

- With both the EX and EM filters in place, slide the optical filter cylinder back into the UVF-3100 analyzer.
- When testing for Target PAHs, be sure the Slot D optics are properly aligned inside the chamber next to the silver dot (located to the left of the lid). Refer to manual for calibration and sample testing instructions.

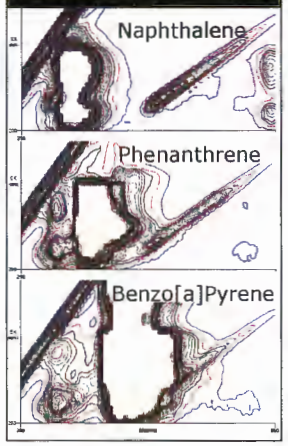
Fluorescence Response of PAH Compounds Vary Due to Size & Shape...

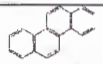
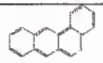
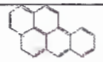
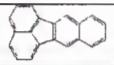
Petroleum sites contain many different types of PAH compounds, which fluoresce differently from one another depending on their size and shape (right) and which excitation and emission filter configurations are used for detection (far right).

Although Sitelab's UVF technology cannot differentiate one compound from another as they often co-fluoresce on top of each other, the analyzer produces 'total' PAH concentrations. Sitelab's Calibration Kit, which contains a mixture of the same PAH compounds reported by GC/MS Method 8270, fluoresces the same when measured on either the Slot A or D optics, but will detect different groups of PAHs when testing contaminated samples. The "Total PAHs" measured on the UVF-3100's Slot A Optics account for all the PAHs in the C10-C22 range, also called Extractable Petroleum Hydrocarbons (EPH) used by regulatory agencies for measuring the more toxic aromatic hydrocarbon fraction found in TPH. The "Target PAHs" measured using the Slot D Optics, fluoresce lower and correlate more directly to the sum of the PAHs reported by EPA Method 8270.

Site-specific response factors may be applied and used to adjust the Sitelab results to accurately estimate the concentrations of Benzo[a]Pyrene or other compounds of concern. Confirmatory analysis with a certified laboratory is required. Ask Sitelab for additional information about PAH response factors.

Topographic Scans of PAHs with Excitation & Emission Wavelengths:



Examples Comparing PAH Fluorescence of UVF-3100 Calibrated to EPH/PAH Kit:		Slot A Optics EPH (Total PAHs)	Slot D Optics Target PAHs
Naphthalene: $C_{10}H_8$		3X Lower	Non Detect
Phenanthrene: $C_{14}H_{10}$		3X Higher	7X Lower
Chrysene: $C_{18}H_{12}$		3X Higher	3X Lower
Benzo[a]Anthracene: $C_{18}H_{12}$		3X Lower	1:1 Same
Benzo[a]Pyrene: $C_{20}H_{12}$		18X Lower	4X Higher
Benzo[k]Fluoranthene: $C_{20}H_{12}$		30X Lower	9X Higher

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Instructions for Sitelab UVF-3100D Target PAH Applications

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PAH Fluorescence Fingerprint Procedure...

1. Calibrate Analyzer

- Select Sitelab's EPH or Total PAHs Calibration Kit (CAL-010 or CAL-060). Both of these kits contain the same mixture of 17 PAHs in the C10-C22 range.
- Calibrate the analyzer for PAHs with all 5 calibrators using either the Slot A or D Optics. The calibration kit responds/fluoresces the same on either filter set. See manual for more details

2. Test for Total PAHs

- Measure the samples first for Total PAHs using the Slot A Optics. Since the EPH concentrations will be higher than the Target PAH concentrations, the dilution tested should be adequate for the Target PAH test.
- Record your Total PAH test results by multiplying the concentration displayed on the analyzer by the sample's dilution factor.

3. Rotate Optical Filters

- Open the lid and pull out the cuvette holder containing the sample.
- Next, pull/slide out the optical filter cylinder and turn it over to locate the Slot D Optics.
- Slide the cylinder back into the analyzer with the Slot D Optics aligned next to the silver dot located to the left of the lid.

4. Test for Target PAHs

- Measure the sample a second time for Target PAHs using the Slot D Optics. Test the same dilution used for the Total PAH analysis. If reading is below 0.1 ppm, prepare a smaller dilution and reanalyze
- Record your Target PAH test results as before.
- Divide the EPH results by the Target PAHs for TPH identification (as ratio or %).

Quality Controls...

Calibration Checks:

Periodically check both PAH curves (Slot A and D), by analyzing one or two Calibrators as if they were samples to see how linear the two curves are and whether or not the analyzer has suffered from drift. Calibration checks should read within 10 to 20% from their true concentration.

Check the Detection Limit:

Test and apply the 0.1 ppm PAH Calibrator as the detection limit. The lowest PAH concentration standard of 0.05 ppm may not always be linear when switching between filter sets, due to subtle impurities in the methanol/blank. Readings between zero and 0.1 ppm are too low and should be reported as Non Detect or test a lesser dilution.

Check for Sample Quenching:

Test a sample twice at two different dilutions to account for possible quenching. If the results are not within 20% from one another, quenching may be occurring (common when testing extracts).

Hydrocarbon Identification...

This time saving feature allows you to test samples for both PAH fractions at once, by rotating the optics from Slot A to Slot D and reanalyzing the sample. The ratios, or proportions, of a sample's Total PAH and Target PAH results will vary depending on how old and what type of petroleum contamination is present.

Example: Soil below a fuel oil tank once containing heating oil is 1,000 ppm EPH and 40 ppm Target PAH. The drop in concentration is 25 times lower, indicating the spill is not fresh, but fairly weathered or degraded (see chart to right).

The Target PAH optics are an integral part of Sitelab's fluorescence fingerprinting method for hydrocarbon identification. When used with the UVF-3100's GRO analysis on the Slot B optics, requiring a separate calibration for testing the volatile C6-C10 BTEX fraction, the fluorescence signatures exhibited provides additional forensic screening data useful for delineating sites having unknown petroleum sources.

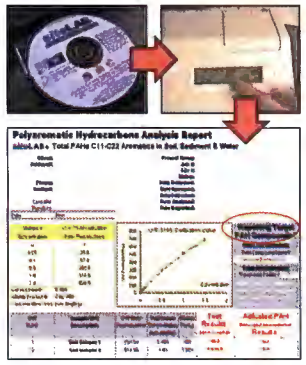
Examples of EPH to PAH Ratio 'Signatures' for Various Contaminated Sites:

Coal Ash/Clinker Sites:	3-5X
MGP Coal Tar Sites:	6-12X
No. 6 Heavy Fuel Oil:	8-10X
Waste Oil/Motor Oil:	10-20X
Weathered Fuel Oils:	15-30X
Fresh No. 2 Diesel Fuel:	40-50X
Humics/Natural Organics:	*2-4X

*Soils with PAH results below 50 ppm which exhibit this ratio difference could be due to high organic interferences and not petroleum.

Calculate Response Factors...

- To determine a response factor, confirmatory lab analysis using GC instrumentation (EPA Method 8270, 8100, etc.) is required first by testing a small group of well homogenized, representative split samples from your site.
- Next, analyze each sample on the UVF-3100 and divide the Sitelab results by the concentrations of each PAH compound reported by the laboratory. Then, calculate the average response factor and enter the value and PAH name in the Test Report.
- Confirmatory lab results must have detectable concentrations to work. Do not use zeros or ND values. Thus, it may be necessary to collect high, medium and low contaminated samples. A clean, non-detect sample may also be useful to account for any potential natural organics that may cause interference when testing samples with low PAHs.



The Software UVF Guide-PAHs program includes a Test Report that automatically adjusts the UVF-3100 sample results by an average response factor for any PAH compound of interest

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Test Soil & Water On-site
Fast • Accurate • Easy to Use

UVF•3100 Operating Manual

for all Sitelab Petroleum Hydrocarbon Applications

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UVF-3100 Standard Operating Procedures Version 6.0

User's Manual

All test procedures require these three very important components (right).

The standard operating procedures and instructions listed in this manual are grouped into sections. If you are looking for a specific topic, go to the categories located at the bottom of each page.

Use Sitelab's Quick Reference Guide when needed. Additional instructions are also provided with each Sitelab Calibration Kit.

Need to order more supplies? Need assistance or help getting started?

For sales or technical support:
Call USA: (978) 363-2299
Email: support@site-lab.com

1 Equipment Required

Model UVF-3100A:
For GRO, VPH, EPH/PAHs, DRO and other TPH Applications.

Model UVF-3100D:
For all 3100A applications plus Target PAH analysis.

Portable analyzer includes field case with all tools needed to perform tests. Warranty, tech support, CD-ROM with software and manual also included.

2 Use Extraction Kits

Product No. EXTR010-20
40 Test Tubes
20 Sitelab® Filters
20 Extraction Jars
20 Syringes + 20 Pipette Tips

Easy to use, disposable kits contain everything you need to prepare samples for analysis, quickly, accurately and quality controlled. Each kit contains enough supplies to test up to twenty soil, sediment or water samples. Solvent not included.

3 Select a Sitelab Calibration Kit

Certified, linear standards used for Sitelab's UVF-3100 analyzer. These products are specially designed to correlate to U.S. EPA GC Methods. All Calibration Kits are reusable for 3 months from date of purchase.

Each kit includes five linear calibrators, plus a Reference Standard, product certificate with instructions and MSDS.

Custom made, certified kits are also available using oil from your site. Ask for details

WARNING! These products contain flammable alcohols. Dispose solvent waste properly.

Popular calibration kits available, which best correlate/match certified laboratory methods:

- Product No. CAL-025: GRO (BTEX) C6-C10 Gasoline Range Hydrocarbons. Compares to EPA Method 8015-GRO
- Product No. CAL-042: TPH-EDRO C10-C40 Extended Diesel Range Hydrocarbons. Compares to EPA Method 8015-DRO
- Product No. CAL-060: Target PAHs for Polyaromatic Hydrocarbon Applications. Compares to EPA Method 8270 GC/MS PAHs
- Product No CAL-010: EPH C11-C22 Aromatic Hydrocarbon Fraction (Total PAHs). Compares to State TPH GC Methods for EPH
- Product No. CAL-057: TPH-Oil for Lubricating Oils, Motor/Waste Oil or Crude Oil Applications. Compares well to TPH Methods 418.1 or 1664

How Ultraviolet Fluorescence Technology Works...

Sitelab's portable Ultraviolet Fluorescence (UVF) technology is a very selective detection method. Aromatic hydrocarbons, which includes benzene, benzo[a]pyrene and other carcinogenic compounds found in petroleum, both excite and emit energy at specific wavelengths. Soil, sediment and water samples are first extracted in solvent using disposable test kits and the fluorescence response of each sample is then quantitated by the UVF-3100 analyzer on a linear, 5-point calibration curve using certified standards sensitive to the wavelengths of interest.

The analyzer contains a UV Lamp which first energizes petroleum hydrocarbons.

After solvent extraction, a sample is poured into a glass cuvette and placed into the analyzer for analysis.

The UVF-3100 is fitted with movable optical Excitation & Emission filters used to detect gasoline range, diesel range and polyaromatic range compounds separately from one another.

Accuracy & Lab Correlation...

- For maximum performance, select and use Sitelab Calibration Kits which are similar to the certified laboratory methods you are using for confirmatory analysis (see examples above).
- If you do not know which laboratory method is going to be used for comparison, or no confirmatory lab analysis is planned for your application, use a Sitelab Calibration Kit that best matches the type or source of the petroleum contamination found on your site. If the type of contamination is unknown or may involve different types of petroleum contaminants, ask Sitelab which calibration products are the most suitable.
- Use response factors to adjust and improve correlation to account for any technology differences (UVF vs. GC), sample homogeneity or other issues where the field screening results do not directly correlate. If the results are proportionately higher or lower, when compared to the lab, apply an 'average' response factor to the UVF concentrations. A new or different calibration kit may also be required.

Laboratory Setup Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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Setup your Work Space...

Setup Work Space

• Before you begin, clear enough table space to set up your Sitelab equipment. Work space should be in a clean, dust-free area having a temperature range from 35 to 100 degrees (F).

• Connect power cords to analyzer and plug into an electric outlet. Use the DC inverter if operating from a car or truck.

• Have your Sitelab 20 Sample Extraction Kits and Calibration Kits nearby (needed to begin).

Solvent Dispenser Bottle

• Fill the dispenser bottle with methanol solvent (HPLC grade).

• Place a small cup below the nozzle to capture drips. Use this cup to collect waste solvent when cleaning/rinsing the glass cuvette during operations.

Methanol Solvent Required!

Always use "HPLC Grade" or high laboratory grade methanol only.

WARNING! Flammable alcohols. Dispose solvent waste properly.

Glass Cuvette Preparation

• Using the solvent dispenser bottle, rinse the glass cuvette with methanol several times between uses to avoid cross contamination. Pour/empty rinse solvent into the waste cup.

• When finished rinsing place cuvette upside down onto clean tissue wipes to drain.

• Handle the cuvette with care. A second cuvette is provided for back up – in case the original is scratched or damaged.

Turn On UVF-3100 Analyzer

• Turn on using the on/off switch located in the back. A 600 second warm-up countdown is displayed. Let the instrument finish it's warm up cycle at the beginning of each day or event.

• If analyzer is already warmed up, press the "H/HOME" key at any time to bypass the warm up sequence and go to the HOME screen. The HOME screen is the main screen used for testing samples or starting a calibration.

Check Lamp for UV Light

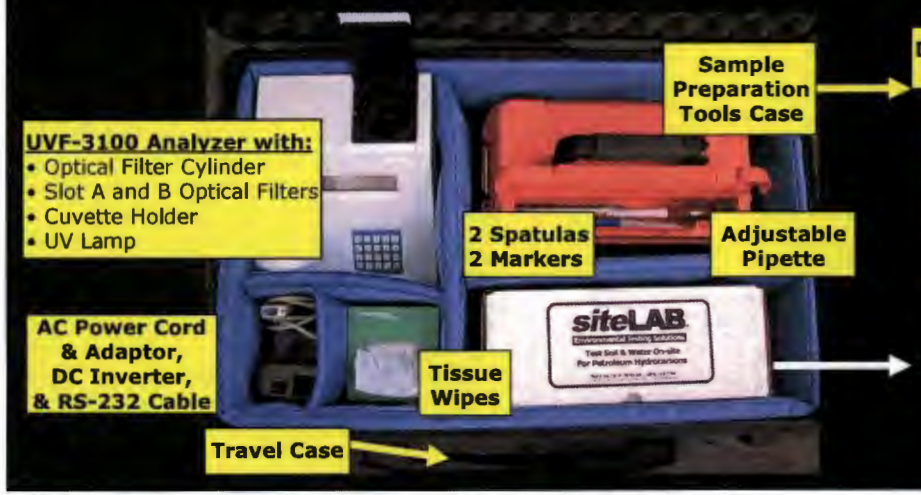
• Slide/pull out the optical filter cylinder and look down into chamber. When on, the UV lamp's blue light should be visible (fan should also be on)

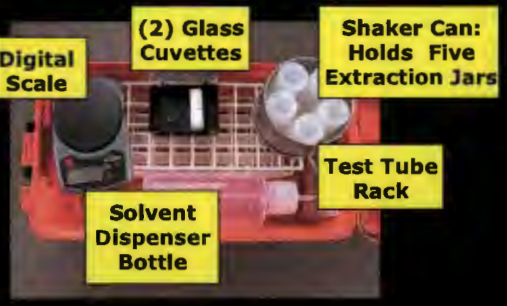
Inspect/Change UV Lamp

• Open rear panel and check mercury vapor lamp. Be sure lamp is secure in socket and not damaged after shipping.

• Do not unplug fan. If you do, be sure to plug it back in!

UVF-3100 Test Equipment Check List...



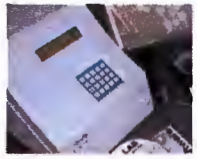


Storage space to hold one:

20 Sample Extraction Kit
Product No. EXTR010-20
40 Test Tubes (for extracts & dilutions)
20 Sitelab® Filters
20 Extraction Jars
20 Syringes + 20 Pipette Tips

Quick Reference Guide & CD-ROM, including:

• Instruction Manual with Standard Operating Procedures
• Software Programs
• Warranty Information



Sample Testing Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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Sample Extraction & Dilution Procedures...

Testing Soil?

- Turn on scale. Place extraction jar on top of scale. Tare weight to zero.
- Measure 5 grams of soil (recommended) into jar using the metal spatulas. Weight should be within 0.1 gram (+/-).

10 grams may also be used, but clays or loamy soils may absorb too much solvent (added in the next step), making it difficult to filter.

Testing Water?

- Using a plastic test tube, measure out 10 mL of water and pour into extraction jar.
- Hydrocarbons in your water sample may be floating on the surface. Before measuring out your sample, shake the sample first to ensure water is homogenized.

2. Add Solvent

- Fill the solvent dispenser bottle with methanol and squeeze out 10 mL of solvent into a test tube and add to extraction jar containing the soil or water sample. Cap and tighten jars when finished.
- Important! Use a marker to label jar with the sample ID and "2X" dilution.

3. Shake Extract

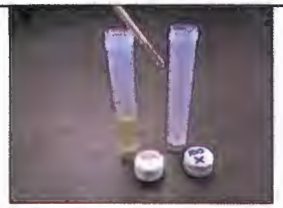
- Shake soil extract jars for several minutes, allowing ample time for the solvent to dissolve the contaminant. Use a timer or wrist watch, if necessary. Let extracts settle for several minutes afterward. This avoids clogs in the next step.
- Shake water extract jars for ten to twenty seconds.

4. Syringe & Filter Extract

- Remove lid and suck up 2 to 4 mL of extract from the jar's surface using a syringe.
- If syringe becomes clogged, let jar sit a few moments longer to let mud and debris settle to bottom, leaving a clear extract layer on top.
- Attach/screw a Sitelab Filter to the syringe and dispense contents back into test tube.

5. Label Extracts

- Label test tube with the sample ID and the dilution created. Examples:
- "2X" if 5 g soil extracted with 10 mL solvent.
- "1X" if 10 g soil extracted with 10 mL solvent.
- "2X" if 10 mL of a water sample was extracted with 10 mL solvent (50/50).



6. Dilute Extract ...Why?

In order for the sample to be detected within the analyzer's calibration range, a dilution must be prepared using the extract for analysis.

- We recommend you start with a 100X or 1,000X first, depending on how contaminated the sample is.
- Avoid testing Extracts! Only test Extracts if the sample has no odor OR no yellowish color.

Pipette...		Dilute To...	
Setting	Volume	5 mL	10 mL
"020"	20 uL	500X	1,000X
"100"	100 uL	100X	200X
"250" x2	500 uL	20X	40X

Note: Dilutions here include 2X from Extract

7. Prepare Dilution

Attach a tip to pipette by pressing down on the dial to extend the teeth and fit/snap in place. Be sure the tip functions properly.

- Adjust the setting on the pipette and transfer extract to a second test tube.
- Dilute with solvent to 5 mL or 10 mL line.

8. Put Dilution in Cuvette

- Fill the glass cuvette about ¾ full with sample dilution. You need enough liquid in the cuvette to clear the two windows on the bottom of the cuvette holder (~3 mL).
- Hold the top of the cuvette with one hand. With the other hand, clean the cuvette with a tissue wipe to remove any excess liquids or fingerprints.

9. Use the Cuvette Holder

- Open the lid on top of the analyzer. Pull out the black cuvette holder from the optical filter cylinder.
- Carefully place glass cuvette into the holder, held in tight by the leaf springs. Be sure to avoid spills.
- The cuvette's position in the holder does not matter – all four sides are identical.

10. Lower into Analyzer

- Lower the cuvette holder back into the analyzer's optical filter cylinder until snug between the grooves
- Important! Be sure the arrow shaped handle of the cuvette holder always points to the silver dot (to the left of the lid).

Continue to Next Step

Sample Testing Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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Analyze Sample & Record Results...

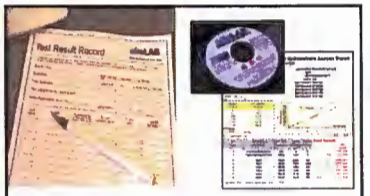
11. Wait for Reading

- Close the lid. Always read samples from the HOME screen.
- The analyzer will then display the sample's concentration.
- Allow a few seconds for the reading to stabilize.
- Concentration units are shown as "ppm" (default mode)

In soil or sediment: ppm as mg/Kg
In water: ppm as mg/mL

12. Calculate Final Result

- Multiply the reading on the display by the sample dilution being tested.
- If you are testing a 100X dilution, for example, and the sample reads "0.542 ppm," multiply the value by 100. The final result is 54.2 ppm.



13. Record Test Results

- Manually record test results using the Test Result Record included with each Sitelab Extraction Kit.
- If connected to a computer, from the HOME screen, press "D" on keypad to send data. See 'Software' section for details.
- To view the sample's raw fluorescence value, press "8" and then return to the HOME screen.

14. "OVER" Readings

- If the sample you're testing reads "OVER," the sample is above the calibration range and a larger dilution is necessary.
- Empty out the test tube and prepare a higher dilution using the Extract and re-analyze.
- If testing a 1,000X dilution, which reads "OVER," pour out all but 1 mL and re-dilute tube to the 10 mL line for a 10,000X.

15. Non-Detect Readings

- Readings between zero and the lowest calibrator <u>should not</u> be reported. Prepare a smaller dilution and re-analyze.
- Or report sample as "ND" by multiplying the dilution tested by the concentration of the lowest calibrator. For example, a 100X sample reads below the 0.1 ppm TPH EDRO calibrator; 100X x 0.1 = ND <10 ppm.

Helpful Pointers Testing Dilutions...

Pipetting Dilutions:

- Sitelab's Gilson® adjustable pipette has an accurate range from 20 to 250 uL (microliters), using special capillary/piston disposable tips, allowing high precision volumetric dilutions.
- After installing, be sure each tip functions properly.
- Always replace a new tip between samples. To remove, push down on the dial firmly until the tip falls off.
- Avoid air bubbles in tip when making dilutions.
- Wipe outside tip with tissue to remove excess liquid, if necessary.

Reading Samples:

- Ideally, report samples which have readings between the lowest to highest calibration standards; in the middle of the calibration curve.
- <u>Remember</u>! if reading is between the lowest calibrator and zero, report as ND or prepare a smaller dilution and re-analyze or test the Extract if no quenching is suspected.
- When preparing dilutions, try to be as accurate as possible when adding solvent to the test tube's 5 mL line or 10 mL line. The meniscus should be as close as possible to the tube's graduations.

Example testing three samples:

Calibrated to Total PAHs:
Linear Range = 0 to 2 ppm
Highest Calibrator = 1.5 ppm
Lowest Calibrator = 0.05 ppm (detection limit)

Dilution:	Reading:	Comments:
1: 100X	"0.550"	OK, report as 55 ppm
2: 100X	"OVER"	Perform a <u>bigger</u> dilution
2: 1,000X	"1.250"	OK, report as 1,250 ppm
3: 100X	"0.020"	Report as ND = <5 ppm (100X x 0.05 = 5) or perform a smaller dilution
3: 10X	"0.210"	OK to report as 2.1 ppm

Quality Controls to Perform...

Sample Quenching?

- Highly concentrated samples and/or samples having a yellowish color when extracted may sometimes "quench" or swamp the detector. Instead of producing an "OVER" reading, the UVF-3100 may display a negative or false-low reading instead.
- Non-experienced operators may not be aware a sample dilution is required. This is why we strongly recommend you prepare and test a dilution first, even if you think the sample is clean. Avoid testing Extracts!
- Quenching is more common when testing GRO, VPH or BTEX.

Check for Quenching:

- Check for quenching by running two dilutions on the same sample. If results are not within 20% from one another, quenching may be occurring.
- At a minimum, always start by testing a sample at a 100X dilution first, or higher, if necessary.
- Empty out first dilution and use the Extract to prepare a higher dilution. Or, simply add more solvent to your current dilution going from the tube's 5 mL line to 10 mL line, which doubles the dilution factor (100X becomes a 200X).

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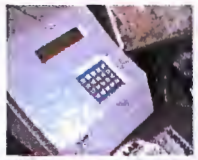

Calibration Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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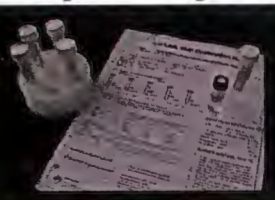
Setup Analyzer...



Choose a Calibration Kit

Select a Sitelab Calibration Kit for your application. Popular tests include GRO, EDRO, PAHs and TPH. Custom-made kits are also available using oil from your site. Ask Sitelab for details.

When to Calibrate?

Recalibrate whenever a different analysis is being performed or if the instrument suffers from drift.

Optical Filter Alignment

Pull out and rotate the optical filter cylinder so that the correct filter slots A,B,C or D are aligned next to the silver dot located to the left of the lid. See your Calibration Kit Certificate for details or use the following:

Slot A: EDRO, EPH/PAH, TPH-Oil
Slot B: GRO (BTEX)
Slot C: Other applications/PCBs
Slot D: Target PAHs

Start a New Calibration...

1. Begin from HOME Screen

Turn on analyzer. Let warm up if necessary. Confirm the lamp is on by sliding the optical filter cylinder out and looking down inside chamber (blue light should be visible). Return/align cylinder back to proper slot (A, B, C or D)

• Start a new calibration from the HOME screen. Press "ENT" from the HOME screen and Press "2" for Calibration.

2. Enter the Max Range

The Max Range setting appears. This sets the upper limit of the calibration curve. Enter the value listed with your Calibration Kit or use the following:

Max Range Values to Use:

Enter "12" for GRO
Enter "20" for TPH-Oil
Enter "6" for TPH-EDRO
Enter "2" for EPH and PAHs

2. Max Range - Continued

• Press "1" if Max Range is OK or "9" to change it.

• When pressing 9, type in the new Max Range concentration and then press "ENT."

• Press "1" to accept the new Max Range you entered and go to next step.

Make a mistake? Press the "ESC" key at any time during the calibration process to abort and return to the HOME screen.

3. Enter Number of Stds

• The UVF-3100 will display the number of standards you want to use to create the calibration curve. For best performance, ALWAYS use all 5 calibrators included with your Sitelab kits.

• Enter "5" then press "ENT".

Note: If you choose to perform a quick, 1-point calibration, be sure to use the highest calibration standard.

4. Start with Highest Std

• You must analyze the highest concentrated standard first, each time you start a new calibration.

• The UVF-3100 displays the "Hi Std Conc." from the previous or current calibration.

• Press "1" if value is OK (if you are re-calibrating to the same analysis). Otherwise, press "9" to change it.

5. Changing the Hi Std?

• After pressing "9", enter the new Hi Std concentration (printed on the Calibrator) and then press "ENT."

• Press "1" to OK and accept the new concentration value you just entered. Examples:

GRO use:	10 ppm
TPH-Oil use:	15 ppm
TPH-EDRO use:	5 ppm
EPH or PAHs use:	1.5 ppm

6. Pour Hi Std into Cuvette

• Open the lid and pull out the cuvette holder.

• Remove the cap on the Hi Std calibrator and pour into the cuvette about ¾ full.

• Carefully place cuvette into the cuvette holder. Be sure to avoid spills. Use tissue wipes to clean the outside glass from any liquids/fingerprints, if necessary.

7. Insert Hi Std, Press <*>

• Lower the cuvette holder back into the optical filter cylinder until snug.

• Be sure the handle's arrow shaped handle is aiming at the silver dot located to the left of the lid.

• Next, close the lid and press the asterisk key <*>.

Continue to Step 8

Calibration Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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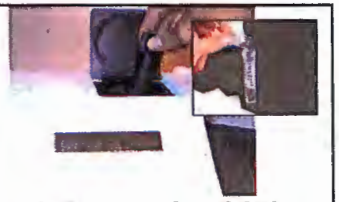
8. Sensitivity Set Value?

After you press the <*> key, do not open the lid. The analyzer adjusts it's sensitivity based on the concentration of the high standard. Once the sens factor is "set," the analyzer measures the Hi Std for several seconds. When finished, it will prompt you to enter the next standard.

Refer to the Calibration Kit Certificate or see Step 15 below for Sensitivity Set values to expect during calibration.



9. Remove the Hi Std

- Open the lid, pull out the cuvette holder and carefully remove cuvette. Pour the Hi Std back into it's test tube. Do not discard (calibrators are reusable)
- Rinse the cuvette several times with solvent so that the next calibrator you use, which will be lower in concentration, will not get cross-contaminated.

10. Calibrators 2 thru 5?

- After completing the Hi Std, analyzing standards 2, 3, 4 and 5 can be done in any random order you choose.
- To save time, use your lowest calibrator as the #2 Std and then go up. This avoids having to rinse the cuvette each time, as the calibrators increase in concentration and thus will not cross-contaminate each other.

11. Analyze #2 Std

- Fill the cuvette ¾ full with the lowest calibration standard and place into UVF-3100 as before.
- Press "9" to change the value. Type in the new value printed on the tube, press "ENT" and then "1" to OK.
- If you forget to change the value, an error may occur and you will need to start all over.

12. Second Std - Continued

- Insert the #2 Std into the analyzer, close the lid and press the <*> key as before.
- When the analyzer is finished and calls for the #3 Std, it is now safe to open the lid. Remove the 2nd calibrator and pour back into it's test tube.
- Invert cuvette onto tissues to drain any excess liquid.

13. Remaining Calibrators

- Analyze the 3rd, 4th and 5th calibrators the same way as the #2 Std.
- Be sure to change and enter the correct concentration for the calibrator each time.
- After testing #5 Std, the analyzer will prompt you to insert a Blank, where clean methanol solvent is used to 'zero' the instrument.

14. Analyze the Blank

- Rinse the cuvette with solvent and invert onto tissue wipes to drain any excess liquid left over from the #5 calibrator.
- Fill cuvette ¾ full with a clean dose of solvent and place into analyzer as before.
- Press "ENT" then the "0" key after value stabilizes. During GRO calibrations, the methanol will yield a high positive value. Do not be alarmed.

15. Calibration Complete!

When finished, the HOME screen appears and is now ready for sample analysis. The curve is electronically stored in memory. If connected to a computer, press "ENT" then "D" to send calibration data to Test Report.

Calibration Sensitivity Check

Press the "8" key to view the calibration sensitivity value.

Optimum Sensitivity Ranges for UVF-3100
Sens% for GRO/BTEX: 30-40
Sens% for PAHs, EPH, EDRO, TPH: 16-22

Quality Controls to Perform...

Calibration Checks:

- Recalibrating the analyzer each time you use it is not necessary as long as you are performing the same analysis.
- Periodically check the curve by analyzing one or two Calibrators as if they were samples to see how linear the curve is and whether or not the analyzer has suffered from drift.
- To test, fill the cuvette ¾ full with a Calibrator, place into the analyzer and wait for reading to stabilize. Do not press "ENT" for Setup/Cal.
- Calibration checks should read within 10 to 20% from their true concentration. If not, a new calibration may be required.

Methanol Blank Checks:

- Periodically analyze your methanol solvent. This is especially important before you begin extracting and testing samples. Blanks ensure the solvent used during operations is clean without interferences.
- When ever you purchase or use a new bottle of methanol, always test it first.
- To test, fill cuvette with a clean dose of solvent and place into the analyzer for analysis. Do not press the zero key.
- Readings should be at or close to zero ppm (+ or -). If not, then recalibrating the analyzer may be necessary.

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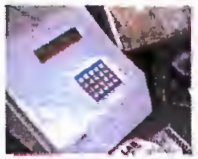

Software Installation Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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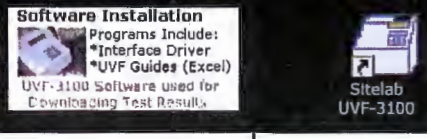
Software Features...

- Recording test results is fast, easy and improves quality control.
- Download and view the analyzer's linear 5-point calibration curve.
- Sample readings and dilutions are automatically calculated and recorded.

System Requirements...

- UVF-3100 Analyzer
- Sitelab Software CD
- RS-232 Serial Cable (standard)
- USB to Serial Adapter (optional/sold separately)
- Microsoft Windows® Operating Systems: XP, 2000, 98 or 95.
- Microsoft Excel
- Serial or USB Port

1. Install Software Programs



- Insert the Sitelab CD-ROM into your computer's compact disk drive. Wait a few moments for the auto start feature to activate your Internet Explorer browser.
- Scroll down and click "Software Installation Program," to begin the installation wizard.

- Next, choose "Run this program from its current location," and then click "Yes" in the Security Warning screen.
- Be sure to choose the Desktop Shortcut icon for easy access.
- After the installation is finished, your desktop reappears. Remove the CD from computer.

A Sitelab folder was created in your Program Files, which contains important programs to be used; a list of UVF-Guide Excel files and one Sitelab.EXE file which serves as the Interface Driver. If, during use, an error occurs or no data is received, check the Sitelab folder for these files.

2. Connect to Analyzer

Standard Cable Connection to Serial Port:

- Use the RS-232 cable supplied with your UVF-3100 and connect it to the male outlet of your computer's serial port.
- Connect the other end of the cable to the female outlet on the back of the UVF-3100.

No Serial Port?

Use Sitelab's USB to Serial Adapter:

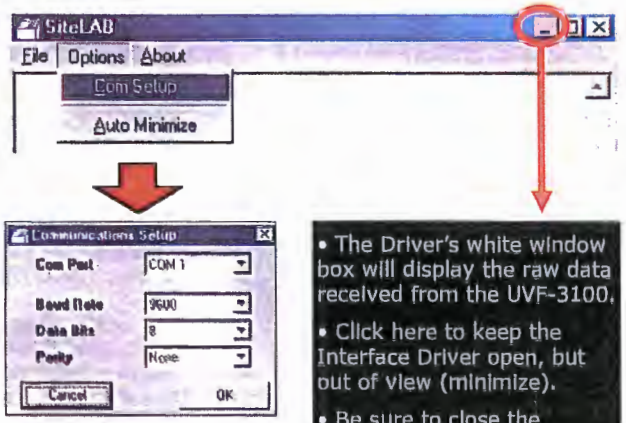
- Compatible with new computers that only have Universal Serial Bus (USB) ports.
- Sold Separately, Product No. 3100USB
- Includes Sitelab CD, USB cable, USB driver CD and installation instructions.

3. Check/Modify the Communication Settings...

About the Sitelab Interface Driver...

The Interface Driver is a program which receives all the raw data coming from the instrument. Computers with different operating systems are configured differently from one another. As such, after installing the Sitelab software, check the Communication Settings on your computer to make sure the data will be received correctly:

- Open the Interface Driver by clicking on the Icon. Go to "Com Setup" found in the Interface Driver's Options Menu and click "Communications Setup."
- Parity must be set to None, Baud Rate set to 9600 and Data Bits set to 8. Adjust these settings if necessary.
- Up to 9 Com Port options are listed. Switch/change the Com Port, if necessary, to accommodate the serial cable or USB connected to your computer.



- The Driver's white window box will display the raw data received from the UVF-3100.
- Click here to keep the Interface Driver open, but out of view (minimize).
- Be sure to close the Interface Driver prior to opening a new UVF Guide.

Run Time Errors?

- If you experience a Run Time Error when sending data from the analyzer, the Interface Driver is on, but the UVF-Guide test report program you are using was either closed or you are trying to send the data to an Excel file that has a different name.
- If a Run Time Error occurs, close out the Interface Driver and any Excel files. Start over by clicking onto the Sitelab icon on your desktop.

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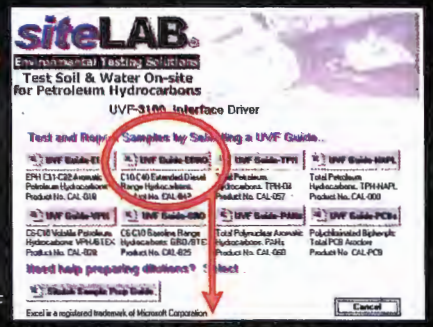
Open the Interface Driver and choose a UVF Guide to record your test results..

Sitelab
UVF-3100

When you open the Interface Driver, a menu screen first appears (right).

The different UVF Guides contain spreadsheets where calibration and sample results are received and recorded.



Select the UVF Guide which matches the test you are performing

• Sitelab's UVF Guides are formatted in Microsoft Excel®, which automatically starts up after you make your selection. The "Test Report" worksheet will open by default.

• The UVF Guides are "Read Only" files, which serve as templates. When it comes time to save your Test Report, you will be asked to save the UVF Guide under a new file name.

• Once you save the UVF Guide under a new name, you can no longer send data to that file as the Interface Driver only delivers data to the Read Only files.

• To begin sending data again, you must close out the Interface Driver and Excel and start over.

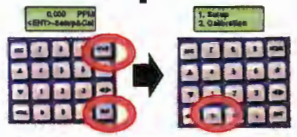
Send Calibration Curve to Test Report...

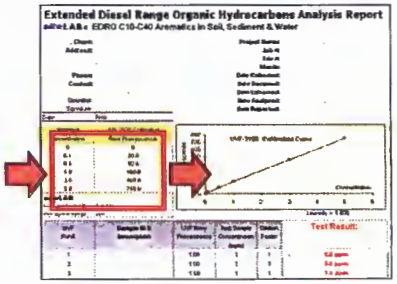
• Sending a new or current calibration curve from the UVF-3100 to the Test Report can be performed at any time as long as the software is running and the cable is connected.

• Starting from the HOME screen, press "ENT" so that the "1.Setup 2.Calibration" screen is displayed and then press the "D" key.

Your computer will then indicate "New Standards Received." Click OK if you want to replace the example calibration curve in the Test Report with the actual calibration data from the instrument.

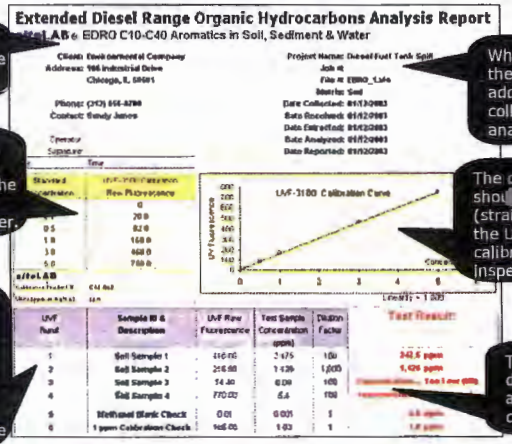
• Press the "H/HOME" key to return to the HOME screen. Do not press "2" unless you want to re-calibrate. Once you click OK, the instrument's concentration and fluorescence response values for all 5 Calibrators and the Blank will be placed into the Test Report and a linear curve will be generated for visual observations.





Note: Refer to the Manual's Software Section, available on the Sitelab CD-ROM, for instructions in using the "Multi-Calibration Guide" feature.

Saving & Editing your Test Report...



Be sure the analysis you performed matches the title and calibration kit applied.

Replace the example calibration curve, [redacted]ch opens by default, [redacted]h the [redacted] calibration [redacted]a [redacted] from the [redacted]lyzer.

Each report can record up to 20 sample results, including [redacted] calibration checks or [redacted] quality control tests performed. If all 20 rows [redacted]p, save the UVF Guide and open a new one to continue.

When finished, enter the project name, address, sample collection date, analysis date, etc.

The calibration curve shou[redacted] have a linear slope (straight line). Confirm the UVF-3100 is properly calibrated by visually inspecting the curve.

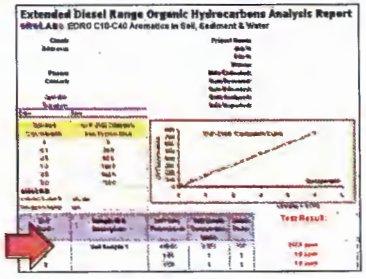
The Test Report will display if a sample is above or below the calibration range.

Send Sample Data to Test Report...

• Send sample results from the UVF-3100 to the computer by pressing the "D" key from the HOME screen at any time. Be sure the sample is inside the instrument with the lid closed before doing so.

• Your computer will then indicate "New Sample Received" and ask you to enter the sample ID and dilution factor – Important!

• Once you name the sample and type in the appropriate dilution being tested, press enter. The sample's data is placed into the Test Report and the final result is calculated (on the right hand side in **red**). Then, continue to the next sample. If you make a mistake, click onto the worksheet and manually enter the information.



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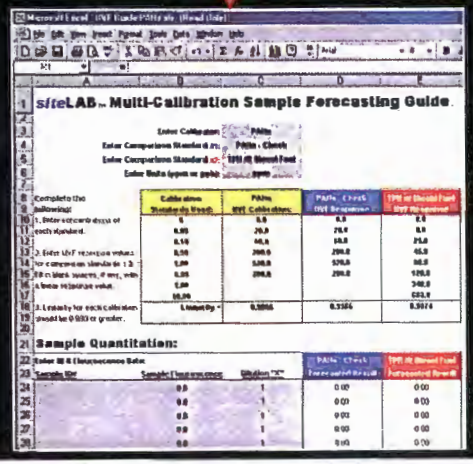
Using the Multi-Calibration Sample Forecasting Guide?

This time saving feature allows you to report test results simultaneously to two different calibration curves, without having to re-calibrate the instrument, even though the UVF-3100 generates results to only one curve at a time. Since both sets of calibration standards are linear to one another, the computer will generate the exact same result as if you re-calibrated the instrument and then re-analyzed the sample to the other calibration curve. Note: the same optics must be used when using this application: Slot A or B, but not both! This excludes a GRO and DRO combination.

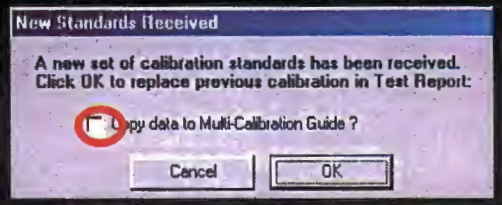
Typical applications include: testing TPH and EDRO together, weathered diesel and fresh diesel together and total PAHs and fuel oils together (as illustrated here). This is also helpful if a petroleum site has mixed types of contamination and you are unsure as to which Calibration Kit should be used to report results, especially if confirmatory lab analysis is performed. The "Forecast Guide" worksheet can be found at the bottom of your screen in each UVF Guide program.

Test Report / Forecast Guide / Data Archive

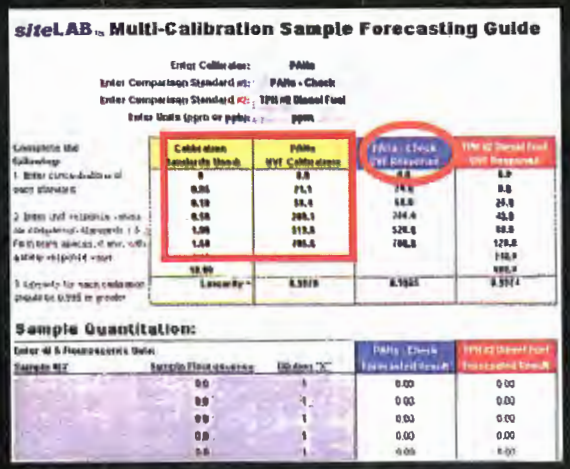


STEP 1: Send Calibration to Forecast Guide

Before you begin analyzing samples, replace the example calibration curve (in yellow blocks) in the UVF Forecast Guide, by checking the box (circled in red below) each time you send a calibration curve from the instrument to the computer as before. Then press OK.

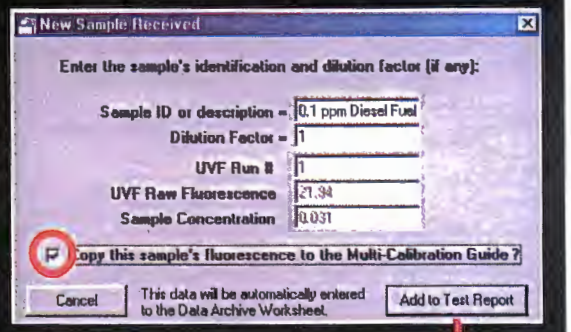


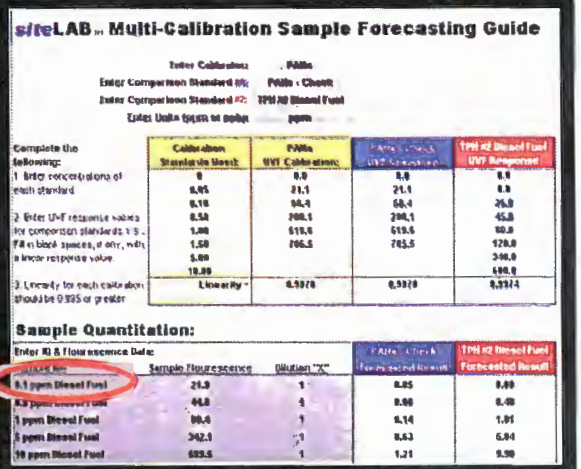
In this example, the blue column is used for Quality Control so that both the computer and UVF-3100 display the same reading. Manually type in the same UVF response values from the UVF's calibration (in yellow).

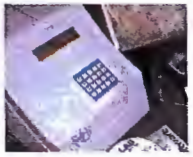


STEP 2: Analyze 2nd Calibrators for Forecast Guide

Using a different Sitelab Calibration Kit, analyze each of the five Calibrators one at a time as if they were samples. Download the results into the Forecast Guide by checking the box (circled in red below).







Software Test Report Programs

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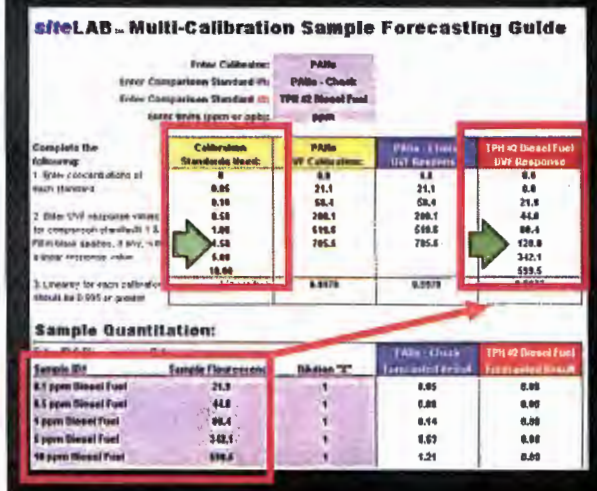
STEP 3: Transfer 2nd Calibration Data to Red Column:

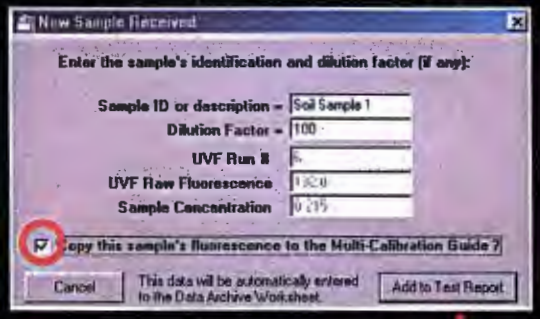
- Manually type the fluorescence response values generated by each of the new Calibrators by replacing the "dummy" UVF responses in the upper right red block.
- Be sure to match these five new fluorescence responses to their respective concentrations displayed in the upper left yellow block.

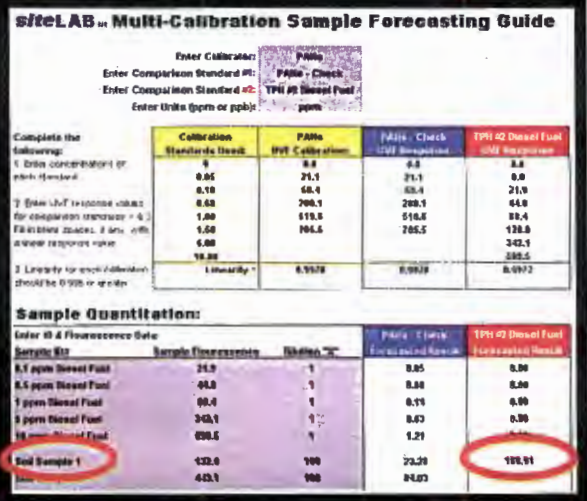
Important! Some of the 2nd set of Calibrators may not be available at the same concentrations as the 1st set. In this case, type in a number which provides the best "linear fit." In this example, the #2 Diesel Fuel Calibration Kit does not contain a 1.5 ppm Calibrator, where as the PAH kit does. Thus, a "120" UVF response value was placed into the space provided by multiplying the Diesel's 1 ppm fluorescence response by 1.5 (green)



STEP 4: Test & Send Sample Data to Multi-Calibration Guide:

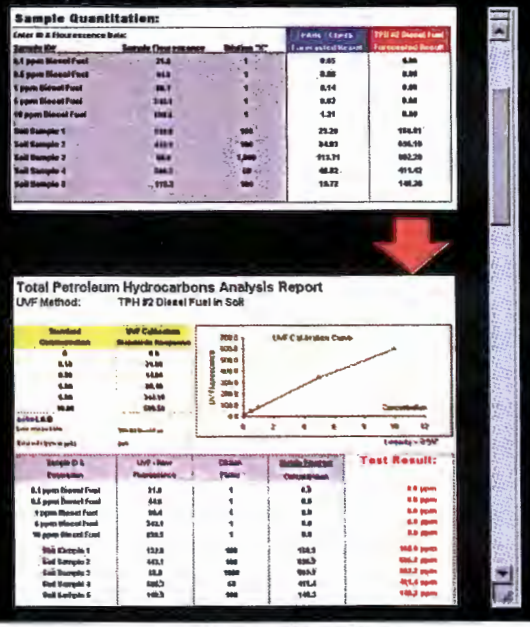
Now that your calibrators are complete, analyze your samples and download the results by checking the box (circled in red) as before. The blue and red columns will display the new concentrations for each curve.





Create a Test Report to the New Calibration Curve:

- Test Reports reflecting the calibration curves you applied and the sample results generated in both the blue and red columns can be found by scrolling down the worksheet.
- Within these Test Reports, be sure to manually type in the concentrations of the calibrators applied, including the fluorescence response values so that the calibration curve can be graphed and visually inspected.
- Since the Sitelab UVF Guides are "Read Only" files, each time you open this program you must manually re-enter the fluorescence response and concentration values in the upper yellow, blue, and red blocks as before. Re-analyzing these new standards each time, however, is not necessary, unless the UVF-3100 itself is re-calibrated to something else.
- To view the UVF-3100's calibration and sample results, click back to the Test Report worksheet at the bottom of your screen.



Troubleshooting Instructions

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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Questions and answers to common problems you may be experiencing...

Software Installation:

Problem: My CD doesn't run when I put it into my computer.

Solution: The CD's auto start feature isn't working. Go into My Computer and manually open the "SitelabInstall.EXE" file.

Problem: Files are missing. Only the SitelabInstall file was downloaded. No other files were installed, including the Excel UVF Guide files.

Solution: In the first "File Download" screen, click "Run this program from its current location." Do not choose "Save this program to disk."

Problem: No data is received when using the USB Serial Adapter.

Solution: Open the Interface Driver and go to the Com Setup feature under the options menu. Change the Com Port setting and re-try.
Use the "HyperTerminal" feature on your computer as an alternative method to receive data. See the instructions included with your Sitelab USB Serial Adapter for details.

Computer Connection:

Problem: Cable is connected from UVF-3100 to computer. But when I press "D" nothing happens, no data is sent.

Solution: Interface Driver and UVF Guide Programs must both be open.

Problem: I get a "Run Time Error" when pressing D.

Solution: The Interface Driver program crashed, as the UVF Guide program was either closed or saved under a new name. Close down both programs and start over again.

Problem: When I press "D" to send data, the computer displays very strange or scrambled data.

Solution: Go to Com Setup in the About menu found in your Interface Driver. Set Parity to "None."

Problem: Pressing "D" on the analyzer's keypad isn't sending calibration data.

Solution: From the HOME screen, press "ENT" to go to the "1.Setup 2.Calibration" screen. Now press D. Press "H" to return to the HOME screen.

UVF-3100 Calibration:

Problem: I get a "Bad Cal" error during or after the calibration process.

Solution: Press "ESC" and then "1" to Abort. Start calibration over again. Be sure you type in the correct concentrations for all 5 Calibrators, including the Max Range value. Check if the correct optical filters (Slot A, B, etc.) are aligned properly next to silver dot to the left of the lid.

Problem: I get "Error5: Blk reads > Std#" message when calibrating.

Solution: The solvent you are using for the Blank fluoresces higher than one of the calibration standards. Be sure the methanol you are using is clean and the glass cuvette is thoroughly rinsed after testing the calibrators. If you try and recalibrate the analyzer and the Blank still creates an error, you may need to prepare new calibrators using your solvent and the Reference Standard supplied with your calibration kit. Refer to the product certificate for preparation instructions. By making new calibrators using your solvent, any methanol interferences will be zeroed out the next time you calibrate.

Refer to the Quality Controls listed in the Calibration Instructions page for additional information.

UVF-3100 Sample Analysis:

Problem: Sample has no reading, or a negative reading, when inside the chamber.

Solution: Check the alignment of the cuvette holder. Be sure the arrow shaped handle points to the silver dot to the left of the lid. The lid must also be closed when reading samples.

Problem: Sample readings drift slowly over time and do not settle.

Solution: Confirm the analyzer is properly calibrated by testing one or two of the calibration standards as if they were samples. If the calibrator concentrations are off and/or the readings drift, recalibrate the analyzer. Before doing so, however, visually inspect the curve by downloading the calibration data to a computer using the software. Be sure you are using the correct optical filters and that the optical filter cylinder is aligned properly. In addition, confirm the UV lamp is on by sliding out the optical filter cylinder. A blue light should be visible from down inside the chamber.

Refer to the Quality Controls listed in the Sample Testing Instructions page for additional information.

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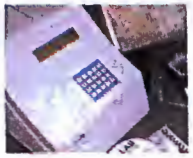
Petroleum Hydrocarbon Solutions
Test Soil & Water On-site
Fast • Accurate • Easy to Use



Quick Reference Guide

for Sitelab UVF•3100 Petroleum Hydrocarbon Applications

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Sample Preparation & Analysis...

Testing Soil?

Using the digital scale and spatulas, weigh 5 grams of soil into an extraction jar (within +/- 0.1 gram)

Testing Water?

Using a plastic test tube, measure out 10 mL of water sample and add to extraction jar.

2. Add Solvent

Add Methanol to solvent dispenser bottle. Using a test tube, dispense solvent to the 10 mL line. Empty into the extraction jar. This creates a 2X Extract Dilution. Shake soil jars by hand for several minutes. Shake water jars for ten to twenty seconds.

3. Filter Extract

Let soil extract jars settle for a few minutes before removing lid. Suck up 2 to 4 mL of extract from the jar's surface using a syringe. Attach/screw a filter to the syringe and dispense contents into test tube. Label extract tube with sample ID and 2X Dilution – keep track!

4. Dilute Extract

Adjust the setting on the Sitelab pipette, attach a tip and use a 2nd test tube to prepare a larger dilution for analysis - in order for the sample to be detected within the analyzer's calibration range.

Recommended Dilutions:
Extract Volume + Solvent = DIL
"100"uL into 5 mL = 100X (start)
"020"uL into 10 mL = 1,000X

5. Add to Cuvette

Pour the dilution made in Step 4 into the glass cuvette. Cuvette needs to be about ¾ full. Use tissue wipes to clean outside glass to remove fingerprints and liquids. Next, carefully slide cuvette into the black cuvette holder. Be sure not to spill sample.

6. Test Sample

Lower into analyzer and close the lid. Be sure the cuvette holder's arrow shaped handle points to silver dot (to left of chamber). Wait a few seconds for concentration to stabilize. Multiply the reading by the dilution tested. Avoid readings below detection limit.

Products Used...

Sitelab test procedures listed here require the following...

UVF-3100 Analyzer & Tools:
Product No. UVF-3100A

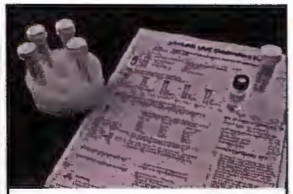
- Optic Emission Filters
- Scale & Spatulas
- Adjustable Pipette
- Solvent Dispenser
- Tissues & Markers
- Software & Manual

20 Sample Extraction Kits:
Product No. EXTR010-20

40 Test Tubes
20 Sitelab® Filters
20 Jars
20 Syringes
20 Pipette Tips

WARNING! Product uses flammable alcohols – Methanol, HPLC grade. Dispose solvent waste properly.

Calibrate Instrument...



1. Calibration Kit

Choose a certified Sitelab Calibration Kit for your application:

Cal Kit & Emission Optics	
GRO/BTEX	Slot B
Total PAHs/EPH	Slot A
TPH-EDRO Range	Slot A
TPH-Oil Range	Slot A
Target PAHs	Slot D

Or ask about custom kits available

2. Setup Analyzer

Turn on. Allow to warm up or press "H" to bypass Rotate filter cylinder so that correct Emission Optics are aligned next to silver dot (to left). Press "ENT" then "2" and enter the proper Maximum Range setting (see cal kit certificate for details).

3. Calibrate

Always start using the highest calibrator first. Pour calibrator into cuvette and lower into analyzer. Be sure to enter and/or change the correct concentration. Pour calibrator back into test tube when finished. Test remaining calibrators

Quality Controls...

4. Clean Cuvette

Rinse with solvent into a waste jar between samples or calibrators. Place upside down onto tissue wipes to drain. Fill with clean methanol and analyze when prompted at end of each calibration. Wait for value to stabilize before pressing zero.

5. Check Curve

Periodically check the calibration curve for drift and linearity by testing one or two standards as if they were samples, including the methanol (as blank). To view curve and report test results, download data using Sitelab UVF3100 software

METHOD 300.0

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

John D. Pfaff
Inorganic Chemistry Branch
Chemistry Research Division

Revision 2.1
August 1993

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

METHOD 300.0

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

1.0 SCOPE AND APPLICATION

1.1 This method covers the determination of the following inorganic anions:

PART A.

Bromide	Nitrite
Chloride	Ortho-Phosphate-P
Fluoride	Sulfate
Nitrate	

PART B.

Bromate	Chlorite
Chlorate	

1.2 The matrices applicable to each method are shown below:

A. Drinking water, surface water, mixed domestic and industrial wastewaters, groundwater, reagent waters, solids (after extraction 11.7), leachates (when no acetic acid is used).

B. Drinking water and reagent waters

1.3 The single laboratory Method Detection Limit (MDL defined in Sect. 3.2) for the above analytes is listed in Tables 1A and 1B. The MDL for a specific matrix may differ from those listed, depending upon the nature of the sample.

1.4 Method A is recommended for drinking and wastewaters. The multilaboratory ranges tested for each anion are as follows:

Analyte	mg/L
Bromide	0.63 - 21.0
Chloride	0.78 - 26.0
Fluoride	0.26 - 8.49
Nitrate-N	0.42 - 14.0
Nitrite-N	0.36 - 12.0
Ortho-Phosphate-P	0.69 - 23.1
Sulfate	2.85 - 95.0

1.5 This method is recommended for use only by or under the supervision of analysts experienced in the use of ion chromatography and in the interpretation of the resulting ion chromatograms.

1.6 When this method is used to analyze unfamiliar samples for any of the above anions, anion identification should be supported by the use of a fortified sample matrix covering the anions of interest. The fortification procedure is described in Sect. 11.6.

1.7 Users of the method data should state the data-quality objectives prior to analysis. Users of the method must demonstrate the ability to generate acceptable results with this method, using the procedures described in Sect. 9.0.

2.0 SUMMARY OF METHOD

2.1 A small volume of sample, typically 2 to 3 mL, is introduced into an ion chromatograph. The anions of interest are separated and measured, using a system comprised of a guard column, analytical column, suppressor device, and conductivity detector.

2.2 The main differences between Parts A and B are the separator columns and guard columns. Sections 6.0 and 7.0 will elicit the differences.

2.3 An extraction procedure must be performed to use this method for solids (See 11.7).

2.4 Limited performance-based method modifications may be acceptable provided they are fully documented and meet or exceed requirements expressed in Sect. 9.0, Quality Control.

3.0 DEFINITIONS

3.1 CALIBRATION BLANK (CB) -- A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

3.2 CALIBRATION STANDARD (CAL) -- A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 FIELD DUPLICATES (FD) -- Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of field duplicates indicate the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.

3.4 INSTRUMENT PERFORMANCE CHECK SOLUTION (IPC) -- A solution of one or more method analytes, surrogates, internal standards, or other test

substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

3.5 LABORATORY FORTIFIED BLANK (LFB) -- An aliquot of reagent water or other blank matrices to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.6 LABORATORY FORTIFIED SAMPLE MATRIX (LFM) -- An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

3.7 LABORATORY REAGENT BLANK (LRB) -- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

3.8 LINEAR CALIBRATION RANGE (LCR) -- The concentration range over which the instrument response is linear.

3.9 MATERIAL SAFETY DATA SHEET (MSDS) -- Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.

3.10 METHOD DETECTION LIMIT (MDL) -- The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

3.11 PERFORMANCE EVALUATION SAMPLE (PE) -- A solution of method analytes distributed by the Quality Assurance Research Division (QARD), Environmental Monitoring Systems Laboratory (EMSL-Cincinnati), U. S. Environmental Protection Agency, Cincinnati, Ohio, to multiple laboratories for analysis. A volume of the solution is added to a known volume of reagent water and analyzed with procedures used for samples. Results of analyses are used by QARD to determine statistically the accuracy and precision that can be expected when a method is performed by a competent analyst. Analyte true values are unknown to the analyst.

3.12 QUALITY CONTROL SAMPLE (QCS) -- A solution of method analytes of known concentrations that is used to fortify an aliquot of LRB or

sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

3.13 STOCK STANDARD SOLUTION (SSS) -- A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

4.0 INTERFERENCES

4.1 Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. Large amounts of an anion can interfere with the peak resolution of an adjacent anion. Sample dilution and/or fortification can be used to solve most interference problems associated with retention times.

4.2 The water dip or negative peak that elutes near, and can interfere with, the fluoride peak can usually be eliminated by the addition of the equivalent of 1 mL of concentrated eluent (7.3 100X) to 100 mL of each standard and sample.

4.3 Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baseline in ion chromatograms.

4.4 Samples that contain particles larger than 0.45 microns and reagent solutions that contain particles larger than 0.20 microns require filtration to prevent damage to instrument columns and flow systems.

4.5 Any anion that is not retained by the column or only slightly retained will elute in the area of fluoride and interfere. Known coelution is caused by carbonate and other small organic anions. At concentrations of fluoride above 1.5 mg/L, this interference may not be significant, however, it is the responsibility of the user to generate precision and accuracy information in each sample matrix.

4.6 The acetate anion elutes early during the chromatographic run. The retention times of the anions also seem to differ when large amounts of acetate are present. Therefore, this method is not recommended for leachates of solid samples when acetic acid is used for pH adjustment.

4.7 The quantitation of unretained peaks should be avoided, such as low molecular weight organic acids (formate, acetate, propionate etc.) which are conductive and coelute with or near fluoride and would bias the fluoride quantitation in some drinking and most waste waters.

4.8 Any residual chlorine dioxide present in the sample will result in the formation of additional chlorite prior to analysis. If any

concentration of chlorine dioxide is suspected in the sample purge the sample with an inert gas (argon or nitrogen) for about five minutes or until no chlorine dioxide remains.

5.0 SAFETY

5.1 The toxicity or carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials or procedures.

5.2 Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets (MSDS) should be made available to all personnel involved in the chemical analysis. The preparation of a formal safety plan is also advisable.

5.3 The following chemicals have the potential to be highly toxic or hazardous, consult MSDS.

5.3.1 Sulfuric acid (7.4)

6.0 Equipment and Supplies

6.1 Balance -- Analytical, capable of accurately weighing to the nearest 0.0001 g.

6.2 Ion chromatograph -- Analytical system complete with ion chromatograph and all required accessories including syringes, analytical columns, compressed gasses and detectors.

6.2.1 Anion guard column: A protector of the separator column. If omitted from the system the retention times will be shorter. Usually packed with a substrate the same as that in the separator column.

6.2.2 Anion separator column: This column produces the separation shown in Figures 1 and 2.

6.2.2.1 Anion analytical column (Method A): The separation shown in Figure 1 was generated using a Dionex AS4A column (P/N 37041). An optional column may be used if comparable resolution of peaks is obtained, and the requirements of Sect. 9.2 can be met.

6.2.2.2 Anion analytical column (Method B). The separation shown in Figure 2 was generated using a Dionex AS9 column (P/N 42025). An optional column may be used if comparable resolution of peaks is

obtained and the requirements of Sect. 9.2 can be met.

6.2.3 Anion suppressor device: The data presented in this method were generated using a Dionex anion micro membrane suppressor (P/N 37106).

6.2.4 Detector -- Conductivity cell: approximately 1.25 μL internal volume, (Dionex, or equivalent) capable of providing data as required in Sect. 9.2.

6.3 The Dionex AI-450 Data Chromatography Software was used to generate all the data in the attached tables. Systems using a stripchart recorder and integrator or other computer based data system may achieve approximately the same MDL's but the user should demonstrate this by the procedure outlined in Sect. 9.2.

7.0 Reagents and Standards

7.1 Sample bottles: Glass or polyethylene of sufficient volume to allow replicate analyses of anions of interest.

7.2 Reagent water: Distilled or deionized water, free of the anions of interest. Water should contain particles no larger than 0.20 microns.

7.3 Eluent solution (Method A and Method B): Sodium bicarbonate (CASRN 144-55-8) 1.7 mM, sodium carbonate (CASRN 497-19-8) 1.8 mM. Dissolve 0.2856 g sodium bicarbonate ($NaHCO_3$) and 0.3816 g of sodium carbonate (Na_2CO_3) in reagent water (7.2) and dilute to 2 L.

7.4 Regeneration solution (micro membrane suppressor): Sulfuric acid (CASRN-7664-93-9) 0.025N. Dilute 2.8 mL conc. sulfuric acid (H_2SO_4) to 4 L with reagent water.

7.5 Stock standard solutions, 1000 mg/L (1 mg/mL): Stock standard solutions may be purchased as certified solutions or prepared from ACS reagent grade materials (dried at 105°C for 30 min) as listed below.

7.5.1 Bromide (Br^-) 1000 mg/L: Dissolve 1.2876 g sodium bromide (NaBr, CASRN 7647-15-6) in reagent water and dilute to 1 L.

7.5.2 Bromate (BrO_3^-) 1000 mg/L: Dissolve 1.1798g of sodium bromate ($NaBrO_3$, CASRN 7789-38-0) in reagent water and dilute to 1 L.

7.5.3 Chlorate (ClO_3^-) 1000 mg/L: Dissolve 1.2753g of sodium chlorate ($NaClO_3$, CASRN 7775-09-9) in reagent water and dilute to 1 L.

7.5.4 Chloride (Cl^-) 1000 mg/L: Dissolve 1.6485 g sodium chloride (NaCl, CASRN 7647-14-5) in reagent water and dilute to 1 L.

7.5.5 Chlorite (ClO_2^-) 1000 mg/L: Dissolve 1.3410g of sodium chlorite ($NaClO_2$, CASRN 7758-19-2) in reagent water and dilute to 1 L.

7.5.6 Fluoride (F^-) 1000 mg/L: Dissolve 2.2100g sodium fluoride (NaF, CASRN 7681-49-4) in reagent water and dilute to 1 L.

7.5.7 Nitrate (NO_3^--N) 1000 mg/L: Dissolve 6.0679 g sodium nitrate ($NaNO_3$, CASRN 7631-99-4) in reagent water and dilute to 1 L.

7.5.8 Nitrite (NO_2^--N) 1000 mg/L: Dissolve 4.9257 g sodium nitrite ($NaNO_2$, CASRN 7632-00-0) in reagent water and dilute to 1 L.

7.5.9 Phosphate ($PO_4^{=}$-P) 1000 mg/L: Dissolve 4.3937 g potassium phosphate (KH_2PO_4, CASRN 7778-77-0) in reagent water and dilute to 1 L.

7.5.10 Sulfate ($SO_4^{=}$) 1000 mg/L: Dissolve 1.8141 g potassium sulfate (K_2SO_4, CASRN 7778-80-5) in reagent water and dilute to 1 L.

NOTE: Stability of standards: Stock standards (7.5) are stable for at least 1 month when stored at 4°C. Except for the chlorite standard which is only stable for two weeks. Dilute working standards should be prepared weekly, except those that contain nitrite and phosphate should be prepared fresh daily.

7.6 Ethylenediamine preservation solution: Dilute 10 mL of ethylenediamine (99%) (CASRN 107-15-3) to 200 mL with reagent water. Use 1 mL of this dilution to each 1 L of sample taken.

8.0 Sample Collection, Preservation and Storage

8.1 Samples should be collected in plastic or glass bottles. All bottles must be thoroughly cleaned and rinsed with reagent water. Volume collected should be sufficient to insure a representative sample, allow for replicate analysis, if required, and minimize waste disposal.

8.2 Sample preservation and holding times for the anions that can be determined by this method are as follows:

Analyte	Preservation	Holding Time
Bromate	None required	28 days

Bromide	None required	28 days
Chlorate	None required	28 days
Chloride	None required	28 days
Chlorite	Cool to 4°C	immediately
Fluoride	None required	28 days
Nitrate-N	Cool to 4°C	48 hours
Combined (Nitrate/Nitrite)	conc. H_2SO_4 to a pH < 2	28 days
Nitrite-N	Cool to 4°C	48 hours
O-Phosphate-P	Cool to 4°C	48 hours
Sulfate	Cool to 4°C	28 days

NOTE: If the determined value for the combined nitrate/nitrite exceeds 0.5 mg/L as N^-, a resample must be analyzed for the individual concentrations of nitrate and nitrite.

8.3 The method of preservation and the holding time for samples analyzed by this method are determined by the anions of interest. In a given sample, the anion that requires the most preservation treatment and the shortest holding time will determine the preservation treatment. It is recommended that all samples be cooled to 4°C and held for no longer than 28 days for Method A and analyzed immediately in Method B.

NOTE: If the sample cannot be analyzed for chlorite within ≤ 10 minutes, the sample may be preserved by adding 1 mL of the ethylenediamine (EDA) preservation solution (7.6) to 1 L of sample. This will preserve the concentration of the chlorite for up to 14 days. This addition of EDA has no effect on bromate or chlorate, so they can also be determined in a sample preserved with EDA. Residual chlorine dioxide should be removed from the sample (per 4.8) prior to the addition of EDA.

9.0 QUALITY CONTROL

9.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, and the periodic analysis of laboratory reagent blanks, fortified blanks and other laboratory solutions as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of the data that are generated.

9.2 INITIAL DEMONSTRATION OF PERFORMANCE

9.2.1 The initial demonstration of performance is used to characterize instrument performance (determination of LCRs and analysis of QCS) and laboratory performance

(determination of MDLs) prior to performing analyses by this method.

9.2.2 Linear Calibration Range (LCR) -- The LCR must be determined initially and verified every 6 months or whenever a significant change in instrument response is observed or expected. The initial demonstration of linearity must use sufficient standards to insure that the resulting curve is linear. The verification of linearity must use a minimum of a blank and three standards. If any verification data exceeds the initial values by ± 10%, linearity must be reestablished. If any portion of the range is shown to be nonlinear, sufficient standards must be used to clearly define the nonlinear portion.

9.2.3 Quality Control Sample (QCS) -- When beginning the use of this method, on a quarterly basis or as required to meet data-quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS. If the determined concentrations are not within ± 10% of the stated values, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before either proceeding with the initial determination of MDLs or continuing with on-going analyses.

9.2.4 Method Detection Limit (MDL) -- MDLs must be established for all analytes, using reagent water (blank) fortified at a concentration of two to three times the estimated instrument detection limit.[6] To determine MDL values, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (S)$$

where, t = Student's t value for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom [t = 3.14 for seven replicates].

S = standard deviation of the replicate analyses.

MDLs should be determined every 6 months, when a new operator begins work or whenever there is a significant change in the background or instrument response.

9.3 ASSESSING LABORATORY PERFORMANCE

9.3.1 Laboratory Reagent Blank (LRB) -- The laboratory must analyze at least one LRB with each batch of samples. Data produced are used to assess contamination from the laboratory environment. Values that exceed the MDL indicate laboratory or reagent contamination should be suspected and corrective actions must be taken before continuing the analysis.

9.3.2 Laboratory Fortified Blank (LFB) -- The laboratory must analyze at least one LFB with each batch of samples. Calculate accuracy as percent recovery (Sect. 9.4.2). If the recovery of any analyte falls outside the required control limits of 90-110%, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

9.3.3 The laboratory must use LFB analyses data to assess laboratory performance against the required control limits of 90-110%. When sufficient internal performance data become available (usually a minimum of 20-30 analyses), optional control limits can be developed from the percent mean recovery (x) and the standard deviation (S) of the mean recovery. These data can be used to establish the upper and lower control limits as follows:

UPPER CONTROL LIMIT = x + 3S
LOWER CONTROL LIMIT = x - 3S

The optional control limits must be equal to or better than the required control limits of 90-110%. After each five to ten new recovery measurements, new control limits can be calculated using only the most recent 20-30 data points. Also, the standard deviation (S) data should be used to establish an on-going precision statement for the level of concentrations included in the LFB. These data must be kept on file and be available for review.

9.3.4 Instrument Performance Check Solution (IPC) -- For all determinations the laboratory must analyze the IPC (a mid-range check standard) and a calibration blank immediately following daily calibration, after every tenth sample (or more frequently, if required) and at the end of the sample run. Analysis of the IPC solution and calibration blank immediately following calibration must verify that the instrument is within ± 10% of calibration. Subsequent analyses of the IPC solution must verify the calibration is still within ± 10%. If the calibration cannot be verified within the specified limits, reanalyze the IPC solution. If the second analysis of the IPC solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated. All samples following

the last acceptable IPC solution must be reanalyzed. The analysis data of the calibration blank and IPC solution must be kept on file with the sample analyses data.

9.4 ASSESSING ANALYTE RECOVERY AND DATA QUALITY

9.4.1 Laboratory Fortified Sample Matrix (LFM) -- The laboratory must add a known amount of analyte to a minimum of 10% of the routine samples. In each case the LFM aliquot must be a duplicate of the aliquot used for sample analysis. The analyte concentration must be high enough to be detected above the original sample and should not be less than four times the MDL. The added analyte concentration should be the same as that used in the laboratory fortified blank.

9.4.1.1 If the concentration of fortification is less than 25% of the background concentration of the matrix the matrix recovery should not be calculated.

9.4.2 Calculate the percent recovery for each analyte, corrected for concentrations measured in the unfortified sample, and compare these values to the designated LFM recovery range 90-110%. Percent recovery may be calculated using the following equation:

$$R = \frac{C_s - C}{s} \times 100$$

where, R = percent recovery.
C_s = fortified sample concentration.
C = sample background concentration.
s = concentration equivalent of analyte added to sample.

9.4.3 Until sufficient data becomes available (usually a minimum of 20 to 30 analysis), assess laboratory performance against recovery limits for method A of 80 to 120% and 75 to 125% for method B. When sufficient internal performance data becomes available develop control limits from percent mean recovery and the standard deviation of the mean recovery.

9.4.4 If the recovery of any analyte falls outside the designated LFM recovery range and the laboratory performance for that analyte is shown to be in control (Sect. 9.3), the recovery problem encountered with the LFM is judged to be either matrix or solution related, not system related.

9.4.5 Where reference materials are available, they should be analyzed to provide additional performance data. The

analysis of reference samples is a valuable tool for demonstrating the ability to perform the method acceptably.

9.4.6 In recognition of the rapid advances occurring in chromatography, the analyst is permitted certain options, such as the use of different columns and/or eluents, to improve the separations or lower the cost of measurements. Each time such modifications to the method are made, the analyst is required to repeat the procedure in Sect. 9.2.

9.4.7 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field duplicates may be analyzed to monitor the precision of the sampling technique. When doubt exists over the identification of a peak in the chromatogram, confirmatory techniques such as sample dilution and fortification, must be used. Whenever possible, the laboratory should perform analysis of quality control check samples and participate in relevant performance evaluation sample studies.

9.4.8 At least quarterly, replicates of LFBs should be analyzed to determine the precision of the laboratory measurements. Add these results to the on-going control charts to document data quality.

9.4.9 When using Part B, the analyst should be aware of the purity of the reagents used to prepare standards. Allowances must be made when the solid materials are less than 99% pure.

10.0 Calibration and Standardization

10.1 Establish ion chromatographic operating parameters equivalent to those indicated in Tables 1A or 1B.

10.2 For each analyte of interest, prepare calibration standards at a minimum of three concentration levels and a blank by adding accurately measured volumes of one or more stock standards (7.5) to a volumetric flask and diluting to volume with reagent water. If a sample analyte concentration exceeds the calibration range the sample may be diluted to fall within the range. If this is not possible then three new calibration concentrations must be chosen, two of which must bracket the concentration of the sample analyte of interest. Each attenuation range of the instrument used to analyze a sample must be calibrated individually.

10.3 Using injections of 0.1 to 1.0 mL (determined by injection loop volume) of each calibration standard, tabulate peak height or area responses against the concentration. The results are used to prepare a calibration curve for each analyte. During this procedure, retention times must be recorded.

10.4 The calibration curve must be verified on each working day, or whenever the anion eluent is changed, and after every 20 samples. If the response or retention time for any analyte varies from the expected values by more than ± 10%, the test must be repeated, using fresh calibration standards. If the results are still more than ± 10%, a new calibration curve must be prepared for that analyte.

10.5 Nonlinear response can result when the separator column capacity is exceeded (overloading). The response of the detector to the sample when diluted 1:1, and when not diluted, should be compared. If the calculated responses are the same, samples of this total anionic concentration need not be diluted.

11.0 Procedure

11.1 Tables 1A and 1B summarize the recommended operating conditions for the ion chromatograph. Included in these tables are estimated retention times that can be achieved by this method. Other columns, chromatographic conditions, or detectors may be used if the requirements of Sect. 9.2 are met.

11.2 Check system calibration daily and, if required, recalibrate as described in Sect. 10.

11.3 Load and inject a fixed amount of well mixed sample. Flush injection loop thoroughly, using each new sample. Use the same size loop for standards and samples. Record the resulting peak size in area or peak height units. An automated constant volume injection system may also be used.

11.4 The width of the retention time window used to make identifications should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size for each analyte. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

11.5 If the response for the peak exceeds the working range of the system, dilute the sample with an appropriate amount of reagent water and reanalyze.

11.6 If the resulting chromatogram fails to produce adequate resolution, or if identification of specific anions is questionable, fortify the sample with an appropriate amount of standard and reanalyze.

NOTE: Retention time is inversely proportional to concentration. Nitrate and sulfate exhibit the greatest amount of change, although all anions are affected to some degree. In some cases this peak migration may produce poor resolution or identification.

11.7 The following extraction should be used for solid materials. Add an amount of reagent water equal to ten times the weight of dry solid material taken as a sample. This slurry is mixed for ten minutes using a magnetic stirring device. Filter the resulting slurry before injecting using a 0.45 μ membrane type filter. This can be the type that attaches directly to the end of the syringe. Care should be taken to show that good recovery and identification of peaks is obtained with the user's matrix through the use of fortified samples.

11.8 It has been reported that lower detection limits for bromate ($\approx$7 μg/L) can be obtained using a borate based eluent[7]. The use of this eluent or other eluents that improve method performance may be considered as a minor modification of the method and as such still are acceptable.

11.9 Should more complete resolution be needed between peaks the eluent (7.3) can be diluted. This will spread out the run but will also cause the later eluting anions to be retained longer. The analyst must determine to what extent the eluent is diluted. This dilution should not be considered a deviation from the method.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Prepare a calibration curve for each analyte by plotting instrument response against standard concentration. Compute sample concentration by comparing sample response with the standard curve. Multiply answer by appropriate dilution factor.

12.2 Report only those values that fall between the lowest and the highest calibration standards. Samples exceeding the highest standard should be diluted and reanalyzed.

12.3 Report results in mg/L.

12.4 Report NO_2^- as N
NO_3^- as N
$HPO_4^=$ as P

13.0 METHODS PERFORMANCE

13.1 Tables 1A and 2A give the single laboratory (EMSL-Cincinnati) MDL for each anion included in the method under the conditions listed.

13.2 Tables 2A and 2B give the single laboratory (EMSL-Cincinnati) standard deviation for each anion included in the method in a variety of waters for the listed conditions.

13.3 Multiple laboratory accuracy and bias data (S_r) and estimated single operator values (S_o) for reagent, drinking and waste water using

method A are given for each anion in Tables 3 through 9. Data from 19 laboratories were used for this data.

13.4 Some of the bias statements, for example chloride and sulfate, may be misleading due to spiking small increments of the anion into large naturally occurring concentrations of the same anion.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 Quantity of the chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

14.3 For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction," available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202) 872-4477.

15.0 WASTE MANAGEMENT

15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any waste discharge permit and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel," available from the American Chemical Society at the address listed in Sect. 14.3.

16.0 REFERENCES

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17.0 TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION DATA

TABLE 1A. CHROMATOGRAPHIC CONDITIONS AND DETECTION LIMITS IN REAGENT WATER (PART A)

ANALYTE	PEAK # *	RETENTION TIME(MIN)	MDL mg/L
Fluoride	1	1.2	0.01
Chloride	2	1.7	0.02
Nitrite-N	3	2.0	0.004
Bromide	4	2.9	0.01
Nitrate-N	5	3.2	0.002
o-Phosphate-P	6	5.4	0.003
Sulfate	7	6.9	0.02

Standard Conditions:

Columns: as specified in 6.2.2.1
Detector: as specified in 6.2.4
Eluent: as specified in 7.3

Pump Rate: 2.0 mL/min.
Sample Loop: 50 µL

MDL calculated from data system using a y-axis selection of 1000 ns and with a stripchart recorder with an attenuator setting of 1 uMHO full scale.

* See Figure 1

TABLE 1B. CHROMATOGRAPHIC CONDITIONS AND DETECTION LIMITS IN REAGENT WATER (PART B)

ANALYTE	PEAK # *	RETENTION TIME(MIN)	MDL mg/L
Chlorite	1	2.8	0.01
Bromate	2	3.2	0.02
Chlorate	4	7.1	0.003

Standard Conditions:

Column: as specified in 6.2.2.2
Detector: as specified in 6.2.4
Eluent: as specified in 7.3

Pump Rate: 1.0 mL/min.
Sample Loop: 50 µL
Attentuation - 1
y-axis - 500 ns

* See Figure 2

TABLE 2A. SINGLE-OPERATOR ACCURACY AND BIAS OF STANDARD ANIONS (METHOD A)

ANALYTE	SAMPLE TYPE	KNOWN CONC. (mg/L)	NUMBER OF REPLICATES	MEAN RECOVERY %	STANDARD DEVIATION (mg/L)
Bromide	RW	5.0	7	99	0.08
	DW	5.0	7	105	0.10
	SW	5.0	7	95	0.13
	WW	5.0	7	105	0.34
	GW	5.0	7	92	0.34
	SD	2.0	7	82	0.06
Chloride	RW	20.0	7	96	0.35
	DW	20.0	7	108	1.19
	SW	10.0	7	86	0.33
	WW	20.0	7	101	5.2
	GW	20.0	7	114	1.3
	SD	20.0	7	90	0.32
Fluoride	RW	2.0	7	91	0.05
	DW	1.0	7	92	0.06
	SW	1.0	7	73	0.05
	WW	1.0	7	87	0.07
	GW	0.4	7	95	0.07
	SD	5.0	7	101	0.35
Nitrate- N	RW	10.0	7	103	0.21
	DW	10.0	7	104	0.27
	SW	10.0	7	93	0.17
	WW	10.0	7	101	0.82
	GW	10.0	7	97	0.47
	SD	10.0	7	82	0.28
Nitrite- N	RW	10.0	7	97	0.14
	DW	10.0	7	121	0.25
	SW	5.0	7	92	0.14
	WW	5.0	7	91	0.50
	GW	10.0	7	96	0.35
	SD	2.0	7	98	0.08
o-Phosphate- P	RW	10.0	7	99	0.17
	DW	10.0	7	99	0.26
	SW	10.0	7	98	0.22
	WW	10.0	7	106	0.85
	GW	10.0	7	95	0.33

TABLE 2A (CONT'D)

Sulfate	RW	20.0	7	99	0.40
	DW	50.0	7	105	3.35
	SW	40.0	7	95	1.7
	WW	40.0	7	102	6.4
	GW	40.0	7	112	3.2

RW = Reagent Water
DW = Drinking Water
SW = Surface Water
WW = Mixed Domestic and Industrial Wastewater
GW = Groundwater
SD = USEPA QC Solid (shale)

TABLE 2B. SINGLE-OPERATOR ACCURACY AND BIAS OF BY-PRODUCT (PART B)

ANALYTE	SAMPLE TYPE	SPIKE (mg/L)	NUMBER OF REPLICATES	MEAN RECOVERY %	STANDARD DEVIATION (mg/L)
Bromate	RW	5.0	7	103	0.07
		1.0	7	98	0.04
		0.1	7	155	0.005
		0.05	7	122	0.01
	DW	5.0	7	95	0.04
		1.0	7	85	0.02
		0.1	7	98	0.005
		0.05	7	98	0.005
Chlorate	RW	5.0	7	101	0.06
		1.0	7	97	0.01
		0.1	7	100	0.01
		0.05	7	119	0.05
	DW	5.0	7	101	0.04
		1.0	7	115	0.01
		0.1	7	121	0.005
		0.05	7	110	0.01
Chlorite	RW	5.0	7	100	0.04
		1.0	7	98	0.01
		0.1	7	86	0.01
		0.05	7	94	0.01
	DW	5.0	7	96	0.03
		1.0	7	100	0.02
		0.1	7	76	0.00
		0.05	7	96	0.01

RW = Reagent Water
DW = Drinking Water

TABLE 3. MULTIPLE LABORATORY (n=19) DETERMINATION OF BIAS FOR FLUORIDE

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.26	0.25	0.08	0.11	-3.8
	0.34	0.29	0.11		-14.7
	2.12	2.12	0.07	0.12	0.0
	2.55	2.48	0.14		-2.7
	6.79	6.76	0.20	0.19	-0.4
	8.49	8.46	0.30		-0.4
Drinking	0.26	0.24	0.08	0.05	-7.7
	0.34	0.34	0.11		0.0
	2.12	2.09	0.18	0.06	-1.4
	2.55	2.55	0.16		0.0
	6.79	6.84	0.54	0.25	+0.7
	8.49	8.37	0.75		-1.4
Waste	0.26	0.25	0.15	0.06	-3.8
	0.34	0.32	0.08		-5.9
	2.12	2.13	0.22	0.15	+0.5
	2.55	2.48	0.16		-2.7
	6.79	6.65	0.41	0.20	-2.1
	8.49	8.27	0.36		-2.6

TABLE 4. MULTIPLE LABORATORY (n=19) DETERMINATION OF BIAS FOR CHLORIDE

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.78	0.79	0.17	0.29	+1.3
	1.04	1.12	0.46		+7.7
	6.50	6.31	0.27	0.14	-2.9
	7.80	7.76	0.39		-0.5
	20.8	20.7	0.54	0.62	-0.5
	26.0	25.9	0.58		-0.4
Drinking	0.78	0.54	0.35	0.20	-30.8
	1.04	0.51	0.38		-51.0
	6.50	5.24	1.35	1.48	-19.4
	7.80	6.02	1.90		-22.8
	20.8	20.0	2.26	1.14	-3.8
	26.0	24.0	2.65		-7.7
Waste	0.78	0.43	0.32	0.39	-44.9
	1.04	0.65	0.48		-37.5
	6.50	4.59	1.82	0.83	-29.4
	7.80	5.45	2.02		-30.1
	20.8	18.3	2.41	1.57	-11.8
	26.0	23.0	2.50		-11.5

TABLE 5. MULTIPLE LABORATORY (n=19)
DETERMINATION OF BIAS FOR NITRITE - NITROGEN

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.36	0.37	0.04	0.04	+2.8
	0.48	0.48	0.06		0.0
	3.00	3.18	0.12	0.06	+6.0
	3.60	3.83	0.12		+6.4
	9.60	9.84	0.36	0.26	+2.5
	12.0	12.1	0.27		+0.6
Drinking	0.36	0.30	0.13	0.03	-16.7
	0.48	0.40	0.14		-16.7
	3.00	3.02	0.23	0.12	+0.7
	3.60	3.62	0.22		+0.6
	9.60	9.59	0.44	0.28	-0.1
	12.0	11.6	0.59		-3.1
Waste	0.36	0.34	0.06	0.04	-5.6
	0.48	0.46	0.07		-4.2
	3.00	3.18	0.13	0.10	+6.0
	3.60	3.76	0.18		+4.4
	9.60	9.74	0.49	0.26	+1.5
	12.0	12.0	0.56		+0.3

TABLE 6. MULTIPLE LABORATORY (n=19)
DETERMINATION OF BIAS FOR BROMIDE

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.63	0.69	0.11	0.05	+9.5
	0.84	0.85	0.12		+1.2
	5.24	5.21	0.22	0.21	-0.6
	6.29	6.17	0.35		-1.9
	16.8	17.1	0.70	0.36	+1.6
	21.0	21.3	0.93		+1.5
Drinking	0.63	0.63	0.13	0.04	0.0
	0.84	0.81	0.13		-3.6
	5.24	5.11	0.23	0.13	-2.5
	6.29	6.18	0.30		-1.7
	16.8	17.0	0.55	0.57	+0.9
	21.0	20.9	0.65		-0.4
Waste	0.63	0.63	0.15	0.09	0.0
	0.84	0.85	0.15		+1.2
	5.24	5.23	0.36	0.11	-0.2
	6.29	6.27	0.46		-0.3
	16.8	16.6	0.69	0.43	-1.0
	21.0	21.1	0.63		+0.3

TABLE 7. MULTIPLE LABORATORY (n=19)
DETERMINATION OF BIAS FOR NITRATE - NITROGEN

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.42	0.42	0.04	0.02	0.0
	0.56	0.56	0.06		0.0
	3.51	3.34	0.15	0.08	-4.8
	4.21	4.05	0.28		-3.8
	11.2	11.1	0.47	0.34	-1.1
	14.0	14.4	0.61		+2.6
Drinking	0.42	0.46	0.08	0.03	+9.5
	0.56	0.58	0.09		+3.6
	3.51	3.45	0.27	0.10	-1.7
	4.21	4.21	0.38		0.0
	11.2	11.5	0.50	0.48	+2.3
	14.0	14.2	0.70		+1.6
Waste	0.42	0.36	0.07	0.06	-14.6
	0.56	0.40	0.16		-28.6
	3.51	3.19	0.31	0.07	-9.1
	4.21	3.84	0.28		-8.8
	11.2	10.9	0.35	0.51	-3.0
	14.0	14.1	0.74		+0.4

TABLE 8. MULTIPLE LABORATORY (n=19)
DETERMINATION OF BIAS FOR ORTHO-PHOSPHATE

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	0.69	0.69	0.06	0.06	0.0
	0.92	0.98	0.15		+6.5
	5.77	5.72	0.36	0.18	-0.9
	6.92	6.78	0.42		-2.0
	18.4	18.8	1.04	0.63	+2.1
	23.1	23.2	0.35		+0.4
Drinking	0.69	0.70	0.17	0.17	+1.4
	0.92	0.96	0.20		+4.3
	5.77	5.43	0.52	0.40	-5.9
	6.92	6.29	0.72		-9.1
	18.4	18.0	0.68	0.59	-2.2
	23.1	22.6	1.07		-2.0
Waste	0.68	0.64	0.26	0.09	-7.2
	0.92	0.82	0.28		-10.9
	5.77	5.18	0.66	0.34	-10.2
	6.92	6.24	0.74		-9.8
	18.4	17.6	2.08	1.27	-4.1
	23.1	22.4	0.87		-3.0

TABLE 9. MULTIPLE LABORATORY (n=19)
DETERMINATION OF BIAS FOR SULFATE

WATER	AM'T ADDED mg/L	AM'T FOUND mg/L	S_t	S_o	BIAS %
Reagent	2.85	2.83	0.32	0.52	-0.7
	3.80	3.83	0.92		+0.8
	23.8	24.0	1.67	0.68	+0.8
	28.5	28.5	1.56		-0.1
	76.0	76.8	3.42	2.33	+1.1
	95.0	95.7	3.59		+0.7
Drinking	2.85	1.12	0.37	0.41	-60.7
	3.80	2.26	0.97		-40.3
	23.8	21.8	1.26	0.51	-8.4
	28.5	25.9	2.48		-9.1
	76.0	74.5	4.63	2.70	-2.0
	95.0	92.3	5.19		-2.8
Waste	2.85	1.89	0.37	0.24	-33.7
	3.80	2.10	1.25		-44.7
	23.8	20.3	3.19	0.58	-14.7
	28.5	24.5	3.24		-14.0
	76.0	71.4	5.65	3.39	-6.1
	95.0	90.3	6.80		-5.0

Method A

Peak	Ret. Time	Ion	mg/L
1	1.17	F^-	2
2	1.73	Cl^-	20
3	2.02	NO_2^-	2
4	2.95	Br^-	2
5	3.20	NO_3^-	10
6	5.38	HPO_4^{2-}	2
7	6.92	SO_4^{2-}	60

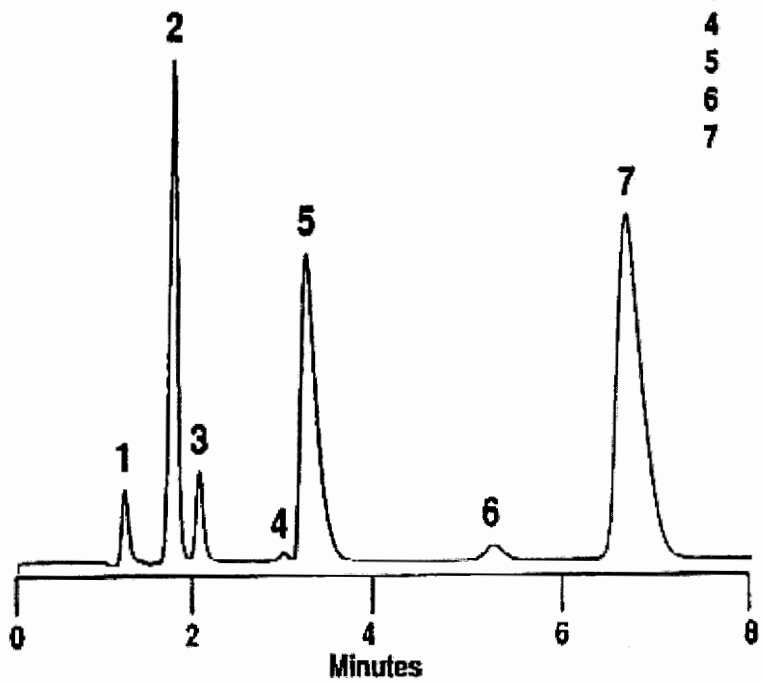

Figure 1. Chromatogram showing separation using the AS4A column

Method B

Peak	Ret. Time	Ion	mg/L
1	2.75	ClO_2^-	0.1
2	3.23	BrO_3^-	0.1
3	3.63	Cl^-	0.1
4	7.08	ClO_3^-	0.1

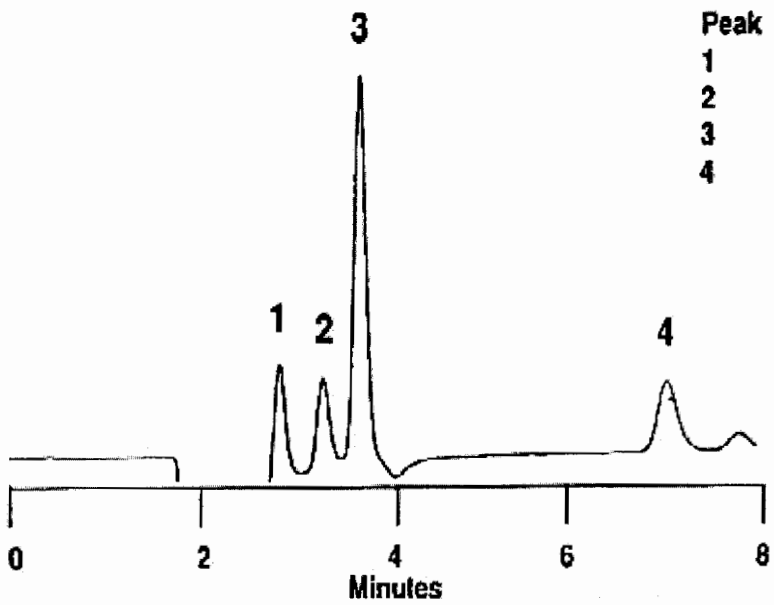

Figure 2. Chromatogram showing separation using the AS9 column

Onsite Laboratory – SAMPLE LOG SHEET

Project ID: _____.

Project Location: _____.

	Collected			Received							Analysis					
Sample ID	By	Date	Time	By	Date	Time	Type*	Container**	Number of Containers	Preservation***	VOCs by EPA 8260/ASTM 5625	PAH by Site LAB	PAH by IA, EPA 4035	TPH by SiteLAB	Nitate by EPA 300	Comments

* Type of Sample: (1) water (2) soil

** Container: (1) bag (2) bottle (3) other _____

*** Preservation: (1) ice (2) HCl (3) Other _____

STONE ENVIRONMENTAL INC

LABORATORY QUALITY MANUAL

Stone Environmental, Inc.
535 Stone Cutters Way
Montpelier, Vermont 05602
(802) 229-4541/(802) 229-5417 FAX

Revision 5
EPA ID Nos. VT00974 and VT00981
September 5, 2006

LABORATORY QUALITY MANUAL
Revision 5

Approval Signatures

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1.0 Policy, Purpose, and Scope

1.1 Policy

Stone Environmental, Inc. (Stone or SEI) provides services that:

- Exceed customer expectations for value, innovation, and excellence,
- Build strong partnerships with all of our stakeholders: customers, co-workers, suppliers, shareholders, and community
- Increase the well being of all of our stakeholders,
- Operate with uncompromising integrity.

Continuous efforts toward improvement are built into every activity of the company including the laboratory. These improvements ensure that Stone maintains a high-quality, efficient mobile testing facility.

1.2 Stone's Mission Statement:

We are market leaders in providing environmental consulting services. We offer innovative solutions for agrochemical environmental fate and exposure, water resource and wastewater management, investigation and remediation and integrated GIS and database management.

1.3 Management Commitment to Quality Assurance

Stone Management is committed to providing the highest quality environmental services in the industry. To ensure that the data produced and reported by Stone meet the requirements of its clients and comply with applicable municipal, state and federal regulations, Stone maintains a Quality System that is clear, effective, well communicated and supported at all levels in the company.

1.4 Purpose

The purpose of this manual is to establish the framework and assign responsibilities to ensure that the staff conforms to this policy. Additionally, this manual is used to inform users of the laboratory's services of the quality practices in place. The laboratory's framework on quality policies and procedures, and the Laboratory Quality Manual (LQM) are in accordance with the National Environmental Laboratory Accreditation Conference (NELAC) standards. The analytical procedures and test results described in this manual are performed in accordance with the NELAC standards and meet all NELAP (National Environmental Laboratory Accreditation Program) requirements for parameters for which accreditation is required or available. This LQM formalizes the quality system that has been established and is in operation for all sample

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related activities including sample handling, receipt, preparation, analysis, and documentation.

1.5 Scope

This LQM applies to all laboratory activities. Where the document uses the terms "must" and "shall", this denotes required activities. Where a practice is described, this denotes guidelines as to how those activities are generally preformed. A more detailed description of an activity or procedure may be provided in Stone's standard operating procedures (SOPs). There is a firm commitment from all members of the laboratory to follow a comprehensive LQM. This commitment and dedication to quality is fully supported from the analytical chemist to upper management in order to meet the objectives of our on-site analytical laboratory and best serve our clients.

This LQM shall undergo an annual review by the QA Manager, Group Officer, and the Laboratory Manager. Revisions to the LQM are distributed throughout the laboratory to replace the outdated copies so that only the most current revision is in use. It is the joint responsibility of the QA Manager, and the Laboratory Manager to ensure that all staff familiarizes themselves with, and comply with, the procedures put forth in this manual and associated documentation.

The policies and practices of quality assurance/quality control presented in the following text are set forth as minimums. This LQM was written to comply with the National Environmental Laboratory Accreditation Conference (NELAC) regulations.

Stone operates under the regulations and guidelines of the following federal programs:

US Army Corp of Engineers, Hazardous, Toxic and Radioactive Waste (USACE HTRW)
Clean Air Act (CAA)
Clean Water Act (CWA)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Navy Facilities, Engineering Service Center (NFESC)
Department of Defense (DOD)
National Pollution, Discharge, and Elimination System (NPDES)
Resource Conservation and Recovery Act (RCRA)
Safe Drinking Water Act (SDWA)
Toxic Substances Control Act (TSCA)
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

A current list of analytical methodologies is provided in Appendix D and the current NELAC accreditation is provided in Appendix E.

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2.0 Management and Quality System Requirements

2.1 Organization

Stone Environmental, Inc. located in Montpelier, Vermont was established in 1993 in response to a need for highly trained geologist, hydrogeologist and Project Managers to perform field studies in support of the Federal, Insecticide, Fungicide, and Rodenticide Act (FIFRA) environmental studies. On-site mobile laboratory services were developed in 1998 to support the groundwater profiling field studies being performed for site characterizations under the Investigation and Remediation Division in support of the private industry, CWA, RCRA, and other regulatory agencies environmental studies.

It is the policy of the company that at each management and operational level a designated group leader or group officer is assigned. The group officer maintains continuity of service and other functions in the event of the absence of key staff. The Laboratory Manager ensures that the staff is made aware of their respective designated group officer and that they are fully aware of the extent and limitations of their responsibility.

It is the policy of the company to discourage and reject all influence or inducements offered either by customers or suppliers which might adversely affect results or otherwise compromise the judgment or impartiality of the staff. It is the responsibility of the Laboratory Manager to inform customers and suppliers of this policy when necessary. In the event that any such influences or inducements are encountered, the staff are instructed to inform management immediately. It is the responsibility of the Group Officer to take appropriate action to prevent recurrence.

The QA Manager oversees the Quality Assurance Management Program within the laboratory. In this way, objectivity in the evaluation of laboratory operations is obtained. The laboratory structure provides a means for communication from the analytical chemist up to the Senior Management. This organization facilitates the generation of data, several levels of data review, and the monitoring of the overall quality of the data produced in the laboratory before it is reported to the client. Resumes of key staff and experience and educational profiles for the entire analytical staff is available at the fixed facility in the employee's training records. An organizational chart of Stone is presented in Appendix A.

2.1.1 Roles and Responsibilities

Each section within the laboratory has specific roles and responsibilities in terms of producing a product of known quality. All laboratory personnel are expected to have a working knowledge of the LQM. A copy of the most recent LQM is available in the laboratory, and Good Laboratory Practice (GLP) standards and associated LQM training is performed for all new laboratory staff.

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It is expected that associates ensure that data is generated in compliance with this LQM. The responsibilities of certain key positions are detailed below.

Vice President/Group Officer (Management) is directly and ultimately responsible for ensuring data quality and providing direction at Stone. Responsibilities include:

- Assist in leadership and management of group (laboratory).
- Participate in development of overall Stone Environmental Policies.
- Ensure that Stone QA policies are followed.
- Provide general supervision and support for Laboratory Manager and Staff.
- Monitor projects that originate from Group.
- Laboratory approved results signatory

The **Laboratory Manager** reports to the Group Officer and is responsible for all aspects of laboratory operation to ensure timely completion of all contractual obligations. Responsibilities include:

- Provide overall leadership and management of laboratory.
- Assist in development of overall Stone Environmental Policies.
- Ensure that laboratory staff follows Stone policies.
- Provide general supervision and support for laboratory staff.
- Propose project assignments and staff scheduling.
- Monitor and manage workload.
- Evaluate training requests and make recommendation to Group Officer.
- Communicate resource needs to Group Officer.
- Laboratory approved results signatory.

The **QA Manager** reports indirectly to the Group Officer and is responsible for the preparation, maintenance and implementation of the LQM. Responsibilities include:

- Direct quality assurance unit (QAU) services on FIFRA projects.
- Develop and implement quality systems for other company processes both project and non-project related.
- Maintain corporate quality system under the GLP and NELAC Standards.
- Authority for stopping, accepting or rejecting analytical data, method modifications, QA programs and QC criteria.
- Conduct internal system and data audits to monitor laboratory compliance with the LQM and SOPs.
- Provide assistance in the development of laboratory management documents including SOPs as well as control, revision and distribution thereof.
- Identify areas where corrective action is required and then ensure implementation and completion of the resulting action.

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- Oversee laboratory participation in performance evaluation programs.
- Act as point of contact regarding QA matters for the laboratory.
- Laboratory approved results signatory.

Project Scientists are instrumental in assisting both the laboratory and the client during the course of a project and often fulfill the role of Project Manager or Analytical Chemists. Responsibilities include:

- Leadership role in project work and development.
- Coordination of laboratory services directly with clients.
- Understanding contractual requirements and effectively communicating client needs to laboratory personnel.
- Notification of clients regarding specific non-conformance, changes or difficulties encountered within the laboratory.
- Investigation of problems with samples and shipping containers received from the field.
- Monitoring of analytical work progress.
- Lead report writing for projects managed.
- Laboratory results signatory.

Analytical Chemists are responsible for the generation of data by analyzing samples according to written SOPs and state regulations. Responsibilities include but may not be limited to:

- Manage and perform analytical analysis as coordinated with the client and the project scientist or manager.
- Maintain a thorough understanding of the LQM and the SOPs associated with their specific function.
- Ensure that all steps related to sample analysis are documented completely and accurately.
- Perform initial review of raw data with the authority to stop, accept or reject data based on compliance with well-defined QC criteria.
- Provide prompt notification to the Laboratory Manager or QA Manager of problems or anomalies detected.
- Monitor and maintain standard laboratory equipment such as refrigerators, ovens, water systems as necessary.
- Report writing and statistical analysis of data.
- Implementation of proper sample receipt procedures and sample preservation.
- Implements, completes and/or reviews external and internal chain-of-custody, as appropriate.
- Communicates and records anomalies associated with condition upon receipt of samples to the Project Scientist or Manager.
- Assigns laboratory identification number (if applicable) to a sample and logs the sample into the Laboratory Information System.

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- Secures sample storage and preservation.
- Assists Health and Safety Officer with sample disposal.
- Reviews storage monitoring records.
- Compiles analytical reports and provides data package and electronic deliverables according to the client request.
- Ensures that all aspects of data deliverable production, organization, contract compliance screening, archival storage, packaging and data delivery operations are performed according to the client requirements.
- With proper data review and secondary review signature, laboratory results signatory.

2.2 Service to the Client

2.2.1 Request, Tender, and Contract Review

Many environmental sampling and analysis programs do not necessarily "fit" into standard laboratory service or product as noted in the TRIAD approach to environmental planning. It is the laboratory's intent to provide standard and customized environmental testing services to our clients. To ensure project success, a thorough review is conducted by the technical staff of technical and QC requirements contained in contracts and scope of services. Contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those services. The Group Officer or his designee, with input from the Laboratory Manager, considers available resources and both current and pending workload prior to accepting new work. If the laboratory determines it has the ability to perform the work a Project Scientist is assigned and a quotation is prepared.

Contract review or scope of services shall include a review of the client's requirements in terms of compound lists, test methodology requested, sensitivity, accuracy, and precision requirements. The Project Scientist or Project Manager ensures that the laboratory's test methods are suitable to achieve these requirements and must ensure that the laboratory holds the appropriate accreditations and approvals to perform the work. The review also includes the laboratory's capabilities in terms turnaround time, capacity, and resources to perform the work including documentation capabilities both hardcopy and electronic.

All contracts and scope of serves entered into by Stone shall be reviewed and approved by the Project Scientist and the Group Officer. Any contract requirement or amendment to a contract or scope of services communicated to the laboratory verbally must be documented and confirmed with the client in writing. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. Contract amendments and scope of services adjustments initiated by the client and/or Stone, are documented in writing or in an e-mail for the benefit of both the client and the laboratory.

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Any documentation between the client and Stone pertaining to the scope of services such as Quality Assurance Plans, Sampling and Analysis Plans, contract amendments, and documented communications shall become part of the permanent project record.

2.2.2 Project Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a Project Scientist/Manager (PM) to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively communicated to the analytical chemist at the bench level before and during the project.

2.2.3 Data Quality Objectives

The data quality objectives discussed below ensure that data are gathered and presented in accordance with procedures appropriate for the intended use, and that the data are of known and documented quality able to withstand scientific and legal scrutiny. The quality of the measurement data is defined in terms of precision, accuracy, representativeness, completeness, comparability, and traceability.

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Total precision is the measurement of the variability with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Duplicate samples and matrix spiked duplicate samples are analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results.

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It therefore reflects the total uncertainty with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into a laboratory control sample (LCS) to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed.

Representativeness is defined as the degree to which a single measurement is indicative of the characteristics of a larger sample or area. More specifically, it is the degree to which the data gathered by the project accurately and precisely represents the actual field conditions. The laboratory makes every effort to ensure a representative aliquot is removed from the sample

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container. Homogenization of the sample is carried out when appropriate.

Completeness is defined as the percentage of measurements that are judged to be valid measurements. Factors negatively affecting completeness include the following: sample leakage or breakage in transit or during handling, missing specified holding times, losing sample during Completeness is compromised when the laboratory analysis through accident or improper handling, improper documentation such that traceability is compromised, or rejection of sample results due to failure to conform to QC criteria specifications. Typically, a completeness objective of at least 90% of the data for on-site analyses or as specified by the statement of work is the goal established for most projects.

Comparability of results between current and past sampling events, and between analytical sequences of a method is achieved through Quality Assurance Project Plans (QAPP), controlled SOP's, and experienced, well trained analysts.

Traceability is the extent to which reported analytical results can be substantiated by supporting documentation. Traceability documentation exists in two essential forms: those, which link the quantitation process to authoritative standards, and those, which explicitly describe the history of each sample from collection to analysis and disposal. The traceability goal for the laboratory is 100%.

2.2.4 Estimation of Uncertainty of Measurements

The components of analytical variability (uncertainty) can be estimated when QC samples of the right type and at the appropriate frequency are incorporated into the measurement process. Stone uses numerous QC samples to obtain data for comparison to analytical DQOs and to ensure that the measurement system is working properly. The QC samples and their application as mentioned above are based on regulatory, method or client specific requirements. As outlined in Section 3.9 QC samples for inorganic and organic analyses may include calibration blanks, instrument blanks, method blanks, laboratory control samples, calibration standards, matrix spikes and surrogate spikes.

The methods that Stone typically performs are well established and works within the published acceptance limits of the methods as recorded in the standard operating procedures. If necessary to establish uncertainty limits on non-routine methods, Stone would employ the use of statistical control charts which provide a means for long-term trend analysis as well as a tool for real time data assessment. Statistical control charts may be prepared for most routine methods and matrices analyzed by the laboratory after accumulation of at least 20 data points. The % recovery of laboratory control samples, matrix spikes and surrogates are monitored and charted if necessary. The relative % difference (RPD) of laboratory duplicates is also monitored and charted as necessary.

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Control limits derived from laboratory data are calculated in terms of multiple standard deviations from a mean or other reference point. Warning limits are set at ± 2 standard deviations and control limits are set at ± 3 standard deviations. Initial limits are established after a minimum of twenty data points is available. Once established, the control limits are updated at least annually. If method specified limits are available, the calculated control limits are compared to them. The laboratory adopts method-specified limits whenever available rather than use laboratory generated limits for actual evaluation of data as the laboratory limits may be to narrow for the overall site data quality objectives. This provides consistency over time, particularly for ongoing projects. In cases where acceptance limits are not specified in methodology, laboratory generated control limits are used for data evaluation if requested by the client.

In addition to control limits, control charts are used to determine if trends are occurring. Data points consistently above or below the mean, or points becoming steadily high or low over time indicate the occurrences of trending or bias in the procedure. Investigation and corrective action is taken if these situations are observed.

2.2.5 Client Confidentiality and Proprietary Rights

It is Stone's policy not to release any information pertaining to projects, except to the client who submitted the samples or who is responsible for payment without the consent of the client. Prior to release of any information to a third party, Stone staff must obtain written consent from the original client. This release may be transmitted via facsimile, but must be on the client company letterhead.

2.2.6 Procedures for Addressing Complaints

This procedure provides guidance for investigation of any client or regulatory agency's technical complaint. That is, complaints concerning the validity of the laboratory's test result or test methods or the interpretation of a client's technical specification. Complaints may originate in written form or verbally. All complaints are documented and investigated by the Project Manager. The Laboratory Director is responsible for working together with the Project Manager to investigate and resolve the complaint. Dependent on the complexity and severity of the complaint, the QA Manager and Project Officers may be called upon to resolve the issue. In cases where the complaint relates to data quality or the quality system, an internal audit is conducted by the QA Manager. The SOP titled *"Client Inquires, Data Revision Requests & Complaint Resolution" (SEI-8.4.n)* provides approved detailed procedures to Stone's staff.

2.2.7 Subcontracting of Tests

Stone does not routinely subcontract on-site analytical services. Samples subcontracted for any reason by the on-site laboratory are sent to laboratories that are competent to perform the tests

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requested at a level equivalent to the requirements of NELAC. Where feasible, the sub-contractor is assessed by the laboratory either through an on-site visit or by the submission of sufficient documentation to determine the subcontractor's capabilities and qualifications. This documentation may include, but is not limited to: LQM, SOP's, recent proficiency test sample results and relevant certifications. Such documentation is filed with the QA Manager and/or his or her designee.

Stone does not subcontract any samples without permission from the client. When permission is granted, samples are shipped to a subcontracting firm and the results of the analyses are transmitted back to Stone for review. These results are synthesized into a final report, documented as subcontracted and presented to the client.

2.3 Document Control

Security and control of documents is necessary to ensure that confidential information is not distributed and that all current copies of a given document are from the latest applicable revision. Unambiguous identification of a document is through a header placed on the top of each page. The header may contain the document name, revision number, revision date and number of pages.

The QA Manager controls the following documents: Laboratory Quality Manual (LQM) and Standard Operating Procedures (SOP's). These documents require written approval by appropriate management prior to release to the laboratory.

The LQM and SOPs are reviewed annually. As approved revisions to controlled documents are prepared and distributed, outdated versions are removed from the laboratory and destroyed. The original copy of each revision is archived by the QA Manager for reference purposes. Documents distributed externally (to clients, etc.) are controlled on a case-by-case basis.

SOP's are written procedures for standardized methods (i.e. SW-846) and are supplied primarily to document specific laboratory procedures used to satisfy the general requirements specified in the individual methods and to explain any differences between the application of the established method and the published procedure. If any difference exists between Stone's SOP and a standard method's specific procedures, method validation studies are performed to document the fact that the change does not adversely affect the applicability of the method. In general, every effort is made to adhere to the protocols of the standard method.

Standard Operating Procedures (SOP's) contain the basic procedures and practices the laboratory uses to analyze a method. These procedures provide a basis for training new associates and for showing customers how analyses are performed.

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2.4 Records

The laboratory retains all records related to sample analysis including raw data, calculations, derived data, calibrations and test reports. These records are maintained in a systematic manner for a minimum of seven (7) years unless other noted and outlined in the SOP, *Document Control, Record System and Archiving (SEI-7.2.n)*. Longer periods of storage may be arranged at the time of project initiation.

Mistakes are never erased, deleted or written over. They are corrected by drawing a single line through the error and entering the correction alongside. The correction is then initialed and dated by the responsible person and if applicable the reason for the change is documented as a footnote as outlined in the SOP *Data Handling, Storage, Retrieval and Error Coding (SEI-4.3.n)*.

Each log book page or, as required, each entry is dated and initialed by the analyst at the time the record is made. Pages inserted into logbooks are stapled to a clean, bound page. Specific information on the types of logbooks, format of entry, and other pertinent information are contained in the appropriate sectional SOPs.

The Laboratory Manager or his/her designee periodically reviews laboratory notebooks for accuracy, completeness, and compliance. If all entries on the pages are correct, then the Laboratory Manager or his/her designee initials and dates the reviewed pages. Corrective action is taken for erroneous entries before the Laboratory Manager or his/her designee signs off with their approval.

2.4.1 Archives and Record Transfer upon Facility Change or Ownership Transfer

Archives are indexed such that records are accessible on either a project or temporal basis. Archives are protected to the degree possible against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented by the archivist.

Stone ensures that all records are maintained as required by the regulatory guidelines and per the SOP (SEI-7.2.*n*) upon facility location change or ownership transfer. Stone location change, all archives are retained by Stone in accordance with the SOP. Upon ownership transfer, record retention requirements are addressed in ownership transfer agreement and the responsibility for maintaining archives for maintaining archives is clearly established.

2.5 Corrective Actions

A nonconformance is typically defined as an unplanned deviation from an established protocol. An occurrence of a nonconformance may be the result of Stone's actions, which would be rendered as a deficiency, or the result of events beyond Stone's control, which would be termed

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an anomaly. All nonconformance's or deviations must be documented.

Deviations from the LQM or SOPs, deficiencies, errors, or out-of-control situations require corrective action. Documentation of the problem, identification of the cause and follow-up action to prevent recurrence is accomplished through the use of documentation.

Any individual who detects the need for corrective action is responsible for initiating the report. Corrective action procedures or deviations may be initiated and are often completed at all levels of the laboratory. If the person initiating the report is uncertain as to what would constitute appropriate corrective action or is unable to resolve the situation, they identify the problem and submit the incomplete report to their Laboratory Manager, the Project Scientist/Manager or the QA Manager who is then responsible for resolution.

All completed corrective action reports and/or deviations are submitted to the QA Manager who is responsible for review and follow up to determine if the corrective action is sufficient, effective and fully implemented. Completed reports are maintained on file in the QA department. Copies of corrective action reports or deviations that are specific to a sample or set of samples will also be filed with the supportive documentation and discussed in each appropriate case narrative.

2.5.1 Correction of Erroneous Reports

The discovery that, for whatever reason, an erroneous result has been released initiates immediate corrective action to rectify the error. If the error is discovered internally then the client is immediately notified by the Project Manager to prevent use of the incorrect report for decision-making. If a client or validator has a question or finds a deficiency concerning the data submittal, the Project Scientist/Manager is responsible for communicating and implementing the corrective action in the laboratory. The analytical results and all supportive documentation in question are submitted to the appropriate section for evaluation. Should a reanalysis be necessary, it is initiated in writing.

Hard copies and revised electronic deliverables (where applicable) are given to the Project Scientist/Manager for re-submission to the client or validator. Revision of the case narrative, should it become necessary, is the responsibility of the Project Scientist/Manager. In some instances, clients request that sample handling information; recalculations or qualitative judgments are re-checked in order to ensure data integrity. In this case, resubmission of the data may not be necessary unless a problem is detected.

The Project Manager brings customer problems that persist in the laboratory to the attention of the Laboratory Manager and/or QA Manager.

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2.5.2 Departures from Policies

Departures from laboratory Standard Operating Procedures are not permitted unless the approval of the Laboratory Manager or the QA Manager is obtained prior to implementation of the departure. These exceptions must be documented with a SOP deviation and/or highlighted in the analytical logbook, which accompanies the analytical results. If a client requests a departure from the laboratory's policies or procedures, the Project Scientist/Manager notifies the Laboratory QA Manager who then discusses the steps necessary to implement such a departure with the Laboratory Manager and appropriate laboratory analytical chemists. If necessary and appropriate method validation studies and method detection limit studies are performed as applicable.

2.6 Preventive Action

In order to prevent system down time, minimize corrective maintenance costs and ensure data validity, the laboratory employs a system of preventive maintenance. General preventive maintenance procedures, many of which are unique to particular instruments, are outlined in each instrument's operation manual. All routine maintenance is performed as recommended by the manufacturer. The manuals also assist in the identification of commonly needed replacement parts, so that an inventory of these parts can be maintained at the laboratory. It is the Laboratory Manager's responsibility to make sure that the most current version of the operator's manual is available in the laboratory. The on-site analytical chemist performs routine maintenance while external technicians may be called in for major repairs.

A bound maintenance and repair log notebook is kept with each instrument to record all routine and non-routine maintenance. Notation of the date and maintenance activity is recorded every time service procedures are performed. This includes routine service checks by laboratory personnel as well as factory service calls. The return to analytical control following instrument repair is also noted in laboratory maintenance logbooks.

2.7 Audits Types and Frequency

There are several different types of audits performed at Stone Environmental, Inc.. Technical system audits are designed to assess the adequacy of a selected system in meeting Stone objectives.

2.7.1 System audits

System audits are technical in nature and may be performed by the QA Manager as an internal audit or by a client or regulatory agency for certification or approval. System audits cover all aspects of the laboratory, both operational and support. These audits are performed annually.

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The QA Manager shall issue the audit report within 30 days of the audit. The audit report is addressed to the Laboratory Manager and Management.

Written responses are required by the Laboratory Manager and the audit response should follow the format of the audit report, and corrective actions and time frames for their implementation are included for each deficiency. If a corrective action requires longer than thirty days to complete, the target date for the corrective action implementation is stated and evidence of the corrective action is submitted to the QA Manager in the agreed upon time frame.

2.7.2 Data Audits

Data audits are performed to assess the quality of results reported to clients. If the results of an audit (either internal or external) indicate that a client's analytical results are questionable the client is notified in writing by either the Project Scientist/Manager or the QA Manager. The laboratory then works with the client and makes every attempt to resolve the issue (i.e., by revising a report, reanalysis of the sample, etc.). Typically, the data audits are performed quarterly.

Records of the data audits are kept, and the frequency of the data audits shall be included in the QA Binder found in the QA Department.

2.7.3 Special Audits

Special Audits are conducted on an as needed basis, generally as a follow up to a specific issue such as client complaints, corrective actions, proficiency testing results, data audits, system audits, third party assessments or regulatory audits. Special audits are performed for a specific issue and report format distribution and timeframes are designed to address the nature of the issue.

2.7.4 External Audits

To become a participant in state and federal accreditation programs, the laboratory may be audited by representatives of regulatory agencies. Any audit findings are formally documented by the QA Manager and submitted to the laboratory for corrective action. The laboratory is required to respond with corrective action to the audit findings and recommendations of the regulatory agencies before accreditation for a particular program can be granted. The Laboratory QA Manager conducts follow-up audits to verify that corrective actions have been implemented. Observations made during these follow-up audits are submitted to the appropriate representatives of the regulatory agency.

2.8 Performance Assessment

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The laboratory participates in internal and external laboratory check sample programs as a means for examining overall laboratory performance as well as to qualify for various federal and state certification programs. Internal or intra-laboratory check sample programs include the submission of blind samples that are carried through normal procedures. The following external or inter-laboratory check sample programs are the typical ones employed to demonstrate analytical proficiency for purposes of monitoring overall laboratory proficiency or to provide proof of acceptable performance for certification or accreditation programs by outside agencies or regulatory bodies:

National Environmental Laboratory Accreditation Conference (NELAC) Semi-annual Proficiency Testing Programs.

The NELAC proficiency-testing program is an extensive and comprehensive check sample program. Private approved vendors administer the program under the direction of the EPA (WP or WS designations). Participating laboratories receive reports detailing acceptability of their reported results and must provide corrective action responses to State Agencies regarding any results that are outside of the control limits.

2.9 Quality System Review by Management

A review of the quality system is conducted annually. Management, including but not limited to the Group Officer, Laboratory Managers and QA Manager, review all aspects of the laboratory's quality system. The purpose of this review is to ensure the suitability and effectiveness of Stone's program as well as provide opportunity for improvements. The review includes the following topics:

- Reports from audits by clients and regulatory agencies
- Reports from internal audits
- Results of proficiency studies
- Corrective actions from the past year and a review of their implementation
- Details of complaints from clients and their resolution
- Training goals and objectives
- Staff, facility and equipment resources
- Future plans and goals
- Monthly Operations Report to Management

In addition to this annual review, a monthly report and meetings occur to communicate issues and needs which arise during the course of operations.

3.0 Technical Requirements

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3.1 Stone Fixed Facility, On-Site Facility and Equipment

Stone has a fundamental responsibility to provide facilities, equipment, maintenance, and an organized program to make necessary improvements to ensure a safe working environment. Unless staffs fulfill their responsibilities for laboratory safety, the safety-related features of the facility and established safety programs will be ineffective. The Employee Health and Safety Manual provides a complete discussion of the safety policies enforced by the company. A copy of the Health and Safety Manual is available during his or her orientation training session. The Health and Safety Officer distribute updates as they occur.

Stone has been active in environmental analysis since developing the Investigation and Remediation Division in 1998. On-site analytical services were provided to support today's expedited and dynamic site investigations including groundwater-profiling studies. The fixed physical layout of Stone is presented in Appendix C. Additionally, a typical mobile laboratory layout is provided in Appendix C. The on-site laboratory will typically be approximately 250 square feet of floor space to house the equipment and two analytical chemists. Based on the size and scope of the on-site work plan the size of the on-site laboratory will vary. The fixed facility and the mobile laboratory is compliant with all Occupational Safety and Health Administration regulations and are equipped with unique environmental controls including air flow monitoring, waste heat utilization, and security. In addition, the laboratory is outfitted with instrumentation exhibiting advanced technology and automation.

The fixed facility and the on-site laboratory facility have computer networking and centralized gas distribution to support its analytical services.

3.1.1 Equipment Inventory

A comprehensive list of major instrumentation available, along with supporting and miscellaneous equipment can also be found in Appendix C.

3.2 Purchasing Services and Supplies

Evaluation and selection of suppliers and vendors is done, in part, on the basis of the quality of their products, their ability to meet the demand for their products on continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations and proof of historical compliance with the similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, all purchases from specific vendors are approved by a member of the management staff.

Chemical reagents, solvents, gases, glassware and general supplies are ordered as needed to

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maintain sufficient quantities on hand. Purchasing guidelines for all equipment and reagents effecting data quality shall meet the requirements of the specific method and testing procedure and be well documented. Similarly, performance specifications are documented for all items of equipment having an effect on data quality. This includes type, age, and acceptance status of the item. Reagents are dated upon receipt and upon opening to establish their order of use and to minimize the possibility of exceeding their shelf life. Specifications for labeling reagents, solutions and standards are outlined in SOP SEI-4.7.*n Labeling Reagents, Solutions and Standards.*

Requests for equipment affecting the quality of analytical data are submitted in writing to the Division and Laboratory Manager and/or Group Officer for technical approval. After approval, the requisition is submitted to the Group Officer for purchase approval.

3.3 Personnel

It is the policy of the company to employ permanent and part time staff that are appropriately qualified and/or trained to perform their respective duties. Where, for commercial reasons, it is necessary to employ temporary staff, the laboratory ensures that the same criteria as those governing permanent staff apply with respect to training and qualifications. In order to ensure that employees have sufficient education and experience to perform a particular task, job descriptions are developed for all personnel.

Personnel training procedures begin with an established orientation program designed to familiarize the new staff with safety and chemical hygiene issues, the importance of quality assurance/quality control in the analytical laboratory, and company policies and benefits. The basic elements of the orientation and training program are outlined in the *Orientation and Training of SEI Staff Standard Operating Procedure (SEI-1.1.n).*

The level of training necessary to perform analytical tasks is determined from employee's academic background and past experience, technical courses, and on-the-job training with specific methods or instrumentation. The responsibility for formal academic training lies foremost with the individual. The responsibility for the additional specialized skills obtained through in-house training or external workshops is a shared obligation of the individual, their supervisor, and the laboratory. An individual's academic and professional experience is kept on file including an initial statement of qualifications or resume and any additional documentation concerning subsequent training. Copies of certificates of completion, transcripts, diplomas, or other documentation may be included in the files as appropriate.

In order to ensure that the policies and objectives of this LQM are communicated to all new personnel, the staff is required to read this LQM during the training process. This training is documented on the *SEI Procedure Specific Training Log* (Appendix B: Forms) and included in the training files of each staff. In addition, LQM training is provided as part of the GLP training

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given as part of Stone's initial orientation. Training records are available for inspection at the fixed facility in Montpelier, VT.

Trainees are under the supervision of experienced analysts who are responsible for showing them the analytical procedures including applicable QA/QC measures. A new analyst is not permitted to perform an analysis until their Laboratory Manager is confident that the analytical and QA/QC procedures can be carried out correctly and method proficiency is documented.

Stone's Vermont facility is equipped with many structural safety features. Each staff is familiar with the location, use, and capabilities of general and specialized safety features within their workplace. To protect staff from potential workplace hazards, Stone provides and requires the use of certain items of protective equipment. These include safety glasses, protective clothing, gloves, respirators, etc. For a complete description of the types of personal safety equipment available and applicable to a particular workspace, refer to the Health and Safety Handbook.

All new personnel are required to demonstrate competency in performing a particular method by successfully completing a Demonstration of Capability (DOC) before conducting analysis independently on client samples.

DOCs are performed by analysis of four replicate QC check samples. Results of successive LCS analysis can be used to fulfill the DOC requirement. The accuracy and precision, measured as average recovery and standard deviation (using n-1) as the population, of the 4-replicate results are calculated and compared to those in the test method (where available). If the test method does not include accuracy and precision requirements, the results are compared to target criteria set by the laboratory. The laboratory sets the target criteria such that they reflect the data quality objectives of specific test method or project data quality objectives. A DOC Certification Statement is recorded and maintained in the employee's training file. Appendix B - Forms shows an example of a DOC Certification Statement.

3.3.1 On-Going Training

Stone has a firm commitment to make sure that all analysts remain proficient in the tests that they perform. SOP's are reviewed annually and analysts are required to read the latest version of the SOP and/or amendments. Proficiency evaluations (both single and double blind) are routinely analyzed by the laboratory upon request and as part of state accreditation programs. Analyst performance on these proficiency tests is tracked and recorded in their training file. Continued performance is documented annually by one of the following:

- The acceptable performance of a double blind sample,
- Successful analysis of a blind performance sample on a similar test method using same technology requiring documentation for one of the test methods,
- At least four consecutive LCSs with acceptable levels of precision and accuracy,

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- Analysis of an authentic sample that has been analyzed by another trained analyst with statistically distinguishable results.

Additionally, SOPs are reviewed annually and analysts are required to read the latest version of the SOP when new revisions are published.

3.3.2 Ethics Policy

Establishing and maintaining a high ethical standard is an important element of a Quality System. In order to ensure that all personnel understand the importance the company places on maintaining high ethical standards at all times; Stone has established an Ethics Agreement (Appendix B- Forms). Each employee signs the Ethics Agreement, signifying agreed compliance with its stated purpose. Ethics is also a component of the QA training program. Each employee is trained in the prevention and detection of improper, unethical, or illegal actions in the orientation QA training program that includes a review of the ethics statement, and discussions about data integrity and repercussion that result from data misrepresentation. Additionally, each employee is encouraged to discuss any fraud and unethical behavior with their supervisor and/or the QA Manager.

3.4 Laboratory Scope of Tests

The on-site or mobile laboratory performs inorganic and organic analyses on various matrices including air, water, soil, and waste. Analyses follow acceptable protocols approved under applicable state and federal programs. Detailed descriptions of method procedures and reporting limits are maintained in the individual method SOP's. Appendix D of this LQM presents a summary of the methods performed by Stone's on-site facility.

3.4.1 Reference to Test Procedures Used

The following list includes the sources for the majority of analytical methods referenced by the laboratory:

EPA SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd Edition, with Update I, Update II, Update IIA and Update III, December 1996.

APHA/AWWA/WPCF, Standard Methods for the Examination of Water and Wastewater, 19th Edition.

ASTM, American Society for Testing & Materials; Annual Book of Standards, 1986 through 1993 editions.

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Plumb, Russell, USEPA Corps of Engineers, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, May 1991.

3.5 Method Validation and Verification Activities

Methods performed at the laboratory are validated prior to sample analysis. Method validation may involve the determination of sensitivity and linearity and reproducibility studies. This would include but are not limited to: writing appropriate method SOPs and performing method detection limit studies.

Determination of Method Selectivity
Method selectivity should be demonstrated for the analyte(s) in the specific matrix or matrices. In some cases, to achieve the required selectivity for an analyte, a confirmation analysis may be required as part of the method.

Determination of Method Sensitivity
Method sensitivity is determined by method or instrument detection limit studies. The procedure to determine the method detection limit (MDL) or limit of detection (LOD) may follow 40CFR Part 136 Appendix B (revision 1.1). The reporting limit for a given analyte may be derived from the MDL.

Determination of Limit of Quantitation (LOQ) or Reporting Limit (RL)
The MDL is the approximate limit at which an analyte can be *qualitatively* detected using a specific method at a 99% confidence interval. The MDL is a statistically calculated value and measures the sensitivity of an entire method and is independent of device. The Reporting Limit (RL) or Limit of Quantitation is the limit at which a compound can be qualitatively detected and *quantified* at a 99% confidence interval. The RLs or LOQ are also set based on specific knowledge about the analyte, project specific requirements and/or regulatory requirements. The RL is always greater than the MDL is typically set based on 3-5 times the MDL or LOD.

Stone reports results to the sample specific RL's for a set of compounds as defined in the published methods. For most methods the low calibration standard is set at the laboratory RL to monitor method sensitivity per instrument per calibration. Sample specific RL's are derived by taking into account various sample specific data, which can include the amount of the sample subject to testing, percent moisture, dilution factors, interferences and the base RL's for the analysis.

In some cases, it is appropriate to report values between the MDL and the RL. In this region, an analyte can be qualitatively detected, but not accurately quantified. Any data point reported in this region is flagged with a "J" to indicate that it is an estimated value.

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Determination of Range
Where appropriate, a determination of the applicable range of the method is performed. In most cases, range is determined and demonstrated by comparison of the response of an analyte in a curve to established and targeted criteria. The curve is used to establish the range of quantitation and the lower and upper values of the curve represent upper and lower quantitation limits. Curves are limited to linear relationships.

Determination of Interferences
A determination that the method is free from interferences in a blank matrix should be performed.

Determination of Capability
DOCs should be performed prior to method performance.

Determination of Accuracy and Precision
Accuracy and precision studies may be required as a separate determination from the DOC. Accuracy and precision studies are generally performed using four replicate analyses with the resulting percent recover and measures of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

Documentation of Method
The method should be formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, a SOP Appendix describing the specific differences in the new method is acceptable in place of a separate SOP.

Continued Demonstration of Method Performance
Continued demonstration of method performance is addressed in the SOP by batch specific QA samples such as Laboratory control samples and method blanks.

3.6 Standard Operating Procedures (SOPs)

SOPs shall be written for all routine technical and administrative activities performed at Stone Environmental, Inc. SOPs shall describe as necessary the analytical, QA/QC and operational protocol to be followed for each activity performed to reflect traceability of measurements. Employees must follow the procedures written in the SOP. Temporary deviations from an SOP may be necessary in order to meet the data quality objectives for a specific client or regulatory agency's request. Any department from the SOP will be documented in the project file.

Stone maintains two types of SOPs: method and procedural SOPs. Method SOPs describe a specific test method. Procedural SOPs describe function and procedures not related to a specific analytical method. SOPs, at a minimum shall undergo review every 2 years. Where a SOP is based on a published method, the laboratory shall maintain a copy of the referenced method as

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well. Stone's SOP are maintained on file at the fixed facility and pertinent laboratory SOPs are provided in each mobile laboratory. /

3.7 Equipment

A comprehensive list of major instrumentation available, along with supporting and miscellaneous equipment can also be found in Appendix C.

3.7.1 Procedures for Calibration and Verification

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established reporting limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method.

Method specific SOP's discuss in detail how each instrument is calibrated, including frequency for calibration and re-calibration, and the source or grade of the calibration materials. The range of analyses performed and instrumentation utilized is extensive and the calibration procedures are instrument specific, varying from analysis to analysis. The calibration procedures for organics usually include an initial system performance check and some type of initial calibration (with a minimum of five calibration standards for most methods) with each analytical series. On-going and closing calibration checks are also included in most analytical series. For each type of calibration standard or performance check there are specific criteria to meet before sample analyses begin. These criteria are established in the methodologies as they are written in the referenced texts or by contract specifications.

Gas Chromatography/Mass Spectrometry (GC/MS) - Prior to analysis of samples, the instrument is tuned with bromofluorobenzene (BFB) for volatile compounds and decafluorotriphenyl-phosphine (DFTPP) for semivolatile compounds or other tune criteria as specified by the method used. No samples are analyzed until the instrument has met the tuning criteria of the method.

In general, the instrument is then calibrated for target compounds. An initial calibration curve is produced to define the working range to establish criteria for identification. This initial calibration is evaluated on a daily basis to ensure that the system is within calibration. If the daily standard does not meet the established criteria, the system is recalibrated.

Gas Chromatography- Each chromatographic system is calibrated prior to performance of analyses. Initial calibration consists of determining the working range, establishing limits of detection, and establishing retention time windows. The calibration is checked as required to ensure that the system remains within specifications. In addition, continuing calibrations are performed at frequencies required by the method used. If the calibration checks do not meet established criteria, corrective action, which may include recalibration and reanalysis of samples,

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is taken.

Metals- Are typically performed in the field using HACH Kits. All applicable calibration requirements are defined in the instrument manual and as specified in the client's work plan.

Wet Chemistry - The field of classical (wet) chemistry involves a variety of instrumental and wet chemical techniques, for on-site measurements these tests are typically performed using designated kits. Calibration and standardization procedures vary depending on the system and analytical methodology required for a specific analysis. The calibration is checked on an ongoing basis to ensure that the system remains within specifications. If the ongoing calibration check does not meet established criteria, analysis is halted and corrective action is taken. The procedures include examination of instrument performance and recalibration and reanalysis of samples back to the previous acceptable calibration check.

3.8 Procedures for Traceability of Measurements

As necessary (when demonstrated by failure to calibrate), and appropriate, a technician services the company balances. This service is documented on each balance with a signed and dated calibration stamp. Balance calibrations are verified on a daily basis using traceable calibrated weights. Analytical balances are checked at multiple weights and the measured weight is recorded in a bound monitoring logbook. Any discrepancies are brought to the immediate attention of the QA Manager.

All mercury thermometers and temperature probes are purchased with certification certificates. The on-site Laboratory Manager maintains all thermometer calibrations. On a daily basis the temperature readings of the refrigerators, and other temperature-controlled equipment are recorded in the monitoring logbook.

Sample storage refrigerators are typically maintained at 4 ± 2 °C.

Traceability of measurements is assured through the use of a system of documentation and analysis of testing materials. The supplier as to their accuracy certifies all standards used in the calibration of instrumentation. The laboratory maintains these certificates of analysis. The preparation of all standards is recorded in Standard Preparation Logbooks. Information to facilitate traceability is included in this documentation. All standard and reagent labels must contain the following information: solution ID, concentration, date of preparation, initials of preparer and expiration date.

The elements of the laboratories standards and reagents traceability program are outlined in the following SOP: *Labeling Reagents, Solutions and Standards (SEI-4.7.n).*

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3.9 Sampling - Procedures for Handling Test Items – Sample Custody

Sample representativeness and integrity are the foundations upon which meaningful analytical results rely. A documented and approved sampling plan reflecting data quality objectives should be in place at the sampling site. The integrity of the sample should be maintained through the use of preservation techniques specified in the relevant protocols. If necessary samples should be submitted to the laboratory under standard chain-of-custody procedures as outlined in the SOP *Chain of Custody Records (SEI-4.2.n)*. Typically, for on-site laboratory work the samples are submitted directly from the field to the lab and documented in the laboratory upon receipt.

A designated analytical chemist receives samples at the laboratory. The analytical chemist removes the samples from the cooler (if applicable) and compares the sample labels with the information provided on the chain of custody form. If applicable, sample preservation, including temperature, is checked at the time of sample receipt.

Samples are considered "compromised" if the following conditions are observed upon receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken and leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservative.
- Samples are received in inappropriate containers.
- COC does not match samples received
- COC is not properly completed or not received.
- Breakage of any Custody Seal.
- Apparent tampering with cooler and/or samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample Labeling.

Any non-conformance or irregularity is noted and brought to the immediate attention of the Project Manager, and if appropriate, a Corrective Action is taken. The Project Manager takes appropriate action and documents the resolution with a phone log and attaches it to the client's chain-of-custody.

The laboratory utilizes a custom designed database or laboratory information system to uniquely identify and track samples and analytical data throughout the mobile facility. The following information is entered into the computer: sample number (unique to this sample), client identification, date prepared (if applicable), date received, sample description (if applicable), additional comments, and notation of special handling instructions. Once logged in the samples are placed in the appropriate storage area pending analysis. Typically, all samples are analyzed on the same day that they are received so long term storage is typically not required.

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3.9.1 Holding Times, Preparation and Sample Screening

Holding times for every analysis are established in the method SOPs or on a project specific basis. Typically, all samples are analyzed on the same day that they are received so holding times are not a concern. The Laboratory Manager and the Client schedules the workload to expedite the field investigations. If any holding times are not met the laboratory informs the Project Manager as soon as possible and the Project Manager notifies the client.

Samples are prepared according to performance base standardized methods. Batches are generated in the lab according to preparation method, analytical method, matrix and reporting turnaround time. In general, if necessary batches do not exceed 20 field samples of the same matrix and are defined as samples prepared at the same time.

Inorganics (Metals and Wet Chemistry) - Samples for analyses are prepared in batches containing a maximum of 20 samples of the same or similar matrix. A laboratory blank and laboratory control sample are digested with each batch. A matrix spike and replicate analyses are performed for every 20 samples of the same matrix as requested by the analytical program.

Organics - Samples for organics analyses are prepared in batches containing a maximum of twenty samples of the same or similar matrix and reporting turnaround time. A method blank is performed with each batch. Lab control samples are extracted with each batch for applicable methods. Matrix spike and matrix spike duplicate analyses are performed for every 20 samples of the same matrix.

Re-preparation - Re-preparation or re-analysis of a sample may be required in cases of contamination, missed dilution, low surrogate recovery, etc. If the need for reanalysis/re-preparation has been determined, the request is forwarded to the appropriate analytical chemist

Screening – If necessary and appropriate samples for organics analyses are screened prior to analysis and/or extraction. Screening helps to prevent unnecessary re-runs and lower instrument re-calibration, re-tune and analyst labor time and may be done on the instrument and the use of a PID.

3.9.2 Sample Disposal

Stone Environmental, Inc. retains samples for up to 30 days after the project report is sent unless prior written arrangements have been made with the client or as in some cases samples require disposal on-site. Samples shall be disposed of in accordance with federal, state and local regulations. The laboratory procedures for sample disposal are further described in the laboratory SOP *On-Site Laboratory Waste Handling, Storage and Disposal* (SEI-10.14.*n*)

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3.10 Assuring the Quality of Test Results

The quality control program implemented in the laboratory includes the analysis of method blanks, check standards, laboratory control samples, analytical spikes, and surrogate spikes. Depending upon the analysis, every analytical series includes one or more of these controls. The combination of controls used in an analysis must be completely representative of the analytical task including all aspects of sample preparation and sample analysis. This section describes routine procedures used to monitor laboratory method performance and substantiate validation of data. Controls analyzed in conjunction with samples are essential in the evaluation of the quality of the generated data. These programs may include any of the following quality controls in addition to other project specific obligations.

Method blanks are prepared and analyzed with each analytical batch of twenty or fewer samples to identify possible sources of contamination within the analytical process. Method blanks are treated as samples (i.e., they go through each stage of the analytical process including glassware, reagents, instrumentation, and any other source of possible contamination that may affect sample results). Surrogate recoveries, and elevated levels of compounds must be evaluated for method blanks. The control limits and corrective actions for method blanks are defined in the method SOP's.

Instrument Blanks and/or Fiber Blanks are prepared as an unprocessed aliquot of reagent used to monitor the contamination of the analytical system. An instrument blank is analyzed at the start of the analytical sequence and after highly contaminated samples to confirm that the instrument is contaminate-free before continuing with sample analyses. Instrument blanks are also commonly known as *continuing calibration blanks* in inorganic analyses.

Laboratory Control Samples (LCS) are prepared and analyzed with each batch of samples. Laboratory control samples are fortified with all compounds of interest at documented levels and when applicable with the same spiking solution as the matrix spike (MS) sample. Aqueous and solid laboratory control samples are analyzed using the same sample preparation, reagents, and analytical methods employed for the samples received. Method performance is monitored by the measure of accuracy of the results. The results of the LCS, used in conjunction with the MS samples provide an indication of whether the laboratory performed the method correctly or the sample matrix affected the results. When a laboratory control sample duplicate (LCSD) is required, a percent recovery may be calculated, as well as a relative percent difference (RPD) between the LCS and the LCSD. The control limits and corrective actions for LCS's are defined in the method SOP's.

Surrogates are non-target analyte compounds that are similar in composition and behavior to the target analytes but are not expected to be found in environmental media (often, isotopically labeled target analyses are used). Surrogates are spiked into every sample, quality control sample and method blank for organic analyses. Extractable organic analyses are spiked with surrogates

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at the time of extraction; and volatiles prior to analysis. Surrogates responses are used to evaluate the accuracy of the laboratory performance of the analytical method in a specific sample matrix and are expressed as percent recoveries. The control limits and corrective action for surrogate spikes are specified in the method SOP's.

Internal Standards (IS) are non-target analyte compounds that are similar to the target analytes but are not expected to be found in environmental media (generally, isotopically labeled target analytes are used) and are added to every standard, quality control sample and field sample at a known concentration prior to analysis. Internal standard area responses and retention times are evaluated in all samples and blanks according to the method of analysis. IS responses are used as the basis for quantitation of target analytes. LCS samples are also commonly known as method blank spikes. The control limits and corrective action for internal standards are specified in the method SOP's.

Matrix Spikes/Matrix Spike Duplicates (MS/MSD) are prepared and analyzed with each batch of 20 samples or less (if specified by the client) of the same matrix for organic analyses and a MS is prepared and analyzed with each batch of 20 samples of the same matrix for inorganic analyses. The MS/MSD samples are prepared by taking an aliquot of an actual site sample and fortifying it with the selected target analytes of interest. The MS/MSD samples are analyzed using the same sample preparation, reagents, and analytical methods employed as the field samples. MS and MSD responses are used to evaluate the accuracy and precision of the laboratory performance of the analytical method in a specific sample matrix. Results from site samples other than that of the client's will not be reported with the data package. Control limits for recoveries of the matrix spike/matrix spike duplicate compounds are listed in the method SOP's.

Replicate analyses are prepared and analyzed for inorganic samples and for certain organic drinking water analyses with each batch of 20 samples of the same matrix. Control limits for replicate analyses are listed in the method SOP's.

Calibration Check Standards are analyzed with each analytical series at the frequencies stated in the methods. For metals, GC, and Wet Chemistry analyses calibration check standards are analyzed at a typical frequency of 10%, or after every ten samples unless otherwise noted in the site work plan. For GC/MS analyses, the frequency of the calibration check standard is every 12 hours. The tuning criteria must be met prior to analyzing blanks, standards or samples. Control limits for calibration check standards are listed in the method SOP's.

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Parameter	QC type	Frequency	Control Limits	Corrective Action
Volatile/Semi-volatile Organics	method blank	1 per batch	Target analytes below RL, 10x exception for lab solvents	System check, reanalysis of affected samples
	surrogate spike	each sample, standard, blank	Limits listed in method	Review, reanlyze based on technical judgment
	MS/MSD	set per 20 samples per matrix	Limits listed in method	Report results
	LCS/	1 per batch	Limits listed in method	Review, reanalyze LCS and associated samples, based on technical judgement.
	ICV (independen)	After initial calibration	%Recovery 70-130, unless otherwise listed in method	Review, reanalyze ICV, check standards, recalibrate if appropriate.
Metals	lab reagent/prep blank	1 per 20 samples or batch	analyte below RL	redigest batch
	LCS	1 per batch	Soils- Limits provided by vendor; Waters - ± 20%	redigest batch
	replicates	1 per 20 samples per matrix	± 20%	flag results
	matrix spikes	1 per 20 samples per matrix	75-125%	flag results
Wet Chemistry	lab reagent/prep blank	1 per 20 samples or batch	analyte RL	system check, reanalysis of batch
	LCS	1 per batch	80-120% recovery	system check, reanalysis of batch
	replicates	1 per 20 samples per matrix	± 20%	flag results
	matrix spike	1 per 20 samples per matrix	75-125%	flag results

RL = Reporting Limit

3.10.1 Proficiency Testing (PT) and Performance Assessment

The laboratory participates in internal and external laboratory check sample programs as a means for examining overall laboratory performance as well as to qualify for various federal and state certification programs. Internal or intra-laboratory check sample programs include the submission of blind samples that are carried through normal procedures. The following external or inter-laboratory check sample programs are the typical ones employed to demonstrate analytical proficiency for purposes of monitoring overall laboratory proficiency or to provide proof of acceptable performance for certification or accreditation programs by outside agencies or regulatory bodies:

National Environmental Laboratory Accreditation Conference (NELAC) Semi-annual Proficiency Testing Programs.

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The NELAC proficiency-testing program is an extensive and comprehensive check sample program. Private approved vendors administer the program under the direction of the EPA (WP or WS designations). Participating laboratories receive reports detailing acceptability of their reported results and must provide corrective action responses to State Agencies regarding any results that are outside of the control limits.

3.11 Data Reduction

The Laboratory provides extensive data review prior to reporting results to the client. In general an analyst will process data in one of the following ways:

- Manual computation of results with manual reporting
- Computer computation of results with manual reporting
- Computer computation and reporting of results

If the analyst manually processes the data, all steps in the computation are provided for review including the source of the input parameters such as response factors, dilution factors, and calibration constants. All calculations of manually processed data are checked during secondary review.

For data that are processed using a computer and then entered into the Laboratory Information System by an analyst or data entry personnel, a hard copy of the computer-generated results is kept and uniquely identified with the sample number and any other preparation or dilution information as may be needed. The hard copy results are used for data validation and secondary review.

If computer processed data are directly acquired from the instrumentation, hard copies of the actual data are made and the analyst verifies that the following are correct before releasing instrumental data to the reporting system:

- Sample numbers
- Calibration constants/ response factors
- Output parameters such as units and compound names
- Numerical values used for detection limits
- Dilution and preparation factors

The hard copy of the results is used for data validation and review. After initial demonstration of proficiency of computerized programs computer calculations are randomly spot checked while the manual entry of every result is verified.

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3.12 Data Review

The analyst is responsible for primary review of data generated from sample analysis. If the instrument calibration and recoveries of all quality control samples are within specified tolerances, then the data are presented for secondary review. If instrument calibration or the recoveries of any quality control samples exceed specified tolerances, then affected sample results are evaluated and generally the samples are submitted for re-analysis. Any manual integration that occurs are dated and signed and if appropriate, noted in the case narrative.

Secondary review (a complete technical review) is typically conducted by the designated data review personnel to determine if analytical results are acceptable. All calibrations, manual calculations and transcriptions are checked for accuracy and quality control sample results are evaluated against specified tolerances. If instrument calibration and recoveries of all quality control samples are within specified tolerances, then the data are presented to a senior analytical chemist or on-site designated deputy for final review.

Designated chemistry personnel perform final review of the data to determine if all analytical results of a sample(s) are consistent. Correlation of results for different parameters of a sample is evaluated at this time before the data is presented in a final report to the client. If discrepancies or deficiencies exist in the analytical results, then corrective action is taken.

Periodic data audits of final reports by the QA Manager are conducted to determine that precision, accuracy, completeness and traceability goals of the sample analysis are being conducted.

3.13 Data Reporting

After all analytical data have been reviewed; the final analytical report is assembled for submission to the client. The on-site laboratory can currently offer five levels for reporting analytical results.

Level I data consist of measurements taken during field analysis with the report consisting of results only.

Level II reporting consists of an analytical report with results only. Internal quality control results are retained on file at the laboratory.

Level III reporting consists of an analytical report with internal quality control results reported; these include laboratory control standards, surrogate spike recoveries, and method blank results.

Level IV data refers to data submitted in CLP-like format. Level IV is defined by the submission of QA/QC supporting material including the raw laboratory data similar to that provided with

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CLP Statements of Work (SOW). Submission of data in this format results in an independently validatable package. Level IV reporting includes narrative or comments of concern, analytical results, supportive documentation including all raw data and preparation sheets, and all documentation related to chain of custody. Once the document is assembled, the sections may be distinguished with colored paper with their respective titles. Copy(s) of the documentation are sent to the client, and the original document is retained in storage for a minimum of seven (7) years.

Level V data have unique requirements in compound identification, quantitation, detection limits, cleanup, or QA/QC requirements. Level V analytical procedures are generally defined as Special Analytical Services. The procedures and QA/QC are specified through these requests. The QA/QC for Level V data usually requires frequent standardization, spikes, duplicates, blanks, and strict compound identification criteria.

3.14 Project Reports

The criteria described in Section 23.1.1 apply to all Project Reports that are generated under NELAC requirements. The criteria described in Section 23.1.2 and 23.1.3 applies to all client reports.

3.14.1 Project Report Content

- Title
- Laboratory Name, address, telephone number, contact person and location where the test was carried out if different from the fixed laboratory address.
- Unique Laboratory Project Number
- Total number of pages (report must be paginated)
- Client Project Number (if applicable)
- Laboratory Sample Identification (if applicable)
- Client Sample Identification
- Test Method
- Matrix and/or description of sample
- Dates: sample collection, collection time, sample receipt, preparation and/or analysis date.
- Definition of data qualifiers
- Reporting units
- Solid samples: indicate dry or wet weight
- Indication by flagging where results are reported below the quantitation limit.

3.14.2 Project Narrative/Cover Letter

A Project Narrative and/or Cover Letter is included with each project report and at a minimum includes and explanation of any and all of the following occurrences:

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- Non-conformances that apply to project contracts and under NELAC requirements.
- "Compromised" sample receipt
- Method Deviations
- QC criteria failures

In addition, each report will include the following statement: The analytical procedures and test results in this report are in accordance with the NELAC standards and meet all NELAC requirements for parameters for which accreditation is required or available. The reports were completed according to contract specific reporting requirements. Any exceptions to the NELAC standard requirements are noted here or in the case narrative and all data has been flagged accordingly.

3.15 Data Integrity and Security

3.15.1 Computer Hardware and Software

Whenever possible the laboratory establishes standards for computer systems and peripheral equipment. In instances, where a vendor-provided solution is bundled with hardware and software, the vendor certifies that the proposed hardware is readily operable with existing hardware platforms, and will provide operating and maintenance instructions. Stone staff or trained vendor technicians configure computer system hardware. Major hardware items include systems used for data collection, multi-user file servers, and multi-user printers.

Prior to release for production, use of any in-house developed software is considered under development. Software is validated prior to release. Validation of software consists of testing the output of the software based on sample input data, and comparing the output with independently calculated results.

Stone employs the use of anti-virus software to detect and remove viruses from software.

3.15.2 Security

Because of the nature of Stone's work, adequate security of the facilities, equipment, and project files is necessary. Access to the fixed facility and typically the on-site facility is controlled through a key system. Visitors register upon entering the building and are accompanied by a staff member while visiting. The Laboratory Manager ensures that personnel are familiar with Stone's security policies.

Stone staff is familiar with and adhere to standards of confidentiality mandated by individual contracts and common sense business practices.

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In addition, all of the Stone staff has been instructed on ethics reflecting our belief that the cornerstone of any business relationship is ethical behavior and data integrity. This policy is a vehicle to reinforce our commitment to quality.

4.0 References

National Environmental Laboratory Accreditation Conference, Constitution, Bylaws and Standards, EPA 600/R-98/151, U. S. Environmental Protection Agency's (EPA) Office of Research and Development, Approved June 5, 2003, Effective July 1, 2003.

General Requirements for Competence of Testing and Calibration Laboratories, ISO/IEC 17025, December 1999.

Quality Systems Manual for Environmental Laboratories, Department of Defense, Version 1, October 2000

5.0 Terms and Definitions

Accuracy: the degree of agreement between a measurement and true or expected value, or between the average of a number of measurements and the true or expected value.

Audit: a systemic evaluation to determine the conformance to specifications of an operational function or activity.

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of a similar matrix, meeting the above mentioned criteria. Where no preparation method exists (example, volatile organics, water) the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, extracts, digestates or concentrates that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Chain of Custody (COC): an unbroken trail of accountability that ensures the physical security of samples, data and records.

Clean Air Act: legislation in 42 U.S.C. 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended.

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Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund): legislation (42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and reauthorization Act of 1986 (SARA), 42 U.S.C. 9601et seq.

Compromised Sample: a sample received in a condition that jeopardizes the integrity of the results. See Section 18.0 for a description of these conditions.

Confidential Business Information (CBI): information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products.

Confirmation: verification of the presence of a component using an additional analytical technique. These may include second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Corrective Action: action taken to eliminate the causes of an existing non-conformance, defect or other undesirable situation in order to prevent recurrence.

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Equipment Blank: a portion of the final rinse water used after decontamination of field equipment; also referred to as Rinsate Blank and Equipment Rinsate.

Document Control: the act of ensuring that documents (electronic or hardcopy and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA): legislation under 7 U.S.C. 135 et seq., as amended.

Federal Water Pollution Control Act (Clean Water Act, CWA): legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat. 816.

Field Blank: a blank matrix brought to the field and exposed to field environmental conditions.
Field of Testing (FOT): a field of testing is based on NELAC's categorization of accreditation based on program, matrix, analyte.

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Good Laboratory Practices (GLP): formal regulations for performing basic laboratory operations outlined in 40 CFR Part 160 and 40 CFR Part 729 and required for activities performed under FIFRA and TSCA.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Instrument Blank: a blank matrix that is the same as the processed sample matrix (i.e. extract, digestate, condensate) and introduced onto the instrument for analysis.

Instrument Detection Limit (IDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is +100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Laboratory Quality Manual (LQM): a document stating the quality policy, quality system and quality practices of the laboratory. The LQM may include by reference other documentation relating to the laboratory's quality system.

Limit of Detection (LOD): the minimum amount of a substance that an analytical process can reliably detect.

Limit of Quantitation (LOQ): the minimum concentration of an analyte or category of analytes in a specific matrix that can be identified and quantified above the method detection limit and within the limits of precision and bias during routine analytical operating conditions.

Matrix: the substrate of a test sample. Common matrix descriptions are Air (air samples as analyzed or as adsorbed into a solution or absorption matrix and desorbed), Aqueous includes surface water, groundwater and effluents, Drinking Water Aqueous sample that has been designated a potable water source, Saline Aqueous sample from an ocean or estuary, or other salt-water source, Liquid: Liquid with <15% settleable solids, Solid: Soil, sediment, sludge or other matrices with >15% settleable solids, Waste (a product or by-product of an industrial process that results in a matrix not previously defined), Tissue Sample of a biological origin such as fish tissue, shellfish, or plant material.

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Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate; Laboratory Duplicate.

Matrix Spike (MS): field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a replicate matrix spike.

Method Blank: a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs using a specific method. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Precision: an estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical and/or biological integrity of the sample.

Proficiency Testing: determination of the laboratory calibration or testing performance by means of inter-laboratory comparisons.

Proficiency Test (PT) Sample: a sample, the composition of which is unknown to the analyst that is provided to test whether the analyst/laboratory can produce analytical results within specified performance limits. Also referred to as Performance Evaluation (PE) Sample.

Proprietary: belonging to a private person or company.

Quality Assurance (QA): an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

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Quality Assurance Project Plan (QAPP): a formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

Quality Control (QC): the overall system of technical activities, the purpose of which is to measure and control the quality of a product or service.

Quality Control Sample: a control sample, generated at the laboratory or in the field, or obtained from an independent source, used to monitor a specific element in the sampling and/or testing process.

Quality Management Plan (QMP): a formal document describing the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an agency, organization or laboratory to ensure the quality of its product and the utility of the product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA/QC.

Quantitation Limit (QL): the minimum amount of a substance that can be quantitatively measured with a specified degree of confidence and within the accuracy and precision guidelines of a specific measurement system. The QL can be based on the MDL, and is generally calculated as 3-5 times the MDL, however, there are analytical techniques and methods where this relationship is not applicable. Also referred to as Practical Quantitation Level (PQL), Estimated Quantitation Level (EQL), Limit of Quantitation (LOQ).

Raw Data: any original information from a measurement activity or study recorded in laboratory notebooks, worksheets, records, memoranda, notes, or exact copies thereof and that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic/optical media, including dictated observations, and recorded data from automated instruments. Reports specifying inclusion of "raw data" do not need all of the above included, but sufficient information to create the reported data.

Record Retention: the systematic collection, indexing and storing of documented information under secure conditions.

Reference Standard: a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.

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Reporting Limit (RL): The level to which data is reported for a specific test method and/or sample. The RL is generally related to the QL. The RL must be minimally at or above the MDL.

Resource Conservation and Recovery Act (RCRA): legislation under 42 USC 321 et seq. (1976).

Safe Drinking Water Act (SDWA): legislation under 42 USC 300f et seq. (1974), (Public Law 93-523).

Sampling and Analysis Plan (SAP): a formal document describing the detailed sampling and analysis procedures for a specific project.

Selectivity: the capability of a measurement system to respond to a target substance or constituent.

Sensitivity: the difference in the amount or concentration of a substance that corresponds to the smallest difference in a response in a measurement system using a certain probability level.

Spike: a known amount of an analyte added to a blank, sample or sub-sample.

Standard Operating Procedure (SOP): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

Storage Blank: a blank matrix stored with field samples of a similar matrix.

Systems Audit: a thorough, systematic, on-site, qualitative review of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system.

Test Method: defined technical procedure for performing a test.

Toxic Substances Control Act (TSCA): legislation under 15 USC 2601 et seq., (1976).
Traceability: the property of a result of a measurement that can be related to appropriate international or national standards through an unbroken chain of comparisons.

Trip Blank: a blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Verification: confirmation by examination and provision of evidence against specified requirements.

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APPENDIX A
Organizational Chart

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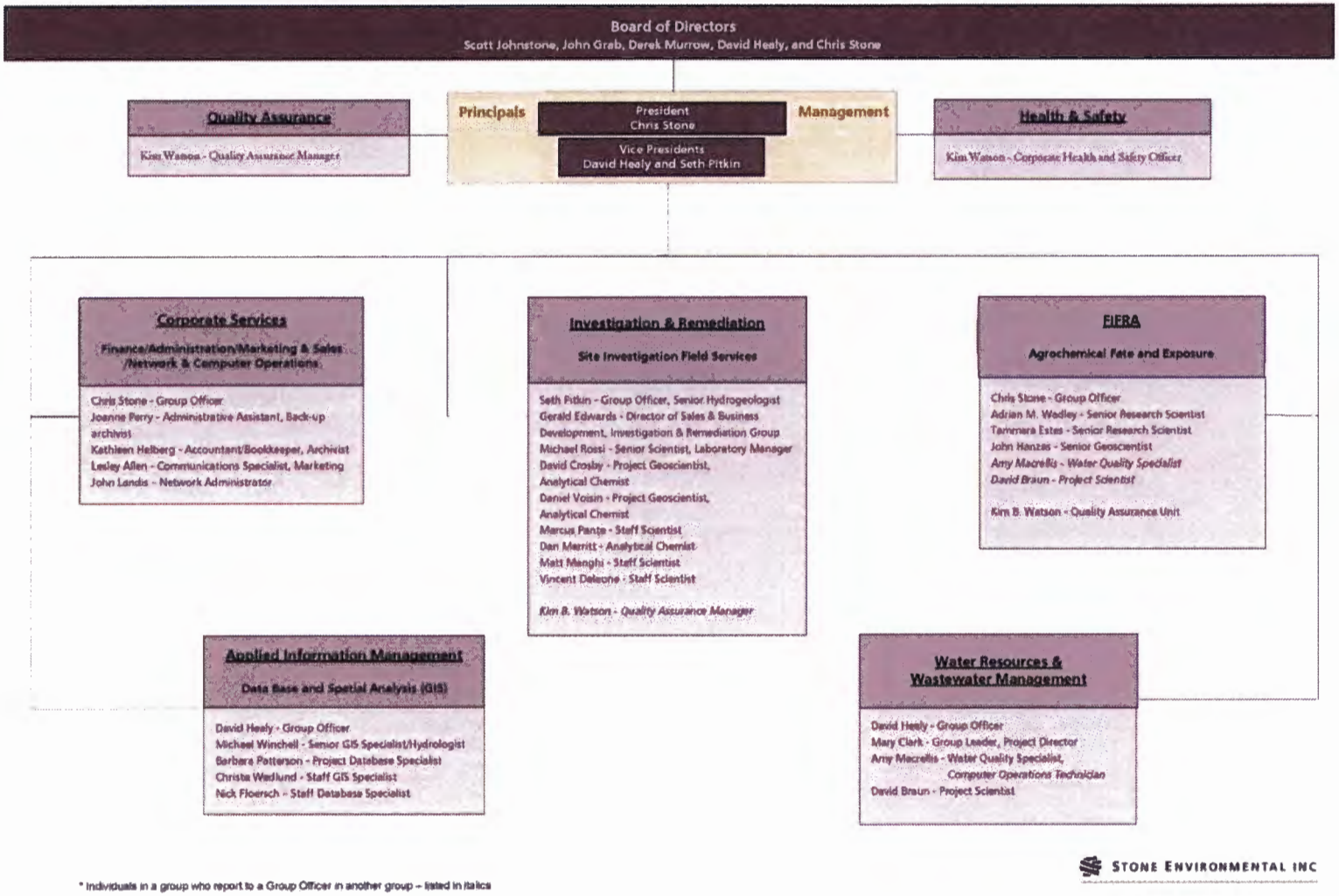

Figure 1. Organizational Chart

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APPENDIX B
Forms:
SEI Procedure Specific Training Log
Demonstration of Capability Certification Statement
Ethics Agreement

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SEI PROCEDURE SPECIFIC TRAINING LOG

PERSONNEL:_____

Nature of Duties, Training or Instruction	SOP Followed (if applicable)	Date	Location	Instructor (s)	Initials

COPIES OF ALL CERTIFICATES, DIPLOMAS, TRANSCRIPTS OR OTHER DOCUMENTATION SHOULD BE ATTACHED.
ORIGINAL FILED IN THE INDIVIDUAL'S TRAINING RECORD LOCATED IN THE ADMINISTRATION DEPARTMENT.

Figure 2. SEI Procedure Specific Training Log.

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DEMONSTRATION OF CAPABILITY
CERTIFICATION STATEMENT

Date:
Laboratory Name: **Stone Environmental, Inc. Mobile Laboratory**
Laboratory Address: 535 Stone Cutters Way, Montpelier, VT 05602
Analyst Name:
Matrix:
Method number: _____SOP #:_____
Analyte, or Class of Analytes or Measured Parameters:

We the undersigned CERTIFY that:

1. The analyst identified above, using the cited test method, which is in use at this facility for the analysis of samples under the National Environmental Laboratory Accreditation Program, has met the Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification.
3. A copy of the test method and the laboratory-specified SOPs are available for all personnel on-site.
4. The data associated with the demonstration capability are true, complete and self-explanatory (1).
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is available for review by authorized assessors.

Laboratory Manager	Signature	Date
Quality Assurance Manager	Signature	Date

(1) True: consistent with Supporting data. Accurate: Based on good laboratory practices consistent with sound scientific Principles/practices. Complete: Includes the results of all supporting performance testing. Self-Explanatory: Data property labeled and stored so that the results are clear and require no additional explanation.

Figure 3. Demonstration of Capability Certification Statement.

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STONE ENVIRONMENTAL INC

Ethics Agreement

It is the policy of Stone Environmental, Inc. (Stone) to incorporate the highest standard of quality and confidentiality with all analytical and field programs by adhering to the following practices:

Stone will only offer analytical procedures for which it can consistently demonstrate compliance with high quality, traceable and legally defensible performance standards. Stone Environmental staff is committed to the practice of complete honesty in the production and reporting of data. Staff who may be aware of misrepresentation of facts or data manipulation to bypass established quality assurance (QA) and quality control (QC) requirements, are required to immediately inform their supervisor or any member of management. In addition, any and all information which is not in the public domain that an employee acquires through the course of his or her employment at Stone, whether the information is owned by Stone or a client or potential client, is to be held in strictest confidence and not disclosed orally or in writing to any person other than a Stone employee or the client.

All employees are asked to sign a copy of the statement below upon their first day of employment.

I, _____ (print name) understand that high standards of integrity are required of me with regard to the duties I perform and the data I report in connection with my employment at Stone. I agree that in the performance of my duties at Stone:
I will not intentionally report data values that are not the actual values obtained;
I will not intentionally report dates, times, sample or QC identifications, or method citations of data analyses that are not the actual dates, times sample or QC identifications, or method citations;
I will not intentionally misrepresent another individual's work; and
If a supervisor or a member of Stone management requests me to engage in or perform an activity that I feel is compromising data validity or quality, I will not comply with the request and report this action immediately to a member of the upper management, up to and including the President of Stone Environmental, Inc.
I will not intentionally report data values that do not meet established quality control criteria as set forth in the Method and/or Standard Operation Procedures, or as defined by Stone Policy.

I agree to inform my Supervisor of any accidental reporting of non-authentic data by me in a timely manner. I agree to inform my Supervisor of any accidental or intentional reporting of non-authentic data by other employees. I have read this Ethics Agreement and understand that failure to comply with the conditions as stated above will result in disciplinary action, up to and including termination from the Stone.

Compliance with this agreement of business ethics and conduct is the responsibility of every Stone employee. Disregard or failing to comply with this standard of business ethics and conduct could lead to disciplinary action up to and including possible termination of employment and criminal action.

Signature: _____ Date: _____

Witness by: _____

Figure 4. Ethics Agreement.

APPENDIX C

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APPENDIX C
Floor Plans and Mobile Laboratory Equipment

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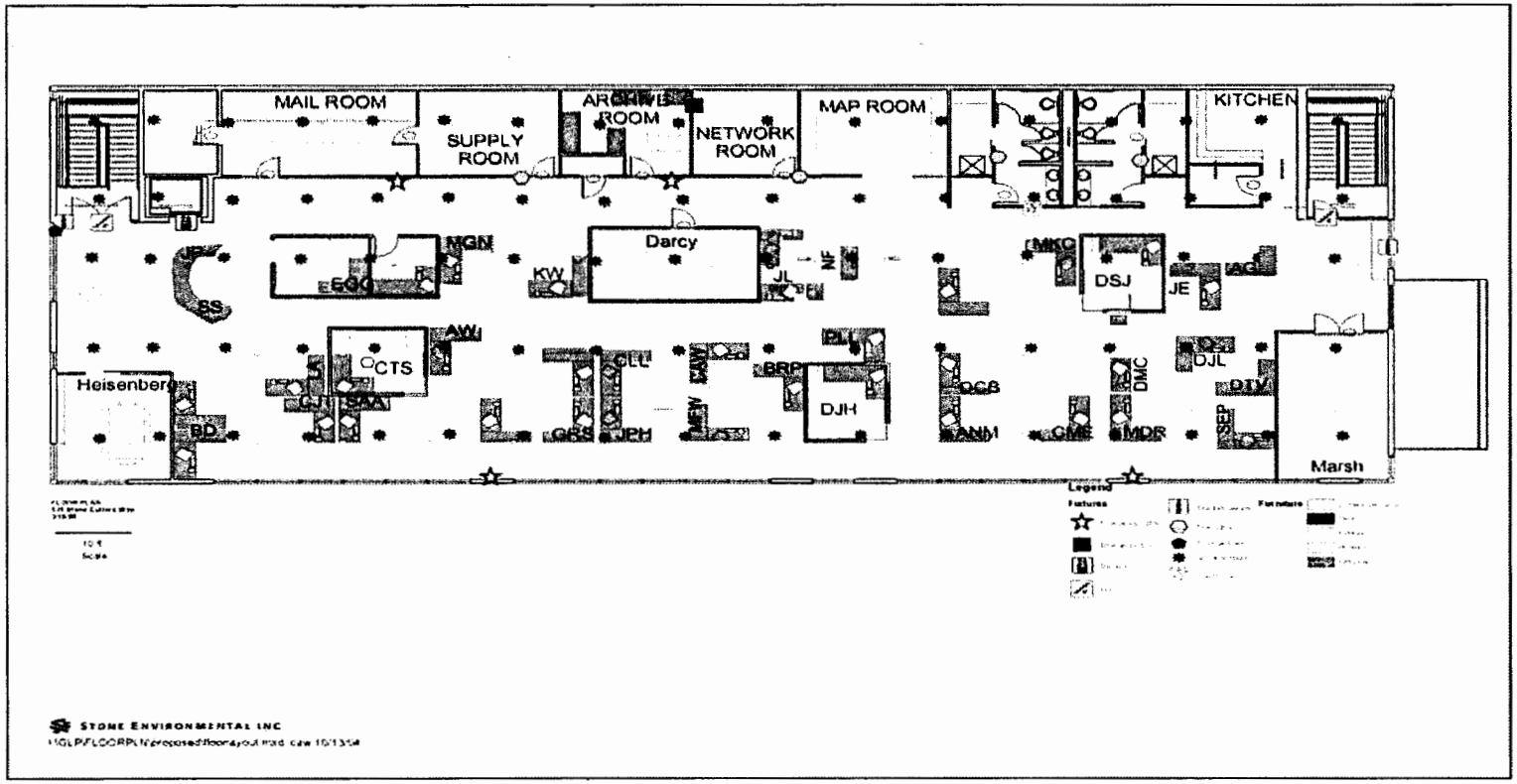

Figure 5. Stone Environmental, Inc. Fixed Facility Floor Layout

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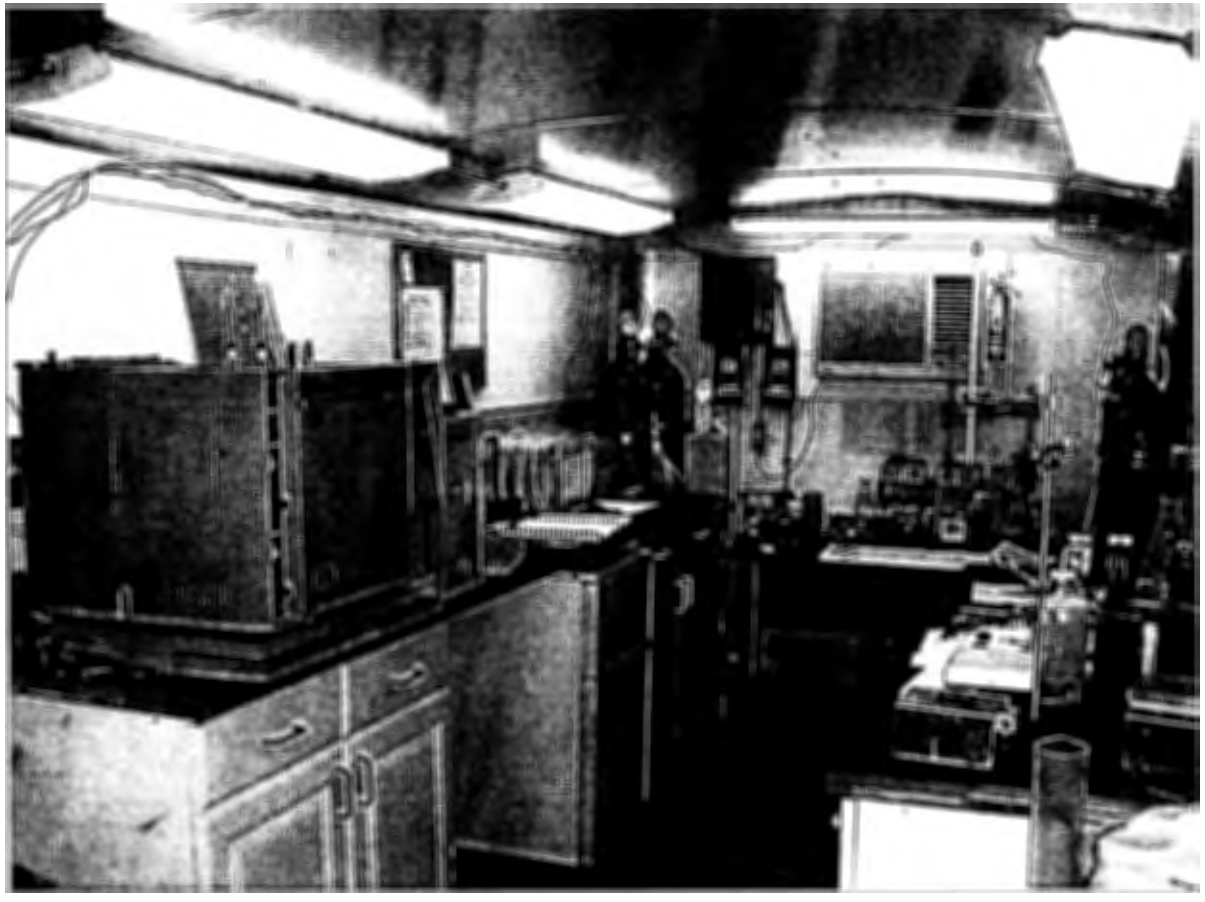

Figure 6. Typical Mobile Laboratory Layout

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Mobile Laboratory Equipment Inventory

The following is a comprehensive list of major instrumentation available along with supporting and miscellaneous equipment.

Mobile Laboratory Set-Up (may include)			
Make and Model	Description	Quantity	Date Acquired
Hewlett Packard HP5890II HP5890	Gas Chromatographs equipped with dual heated injection ports, capillary inlets for split/splitless, and dual FID (flame ionization detectors). Data is collected on HP G2070AA ChemStation, Rev A.09 03[1417]	4	5/98, 2/03, 3/03, 5/03
Hewlett Packard HP5971A MSD	GC/MS System with HP5890II GC. Equipped with dual injection and dual detectors (a MS detector and FID detector). HPG1033A NIST Spectral Library, Data is collected on HP G1701AA MS ChemStation.	2	10/03 12/05
Metorex X-MET 3000TX	X-Ray Fluorescence System with miniature x-ray tube and 40kV HV supply and high resolution SiPIN detector System	1	09/04
Supelco	Solid Phase Micro-Extraction (SPME) preparation of Volatile and Semi-volatile analytes	4	Various
Various	Miscellaneous equipment: Hot Plates-PC-400, stir plates, pH meter, balances, syringes, laboratory support equipment, pressure regulators		Various
Trailer/ Truck/Vehicle	Mobile Lab 2 = VIN# 1UK500F2541047129 Mobile Lab 1 = VIN# 1UK500G29V1022699 Truck 2 = VIN#JW6CEJ1G7SL002457	3	Various

Information Systems

All terminals, PC's and printers are connected on an integrated Local Area Network (LAN) via network switches, routers and wide area links. Extensive variety of software to aid in data analysis and presentation: Microsoft Office Products (Excel, Word, etc), programming environments.

All lab personnel have access to the World Wide Web for additional resources.

Additional equipment follows:

Information Services	
Description	Quantity
Printers	3
Personal computers	8
HP GC/MS's with HP chemstation (3)	1

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APPENDIX D
Analytical Methodologies

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Stone Environmental, Inc. Mobile Laboratory
Analytical Methodologies

Reference	Method	Description
ASTM	D6520	Solid Phase Micro-extraction of water and its headspace for analysis of Volatile and Semi-volatile Organic Compounds
ASTM	D6520	Methanol extraction of soils (EPA 5035) and Solid Phase Micro-extraction of soil extract and its headspace for analysis of Volatile and Semi-volatile Organic Compounds
EPA SW846	8260	Volatile Organic Compounds by Gas Chromatography (GC)/Mass Spectrometry (GCMS) for Waters and Soils using Solid Phase Micro-extraction.
EPA SW-846	Modified 8015	TPH- Gasoline and Diesel
EPA SW-846	Modified 8021	GC Aromatic and Halogenated Volatile Organics
EPA SW-846	Modified 8082	Determination of Polychlorinated Biphenyls (PCBs) by Gas Chromatography with an Electron Capture Detector (ECD)
EPA SW-846	8061	Phthalate Esters by GC/ECD
EPA SW-846	6200	Field Portable XRF Spectroscopy for the Determination of Elemental Concentrations in Soil and Sediment
EPA SW-846	4020	Screening for PCBs by Immunoassay
Standard Methods	3500FE	Ferrous Iron (Phenanthroline Method)
Standard Methods	4500 CIG	Chlorine

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APPENDIX E
Laboratory Accreditation

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State of Florida
Department of Health, Bureau of Laboratories

This is to certify that

E97932
STONE ENVIRONMENTAL, INC.
535 STONE CUTTERS WAY MOBILE LAB - IUK500F2541047129
MONTPELIER, VT 05602

JUN 29 2006

has complied with Florida Administrative Code 64E-1,
for the examination of Environmental samples in the following categories

NON-POTABLE WATER - VOLATILE ORGANICS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

EFFECTIVE July 01, 2006 THROUGH June 30, 2007

Dian Sharma, Ph.D.
Acting Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1897, 7/04
NON-TRANSFERABLE E97932-02-7/1/2006

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Jeb Bush
Governor

FLORIDA DEPARTMENT OF HEALTH

M. Rony François, M.D., M.S.P.H, Ph.D.
Secretary

Laboratory Scope of Accreditation

Attachment to Certificate #: E97932-02, expiration date June 30, 2007. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E97932 **EPA Lab Code: VT00974** **(802) 229-2194**

E97932
Stone Environmental, Inc.
535 Stone Cutters Way
Mobile Lab - 1UK500F2541047129
Montpelier, VT 05602

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1-Trichloroethane	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	6/23/2004
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	4/27/2005
1,3-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
1,4-Dichlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Benzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Benzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Bromoform	EPA 8260	Volatile Organics	NELAP	6/23/2004
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	6/23/2004
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	6/23/2004
Chlorobenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Chloroethane	EPA 8260	Volatile Organics	NELAP	4/27/2005
Chloroform	EPA 8260	Volatile Organics	NELAP	6/23/2004
cis-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/23/2004
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	6/23/2004
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	6/23/2004
Ethylbenzene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	9/23/2004
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	6/23/2004
Methylene chloride	EPA 8260	Volatile Organics	NELAP	4/27/2005
Styrene	EPA 8260	Volatile Organics	NELAP	4/27/2005
Tetrachloroethylene (Perchloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004

Clients and Customers are urged to verify the laboratory's current certification status with the Environmental Laboratory Certification Program. **Issue Date: 7/1/2006** **Expiration Date: 6/30/2007**

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FLORIDA DEPARTMENT OF HEALTH

M. Rony François, M.D., M.S.P.H, Ph.D.
Secretary

Laboratory Scope of Accreditation

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State Laboratory ID: E97932 **EPA Lab Code: VT00974** **(802) 229-2194**

E97932
Stone Environmental, Inc.
535 Stone Cutters Way
Mobile Lab - IUK500F2541047129
Montpelier, VT 05602

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	9/23/2004
Toluene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Toluene	EPA 8260	Volatile Organics	NELAP	9/23/2004
trans-1,2-Dichloroethylene	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/23/2004
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	4/27/2005
Trichloroethene (Trichloroethylene)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	9/23/2004
Vinyl chloride	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	9/23/2004
Xylene (total)	ASTM D6520-00	Volatile Organics	NELAP	12/16/2004
Xylene (total)	EPA 8260	Volatile Organics	NELAP	9/23/2004

Clients and Customers are urged to verify the laboratory's current certification status with the Environmental Laboratory Certification Program. **Issue Date: 7/1/2006** **Expiration Date: 6/30/2007**

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System A

MS, PDMS, SIM, Water
2 ppb, 20 ppb for ketones
Cal: 1 - 50 ppb, 10 - 500 ppb for ketones
10/4/2006

Cpd	1 6100413	2 6100417	3 6100418	4 6100419	5 6100420	6 6100421	7 6100422	Ave	% Recovery	Std Dev	MDL	RL	Cpd
Chloromethane	2.02	1.64	2.25	1.63	1.51	1.69	1.94	1.81	90.6%	0.26	0.83	2.00	Chloromethane
Vinyl Chloride	2.1	1.41	1.9	1.85	2.27	1.72	1.9	1.88	93.9%	0.27	0.86	2.00	Vinyl Chloride
Bromomethane	2.15	2	2.36	1.98	3.73	2.26	2.24	2.39	119.4%	0.61	1.91	2.00	Bromomethane
Chloroethane	2.04	1.46	1.73	1.97	2.32	1.61	1.81	1.85	92.4%	0.29	0.90	1.00	Chloroethane
1,1,2-Trichloro-1,2,2-trif	1.68	1.88	2.03	1.64	2.08	1.42	1.74	1.78	89.1%	0.23	0.73	1.00	1,1,2-Trichloro-1,2,2-trif
1,1-Dichloroethene	1.89	1.82	2.13	1.83	1.95	1.82	1.99	1.92	95.9%	0.11	0.36	1.00	1,1-Dichloroethene
Carbon Disulfide	2.01	1.88	1.98	2.07	2.08	1.62	1.98	1.95	97.3%	0.16	0.50	1.00	Carbon Disulfide
Methylene Chloride	1.97	1.5	2.07	1.99	1.79	1.62	1.93	1.84	91.9%	0.21	0.66	1.00	Methylene Chloride
t-Butyl-methyl ether	2.02	1.97	1.97	1.94	2.02	1.58	1.97	1.92	96.2%	0.15	0.49	1.00	t-Butyl-methyl ether
trans-1,2-Dichloroethene	2.16	2.13	2.09	2.13	1.95	1.78	2.21	2.06	103.2%	0.15	0.47	1.00	trans-1,2-Dichloroethene
1,1-Dichloroethane	2.07	1.9	2.04	1.99	1.96	1.65	2.03	1.95	97.4%	0.14	0.45	1.00	1,1-Dichloroethane
cis-1,2-Dichloroethene	1.76	2.36	1.74	2.32	1.84	1.53	1.74	1.90	94.9%	0.32	0.99	1.00	cis-1,2-Dichloroethene
2-Butanone	27.77	14.23	22.66	22.79	26.09	19.66	24.93	22.59	113.0%	4.53	14.22	20.00	2-Butanone
Chloroform	1.91	1.79	1.97	2.02	1.99	1.58	1.8	1.87	93.3%	0.15	0.49	1.00	Chloroform
1,1,1-Trichloroethane	2.15	2	2.23	2.13	2.21	1.71	2.16	2.08	104.2%	0.18	0.57	1.00	1,1,1-Trichloroethane
Cylcohexane	2.06	1.99	2.26	1.99	2.25	1.62	1.97	2.02	101.0%	0.21	0.67	1.00	Cylcohexane
Carbon Tetrachloride	2.09	2.05	2.22	2.14	2.23	1.73	2.13	2.08	104.2%	0.17	0.53	1.00	Carbon Tetrachloride
Benzene	2.16	2	2.12	2.13	2.18	1.73	2.11	2.06	103.1%	0.16	0.49	1.00	Benzene
1,2-Dichloroethane	2.2	2.11	2.05	2.1	2.14	1.68	1.99	2.04	101.9%	0.17	0.54	1.00	1,2-Dichloroethane
Trichloroethene	2.03	1.84	2.01	2.01	2.01	1.67	2.07	1.95	97.4%	0.14	0.45	1.00	Trichloroethene
Methyl Cyclohexane	1.55	1.81	1.79	1.48	1.85	1.23	1.61	1.62	80.9%	0.22	0.70	1.00	Methyl Cyclohexane
1,2-Dichloropropane	2.22	1.97	1.95	1.91	2.17	1.79	2.09	2.01	100.7%	0.15	0.48	1.00	1,2-Dichloropropane
Bromodichloromethane	2.07	1.95	1.92	2.02	2.04	1.65	2	1.95	97.5%	0.14	0.45	1.00	Bromodichloromethane
cis-1,3-Dichloropropene	2.28	2.04	2	1.99	2.09	1.72	2	2.02	100.9%	0.17	0.52	1.00	cis-1,3-Dichloropropene
4-Methyl-2-pentanone	22.86	22.54	20.59	20.31	22.14	17.3	21.17	20.99	104.9%	1.89	5.94	10.00	4-Methyl-2-pentanone
Toluene	2.39	2.18	2.35	2.26	2.34	1.99	2.3	2.26	112.9%	0.14	0.43	1.00	Toluene
trans-1,3-Dichloropropene	2.36	2.2	2.19	2.18	1.81	1.78	2.57	2.16	107.8%	0.28	0.89	1.00	trans-1,3-Dichloropropene
1,1,2-Trichloroethane	2.16	2.11	2.1	1.92	2.16	1.58	1.93	1.99	99.7%	0.21	0.65	1.00	1,1,2-Trichloroethane
Tetrachloroethene	2.2	2.03	2.15	2.01	2.14	1.88	2.13	2.08	103.9%	0.11	0.35	1.00	Tetrachloroethene
2-Hexanone	27.36	23.56	23.59	22.03	25.59	20.56	24.87	23.94	119.7%	2.26	7.09	10.00	2-Hexanone
Dibromochloromethane	2.04	2.01	2.02	1.88	1.99	1.62	1.95	1.93	96.5%	0.15	0.46	1.00	Dibromochloromethane
1,2-Dibromoethane	2.09	2.05	1.95	1.91	2.04	1.58	1.89	1.93	96.5%	0.17	0.54	1.00	1,2-Dibromoethane
Chlorobenzene	1.97	1.8	2.35	2.29	1.95	2.05	1.91	2.05	102.3%	0.20	0.64	1.00	Chlorobenzene
Ethylbenzene	2.02	1.76	1.92	1.83	1.97	1.68	1.87	1.86	93.2%	0.12	0.37	1.00	Ethylbenzene
m+p-Xylenes	4.72	4.27	4.6	4.3	4.6	4.06	4.58	4.45	111.2%	0.24	0.75	1.00	m+p-Xylenes
o-Xylene	2.35	2.14	2.26	2.13	2.28	2	2.27	2.20	110.2%	0.12	0.38	1.00	o-Xylene
Styrene	2.36	2.16	2.28	2.15	2.28	2.01	2.28	2.22	110.9%	0.12	0.37	1.00	Styrene
Bromoform	2.22	1.87	2.01	1.77	1.72	1.42	1.77	1.83	91.3%	0.25	0.78	1.00	Bromoform
Isopropylbenzene	2.25	2.07	2.19	2.01	2.25	1.93	2.17	2.12	106.2%	0.12	0.39	1.00	Isopropylbenzene
1,1,2,2-Tetrachloroethane	2.03	2	1.94	1.93	2.06	1.63	1.9	1.93	96.4%	0.14	0.45	1.00	1,1,2,2-Tetrachloroethane
1,3,5-Trimethylbenzene	2.38	1.75	2.37	2.14	2.47	2.08	2.36	2.22	111.1%	0.25	0.79	1.00	1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene	2.05	1.87	1.97	1.78	2.06	1.69	1.91	1.90	95.2%	0.14	0.43	1.00	1,2,4-Trimethylbenzene
1,3-Dichlorobenzene	2.38	2.17	2.28	2.11	2.3	2.01	2.26	2.22	110.8%	0.13	0.40	1.00	1,3-Dichlorobenzene
1,4-Dichlorobenzene	2.35	2.15	2.27	2.1	2.29	2	2.24	2.20	110.0%	0.12	0.38	1.00	1,4-Dichlorobenzene
1,2-Dichlorobenzene	2.38	2.21	2.31	2.14	2.33	1.99	2.26	2.23	111.6%	0.13	0.42	1.00	1,2-Dichlorobenzene
1,2-Dibromo-3-chloropropan	2.36	2.3	2.21	2.11	2.33	1.73	2.13	2.17	108.4%	0.22	0.68	1.00	1,2-Dibromo-3-chloropropan
1,2,4-Trichlorobenzene	2.32	2.13	2.19	2.07	2.28	1.86	2.11	2.14	106.9%	0.15	0.48	1.00	1,2,4-Trichlorobenzene
Naphthalene	2.51	2.32	2.41	2.23	2.45	1.99	2.3	2.32	115.8%	0.17	0.54	1.00	Naphthalene

STONE ENVIRONMENTAL INC

System B

FID
40 ppb
Cal: 20-500ppb
7/17/2007

	1	2	3	4	5	6	7					
Cpd	M7071403	M7071404	M7071405	M7071406	M7071407	M7071408	M7071409	Ave	% Recovery	Std Dev	MDL	RL	Cpd
Vinyl Chloride	40.67	40.10	39.26	38.21	42.58	39.86	39.51	40.03	100.1%	1.361	4.28	20	Vinyl Chloride
trans-1,2-Dichloroethene	36.73	36.20	34.72	36.22	36.74	35.95	35.13	35.96	89.9%	0.770	2.42	20	trans-1,2-Dichloroethene
1,1-Dichloroethane	29.99	30.23	29.25	30.17	30.65	30.03	29.22	29.93	74.8%	0.524	1.64	20	1,1-Dichloroethane
cis-1,2-Dichloroethene	27.14	28.20	25.21	28.69	28.36	28.31	26.85	27.54	68.8%	1.231	3.86	20	cis-1,2-Dichloroethene
Carbon Tetrachloride	51.79	52.29	51.29	50.48	49.55	50.46	49.91	50.82	127.1%	1.001	3.14	20	Carbon Tetrachloride
1,1,1-Trichloroethane	43.73	41.59	40.83	41.54	41.73	39.45	42.74	41.66	104.1%	1.357	4.26	20	1,1,1-Trichloroethane
Benzene	30.09	30.25	28.60	31.20	31.13	35.36	30.38	31.00	77.5%	2.106	6.61	20	Benzene
1,2-Dichloroethane	30.82	30.20	29.48	31.83	30.94	29.54	30.75	30.51	76.3%	0.835	2.62	20	1,2-Dichloroethane
Trichloroethene	38.87	37.96	40.91	38.58	38.63	38.13	38.50	38.80	97.0%	0.981	3.08	20	Trichloroethene
Toluene	33.86	33.38	33.32	33.93	34.56	34.24	34.86	34.02	85.1%	0.574	1.80	20	Toluene
Tetrachloroethene	42.39	40.55	40.04	40.55	40.51	40.42	42.15	40.94	102.4%	0.925	2.91	20	Tetrachloroethene
Chlorobenzene	27.64	27.35	26.85	28.16	29.03	28.16	28.44	27.95	69.9%	0.726	2.28	20	Chlorobenzene
Ethylbenzene	37.05	35.53	35.41	35.89	36.37	36.01	37.20	36.21	90.5%	0.702	2.20	20	Ethylbenzene
m+p-Xylenes	75.91	72.40	72.41	72.93	73.95	73.27	75.83	73.81	92.3%	1.501	4.71	20	m+p-Xylenes
o-Xylene	34.66	33.63	33.93	34.21	34.92	33.93	34.72	34.29	85.7%	0.486	1.53	20	o-Xylene
Bromofluorobenzene	26.68	25.65	25.42	26.64	27.92	26.89	27.63	26.69	66.7%	0.925	2.90	20	Bromofluorobenzene
1,3-Dichlorobenzene	34.99	32.10	32.30	32.21	33.23	33.45	33.47	33.11	82.8%	1.023	3.21	20	1,3-Dichlorobenzene
1,4-Dichlorobenzene	32.48	29.72	30.55	30.37	31.47	31.96	31.61	31.17	77.9%	0.979	3.07	20	1,4-Dichlorobenzene
1,2-Dichlorobenzene	30.75	28.10	29.55	29.40	30.50	30.82	29.09	29.74	74.4%	1.002	3.15	20	1,2-Dichlorobenzene

USACE Candidate Environmental Laboratory
Self-Declaration Form

The following form is to provided to the candidate environmental laboratory by the COR, filled-out and returned by the laboratory (with the accompanying required documentation specified below), and evaluated by the COR for policy compliance before the laboratory can provide environmental analytical support to USACE contracts. Before testing services can be performed by the laboratory, the COR will notify the candidate laboratory of the acceptability of the declaration and supporting documentation. The form is to be updated on an annual basis.

Legal name of laboratory:	GEL Laboratories, LLC
Street address:	2040 Savage Road Charleston. SC 29407
Name of Owner:	James M. Stelling, Kathleen H. Stelling, Douglas E. Earnst
Owner address (if different):	
Phone number:	(843) 556-8171
E-Mail address:	
Web site:	www.gel.net
Laboratory director:	Carey J. Bocklet
Phone number:	(843) 556-8171
E-Mail address:	cjb@gel.com
Quality Assurance Officer:	Robert L. Pullano
Phone number:	(843) 556-8171
E-Mail address:	rlp@gel.com

USACE Candidate Environmental Laboratory
Self-Declaration Form

The undersigned persons understand and acknowledge that:

a. Laboratory operations, which will be utilized for testing in support of environmental analytical testing for USACE, are in full compliance with the DOD Quality Systems Manual (Version 3, including NELAC Standard Chapter 5 and Appendix requirements). All written documentation provided to USACE, accompanying this declaration, accurately reflect policy/practices implemented by laboratory staff.

b. The Laboratory will notify USACE immediately of change in status of laboratory operations that may affect on-going compliance as declared per item a.

c. The Laboratory acknowledges that USACE may audit the laboratory, relative to policy compliance at any time deemed appropriate; and will allow a designated COR full access to information and facilities to conduct such audit operations.

d. Signatories are authorized to sign this form on behalf of the owner and that there are no misrepresentations in the information provided in the initial laboratory assessment package.

Signature of Quality Assurance Officer:	
Date:	**6/4/07**
Signature of Laboratory Director:	
Date:	**6/4/07**

Note - A completed declaration form is to be accompanied by:

- a copy of the laboratory's current Quality Manual (including QA SOPs and Ethics program policies/procedures),
- sample preparation and determinative method SOPs for all project required parameters, and
- method performance data — PT sample results (2 rounds), MDL studies and LCS control ranges for the preparatory-determinative method combinations — for all project required parameters. Documentation related to NELAP accreditation(s) for parameters can serve as evidence for successful PT samples results.

SEVERN TRENT STL

Date: 11/2/2005

Introductory Statement for STL STL Denver Self Declaration Submittal

DoD Quality Systems Manual
Final Version 3, dated March 2005

Legal Name of Laboratory:	STL Denver
Laboratory Director:	Robert C. Hanisch
Quality Assurance Manager:	Michael L. Schmitt
Street Address:	4955 Yarrow St.
City / State / Zip Code:	Arvada, CO 80002
Phone Number:	303-736-0100
Fax Number:	303-421-7171
Web Site:	http://www.stl-inc.com

STL Denver has a well developed and mature Quality System. This system meets the requirements of the NELAC Standards as applicable to environmental laboratories. The STL Denver Quality System is detailed in the Laboratory Quality Manual, STL Policies and in the laboratory standard operating procedures. STL Denver is accredited for the methods that it will perform in support of the USACE as referenced in the QSM.

STL Denver routinely assesses compliance with its quality system and is also subject to numerous assessments by external agencies and programs. We consider our overall level of compliance with the NELAC standard and the Appendix requirements to be excellent. While our Quality System has been determined to be compliant with NELAC, there are instances of non-compliance that occur which are documented and corrected as part of the assessment process. With this in mind, it is not possible for any lab to claim full compliance, meaning they meet all requirements all of the time. A good quality system recognizes the need for corrective action and continuous improvement.

STL Denver has reviewed the Department of Defense Quality Systems Manual (DoD QSM) as compared with its quality system. We have documented our level of compliance with the QSM and identified specific variances between the current laboratory Quality System and the QSM. The results of this review are presented in the following document.

STL Denver will work with our DoD clients to develop Quality Assurance Project Plans with appropriate data quality objectives that reflect the laboratory Quality System in light of the QSM requirements. Specific objectives found in the QSM that may not be supported by the laboratory quality system should be discussed in detail prior to completion of the QAPjP.

WI-STL-019/A-05/05

SEVERN TRENT STL

STL (Location)
Date: 11/2/2005

Self-Declaration Statement for the DoD Quality Systems Manual
Final Version 3, dated March 2005

Legal Name of Laboratory:	STL Denver
Street Address:	4955 Yarrow St.
City / State / Zip Code:	Denver, CO 80002
Phone Number:	303-736-0100
Fax Number:	303-421-7171
Web Site:	http://www.stl-inc.com
Name of Owner:	Severn Trent Laboratories, Inc.
Owner Address:	The Founders Building, Suite 300 580 Virginia Drive
City / State / Zip Code:	Ft. Washington, PA 19034-2707
Phone Number:	(215) 646-9201

The undersigned persons understand and acknowledge that:

a. Laboratory operations, which will be utilized for testing in support of environmental analytical testing for USACE, are in full compliance with the DoD QSM (Version 3), including NELAC Standard Chapter 5 and Appendix requirements. All written documentation provided to USACE, accompanying this declaration, accurately reflect policy/practices implemented by laboratory staff.

b. The Laboratory will notify the USACE immediately of change in status of laboratory operations that may affect on-going compliance as declared per item a.

c. The Laboratory acknowledges that USACE may audit the laboratory, relative to policy compliance at any time deemed appropriate; and will allow a designated COR full access to information and facilities to conduct such audit operations.

d. Signatories are authorized to sign this form on behalf of the owner and that there are no misrepresentations in the information provided in the initial laboratory assessment package.

****** DISCLAIMER ******

STL Denver has reviewed the Department of Defense Quality Systems Manual (DoD QSM) as compared with its quality system, as contained in its Laboratory Quality Manuals and associated Standard Operating Procedures. STL documents our level of compliance with the QSM and identifies variances between the current laboratory Quality System and the QSM, and we expect project requirements to be negotiated on a project-specific basis. In addition to identified variances with the DoD QSM, instances of noncompliance may be identified during quality assessments and such instances will be addressed via the laboratory's documented corrective action procedures, and as part of STL's commitment to continuous improvement.

Laboratory Director Robert C. Hanisch	Robert C Hanisch Signature	11/2/2005 Date
	Email Address:	RHanisch@stl-inc.com
Quality Assurance Manager Michael L. Schmitt	Michael L. Schmitt Signature	11/2/2005 Date
	Email Address:	MSchmitt@stl-inc.com

WI-STL-020/A-05/05

SEVERN TRENT STL

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Santa Ana, CA 92705

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STANDARD OPERATING PROCEDURE

TITLE: **SUPPLEMENTAL REQUIREMENTS for NAVY AIR PROJECTS under the DEPARTMENT of DEFENSE QUALITY SYSTEMS MANUAL, REV. 3, JANUARY 2006**

(SUPERSEDES NONE)

Prepared by: Maria Friedman

Reviewed by: _____ 6-14-7
Dave Kammerer, Technical Specialist — Date

Approved by: _____ 6-14-2007
Maria Friedman, Quality Assurance Manager — Date

Approved by: _____ 06/14/2007
William Nash, Environmental Health & Safety Coordinator — Date

Approved by: _____ 6/14/07
Elizabeth Winger, Laboratory Director — Date

Proprietary Information Statement:

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1. SCOPE AND APPLICATION

1.1. This standard operating procedure (SOP) describes the unique requirements that are not within the scope of procedures and policies routinely performed at STL Los Angeles (STL LA) for the analysis of air samples.

1.2. The practices and procedures in this SOP supplement the requirements and procedures found in laboratory SOPs and policies, the STL Quality Management Plan (QMP), and the STL LA Laboratory Quality Manual (LQM).

1.3. The requirements described herein must be followed for all Navy project air work directed under the "Department of Defense Quality Systems Manual for Environmental Laboratories, version 3, January 2006", whether received directly from the Navy prime contractor or subcontracted from another laboratory, either within or outside the STL network of laboratories.

1.4. For the purpose of this SOP, the term DOD QSM will refer to the "Department of Defense Quality Systems Manual for Environmental Laboratories, version 3, January 2006."

1.5. The Navy prime contractor is the only recognized authority to provide project-specific requirements or instructions that modify or supersede practices delineated in this SOP.

1.6. Any deviation from the method SOP, Navy-specific SOP, or project requirements must have prior Navy approval. Non-conformances are described in SOP SANA-QA-0018.

1.7. The target analytes and reporting limits (RLs) reported by the laboratory for Navy air projects may be found in section 8.

2. RESPONSIBILITIES

2.1. Analyst

2.3.1. Complies with the contents of this SOP for all Navy project air work being completed under the DOD QSM, unless the department manager/area supervisor or laboratory project manager (PM) communicates different project-specific requirements.

2.3.2. Follows practices and procedures described in applicable laboratory SOPs, policies, the STL QMP, and the STL LA LQM for operations not described in this SOP or other project-specific documents.

2.2. Department Manager/Area Supervisor

2.4.1. Ensures that this SOP is followed for all Navy project air work being completed under the DOD QSM, unless the laboratory PM communicates different project-specific requirements.

2.4.2. Ensures that practices and procedures described in applicable laboratory SOPs, policies, the STL QMP, and the STL LA LQM are followed for operations not specifically described in this SOP or other project-specific documents.

2.3. Project Manager

2.5.1. Effectively communicates to the laboratory staff when the DOD QSM requirements apply for each Navy air project. For example, requirements may be listed in the Client Requirements Checklist (for analyst's review) in the laboratory's information management system (LIMS).

2.5.2. Notifies the laboratory sample custodian and the department manager/area supervisor of the expected arrival of Navy air samples so that the requirements of this SOP may be followed.

2.5.3. Communicates other project-specific requirements to the department manager/area supervisor and/or analysts.

2.5.4. Obtains and provides project-specific documents from Navy prime contractors.

2.4. It is the responsibility of the laboratory director, the quality assurance (QA) manager, and the department manager/area supervisor of this facility to ensure that the procedure described is performed in full compliance with this SOP. It is also their responsibility to supply adequate training, materials, and equipment to enable the employee to perform the requirements of this SOP correctly.

3. DEFINITIONS

3.1. Please refer to the specific method SOPs.

4. SAFETY

4.1. Employees must abide by the policies and procedures in the Corporate Safety Manual (CSM), Lab Specific Addendum to the CSM, and this document.

4.2. Specific Safety Concerns and Requirements

4.2.1. Normal office dependent safety precautions must be taken in performing this SOP. If personnel are required to perform any portion of the procedure in the laboratory area, appropriate personal protective equipment and precautions described in the appropriate method SOPs must be followed.

5. QUALITY CONTROL

5.1. The quality control (QC) checks described below are not inclusive of all the QC requirements of the DOD QSM. Detailed QC requirements, including corrective actions, may be found in the tables in Appendix DOD-B of the DOD QSM. Additional corrective actions for failed QC checks may also be found in the appropriate method SOPs.

5.2. Demonstration of Analyst Capability

5.2.1. Prior to using any test method and at any time there is a significant change in instrument type, personnel, or test method, an initial demonstration of capability (IDOC) must be performed.

5.3. Method Detection Limit (MDL)

5.3.1. At initial set-up and subsequently once per 12-month period, an MDL study must be performed and verified immediately thereafter for each target analyte in each test method.

5.3.2. Navy air samples may not be analyzed on instrumentation that does not have valid MDLs.

5.3.3. MDLs may not be assigned values but must be experimentally derived and determined under strict adherence to 40 CFR 136, Appendix B.

5.4. Calibration

5.4.1. For the minimum five-point initial calibration (ICAL), one of the options below must be met:

5.4.1.1. Gas Chromatography/Mass Spectrometry (GC/MS) Analysis

5.4.1.1.1. Option 1: Relative Standard Deviation (RSD) for each analyte = 15%

5.4.1.1.2. Option 2: linear least squares regression r = 0.995

5.4.1.1.3. Option 3: non-linear regression - coefficient of determination (COD) $r^2 = 0.99$ (6 points shall be used for second order, 7 points shall be used for third order)

5.4.1.2. Gas Chromatography (GC) Analysis

5.4.1.2.1. Option 1: RSD for each analyte = 20%

5.4.1.2.2. Option 2: linear least squares regression r = 0.995

5.4.1.2.3. Option 3: non-linear regression - COD $r^2 = 0.99$ (6 points shall be used for second order, 7 points shall be used for third order)

5.4.2. An initial calibration verification (ICV) standard (i.e., from a source distinct from the stocks used for the initial calibration) must be analyzed after the calibration curve and prior to analysis of samples. The second source standard must meet the acceptance criteria stated below:

5.4.2.1. GC/MS Analysis

5.4.2.1.1. Value of second source for all analytes must be within $\pm$ 25% of expected value (initial source).

5.4.2.2. GC Analysis

5.4.2.2.1. Value of second source for all analytes must be within $\pm$ 20% of expected value (initial source).

5.4.3. For the daily continuing calibration verification (CCV), all analytes must be within $\pm$ 20% of the expected value from the ICAL.

5.4.3.1. GC/MS Analysis

5.4.3.1.1. Analyze CCV before sample analysis and every 12-hour analytical batch

5.4.3.2. GC Analysis

5.4.3.2.1. Analyze CCV before sample analysis and after every 10 field samples and at the end of the analytical sequence. Please note that GC/MS methods are exempt from the bracketing requirement.

5.5. Method Blank (MB)

5.5.1. All blanks required or recommended in the source reference method must be used. One MB is required for every analytical batch whether or not the source reference method includes a preparation step prior to analysis.

5.5.2. No analyte in the MB may exceed ½ the RL. For common laboratory contaminants, no analyte must be detected in the MB that is $\geq$ RL.

5.6. Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD)

5.6.1. One LCS/LCSD pair is required for every analytical batch and must contain all target analytes to be reported, including surrogates, unless otherwise dictated by project-specific requirements.

5.6.2. Since no specific control limits are defined in the DOD QSM for air analyses, laboratory-generated control limits will be used for Navy air projects. The number of analytes that may be allowed to fall outside acceptance limits will be determined and evaluated against the National Environmental Laboratory Accreditation Conference (NELAC) Standards described in the appropriate method SOPs.

5.7. Matrix Spike and Matrix Spike Duplicate (MS/MSD)

5.7.1. MS/MSD samples are not applicable to air testing methods. In lieu of an MS/MSD, an LCSD is analyzed in addition to an LCS (see section 5.4 above).

5.8. Confirmation of Positive GC Results

5.8.1. The confirmation of positive results from GC analysis is not performed for air testing methods.

6. ADDITIONAL DOD QSM REQUIREMENTS

6.1. Data Review

6.1.1. Each analyst is responsible for 100% review of the data generated. Documentation including nonconformance memos (NCM), narratives, and data review forms must be generated and reported with the project file.

6.1.2. An **independent peer review** of 100% of all Navy project data must be conducted. An individual qualified to perform the analytical method

completes the peer review. If only one individual is qualified to perform the analytical method, then management may designate the most appropriately qualified individual to complete the peer review. The following checks must be performed and documented:

6.1.2.1. 100% of manual entries for transcription errors

6.1.2.2. 100% of manual calculations for accuracy

6.1.2.3. Spot checks of computer calculations to verify program validity

6.1.2.4. Compliance with method and project-specific QC requirements

6.1.2.5. Completeness of raw data or supporting materials

6.1.2.6. Confirmation of spectral assignments and identification of tentatively identified compounds (TICs), when applicable

6.1.2.7. Deviations from method or requirements

6.1.2.8. Accuracy of reported values for dilutions

6.1.2.9. Reasonableness of results

6.1.3. An area supervisor or designee must perform the technical review. The technical review must include the following:

6.1.3.1. Check for compliance with method and project-specific requirements

6.1.3.2. Check for completeness of the reported information

6.1.3.3. Check for information for the report narrative

6.1.3.4. Evaluation of the reasonableness of the result

6.1.4. The same individual may not perform peer and supervisory review on a given data set. However, this requirement is waived if the area supervisor (or designee) is the <u>only qualified peer analyst</u> for a method. The requirement for technical or supervisory review is waived for the method in question. For data sets and methods where the technical or supervisory review has been waived, the area supervisor (or designee) must complete and document the peer review.

6.1.5. All manual integrations performed on any client sample must be discussed in the report narrative. The analyst who performed the manual integration must generate the NCM to relay to the PM the manual integration performed.

6.1.6. Project management review must be performed on 100% of all Navy project reports. The PM is authorized to release and sign final data reports. Project management reviews must be documented and enclosed in the project report file.

6.1.7. QA data review must be conducted on at least 10% of the project reports and is not incorporated into the review cycle prior to reporting. The review must include compliance with required QC practices, approved SOPs (including the Navy-specific SOP), and method and project requirements. QA review is independent of the data reporting process and may be conducted after the subject data have been reported to the client. The QA data review is a documented process. Issues with the data are forwarded to management, to the appropriate PM, and to the air lab for review and corrective action. Any corrective action deemed necessary must be addressed, documented, and closed. The final results of these audits will be stored in the QA files and copy enclosed with the project file.

6.2. Standard Operating Procedures

6.2.1. The laboratory must have an SOP for each referenced air method it performs. In order to ensure that SOPs reflect actual practice, they must be reviewed on a routine basis, at least once every 12 months.

6.2.2. All SOPs relevant to Navy air work and/or the DOD QSM must be reviewed at least annually and must be available prior to the analysis of any Navy air project samples.

6.2.3. The facility and corporate SOPs do not reference the control criteria for QC samples (e.g., LCS and surrogates). The latest and valid control limits are available in the laboratory's data reporting system.

6.3. Records Retention

6.3.1. In the absence of alternative project-specific client instructions, Navy project records must be kept for ten years.

6.4. Subcontracting

6.4.1. STL LA will not subcontract or use any other STL laboratory without obtaining prior written approval from the Navy. If contract requirements with the Navy prime contractor specify the use of other laboratories (including other STL laboratories), the contract provision supersedes this requirement. If the subcontracting decision is made independently at the laboratory, and not at the direction of the Navy prime contractor, then the guidelines below must be followed:

6.4.1.1. The subcontract laboratory must have Navy approval, if offered, for the proposed analyses.

6.4.1.2. Where any part of the testing covered under the National Environmental Laboratory Accreditation Program (NELAP) needs to be subcontracted, the subcontract laboratory must also possess NELAP accreditation for the tests to be performed.

6.4.1.3. The laboratory shall advise the client in writing of its intention to subcontract any portion of the testing to another party.

6.4.1.4. The samples must be maintained and processed under a documented chain of custody (COC).

6.4.1.5. STL LA must maintain full responsibility for ensuring that data quality and deliverables comply with the contract, method, and Navy requirements.

6.4.1.6. The laboratory shall retain records demonstrating that the above requirements have been met.

6.5. Recording of Date and Time of Sampling

6.5.1. Sampling Receiving staff records into the LIMS the date and time of sampling, obtained from the information provided by the client in the sample label and/or the COC record.

6.5.1.1. The absence of a recorded sampling time on the COC for any sample with a holding time of less than 48 hours is considered an anomaly that must be documented on the sample/cooler receipt form. The Sample Receiving staff must generate an NCM must also be filed and the client contacted for further instructions.

6.6. Recording of Date and Time of Analysis

6.6.1. Both the date and the time of sample analysis are considered essential information, regardless of the length of the holding time, which must be recorded in the associated laboratory bench sheet or logbook.

6.7. Accuracy in Recording Vacuum/Pressure

6.7.1. The vacuum or pressure of a canister sample recorded must be documented to the same or actual level of accuracy as indicated in the associated SOP (e.g., recording 14 psia vs. 14.0 psia).

6.8. Dilutions

6.8.1. Dilution of a sample is required when target analyte concentration(s) exceed the calibrated range of the analytical instrument. An attempt must be made to use the smallest dilution required to obtain a response near the center or in the upper half of the calibrated range. All dilutions must be indicated in notation of format 2X (2 times), 10X (10 times), nX (n times), etc. to indicate the number of additional volume of diluent added to an equivalent volume of sample in performing the dilution. Exceptions to this requirement will only be allowed when instrument software cannot be modified to change the printed dilution output format. The prepared sample matrix must not be altered by the dilution, except for the change in volume.

6.9. Training

6.9.1. Employee training must be completed following the instructions in SOP SANA-QA-0016, Employee Orientation and Training. Requirements for Demonstration of Capability (DOC) are discussed in detail in this SOP.

7. REFERENCES

7.1. STL QMP, current revision

7.2. STL LA LQM, current revision

7.3. Policy QA-SANA-002, Quality Control Program, current revision

7.4. Policy QA-SANA-010, Maintaining Time Integrity, current revision

7.5. SOP SANA-QA-0016, Employee Orientation and Training, current revision

7.6. Navy Installation Restoration Chemical Data Quality Manual, September 1999

7.7. Department of Defense Quality Systems Manual, Rev. 3, January 2006

7.8. Test Methods for Evaluating Solid Waste, Third Edition, SW-846, US EPA

7.9. Procedure for the Determination of the Method Detection Limit, 40CFR Part136, Appendix B

8. MISCELLANEOUS (FIGURES, TABLES, APPENDICES, ETC.)

Table 1: EPA TO-14A Target Analytes, RLs, and LCS/LCSD and Surrogates Acceptance Limits

Compound	RL, ppbv	LCS/LCSD and Surrogates Acceptance Limits		
		Lower Control Limit, %Recovery	Upper Control Limit, %Recovery	Relative Percent Difference (RPD)
Acetone	10	70	130	25
Benzene	2.0	70	130	25
Benzyl chloride	25	60	140	25
Bromodichloromethane	2.0	70	130	25
Bromoform	2.0	70	130	25
Bromomethane	2.0	70	130	25
2-Butanone (MEK)	10	60	140	25
Carbon disulfide	10	70	130	25
Carbon tetrachloride	2.0	70	130	25
Chlorobenzene	2.0	70	130	25
Dibromochloromethane	2.0	70	130	25
Chloroethane	4.0	70	130	25
Chloroform	2.0	70	130	25
Chloromethane	4.0	70	130	25
1,2-Dibromoethane (EDB)	2.0	70	130	25
1,2-Dichlorobenzene	2.0	70	130	25
1,3-Dichlorobenzene	2.0	70	130	25
1,4-Dichlorobenzene	2.0	70	130	25
Dichlorodifluoromethane	2.0	70	130	25
1,1-Dichloroethane	2.0	70	130	25
1,2-Dichloroethane	2.0	70	130	25
cis-1,2-Dichloroethene	2.0	70	130	25
trans-1,2-Dichloroethene	2.0	70	130	25
1,1-Dichloroethene	2.0	70	125	25
1,2-Dichloropropane	2.0	70	130	25
cis-1,3-Dichloropropene	2.0	70	130	25

trans-1,3-Dichloropropene	2.0	70	130	25
1,2-Dichloro-1,1,2,2-tetrafluoroethane	2.0	70	130	25
Ethylbenzene	2.0	70	130	25
4-Ethyltoluene	2.0	70	130	25
Hexachlorobutadiene	4.0	60	140	25
2-Hexanone	10	60	140	25
Methylene chloride	2.0	75	120	25
4-Methyl-2-pentanone (MIBK)	10	70	130	25
Styrene	2.0	70	130	25
1,1,2,2-Tetrachloroethane	2.0	65	130	25
Tetrachloroethene	2.0	70	130	25
Toluene	2.0	75	125	25
1,2,4-Trichlorobenzene	5.0	70	130	25
1,1,1-Trichloroethane	2.0	70	130	25
1,1,2-Trichloroethane	2.0	70	130	25
Trichloroethene	2.0	70	125	25
Trichlorofluoromethane	2.0	70	130	25
1,1,2-Trichloro-1,2,2-trifluoroethane	2.0	70	130	25
1,2,4-Trimethylbenzene	3.0	70	130	25
1,3,5-Trimethylbenzene	3.0	70	130	25
Vinyl acetate	10	70	130	25
Vinyl chloride	2.0	60	140	25
m-Xylene & p-Xylene	2.0	70	130	25
o-Xylene	2.0	70	130	25
Xylenes (total)	2.0	70	130	25
4-Bromofluorobenzene	n/a	70	130	n/a
1,2-Dichloroethane-d4	n/a	70	130	n/a
Toluene-d8	n/a	70	130	n/a

Table 2: EPA TO-15 Scan Target Analytes, RLs, and LCS/LCSD and Surrogates Acceptance Limits

Compound	RL, ppb (v/v)	LCS/LCSD and Surrogates Acceptance Limits		
		Lower Control Limit, %Recovery	Upper Control Limit, %Recovery	Relative Percent Difference (RPD)
Acetone	0.80	70	130	25
Benzene	0.20	70	130	25
Benzyl chloride	0.40	60	140	25
Bromodichloromethane	0.20	70	130	25
Bromoform	0.20	70	130	25
Bromomethane	0.20	70	130	25
2-Butanone (MEK)	1.0	60	140	25
Carbon disulfide	1.0	70	130	25
Carbon tetrachloride	0.20	70	130	25
Chlorobenzene	0.20	70	130	25
Dibromochloromethane	0.20	70	130	25
Chloroethane	0.40	70	130	25
Chloroform	0.20	70	130	25
Chloromethane	0.40	70	130	25
1,2-Dibromoethane (EDB)	0.20	70	130	25
1,2-Dichlorobenzene	0.20	70	130	25
1,3-Dichlorobenzene	0.20	70	130	25
1,4-Dichlorobenzene	0.20	70	130	25
Dichlorodifluoromethane	0.20	70	130	25
1,1-Dichloroethane	0.20	70	130	25
1,2-Dichloroethane	0.20	70	130	25
cis-1,2-Dichloroethene	0.20	70	130	25
trans-1,2-Dichloroethene	0.20	70	130	25
1,1-Dichloroethene	0.20	70	130	25
1,2-Dichloropropane	0.20	70	130	25
cis-1,3-Dichloropropene	0.20	70	130	25
trans-1,3-Dichloropropene	0.20	70	130	25
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.20	70	130	25
Ethylbenzene	0.20	70	130	25
4-Ethyltoluene	0.40	70	130	25
Hexachlorobutadiene	0.40	60	140	25
2-Hexanone	0.40	60	140	25
Methylene chloride	0.20	65	125	25

4-Methyl-2-pentanone (MIBK)	0.40	70	130	25
Styrene	0.20	70	130	25
1,1,2,2-Tetrachloroethane	0.20	55	135	25
Tetrachloroethene	0.20	70	130	25
Toluene	0.30	65	135	25
1,2,4-Trichlorobenzene	0.80	70	130	25
1,1,1-Trichloroethane	0.20	70	130	25
1,1,2-Trichloroethane	0.20	70	130	25
Trichloroethene	0.20	65	135	25
Trichlorofluoromethane	0.40	70	130	25
1,1,2-Trichloro-1,2,2-trifluoroethane	0.40	70	130	25
1,2,4-Trimethylbenzene	0.40	70	130	25
1,3,5-Trimethylbenzene	0.40	70	130	25
Vinyl acetate	1.0	70	130	25
Vinyl chloride	0.20	60	140	25
m-Xylene & p-Xylene	0.50	70	130	25
o-Xylene	0.20	70	130	25
Xylenes (total)	0.50	70	130	25
4-Bromofluorobenzene	n/a	70	130	n/a
1,2-Dichloroethane-d4	n/a	70	130	n/a
Toluene-d8	n/a	70	130	n/a

Table 3: EPA TO-15 SIM Target Analytes, RLs, and LCS/LCSD and Surrogates Acceptance Limits

Compound	RL, ppb (v/v)	LCS/LCSD and Surrogates Acceptance Limits		
		Lower Control Limit, %Recovery	Upper Control Limit, %Recovery	Relative Percent Difference (RPD)
Benzene	0.047	70	125	20
Chloroform	0.014	75	120	20
1,1-Dichloroethane	0.0050	70	120	20
1,2-Dichloroethane	0.0070	70	125	20
cis-1,2-Dichloroethene	0.014	65	120	20
trans-1,2-Dichloroethene	0.014	70	130	20
1,1-Dichloroethene	0.010	70	120	20
Methylene chloride	0.12	65	120	20
Tetrachloroethene	0.020	70	125	20
1,1,1-Trichloroethane	0.020	70	130	20
1,1,2-Trichloroethane	0.018	70	120	20
Trichloroethene	0.0025	70	120	20
Vinyl chloride	0.0050	70	125	20
4-Bromofluorobenzene	n/a	70	130	n/a
1,2-Dichloroethane-d4	n/a	70	130	n/a
Toluene-d8	n/a	70	130	n/a

Table 4: ASTM-D1946 Target Analytes, RLs, and LCS/LCSD Acceptance Limits

Compound	RL, % (v/v)	LCS/LCSD Acceptance Limits		
		Lower Control Limit, %Recovery	Upper Control Limit, %Recovery	Relative Percent Difference (RPD)
Carbon dioxide	0.010	75	125	20
Carbon monoxide	0.0010	70	130	30
Ethane	0.00050	70	130	30
Ethene	0.00050	70	130	30
Helium	0.020	70	130	30
Hydrogen	0.020	70	130	30
Methane	0.00020	75	135	20
Nitrogen	1.0	70	130	30
Oxygen	0.20	70	130	30

9. SOP REVISION HISTORY

9.1. Not applicable at this time.

APPENDIX B

HISTORICAL DATA SUMMARIES

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY
HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
15	Hospital – Radiology	X-ray processing Rack washing	8	31	Heavy metals Developer Chemicals	SRU	SE SRU influent SE SRU effluent SE Processor	Grab Grab Grab
15	Hospital –Surgical Services	Floor washing Sterilization	11	13	BOD, COD, TDS	None	None	None
15	Hospital-Laboratory	Sinks	< 1	< 1	Chemicals used in analysis	None	None	None
15	Hospital - Boiler Room	Boiler/ chiller system	< 1	< 1	None	None	None	None
16	AAFES Washrack	Vehicle washing	6,600	12,000	POLs, surfactants, oil & grease, TSS	Sand trap #54	Washrack	Dye test
17	Flight Medicine (Dental)	Floor washing X-ray processing	2	17	Heavy metals (silver), surfactants	SRU at Building 15	None	None
18	AAFES Service Station	Floor washing	1	5	POLs, oil & grease, TSS	OWS #55	None	None
56	Washrack associated with Building 56	Vehicle washing	720	720	POLs, BOD, COD, oil & grease, TSS	OWS #14	None	None
138	Motorpool Washrack	Vehicle washing Equipment washing Floor washing	9,000	16,200	Surfactants, POLs, oil & grease, BOD, COD, TSS	OWS #9	OWS influent OWS effluent	Grab Grab
193	General and Special Purpose Maintenance	Floor washing	24	60	BOD, COD, surfactants, oil & grease, POLs, TSS	Grit chamber OWS #8B	None	None

Key at end of Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY
HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
195	Allied Trades	Radiator test tank Glass grinding coolant	22	155	POLs, BOD, COD, heavy metals, VOCs, SVOCs, TSS	Screens in tank	Radiator test tank	Grab
198	General Purpose Shop	Floor washing	41	60	POLs, BOD, COD, surfactants, oil & grease, TSS	Grit chamber OWS #7A OWS #7B	None	None
231	Auto Hobby Shop	Floor washing Equipment washing Vehicle washing AFFF	112	1,509	BOD, COD, surfactants, heavy metal, VOCs, SVOCs, oil & grease, POLs, TSS	Sand trap #35C OWS #35B	OWS influent OWS effluent	Grab Grab
273	Dental Clinic	Floor washing X-ray processing	19	27	Heavy metal (silver), surfactants	SRU	SRU influent SRU effluent	Grab Grab
282	Lockheed Martin-Corrosion Control and Wheel and Tire Shop	Floor washing (discharged to parts washer)	0	0	None	OWS #11A OWS #11B	None	None
285	German Air Force Parking Hangar	Floor washing AFFF	9	30	POLs, surfactants, TSS	OWS #58 and AFFF holding pond	OWS influent OWS effluent	Grab Grab
286	German Air Force Maintenance Hangar	Floor washing AFFF	9	30	POLs, oil & grease, TSS, surfactants	OWS #58 and AFFF holding pond	None	None
300	Lockheed Martin-Engine Shop	Floor washing	7	50	POLs, oil & grease, TSS, surfactants	Sediment trap #13	OWS influent OWS effluent	Grab Grab
301	Lockheed Martin-Phase Maintenance	Floor washing (discharged at Building 309)	0	0	POLs, oil & grease, TSS	None	Floor wash water	Grab

Key at end of Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
304	Fire Department (Station 1)	Floor washing Vehicle washing Equipment washing	2,585	2,730	POLs, oil & grease, BOD, surfactants, TSS	Grease trap OWS #19B OWS #40	Sanitary sewer	Dye test
304A	Fire Truck Maintenance	Floor washing AFFF	26	90	POLs, COD, BOD, surfactants, oil & grease, TSS	OWS #19B	None	None
306	T-38 Washrack	Aircraft washing	91	1,250	Oil & grease, POLs, VOCs, SVOCs, metals	OWS #18	None	None
308	Lockheed Martin-AGE Shop	Floor washing (discharged to Building 309)	0	0	Oil & grease, POLs, COD, BOD, surfactants, TSS	None	None	None
309	Lockheed Martin-AGE Shop	Floor washing (includes flow from Buildings 301, 308 and 315) Ground equipment washing Vehicle washing	107	1,130	POLs, BOD, TSS, surfactants, oil & grease	OWS #10A OWS #10B	None	None
315	Lockheed Martin - Fuel Cell Repair	Floor washing (discharged to Building 309 washrack)	0	0	None	None	Floor wash water	Grab
332	Visual Information Support	Photoprocessing	270	278	Heavy metals, Process/ developer chemicals	SRU	SRU influent SRU effluent C-41 Processor effluent	Grab Grab Grab
374	Pest Management	Vehicle washing Equipment washing Floor washing	231	1,020	Herbicides, pesticides, POLs, oil & grease, BOD, COD, surfactants, TSS	OWS #51	OWS effluent	Grab
578	48th Air Rescue	Engine washing, aircraft washing, floor washing, trench drain flushing, AFFF	39	1005	BOD, oil & grease, POLs, VOCs, SVOCs, metals	OWS #53	Helicopter engine wash water	Grab

Key at end of Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
704	POL Maintenance Washrack	Vehicle washing	14	340	POLs, surfactants, oil & grease, TSS	OWS #1	OWS influent OWS effluent	Grab Grab
702	Refueling Vehicle Maintenance	Floor washing	11	80	POLs, oil & grease, COD, BOD, surfactants, TSS	Grit chamber OWS #2	OWS influent OWS effluent	Grab Grab
800	Propulsion Flight Engine Repair	Floor washing Trailer washing	21	70	POLs, oil & grease, surfactants, VOCs, SVOCs, metals, TSS	OWS #23B	Potable water OWS influent OWS effluent Sanitary sewer	Grab Grab Grab Dye test
822	Aerospace Ground Equipment Maintenance	Floor washing Vehicle washing Equipment washing	177	1,215	POLs, antifreeze, BOD, COD, surfactants, heavy metals, TSS	OWS #25B	OWS influent OWS effluent	Grab Grab
827	AGE Washrack	Vehicle washing Equipment washing Floor washing	376	685	POLs, oil & grease, BOD, COD, surfactants, TSS	OWS #26	OWS influent OWS effluent	Grab Grab
830	Structural Maintenance	AFFF	0	0	BOD, heavy metals, VOCs, SVOCs	OWS #27A OWS #27B	None	None
837	Aerospace Fuels Laboratory	Canister rinsing Glassware rinsing	36	50	POLs, oil & grease, surfactants, VOCs, SVOCs	OWS #41	OWS influent OWS effluent	Grab Grab
844	Dyncorp Vehicle Maintenance	None	0	0	None	OWS #36B Grit chamber	None	None
851	Non-Destructive Inspection	Floor washing Vehicle washing Liquid fluorescent penetrant X-ray processing	64	1,346	BOD, COD, heavy metals, surfactants, TSS	SRU	SRU influent SRU effluent Dye penetrant rinse water X-ray processor effluent	Grab Grab Grab Grab

Key at end of Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY
HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
856	Dyncorp Washrack at the Paint and Body Shop	Vehicle Washing	514	5,760	POLs, oil & grease, BOD, COD, surfactants, TSS	OWS #38	OWS influent OWS effluent	Grab Grab
866	Wheel and Tire Repair and Reclamation/ Hydraulics	Floor washing	1	10	POLs, surfactants, oil & grease, TSS	None	Sanitary Sewer	Dye test
868	Fuel Systems Repair/ 7th FS Maintenance Hangar	Floor washing Vehicle washing AFFF (deactivated)	76	510	POLs, oil & grease, surfactants, TSS	AFFF holding pond	None	None
869	Fire Department (Station 2)	Floor washing Vehicle washing Equipment washing	442	3,060	POLs, oil & grease, BOD, surfactants, TSS	OWS #44A OWS #44B	NW outdoor trench drain	Grab
877	Phase Inspection/ Egress	Floor washing	7	36	POLs, oil & grease, TSS, VOCs, SVOCs	OWS #37A	OWS influent OWS effluent	Grab Grab
897	Photo Lab	Floor washing Equipment washing Photoprocessing	376	1,185	Heavy metals (silver), chemicals in developing process	Primary SRU Secondary SRU	Primary SRU influent and effluent Secondary SRU effluent Flexicolo or RA Developer effluent	Grab Grab Grab Grab
898	Aircraft Maintenance 9th FS	Floor washing AFFF	2	175	POLs, BOD, COD, oil & grease, TSS	None	None	None
901	Transportation/AGE	Floor washing Mop rinsing	10	40	POLs, BOD, COD, surfactants, oil & grease, TSS	None	None	None
902	Structural Maintenance /Supply	Floor washing Mop rinsing	16	200	Surfactants, oil & grease, TSS	None	None	None

Key at en Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY
HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
907	MMS Vehicle Washrack	Vehicle washing Equipment washing	60	420	POLs, BOD, COD, surfactants, oil & grease, TSS	OWS #29A OWS #29B	OWS #29A influent OWS #29B effluent	Grab Grab
918	MMS Equipment Washrack	Floor washing Equipment washing Vehicle washing ROWPU purging	219	950	POLs, surfactants, oil & grease, TSS	OWS #39 (outside washrack) OWS #39B and OWS #39C (Inside trench drains)	OWS #39 influent OWS #39 effluent	Grab Grab
1078/1080	Lockheed Martin Services, Inc. and associated Washrack	Vehicle washing Aircraft washing	148	1,495	POLs, surfactants, oil & grease, TSS, metals	OWS #31 (1080) OWS #32 (1078 – washrack)	OWS #33 influent OWS #32 effluent	Grab Grab
1178	Welding, Nondestructive Inspection (NDI), Paint Shop	Floor washing Fluorescent penegraph TIG welder coolant	7	33	Heavy metals, VOCs, SVOCs, TSS	None	Dye penetrant rinse water	Grab
1185	Heat Treatment	TIG welder coolant Heat treating furnace coolant	824	2,882	POLs, TSS	None	None	None
1226	Equipment Maintenance	Floor washing Trailer washing	20	75	POLs, oil & grease, surfactants, TSS	OWS #56	None	None
11285	German Air Force Test Cell	None	0	0	None	OWS #57	None	None
11648	Lockheed Martin-F4 Test Cell	Floor washing	11	75	POLs, TSS	OWS #22	None	None
11649	F-117A Test Cell	Floor washing	11	75	POLs, oil & grease, surfactants, TSS	OWS #22	OWS effluent at manhole	Grab
21812	8th FS Hangarette (seven total)	Floor washing AFFF	63	525	POLs, BOD, metals TSS	OWS #46 AFFF holding pond	OWS influent OWS effluent OWS/AFFF pond/lift station	Grab Grab Grab/Dye test

Key at end of Table

Table 1-7

SUMMARY OF RESULTS, INDUSTRIAL WASTEWATER PRETREATMENT SURVEY
HOLLOMAN AFB

Building Number	Building Name	Industrial Wastewater Flow Type(s)	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)	Pollutants of Concern	Existing Pretreatment	Proposed Sampling Location(s)	Sample Type(s)
21818	7th FS Hangarette (seven total)	Floor washing AFFF	28	210	POLs, BOD, metals TSS	OWS #46 AFFF holding pond	Floor wash water	Grab
21820	9th FS Hangarette (eight total)	Floor washing AFFF	32	200	POLs, BOD, metals TSS	OWS #46 AFFF holding pond	None	None
TOTAL INDUSTRIAL WASTEWATER FLOW			23,502	60,114				
-	WWTP	Total Influent	—	—	POLs, BOD, COD, metals, TSS, VOCs	—	Influent Effluent	3-day Composite 3-day Composite
15	Hospital	X-ray processing Sterilization Floor washing	—	—	BOD, COD, surfactants, VOCs, SVOCs, TDS, metals, phosphates, sulfides, chlorides	SRUs	Manhole 247A	2-day Composite
-	German Air Force	AFFF fire suppressant Floor washing	—	—	POLs, BOD, TDS, TSS, surfactants	Various OWSs AFFF pond	Manhole 336A OWS/AFFF Pond/Lift Station	2-day Composite Dye test
-	Lockheed Facilities	Floor washing Aircraft washing Vehicle washing Ground equipment washing	—	—	POCs, TSS, BOD, COD, TDS, surfactants	Various OWSs	Manhole 280A	2-day Composite
-	UST Leak Area	Fuel contaminated groundwater	—	—	POLs, COD, BOD, phenol, TSS, TDS, SVOCs	—	Manhole 418A	2-day Composite
-	Inactive manhole 400	Fuel contaminated groundwater	—	—	Oil & grease, POLs, VOCs	None	Manhole 400	Grab
-	Inactive manhole 402	Fuel contaminated groundwater	—	—	Oil & grease, POLs, VOCs	None	Manhole 402	Grab
-	Inactive manhole 403	Fuel contaminated groundwater	—	—	Oil & grease, POLs, VOCs	None	Manhole 403	Grab

Key at end of Table

Key:

AFFF -	Aqueous Film-Forming Foam
AGE -	Aerospace Ground Equipment
BOD -	Biochemical Oxygen Demand
COD -	Chemical Oxygen Demand
FS -	Fighter Squadron
NDI -	Non-Destructive Inspection
OWS -	In-Ground Oil/Water Separator
POLs -	Petroleum, Oil, and Lubricants
RUWPU -	Reverse Osmosis Water Purification Unit
SE -	Southeast
SRU -	Silver Recovery Unit
SVOCs -	Semi-Volatile Organic Compounds
TDS -	Total Dissolved Solids
TIG -	
TSS -	Total Suspended Solids
UST -	Underground Storage Tank
VOCs -	Volatile Organic Compounds
WWTP -	Wastewater Treatment Plant

Table 1-8

SUMMARY OF OIL/WATER SEPARATOR SURVEY RESULTS, APRIL 1997
HOLLOMAN AFB

Building No.	Building Name	OWS/Sand Trap #	Condition
16	AAFES Washrack	Sand Trap #54	Good
18	AAFES Service Station	OWS #55	Out of service (floor drains sealed)
56	Washrack	OWS #14	Clogging problems in drain
138	Motorpool Washrack	OWS #9	Skimmer below static water level
193	General and Special Purpose Maintenance	OWS #8B	Oil and debris in all three chambers, flow blockage to downstream manhole
198	General Purpose Shop	OWS #7A OWS #7B	Oil in all three chambers
231	Auto Hobby Shop	Sand Trap #35C OWS #35B	Strong odor in OWS
282	Lockheed Martin Corrosion Control and Wheel and Tire Shop	OWS #11A OWS #11B	#11A clean and dry, #11B had sheen
285 286	German Air Force Parking Hangar and German Air Force Maintenance Hangar	OWS #58	Good
300	Lockheed Martin Engine Shop	Sediment Trap #13	Good
304	Fire Department (Station 1)	OWS #19B OWS #40	Good
304A	Fire Truck Maintenance	OWS # 19B	Past problems with overflows
306	T-38 Washrack	OWS #18	Not known
309	Lockheed Martin AGE Shop	OWS #10A OWS #10B	Oil and solids in both chambers of #10A, oil in all three chambers of #10B
374	Pest Management	OWS #51	Good
578	48th Air Rescue	OWS #53	Not known
702	Refueling Vehicle Maintenance	OWS #2	Oil in all three chambers
704	Vehicle Washrack	OWS #1	Good, no oil in effluent chamber
800	Propulsion Flight Engine Repair	OWS #23B	Not known
822	AGE Maintenance	OWS #25B	Not known
827	AGE Washrack	OWS #26	Emulsified oil in effluent chamber
830	Structural Maintenance	OWS #27A OWS #27B	# 27A not in use, # 27B clean – no wastewater produced here
837	Aerospace Fuels Laboratory	OWS #41	Effluent chamber had more oil than the influent chamber, very strong odor
844	Dyncorp Vehicle Maintenance	OWS #36B	Not known
856	Dyncorp Washrack at Paint and Body Shop	OWS #38	Oil in effluent chamber
869	Fire Department (Station 2)	OWS #44A OWS#44B	Good
877	Phase Inspection/Egress	OWS #37A	Oil in all chambers

Table 1-8

SUMMARY OF OIL/WATER SEPARATOR SURVEY RESULTS, APRIL 1997
HOLLOMAN AFB

Building No.	Building Name	OWS/Sand Trap #	Condition
907	MMS Vehicle Washrack	OWS #29A OWS #29B	Drain baskets clogged, #29A had strong odor, #29B needs to be cleaned
918	MMS Equipment Washrack	OWS #39 (outside washrack) OWS #39B and OWS #39C (inside trench drains)	All need cleaning
1078	Lockheed Martin Services Washrack	OWS #32	Not known
1080	Lockheed Martin Services	OWS #31	Not known
1226	Equipment Maintenance	OWS #56	Could not be opened
11285	German Air Force Test Cell	OWS #57	Not known
11648 11949	Lockheed Martin F-4 Test Cell F-117A Test Cell	OWS #22	Not known
21812 21818 21820	8th FS Hangarette 7th FS Hangarette 9th FS Hangarette	OWS #46	Good

Key:

AGE = Aerospace ground equipment.
FS = Fighter Squadron.
OWS = Oil/water Separator.

Table 1-9

INDUSTRIAL WASTEWATER SOURCE CATEGORIES AND SUMMARY OF ESTIMATED FLOW RATES HOLLOMAN AFB

Source Category	Average Daily Flow (gallons)	Maximum Daily Flow (gallons)
Vehicle Washing	17,071	39,075
Equipment Washing	3,746	8,692
Floor Washing	865	4,240
Boiler/chiller/cooling water	832	2,896
Photoprocessing/X-ray/NDI	665	1,977
Aircraft Washing	235	2,684
RUWPU Purging/radiator tank testing	88	550
Totals	23,502	60,114

APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
TPH					From [3]NMED TPH SSLs
Diesel #2 / crankcase oil	NA	1,800	1,720		880
#3 and #6 Fuel Oil	NA	1,400	1,340		860
Kerosene and jet fuel	NA	3,000	2,860		940
Mineral oil dielectric fluid	NA	3,700	3,640		1,560
Unknown oil	NA	2,300	200		800
Waste oil	NA	NA	Constituents		2,500
Gasoline	NA	NA	Constituents		Constituents
Metals: Method 6010B/6020					From [4]NMED SSLs
Aluminum	7429-90-5		5,000		7.78E+04
Antimony	7440-36-0			6	3.13E+01
Arsenic	7440-38-2	100		10	3.90E+00
Barium	7440-39-3	1000		2,000	1.56E+04
Beryllium	7440-41-7			4	1.56E+02
Cadmium	7440-43-9	10		5	3.90E+01
Calcium	7440-70-2				
Chromium, Total	7440-47-3	50		100	1.00E+05
Chromium VI	7440-47-3				2.34E+02
Cobalt	7440-48-4		50		1.53E+03
Copper	7440-50-8		1,000		3.13E+03
Iron	7439-89-6		1,000		2.35E+04
Lead	7439-92-1	50		15 AL	4.00E+02
Molybdenum	7439-98-7		1,000		3.91E+02
Magnesium	7439-95-4				
Manganese	7439-96-5		200		3.59E+03
Nickel	7440-02-0		200		1.56E+03
Potassium	7440-09-7				
Selenium	7782-49-2	50		50	3.91E+02

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
Silver	7440-22-4	50			3.91E+02
Sodium	7440-23-5				
Strontium	7440-24-6				4.69E+04
Tin	7440-31-5				
Titanium	7440-32-6				
Vanadium	7440-62-2				7.82E+01
Zinc	7440-66-6		10,000		2.35E+04

Table C-1				
Applicable or Relevant and Appropriate Requirement- Based Action Levels				
		Groundwater (µg/L)		**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC	**[2]Federal Primary MCLs**	
		A. Human Health / **B. Other Standards**	**Non-Risk Based**	
Pesticides: Method 8081A				From [4]NMED SSLs
4,4'-DDD	72-54-8			2.44E+01
4,4'-DDE	72-55-9			1.72E+01
4,4'-DDT	50-29-3			1.72E+01
Aldrin	309-00-2			2.84E-01
Chlordane	57-74-9		2	1.62E+01
Dieldrin	60-57-1			3.04E-01
Endosulfan I	959-98-8			3.67E+02
Endosulfan II	33213-65-9			
Endosulfan sulfate	1031-07-8			
Endri	72-20-8		2	1.83E+01
Endrin aldehyde	7421-93-4		2	
Endrin ketone	53494-70-5		2	
Heptachlor	76-44-8		0.4	1.08E+00
Heptachlor epoxide	1024-57-3		0.2	
Methoxychlor	72-43-5		40	
Toxaphene	8001-35-2		3	4.42E+00
alpha-BHC	319-84-6			9.02E-01
alpha-Chlordane	5103-71-9		2	
beta-BHC	319-85-7			3.16E+00
delta-BHC	319-86-8		0.2	
gamma-BHC (Lindane)	58-89-9		0.2	4.37E+00
gamma-Chlordane	5103-74-2		2	
Chlorinated Herbicides: Method 8151A				From [4]NMED SSLs
2,4,5-T	93-76-5			
2,4,5-TP (Silvex)	93-72-1		50	
2,4-D	94-75-7		70	
2,4-DB	94-82-6			

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			Soil (mg/Kg)
		[1]NM Groundwater Standards 20.6.2 NMAC		[2]Federal Primary MCLs	
		A. Human Health	B. Other Standards	Non-Risk Based	
Dalapon	75-99-0			200	
Dicamba	1918-00-9				
Dichloroprop	120-36-5				
Dinoseb	88-85-7			7	
MCPA	94-74-6				
MCPP (Mecoprop)	93-65-2				
Pentachlorophenol	87-86-5			1	2.98E+01
Picloram	1918-02-1			500	

Table C-1				
Applicable or Relevant and Appropriate Requirement- Based Action Levels				
		Groundwater (µg/L)		**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC	**[2]Federal Primary MCLs**	
		A. Human Health / **B. Other Standards**	**Non-Risk Based**	
Volatile Organics: Method 8260B				From [4]NMED SSLs
1,1,1-Trichloroethane	71-55-6	60	200	5.63E+02
1,1,2,2-Tetrachloroethane	79-34-5	10		5.55E+00
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1			3.28E+03
1,1,2-Trichloroethane	79-00-5	100	5	1.19E+01
1,1-Dichloroethane	75-34-3			
1,1-Dichloroethene	75-35-4	5	7	2.06E+02
1,2,4-Trichlorobenzene	120-82-1		70	6.93E+01
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8		0.2	1.84E+00
1,2-Dibromoethane (EDB)	106-93-4		0.05	5.04E-01
1,2-Dichlorobenzene	95-50-1		600	3.74E+01
1,2-Dichloroethane	107-06-2	10	5	6.04E+00
1,2-Dichloropropane	78-87-5		5	6.00E+00
1,3-Dichlorobenzene	541-73-1			3.26E+01
1,4-Dichlorobenzene	106-46-7		75	3.95E+01
2-Butanone (MEK)	78-93-3			3.18E+04
2-Hexanone (Methyl Butyl Ketone)	591-78-6			
4-Methyl-2-pentanone (MIBK)	108-10-1			
Acetone	67-64-1			2.18E+04
Benzene	71-43-2	10	5	1.03E+01
Bromochloromethane	74-97-5		80	
Bromodichloromethane	75-27-4		80	1.44E+01
Bromoform	75-25-2		80	
Bromomethane (Methyl Bromide)	74-83-9			8.51E+00
Carbon disulfide	75-15-0			4.60E+02
Carbon tetrachloride	56-23-5	10	5	3.47E+00
Chlorobenzene	108-90-7		100	1.94E+02
Chloroethane (Ethyl Chloride)	75-00-3			6.33E+01

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
Chloroform	67-66-3	100		80	4.00E+00
Chloromethane (Methyl Chloride)	74-87-3				2.18E+01
cis-1,2-Dichloroethene	156-59-2			70	7.65E+01
cis-1,3-Dichloropropene	10061-01-5				
Cyclohexane	110-82-7				
Dibromochloromethane	124-48-1			80	1.48E+01
Dichlorodifluoromethane	75-71-8				1.61E+02

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
Ethylbenzene	100-41-4	750		700	1.28E+02
Isopropylbenzene (Cumene)	98-82-8				
Methyl Acetate	79-20-9				3.76E+04
Methyl tert-butyl ether (MTBE)	1634-04-4				
Methylcyclohexane	108-87-2				7.89E+01
Methylene Chloride (Dichloromethane)	75-09-2	100		5	1.82E+02
Styrene	100-42-5			100	1.00E+02
Tetrachloroethene	127-18-4	20		5	1.25E+01
Toluene	108-88-3	750		1,000	2.52E+02
trans-1,2-Dichloroethene	156-60-5			100	1.12E+02
trans-1,3-Dichloropropene	10061-02-6				
Trichloroethene	79-01-6			5	
Trichlorofluoromethane	75-69-4				5.88E+02
Vinyl chloride (child)	75-01-4	1		2	2.25E+00
Xylenes (total)	1330-20-7	620		10,000	8.20E+01
Semi-Volatile Organics: Method 8270C					From [4]NMED SSLs
1,1'-Biphenyl	92-52-4				3.08E+03
1-Methylnaphthalene	90-12-0				
2,4,5-Trichlorophenol	95-95-4				6.11E+04
2,4,6-Trichlorophenol	88-06-2				6.11E+00
2,4-Dichlorophenol	120-83-2				1.83E+02
2,4-Dimethylphenol	105-67-9				1.22E+03
2,4-Dinitrophenol	51-28-5				1.22E+02
2,4-Dinitrotoluene	121-14-2				1.22E+02
2,6-Dinitrotoluene	606-20-2				
2-Chloronaphthalene	91-58-7				
2-Chlorophenol	95-57-8				1.66E+02
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	534-52-1				
2-Methylnaphthalene	91-57-6				

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
2-Methylphenol (o-Cresol)	95-48-7				
2-Nitroaniline	88-74-4				
2-Nitrophenol	88-75-5				
3,3'-Dichlorobenzidine	91-94-1				1.08E+01
3-Nitroaniline	99-09-2				
4-Bromophenyl phenyl ether	101-55-3				
4-Chloro-3-methylphenol	59-50-7				

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
4-Chloroaniline	106-47-8				
4-Chlorophenyl phenyl ether	7005-72-3				
4-Methylphenol (p-Cresol)	106-44-5				
4-Nitroaniline	100-01-6				
4-Nitrophenol	100-02-7				
Acenaphthene	83-32-9				3.73E+03
Acenaphthylene	208-96-8				
Acetophenone	98-86-2				1.48E+03
Anthracene	120-12-7				2.20E+04
Atrazine	1912-24-9			3	
Benzaldehyde	100-52-7				
Benzo(a)anthracene	56-55-3				6.21E+00
Benzo(a)pyrene	50-32-8			0.2	6.21E-01
Benzo(b)fluoranthene	205-99-2				6.21E+00
Benzo(g,h,i)perylene	191-24-2				
Benzo(k)fluoranthene	207-08-9				
bis(2-Chloroethoxy)methane	111-91-1				
bis(2-Chloroethyl)ether	111-44-4				2.44E+00
bis(2-Chloroisopropyl)ether [2,2'-oxybis(1-chloropropane)]	108-60-1				3.87E+01
bis(2-ethylhexyl)phthalate	117-81-7				3.47E+02
Butyl benzyl phthalate	85-68-7				
Caprolactam	105-60-2				
Carbazole	86-74-8				
Chrysene	218-01-9				6.15E+02
Dibenz(a,h)anthracene	53-70-3				6.21E-01
Dibenzofuran	132-64-9				1.42E+02
Diethyl phthalate	84-66-2				4.89E+04
Dimethyl phthalate	131-11-3				1.00E+05
Di-n-butyl phthalate	84-74-2				6.11E+03

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
Di-n-octyl phthalate	117-84-0				
Fluoranthene	206-44-0				2.29E+03
Fluorene	86-73-7				2.66E+03
Hexachlorobenzene	118-74-1			1	3.04E+00
Hexachlorobutadiene	87-68-3				
Hexachlorocyclopentadiene	77-47-4			50	3.66E+02
Hexachloroethane	67-72-1				6.11E+01

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	
Indeno(1,2,3-cd)pyrene	193-39-5				
Isophorone	78-59-1				5.12E+03
Naphthalene	91-20-3				7.95E+01
Nitrobenzene	98-95-3				2.28E+01
N-Nitroso-di-n-propylamine	621-64-7				
N-Nitrosodiphenylamine	86-30-6				9.93E+02
Pentachlorophenol	87-86-5			1	2.98E+01
Phenanthrene	85-01-8				1.83E+03
Phenol	108-95-2				1.83E+04
Pyrene	129-00-0				2.29E+03
Method 300.0					From [4]NMED SSLs
Chloride	16887-00-6		250,000		
Nitrate	14797-55-8	10,000		10,000	1.00E+05
Nitrite	14797-65-0			1,000	7.82E+03
Orthophosphate	PO4				
Perchlorate	14797-73-0				
Sulfate	14808-79-8		600,000		
Radioactivity:				pCi/L	From [5]NMED Radioisotope SSLs, pCi/g
Carbon 14				2,000	2
Tritium				20,000	4
Radium 226				5	0.016
Radium 228				5	0.016

Footnotes

[1]New Mexico Water Quality Control Commission's (WQCC) groundwater standards for contaminants (20.6.2.3103 NMAC)

[2]EPA's National Priority Drinking Water Standards Maximum Contaminant Levels (MCLs).

[3] *NMED TPH Screening Guidelines (October, 2006)*.

[4]NMED's *Technical Background Document for Development of Soil Screening Levels (June 2006)*

Table C-1					
Applicable or Relevant and Appropriate Requirement- Based Action Levels					
		Groundwater (µg/L)			**Soil (mg/Kg)**
		[1]NM Groundwater Standards 20.6.2 NMAC		**[2]Federal Primary MCLs**	
		A. Human Health	**B. Other Standards**	**Non-Risk Based**	

[5] *Soil Screening Guidance for Radionuclides: Technical Background Document (October 2000)*

TABLE C-1
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
GROUNDWATER

List of Analytes

1 - Analyze for "Petroleum-Related Contaminants" as defined in NMED TPH Screening Guidelines
2 - Analyze for "Petroleum-Related Contaminants" as defmed in NMED TPH Screening Guidelines
3 - The value for hexavalent chromium (CAS No. 18540-29-9) is used as surrogate Region 9 PRG, SW 62-777, 62-302, NRWQC, and Region 4 SW Chronic values for this compound.
4 - The value for mercury chloride (CAS No. 7487-94-7) is used as a surrogate Region 9 PRG value for this compound.
5 - The value for thallium and compounds (CAS No. 7446-18-6) is used as a surrogate Region 9 PRG value for this compound.
6 - The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
7 - The value for endosulfan (CAS No. 115-29-7) is used as a surrogate value for this compound.
The value for endrin (CAS No. 72-20-8) is used as a surrogate value for this compound.
8 - The value for chlordane (CAS No. 54-74-9) is used as a surrogate MCL value for this compound.
9 - The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
10 - The value for gamma-BHC (CAS No. 58-89-9) is used as a surrogate MCL, Region 9 PRG, SW 62-777, 62-302, and Region 4 SW Chronic values for this compound.
11 - The value for total PCBs (CAS No. 1336-36-3) is used as a surrogate value for this compound, except for Region 9 PRG value.
12 - The value for methyl isobutyl ketone (CAS No. 108-10-1) is used as surrogate Region 9 PRG and SW 62-777 values for this compound.
13 - The value for bromodichloromethane (CAS No. 75-27-4) is used as Region 9 PRG, SW 62-777, and 62-302 surrogate values for this compound.
14 - The value for 1,3-dichloropropene (CAS No. 542-75-6) is used as a surrogate value for this compound.
15 - The value for 4-nitrophenol (CAS No. 100-02-7) is used as a surrogate value for this compound.
16 - The value for acenaphthene (CAS No. 83-32-9) is used as surrogate Region 9 PRG and Region 4 SW values and total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
17 - The value for total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
18- The value for pyrene (CAS No. 129-00-0) is used as a surrogate Region 9 PRG value and the value for total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
19- This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/high resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte.

GCTL Risk or Non-Risk Based Criteria

*- Organoleptic criteria are assumed to be non-risk based.
GCTLs based on Human Health Advisories are assumed to be risk-based.

Federal Primary MCLs, 2002 Edition of the Drinking Water Standards and Health Advisories (Summer 2002)

AL Action level

EPA Region 9 PRGs - Tap Water (10/01/02)

* Values for noncarcinogens are adjusted by a Hazard Index (HI) of 0.1 to account for additive effects.
C Carcinogenic effects.
N Noncarcinogenic effects.
Note: Significant figures are based on electronic download from the EPA Region 9 website (www.epa.gov/region09/waste/sfund/prg/)

New Mexico Groundwater Standards 20.6.2 NMAC

NRWQC-CCC: Priority Pollutants - Freshwater 40 CFR 131 (4/99)

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are give for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.
B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) from the 1980 Ar
C This criterion is based on carcinogenicity of 10-6 risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10-5, move the decimal point in the recommended criterion one place to the right).
D Freshwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable

fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource Center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR 131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp{mA [ln(hardness)]+ bA}(CF), or CCC (dissolved) = exp{mC [ln(hardness)]+ bC} (CF) and the parameters specified in Appendix B to the Preamble- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC = exp(1.005(pH)-4.869; CCC = exp(1.005(pH)-5.134). Values displayed in table correspond to a pH of 7.8.

G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

J EPA has not calculated human health criterion for this contaminant. However, permit authorities should address this contaminant in NPDES permit actions using the State's existing narrative criteria for toxics.

K This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

M EPA is currently reassessing the criteria for arsenic. Upon completion of the reassessment the Agency will publish revised criteria as appropriate.

N PCBs are a class of chemicals which include aroclors, 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825 and 12674112 respectively. The aquatic life criteria apply to this set of PCBs.

O The derivation of the CCC for this pollutant did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

P This criterion applies to total pcbs, I.e., the sum of all congener or all isomer analyses.

Q This recommended water quality criterion is expressed as µg free cyanide (as CN)/L.

S This recommended water quality criterion refers to the inorganic form only.

T This recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922 that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

W Although EPA has not published a final criteria document for this compound it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed liter with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.

X There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

Z A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

aa This CCC is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA 440/5-84-032), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87-003).

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Resid of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

ff This recommended water quality criterion was derived in Ambient Water Quality Criteria Saltwater Copper Addendum (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-222237, May 4, 199:

gg EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be unc In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the

FC Total recoverable cadmium is calculated from the following formula with an assumed hardness of 100 mg/L as $CaCO_3$: e[0.7409*(ln hardness - 4.719)].

FL Total recoverable lead conversion factor: 1.46203 - [(ln hardness)(0.145712)]

TR Result is a total recoverable concentration based on an assumed hardness of 100 mg/L as $CaCO_3$.

NRWQC-CCC: Non-Priority Pollutants - Freshwater 40 CFR 131 (4/99)

A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

B The organoleptic effect criterion is more stringent than the value presented in the non priority pollutants table.

C A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.

TABLE C-1
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
GROUNDWATER

E This criterion has been revised to reflect the Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) used to derive the

F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).

G This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).

1 This value is expressed in terms of total recoverable metal in the water column.

L There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 µg/L is based on a toxicity test with the striped bass in water with pH = 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicated that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured.

Acronyms:

CCC - Criterion Continuous Concentration
FAC - Florida Administrative Code
MQL - Method Quantitation Limit
NRWQC National Recommended Water Quality Criteria
PRG - Preliminary Remediation Goal

Note:

The MQL is defined as the lowest level that can be reliably detected within specified limits of precision and accuracy during routine laboratory operating conditions.
The **MQL** will be set at 3 to 5 times the MDL and shall be the **lowest standard used during calibration procedures for each analytical method.**

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

Analyte Name	CAS Number	Surface Water (ug/L)												
		EPA Region 9 PRGs Tap Water Screening Levels*		NM Surface Water Criteria 20.6.4 NMAC		NRWQC						EPA Region 4 Freshwater Surface Water Chronic Screening Values		Aqueous MQL
						Priority				Non-Priority				
						Freshwater - CCC		Human Health		Freshwater - CCC		Human Health				
		Risk-Based		Risk-Based		Risk-Based							Risk-Based		
TPH														
Diesel #2 / crankcase oil				1800									0.01	CC	500
#3 and #6 Fuel Oil				1400											
Kerosene and jet fuel				3000											
Mineral oil dielectric fluid				3700											
Unknown oil				2300											
Waste oil[1]				NA											
Gasoline[2]				NA											
Metals: Method 6010B/6020														
Aluminum	7429-90-5	3650	N	13						87	G,I,L		87	CC	200
Antimony	7440-36-0	1.46	N	4300	P			14	B,Z				160		6
Arsenic	7440-38-2	0.045	C	24.2	C,P	150	A,D,K,TR	0.018	C,M,S						5
Barium	7440-39-3	255	N									1000	A		10
Beryllium	7440-41-7	7.3	N						J,Z				0.53		5
Cadmium	7440-43-9	1.82	N			0.271	D,E,K,FC		J,Z				0.66	CC, 2	5
Calcium	7440-70-2														500
Chromium, Total [1]	7440-47-3	10.9	N			11.4	D,K,TR		J,Z (total)				11	CC	5
Cobalt	7440-48-4	72.9	N												20
Copper	7440-50-8	145.9	N			9.4	D,E,K,cc,TR	1300	U				6.54	CC, 2	20
Iron	7439-89-6	1095	N							1000	F	300	A	1000 CC	40
Lead	7439-92-1					3.2	D,E,bb,gg, FL,TR		J				1.32	CC, 2	5
Magnesium	7439-95-4														500
Manganese	7439-96-5	87.6	N									50	A		10
Nickel	7440-02-0	73	N	4600	P	52.2	D,E,K,TR	610	B				87.71	CC, 2	40
Potassium	7440-09-7														1000
Selenium	7782-49-2	18.2	N	11000	P	5	T	170	Z				5	CC	5
Silver	7440-22-4	18.2	N										0.012	2	10
Sodium	7440-23-5														500
Strontium	7440-24-6	2190	N												50
Tin	7440-31-5	2190	N												100
Titanium	7440-32-6														50
Vanadium	7440-62-2	25.5	N												10
Zinc	7440-66-6	1095	N	69000	P	122	D,E,K,TR	9100	U				58.91	CC, 2	20
Method 7041 GFAA														
Antimony	7440-36-0	1.46	N	4300	P			14	B,Z				160		6
Method 7060A GFAA														
Arsenic	7440-38-2	0.045	C	24.2	C,P	150	A,D,K,TR	0.018	C,M,S						5
Method 7421 GFAA														
Lead	7439-92-1					3.2	D,E,bb,gg,FL,TR		J				1.32	CC, 2	5

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

| Analyte Name | CAS Number | Surface Water (ug/L) | | |

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		EPA Region 9 PRGs Tap Water Screening Levels*		NM Surface Water Criteria 20.6.4 NMAC		NRWQC						EPA Region 4 Freshwater Surface Water Chronic Screening Values	Aqueous MQL
						Priority				Non-Priority			
						Freshwater - CCC		Human Health		Freshwater - CCC	Human Health		
		Risk-Based		Risk-Based		Risk-Based						Risk-Based	
1,2-Dibromoethane (EDB)	106-93-4	0.0008	C										1
1,2-Dichlorobenzene	95-50-1	37	N	17000				2700	B,Z			15.8	1
1,2-Dichloroethane	107-06-2	0.12	C	990	C			0.38	B,C			2000	1
1,2-Dichloropropane	78-87-5	0.16	C	390	C			0.52	B,C			525	1
1,3-Dichlorobenzene	541-73-1	0.55	N	2600				400				50.2	1
1,4-Dichlorobenzene	106-46-7	0.50	C	2600				400	Z			11.2	1
2-Butanone (MEK)	78-93-3	190	N										10
2-Hexanone (Methyl Butyl Ketone) [10]	591-78-6	15.8	N										10
4-Methyl-2-pentanone (MIBK)	108-10-1	15.8	N										10
Acetone	67-64-1	60.8	N										10
Benzene	71-43-2	0.34	C	710	C			1.2	B,C			53	1
Bromochloromethane [11]	74-97-5	0.18	C										1
Bromodichloromethane	75-27-4	0.18	C	460	C								1
Bromoform	75-25-2	8.51	C					4.3	B,C			293	1
Bromomethane (Methyl Bromide)	74-83-9	0.87	N									110	1
Carbon disulfide	75-15-0	104	N										1
Volatile Organics: Method 8260B													
Carbon tetrachloride	56-23-5	0.17	C	44	C			0.25	B,C			352	1
Chlorobenzene	108-90-7	10.6	N	21000				680	B,Z			195	1
Chloroethane (Ethyl Chloride)	75-00-3	4.64	C										1
Chloroform	67-66-3	6.17	N	4700	C			5.7	B,C			289	1
Chloromethane (Methyl Chloride)	74-87-3	1.51	C	16000	C							5500	1
cis-1,2-Dichloroethene	156-59-2	6.08	N										1
cis-1,3-Dichloropropene [12]	10061-01-5	0.4	C									24.4	1
Cyclohexane	110-82-7	3467	N										1
Dibromochloromethane	124-48-1	0.13	C										1
Dichlorodifluoromethane	75-71-8	39.5	N										1
Ethylbenzene	100-41-4	2.9	C	29000				3100	B,Z			453	1
Isopropylbenzene (Cumene)	98-82-8	65.8	N										1
Methyl Acetate	79-20-9	608	N										1
Methyl tert-butyl ether (MTBE)	1634-04-4	13.3	C										1
Methylcyclohexane	108-87-2	522	N										1
Methylene Chloride (Dichloromethane)	75-09-2	4.28	C	16000	C							1930	1
Styrene	100-42-5	164	N										1
Tetrachloroethene	127-18-4	0.66	C	88.5	C,P			0.8	C			84	1
Toluene	108-88-3	72.3	N	200000				6800	B,Z			175	1
trans-1,2-Dichloroethene	156-60-5	12.2	N					700	B,Z			1350	1
trans-1,3-Dichloropropene [12]	10061-02-6	0.4	C					10	B			24.4	1
Trichloroethene	79-01-6	0.03	C	810	C			2.7	C				1

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

Analyte Name	CAS Number	Surface Water (ug/L)																
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						Priority				Non-Priority						
						Freshwater - CCC		Human Health		Freshwater - CCC		Human Health				
		Risk-Based		Risk-Based		Risk-Based								Risk-Based		
Trichlorofluoromethane	75-69-4	129	N													1
Vinyl chloride	75-01-4	0.02	C	5250	C			2	C							1
Xylenes (total)	1330-20-7	20.9	N													1
Semi-Volatiles Organics: Method 8270C																
1,1'-Biphenyl	92-52-4	30.4	N													10
1-Methylnaphthalene	90-12-0															10
2,4,5-Trichlorophenol	95-95-4	365	N									2600	B,E			10
2,4,6-Trichlorophenol	88-06-2	0.365	N					2.1	B,C,U					3.2		10
2,4-Dichlorophenol	120-83-2	10.9	N	790				93	B,U					36.5		10
2,4-Dimethylphenol	105-67-9	73	N	2300				540	B,U					21.2		10
Semi-Volatiles Organics: Method 8270C																
2,4-Dinitrophenol	51-28-5	7.3	N	14000				70	B					6.2		50
2,4-Dinitrotoluene	121-14-2	7.3	N	91	C			0.11	C					310		10
2,6-Dinitrotoluene	606-20-2	3.65	N													10
2-Chloronaphthalene	91-58-7	48.7	N	4300				1700	B,U							10
2-Chlorophenol	95-57-8	3.04	N	400				120	B,U					43.8		10
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	534-52-1			765				13.4						2.3		10
2-Methylnaphthalene	91-57-6															10
2-Methylphenol (o-Cresol)	95-48-7	182	N													10
2-Nitroaniline	88-74-4	0.10	N													50
2-Nitrophenol [13]	88-75-5													3500		10
3,3'-Dichlorobenzidine	91-94-1	0.15	C	0.77	C			0.04	B,C							20
3-Nitroaniline	99-09-2															50
4-Bromophenyl phenyl ether	101-55-3															10
4-Chloro-3-methylphenol	59-50-7								U					0.3		10
4-Chloroaniline	106-47-8	14.6	N													10
4-Chlorophenyl phenyl ether	7005-72-3															10
4-Methylphenol (p-Cresol)	106-44-5	18.2	N													10
4-Nitroaniline	100-01-6															50
4-Nitrophenol	100-02-7													82.8		10
Acenaphthene	83-32-9	36.5	N	2700				1200	B,U					17		10
Acenaphthylene [14]	208-96-8	36.5	N											17		10
Acetophenone	98-86-2															10
Anthracene	120-12-7	183	N	110000				9600	B							10
Atrazine	1912-24-9	0.30	C													10
Benzaldehyde	100-52-7	365	N													10
Benzo(a)anthracene [15]	56-55-3	0.092	C	0.49	C			0.0044	B,C							10
Benzo(a)pyrene [15]	50-32-8	0.009	C	0.49	C,P			0.0044	B,C							10
Benzo(b)fluoranthene [15]	205-99-2	0.092	C	0.49	C			0.0044	B,C							10
Benzo(g,h,i)perylene [16]	191-24-2	18.3	N													10

TABLE C-2
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SURFACE WATER

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						Priority				Non-Priority				
						Freshwater - CCC		Human Health		Freshwater - CCC	Human Health			
		Risk-Based		Risk-Based		Risk-Based						Risk-Based		
Benzo(k)fluoranthene [15]	207-08-9	0.92	C	0.49	C			0.0044	B,C					10
bis(2-Chloroethoxy)methane	111-91-1													10
bis(2-Chloroethyl)ether	111-44-4	0.01	C	14	C			0.031	B,C			2380		10
bis(2-Chloroisopropyl)ether [2,2'-oxybis(1-chloropropane)]	108-60-1	0.27	C	170000				1400	B					10
Semi-Volatiles Organics: Method 8270C														
bis(2-ethylhexyl)phthalate	117-81-7	4.80	C	59				1.8	B,C,X			0.3		10
Butyl benzyl phthalate	85-68-7	730	N					3000	B,W			22		10
Caprolactam	105-60-2	1825	N											10
Carbazole	86-74-8	3.36	C											10
Chrysene [15]	218-01-9	9.21	C	0.49	C			0.0044	B,C					10
Dibenz(a,h)anthracene [15]	53-70-3	0.009	C	0.49	C			0.0044	B,C					10
Dibenzofuran	132-64-9	2.43	N											10
Diethyl phthalate	84-66-2	2920	N	12000				23000	B,W			521		10
Dimethyl phthalate	131-11-3	36487	N	2900000				313000	W			330		10
Di-n-butyl phthalate	84-74-2	365	N					2700	B,W			9.4		10
Di-n-octyl phthalate	117-84-0	145.9	N											10
Fluoranthene	206-44-0	146.0	N	370				300	B			39.8		10
Fluorene	86-73-7	24.3	N	1400				1300	B					10
Hexachlorobenzene	118-74-1	0	C	0.0077	C,P			0.00075	B,C					10
Hexachlorobutadiene	87-68-3	0.86	C	500	C			0.44	B,C			0.93		10
Hexachlorocyclopentadiene	77-47-4	25.5	N	17000				240	B,U,Z			0.07		10
Hexachloroethane	67-72-1	4.8	C	89	C			1.9	B,C			9.8		10
Indeno(1,2,3-cd)pyrene [15]	193-39-5	0.09	C	0.49	C			0.0044	B,C					10
Isophorone	78-59-1	70.8	C	26000	C			36	B,C			1170		10
Naphthalene	91-20-3	0.62	N									62		10
Nitrobenzene	98-95-3	0.34	N	1900				17	B			270		10
N-Nitroso-di-n-propylamine	621-64-7	0.01	C	14	C			0.005	B,C					10
N-Nitrosodiphenylamine	86-30-6	13.7	C	160	C			5	B,C			58.5		10
Pentachlorophenol	87-86-5	0.56	C	82	C	15	F,K	0.28	B,C			13	CC	10
Phenanthrene [16]	85-01-8	18.3	N											10
Phenol	108-95-2	2190	N	4600000				21000	B,U			256		10
Pyrene	129-00-0	18.3	N	11000				960	B					10
Dioxins: Method 8290														
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) [17]	1746-01-6	0.0000004	C	0.00000014	C,P			1.3E-08	C			0.00001	3	~ 0.00001
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD) [17]	40321-76-4													~ 0.00001
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	57653-85-7													~ 0.000025
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	39227-28-6													~ 0.000025

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

Analyte Name	CAS Number	Surface Water (ug/L)											
		EPA Region 9 PRGs Tap Water Screening Levels*		NM Surface Water Criteria 20.6.4 NMAC		NRWQC						EPA Region 4 Freshwater Surface Water Chronic Screening Values	Aqueous MQL
						Priority				Non-Priority			
						Freshwater - CCC		Human Health		Freshwater - CCC		Human Health			
		Risk-Based		Risk-Based		Risk-Based							Risk-Based	
Dioxins: Method 8290													
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	19408-74-3												~ 0.000025
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD) [17]	35822-39-4												~ 0.000025
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD) [17]	3268-87-9												~ 0.00005
2,3,7,8-Tetrachlorodibenzofuran (TCDF) [17]	51207-31-9												~ 0.000025
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF) [17]	57117-41-6												~ 0.000025
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF) [17]	57117-31-4												~ 0.000025
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF) [17]	57117-44-9												~ 0.000025
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF) [17]	72918-21-9												~ 0.000025
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF) [17]	70648-26-9												~ 0.000025
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF) [17]	60851-34-5												~ 0.000025
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF) [17]	67562-39-4												~ 0.000025
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF) [17]	55673-89-7												~ 0.000025
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) [17]	39001-02-0												~ 0.00005
PAHs: Method 8310													
1-Methylnaphthalene	90-12-0												2
2-Methylnaphthalene	91-57-6												2
Acenaphthene	83-32-9	36.5	N	2700				1200	B,U			17	2
Acenaphthylene [14]	208-96-8	36.5	N									17	2
Anthracene	120-12-7	183	N	110000				9600	B				1
Benzo(a)anthracene [15]	56-55-3	0.092	C	0.49	C			0.0044	B,C				0.2
Benzo(a)pyrene [15]	50-32-8	0.009	C	0.49	C,P			0.0044	B,C				0.2
Benzo(b)fluoranthene [15]	205-99-2	0.092	C	0.49	C			0.0044	B,C				0.2
Benzo(g,h,i)perylene [16]	191-24-2	18.3	N										0.5
Benzo(k)fluoranthene [15]	207-08-9	0.92	C	0.49	C			0.0044	B,C				0.5
Chrysene [15]	218-01-9	9.21	C	0.49	C			0.0044	B,C				0.5
Dibenz(a,h)anthracene [15]	53-70-3	0.009	C	0.49	C			0.0044	B,C				0.2
Fluoranthene	206-44-0	146	N	370				300	B			39.8	0.5
Fluorene	86-73-7	24	N	14000				1300	B				2
Indeno(1,2,3-cd)pyrene [15]	193-39-5	0.1	C	0.49	C			0.0044	B,C				0.2
PAHs: Method 8310													
Naphthalene	91-20-3	0.62	N									62	2
Phenanthrene [16]	85-01-8	18.3	N										1
Pyrene	129-00-0	18.3	N	11000				960	B				0.5

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

Analyte Name	CAS Number	Surface Water (ug/L)											
		EPA Region 9 PRGs Tap Water Screening Levels*		NM Surface Water Criteria 20.6.4 NMAC	NRWQC						EPA Region 4 Freshwater Surface Water Chronic Screening Values		Aqueous MQL
					Priority				Non-Priority				
					Freshwater - CCC		Human Health		Freshwater - CCC	Human Health			
		Risk-Based		Risk-Based	Risk-Based						Risk-Based		
Explosives: Method 8330													
1,3,5-Trinitrobenzene	99-35-4	109	N										2
1,3-Dinitrobenzene	99-65-0	0.36	N										2
2,4,6-Trinitrotoluene	118-96-7	2.24	C										2
2,4-Dinitrotoluene	121-14-2	7.3	N				0.11	C			310		2
2,6-Dinitrotoluene	606-20-2	3.65	N										2
2-Amino-4,6-dinitrotoluene	35572-78-2												2
2-Nitrotoluene	88-72-2	6.1	N										2
3-Nitrotoluene	99-08-1	6.1	N										2
4-Amino-2,6-dinitrotoluene	19406-51-0												2
4-Nitrotoluene	99-99-0	6.1	N										2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	0.61	C										1
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8	36.5	N										2
Nitrobenzene	98-95-3	0.34	N				17	B			270		2
Nitroglycerin	55-63-0	4.8	C										5
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	182	N										2
Pentaerythritol tetranitrate	78-11-5												5
Cyanide: Method 9010B													
Cyanide	57-12-5	0.62	N		5.2	K,Q	700	B,Z			5.2	CC	10
Total Organic Halides: Method 9020B													
Total Organic Halides	TOX												500
Total Organic Carbon: Method 9060													
Total Organic Carbon	TOC												1000
Method 160.1													
Total Dissolved Solids	TDS												10000
Method 200.7													
Manganese	7439-96-5	87.6	N							50	A		15
Method 300.0													
Chloride	16887-00-6								230000	G		230000 CC	1000
Nitrate	14797-55-8	1000	N										500
Nitrite	14797-65-0	100	N										500
Orthophosphate	PO4												500
Method 300.0													
Perchlorate	14797-73-0												4
Sulfate	14808-79-8												1000
Method 310.1													
Alkalinity	ALK								20000	F			5000
Method 314.0													
Perchlorate	14797-73-0												4
Method 353.2													
Nitrate	14797-55-8	1000	N										100
Nitrite	14797-65-0	100	N										100

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

Analyte Name	CAS Number	Surface Water (ug/L)							
		EPA Region 9 PRGs Tap Water Screening Levels*	NM Surface Water Criteria 20.6.4 NMAC	NRWQC				EPA Region 4 Freshwater Surface Water Chronic Screening Values	Aqueous MQL
				Priority		Non-Priority			
				Freshwater - CCC	Human Health	Freshwater - CCC	Human Health		
		Risk-Based	Risk-Based	Risk-Based				Risk-Based	
Method 365.1									
Orthophosphate	PO4								50
Phosphorous, total	P								100
Method 376.2									
Sulfide	18496-25-8							2 CC	1000

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

List of Analytes

1 - The value for hexavalent chromium (CAS No. 18540-29-9) is used as surrogate Region 9 PRG, SW 62-777, 62-302, NRWQC, and Region 4 SW Chronic values for this compound.
2 - The value for mercury chloride (CAS No. 7487-94-7) is used as a surrogate Region 9 PRG value for this compound.
3 - The value for thallium and compounds (CAS No. 7446-18-6) is used as a surrogate Region 9 PRG value for this compound.
4 - The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
5 - The value for endosulfan (CAS No. 115-29-7) is used as a surrogate value for this compound.
6 - The value for endrin (CAS No. 72-20-8) is used as a surrogate value for this compound.
7 - The value for chlordane (CAS No. 54-74-9) is used as a surrogate value for this compound.
The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
8 - The value for gamma-BHC (CAS No. 58-89-9) is used as a surrogate Region 9 PRG, SW 62-777, 62-302, and Region 4 SW Chronic values for this compound.
9 - The value for total PCBs (CAS No. 1336-36-3) is used as a surrogate value for this compound, except for Region 9 PRG value.
10 - The value for methyl isobutyl ketone (CAS No. 108-10-1) is used as surrogate Region 9 PRG and SW 62-777 values for this compound.
11 - The value for bromodichloromethane (CAS No. 75-27-4) is used as Region 9 PRG, SW 62-777, and 62-302 surrogate values for this compound.
12 - The value for 1,3-dichloropropene (CAS No. 542-75-6) is used as a surrogate value for this compound.
13 - The value for 4-nitrophenol (CAS No. 100-02-7) is used as a surrogate value for this compound.
14 - The value for acenaphthene (CAS No. 83-32-9) is used as surrogate Region 9 PRG and Region 4 SW values and total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
15 - The value for total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
16 - The value for pyrene (CAS No. 129-00-0) is used as a surrogate Region 9 PRG value and the value for total PAHs is used as surrogate SW 62-777 and 62-302 values for this compound.
17 - This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/high resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte.

EPA Region 9 PRGs - Tap Water (10/01/02)

* Values for noncarcinogens are adjusted by a Hazard Index (HI) of 0.1 to account for additive effects.
C Carcinogenic effects.
N Noncarcinogenic effects.
Note: Significant figures are based on electronic download from the EPA Region 9 website (www.epa.gov/region09/waste/sfund/prg/)

New Mexico Surface Water Criteria (Human Health) - 20.6.4 NMAC, October 11, 2002

C Cancer Causing
P Persiostant

NRWQC-CCC: Priority Pollutants - Freshwater 40 CFR 131 (4/99)

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are give for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.
B This criterion has been revised to reflect the Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.
C This criterion is based on carcinogenicity of 10-6 risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10-5, move the decimal point in the recommended criterion one place to the right).
D Freshwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource Center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR 131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.
E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp{mA [ln(hardness)]+ bA}(CF), or CCC (dissolved) = exp{mC [ln(hardness)]+ bC} (CF) and the parameters specified in Appendix B to the Preamble- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.
F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC = exp(1.005(pH)-4.869; CCC = exp(1.005(pH)-5.134). Values displayed in table correspond to a pH of 7.8.
G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
J EPA has not calculated human health criterion for this contaminant. However, permit authorities should address this contaminant in NPDES permit actions using the State's existing narrative criteria for toxics.
K This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.
M EPA is currently reassessing the criteria for arsenic. Upon completion of the reassessment the Agency will publish revised criteria as appropriate.
N PCBs are a class of chemicals which include aroclors, 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825 and 12674112 respectively. The aquatic life criteria apply to this set of PCBs.

TABLE C-2
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SURFACE WATER

O The derivation of the CCC for this pollutant did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.
P This criterion applies to total pcbs, i.e., the sum of all congener or all isomer analyses.
Q This recommended water quality criterion is expressed as µg free cyanide (as CN)/L.
S This recommended water quality criterion refers to the inorganic form only.
T This recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922 that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.
U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.
V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.
W Although EPA has not published a final criteria document for this compound it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed literature draft aquatic life with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.
X There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.
Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
Z A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.
aa This CCC is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.
bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA 440/5-84-032), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87-003).
cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.
ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure i of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.
ff This recommended water quality criterion was derived in Ambient Water Quality Criteria Saltwater Copper Addendum (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-222237, May 4, 1995).
gg EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.
hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.
FC Total recoverable cadmium is calculated from the following formula with an assumed hardness of 100 mg/L as $CaCO_3$: e[0.7409*(ln hardness - 4.719)].
FL Total recoverable lead conversion factor: 1.46203 - [(ln hardness)(0.145712)]
TR Result is a total recoverable concentration based on an assumed hardness of 100 mg/L as $CaCO_3$.

NRWQC-CCC: Non-Priority Pollutants - Freshwater 40 CFR 131 (4/99)
A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.
B The organoleptic effect criterion is more stringent than the value presented in the non priority pollutants table.
C A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.
E This criterion has been revised to reflect the Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) used to derive the original criterion was
F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).
G This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).
I This value is expressed in terms of total recoverable metal in the water column.
L There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 µg/L is based on a toxicity test with the striped bass in water with pH = 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicated that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured.

EPA Region 4 Surface Water Screening Values (Chronic) - Freshwater (6/23/00)
2 Hardness-dependant
3 Based on the marketability of fish. The use of other values which may have greater ecological significance may be considered.
5 Lowest plant value reported.
CC Criteria

Acronyms:
CCC - Criterion Continuous Concentration
FAC - Florida Administrative Code
MQL - Method Quantitation Limit
NRWQC- National Recommended Water Quality Criteria
PRG - Preliminary Remediation Goal

Note:
The MQL is defined as the lowest level that can be reliably detected within specified limits of precision and accuracy during routine laboratory operating conditions.
The **MQL** will be set at 3 to 5 times the MDL and shall be the **lowest standard used during calibration procedures for each analytical method.**

TABLE C-3
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SOIL

Analyte Name	CAS Number	Soil (mg/kg)									
		NMED Soil Screening Levels						EPA Region 9 PRGs Industrial #		EPA Region 9 PRGs Residential #	Solids MQL
		Residential		Industrial/ Occupational		Construction Worker		Risk-Based			
MA-TPH											
Diesel #2 / crankcase oil	--	880		2200							10
#3 and #6 Fuel Oil	--	860		2150							
Kerosene and jet fuel	--	940		2350							
Mineral oil dielectric fluid	--	1560		3400							
Unknown oil	--	800		2000							
Waste oil[1]	--	2500		5000							
Gasoline[2]	--	NA		NA							
Metals: Method 6010B/6020											
Aluminum	7429-90-5	74000	nc	100000	max	0.75	nc	100000	max	7600 nc	10
Antimony	7440-36-0	30	nc	92	nc	110	nc	41	nc	3.1 nc	0.5
Arsenic	7440-38-2	3.9	ca	17	ca	0.019	ca	1.6	ca	0.39 ca	0.8
Barium	7440-39-3	5200	nc	15000	nc	0.077	nc	6700	nc	540 nc	0.5
Beryllium	7440-41-7	150	nc	440	nc	0.0031	nc	1900	ca	15 nc	0.5
Cadmium	7440-43-9	70	nc	190	nc	0.047	ca	45	nc	3.7 nc	0.2
Calcium	7440-70-2										10
Chromium, Total [1]	7440-47-3							448	ca	211 ca	0.5
Cobalt	7440-48-4	4500	nc	13000	nc	0.16	nc	1900	ca	900 ca	1
Copper	7440-50-8	2800	nc	8500	nc	10000	nc	4100	nc	310 nc	1
Iron	7439-89-6	23000	nc	69000	nc	80000	nc	100000	max	2300 nc	5
Lead	7439-92-1	400	NC	1000	nc	1	nc	75	nc	40 nc	0.25
Magnesium	7439-95-4										25
Manganese	7439-96-5	7800	nc	14000	nc	0.0075	nc	1900	nc	180 nc	0.5
Nickel	7440-02-0	1500	nc	4400	nc	0.031	nc	2000	nc	160 nc	2
Potassium	7440-09-7										50
Selenium	7782-49-2	380	nc	1200	nc	1300	nc	510	nc	39 nc	0.25
Silver	7440-22-4	380	nc	1200	nc	1300	nc	510	nc	39 nc	1
Sodium	7440-23-5										50
Metals: Method 6010B/6020											
Strontium	7440-24-6	37000	nc	89000	nc	150000	max	100000	max	4700 nc	5
Thallium [2]	7440-28-0	6.1	nc	18	nc	21	nc	6.7	nc	0.52 nc	0.5
Tin	7440-31-5							100000	max	4690 nc	5
Titanium	7440-32-6										5

TABLE C-3
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SOIL

Analyte Name	CAS Number	Soil (mg/kg)											
		NMED Soil Screening Levels								EPA Region 9 PRGs Industrial #		EPA Region 9 PRGs Residential #	Solids MQL
		Residential		Industrial/ Occupational		Construction Worker				Risk-Based			
Vanadium	7440-62-2	530	nc	1600	nc	1900	nc			720	nc	55 nc	2.5
Zinc	7440-66-6	23000	nc	69000	nc	80000	nc			100000	max	2300 nc	5
Method 7060A GFAA													
Arsenic	7440-38-2	3.9	ca	17	ca	0.019	ca			1.6	ca	0.39 ca	0.5
Method 7421 GFAA													
Lead	7439-92-1	400	NC	1000	nc	1	nc			75	nc	40 nc	0.5
Mercury (soil): Method 7471A													
Mercury [3]	7439-97-6	23	nc	69	nc	80	nc			31	nc	2.3 nc	0.1
Method 7740 GFAA													
Selenium	7782-49-2	380	nc	1200	nc	1300	nc			510	nc	39 nc	0.5
Petroleum Hydrocarbons: Method 8015B													
Diesel Range Organics	DRO												10
Gasoline Range Organics	GRO												1
Aromatic Volatile Organics: Method 8021B													
Benzene	71-43-2	6.4	ca	5.6	nc	29	nc			1.3	ca	0.6 ca	0.005
Ethylbenzene	100-41-4	68	sat	68	sat	68	sat			20	ca	8.9 ca	0.005
Methyl tert-butyl ether	1634-04-4									160	ca	62 ca	0.005
Toluene	108-88-3	180	sat	180	sat	180	sat			520	sat	520 sat	0.005
Xylenes (total)	1330-20-7	63	sat	63	sat	63	sat			420	sat	27 nc	0.005
Pesticides: Method 8081A													
4,4'-DDD	72-54-8	24	ca	100	nc	0.27	nc			10	ca	2.4 ca	0.003
4,4'-DDE	72-55-9	17	ca	75	ca	0.27	nc			7	ca	1.7 ca	0.003
4,4'-DDT	50-29-3	17	ca	75	ca	0.27	nc			7	ca	1.7 ca	0.003
Pesticides: Method 8081A													
Aldrin	309-00-2	0.29	ca	1.2	ca	0.016	nc			0.1	ca	0.029 ca	0.0017
Chlordane [4]	57-74-9	16	ca	70	ca	0.11	nc			6.5	ca	1.6 ca	0.017
Dieldrin	60-57-1	0.3	ca	1.3	ca	0.018	ca			0.11	ca	0.03 ca	0.003
Endosulfan I [5]	959-98-8	370	nc	890	nc	3.2	nc			370	nc	37 nc	0.003
Endosulfan II [5]	33213-65-9	370	nc	890	nc	3.2	nc			370	nc	37 nc	0.003
Endosulfan sulfate [5]	1031-07-8	370	nc	890	nc	3.2	nc			370	nc	37 nc	0.003
Endrin	72-20-8	18	nc	44	nc	0.16	nc			18	nc	1.8 nc	0.003
Endrin aldehyde [6]	7421-93-4	18	nc	44	nc	0.16	nc			18	nc	1.8 nc	0.003
Endrin ketone [6]	53494-70-5	18	nc	44	nc	0.16	nc			18	nc	1.8 nc	0.003

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		Residential	Industrial/ Occupational	Construction Worker	Risk-Based		
Heptachlor	76-44-8	1.1 ca	4.5 ca	0.062 ca	0.38 ca	0.11 ca	0.0017
Heptachlor epoxide	1024-57-3				0.19 ca	0.053 ca	0.0017
Methoxychlor	72-43-5				3100 nc	310 nc	0.0017
Toxaphene	8001-35-2	4.4 ca	19 ca	0.26 ca	1.6 ca	0.44 ca	0.05
alpha-BHC	319-84-6				0.36 ca	0.09 ca	0.0017
alpha-Chlordane [7]	5103-71-9						0.003
beta-BHC	319-85-7	0.9 ca	3.9 ca	0.046 ca	1.3 ca	0.32 ca	0.0017
delta-BHC [8]	319-86-8						0.0017
gamma-BHC (Lindane)	58-89-9	4.4 ca	19 ca	0.16 nc	1.7 ca	0.44 ca	0.0017
gamma-Chlordane [7]	5103-74-2						0.003
PCBs: Method 8082							
Aroclor 1016 [9]	12674-11-2	3.9 nc	8.9 nc	0.038 nc	21 ca	0.39 nc	0.5
Aroclor 1221 [9]	11104-28-2	2.2 ca	9.2 ca	0.15 ca	0.74 ca	0.22 ca	0.5
Aroclor 1232 [9]	11141-16-5	2.2 ca	9.2 ca	0.15 ca	0.74 ca	0.22 ca	0.5
PCBs: Method 8082							
Aroclor 1242 [9]	53469-21-9	2.2 ca	9.2 ca	0.15 ca	0.74 ca	0.22 ca	0.5
Aroclor 1248 [9]	12672-29-6	1.1 nc	2.5 nc	0.011 nc	0.74 ca	0.22 ca	0.5
Aroclor 1254 [9]	11097-69-1	1.1 nc	2.5 nc	0.011 nc	0.74 ca	0.22 ca	0.5
Aroclor 1260 [9]	11096-82-5	1.1 nc	2.5 nc	0.011 nc	0.74 ca	0.22 ca	0.5
Chlorinated Herbicides: Method 8151A							
2,4,5-T	93-76-5				620 nc	61 nc	0.04
2,4,5-TP Silvex	93-72-1				490 nc	49 nc	0.04
2,4-D	94-75-7				770 nc	69 nc	0.2
2,4-DB	94-82-6				490 nc	49 nc	0.2
Dinoseb	88-85-7				62 nc	6.1 nc	0.2
Dalapon	75-99-0				1800 nc	180 nc	1.2
Dicamba	1918-00-9				1800 nc	180 nc	1.2
Dichloroprop	120-36-5						0.2
MCPA	94-74-6				31 nc	3.1 nc	1.2
MCPP (Mecoprop)	93-65-2				62 nc	6.1 nc	4
Pentachlorophenol	87-86-5				9 ca	3 ca	0.2
Picloram	1918-02-1				4300 nc	430 nc	0.2

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SOIL

Analyte Name	CAS Number	Soil (mg/kg)											
		NMED Soil Screening Levels								EPA Region 9 PRGs Industrial #		EPA Region 9 PRGs Residential #	Solids MQL
		Residential		Industrial/ Occupational		Construction Worker				Risk-Based			
Volatile Organics: Method 8260B													
1,1,1-Trichloroethane	71-55-6	510	sat	510	sat	510	sat			1200	sat	1200 sat	0.05
1,1,2,2-Tetrachloroethane	79-34-5	3.6	ca	8.2	ca	160	ca			0.93	ca	0.41 ca	0.005
1,2,2-Trichloro-1,1,2-trifluoroethane	76-13-1									5600	sat	5600 sat	0.005
1,1,2-Trichloroethane	79-00-5	7.9	ca	18	ca	160	nc			1.6	ca	0.73 ca	0.005
1,1-Dichloroethane	75-34-3									170	nc	51 nc	0.05
1,1-Dichloroethene	75-35-4									41	nc	12 nc	0.05
1,2,4-Trichlorobenzene	120-82-1	520	nc	530	sat	530	sat			3000	sat	65 nc	0.005
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8									0.046	ca	0.019 ca	0.005
1,2-Dibromoethane (EDB)	106-93-4									0.028	ca	0.0069 ca	0.005

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		NMED Soil Screening Levels			EPA Region 9 PRGs Industrial #	EPA Region 9 PRGs Residential #	Solids MQL
		Residential	Industrial/ Occupational	Construction Worker	Risk-Based		
Volatile Organics: Method 8260B							
1,2-Dichlorobenzene	95-50-1				370 sat	370 sat	0.005
1,2-Dichloroethane	107-06-2				0.6 ca	0.28 ca	0.005
1,2-Dichloropropane	78-87-5				0.74 ca	0.34 ca	0.005
1,3-Dichlorobenzene	541-73-1				6.3 nc	1.6 nc	0.005
1,4-Dichlorobenzene	106-46-7				7.9 ca	3.4 ca	0.005
2-Butanone (MEK)	78-93-3				2700 nc	730 nc	0.1
2-Hexanone (Methyl Butyl Ketone) [10]	591-78-6				280 nc	79 nc	0.1
4-Methyl-2-pentanone (MIBK)	108-10-1				280 nc	79 nc	0.1
Acetone	67-64-1				600 nc	160 nc	0.1
Benzene	71-43-2	6.4 ca	5.6 nc	29 nc	1.3 ca	0.6 ca	0.005
Bromochloromethane [11]	74-97-5				1.8 ca	0.82 ca	0.005
Bromodichloromethane	75-27-4	9.6 ca	22 ca	450 ca	1.8 ca	0.82 ca	0.05
Bromoform	75-25-2				220 ca	62 ca	0.05
Bromomethane (Methyl Bromide)	74-83-9	3.7 nc	3 nc	15 nc	1.3 nc	0.39 nc	0.05
Carbon disulfide	75-15-0				720 sat	36 nc	0.05
Carbon tetrachloride	56-23-5	1.6 nc	1.3 nc	6.8 nc	0.55 ca	0.25 ca	0.05
Chlorobenzene	108-90-7	140 nc	120 nc	190 nc	53 nc	15 nc	0.05
Chloroethane (Ethyl Chloride)	75-00-3				6.5 ca	3 ca	0.05
Chloroform	67-66-3	0.38 nc	0.3 nc	1.6 nc	12 ca	3.6 ca	0.05
Chloromethane (Methyl Chloride)	74-87-3				2.6 ca	1.2 ca	0.05
cis-1,2-Dichloroethene	156-59-2	41 ca	33 ca	170 nc	15 nc	4.3 nc	0.005
cis-1,3-Dichloropropene [12]	10061-01-5				1.76 ca	0.78 ca	0.005
Cyclohexane	110-82-7				140 sat	140 sat	0.005
Dibromochloromethane	124-48-1				2.6 ca	1.1 ca	0.05
Dichlorodifluoromethane	75-71-8				31 nc	9.4 nc	0.005
Ethylbenzene	100-41-4	68 sat	68 sat	68 sat	20 ca	8.9 ca	0.005
Isopropylbenzene (Cumene)	98-82-8				200 nc	57 nc	0.005
Semi-Volatiles Organics: Method 8270C							
Methyl Acetate	79-20-9				9200 nc	2200 nc	0.005
Methyl tert-butyl ether (MTBE)	1634-04-4				160 ca	62 ca	0.05
Methylcyclohexane	108-87-2				870 nc	260 nc	0.005
Methylene Chloride (Dichloromethane)	75-09-2				21 ca	9.1 ca	0.05

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SOIL

Analyte Name	CAS Number	Soil (mg/kg)					
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		Residential	Industrial/ Occupational	Construction Worker	Risk-Based		
Styrene	100-42-5				1700 sat	1700 sat	0.05
Tetrachloroethene	127-18-4	49 ca	100 sat	100 sat	3.4 ca	1.5 ca	0.005
Toluene	108-88-3	180 sat	180 sat	180 sat	520 sat	520 sat	0.005
trans-1,2-Dichloroethene	156-60-5	60 nc	49 nc	250 nc	23 nc	6.9 nc	0.005
trans-1,3-Dichloropropene [12]	10061-02-6				1.76 ca	0.78 ca	0.005
Trichloroethene	79-01-6	16 ca	18 nc	92 nc	0.11 ca	0.053 ca	0.005
Trichlorofluoromethane	75-69-4				2000 sat	39 nc	0.005
Vinyl chloride	75-01-4	0.21 ca	0.45 ca	10 nc		0.08 ca	0.005
Xylenes (total)	1330-20-7	63 sat	63 sat	63 sat	420 sat	27 nc	0.005
1,1'-Biphenyl	92-52-4				350 sat	350 sat	0.33
1-Methylnaphthalene	90-12-0						0.33
2,4,5-Trichlorophenol	95-95-4	6100 nc	15000 nc	54 nc	6200 nc	610 nc	0.33
2,4,6-Trichlorophenol	88-06-2	440 ca	1900 ca	27 ca	6.2 nc**	0.61 nc**	0.33
2,4-Dichlorophenol	120-83-2				180 nc	18 nc	0.33
2,4-Dimethylphenol	105-67-9				1200 nc	120 nc	0.33
2,4-Dinitrophenol	51-28-5				120 nc	12 nc	1.6
2,4-Dinitrotoluene	121-14-2				120 nc	12 nc	0.33
2,6-Dinitrotoluene	606-20-2				62 nc	6.1 nc	0.33
2-Chloronaphthalene	91-58-7				2300 nc	490 nc	0.33
2-Chlorophenol	95-57-8				24 nc	6.3 nc	0.33
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	534-52-1						0.7
2-Methylnaphthalene	91-57-6						0.33
2-Methylphenol (o-Cresol)	95-48-7				3100 nc	310 nc	0.33
Semi-Volatiles Organics: Method 8270C							
2-Nitroaniline	88-74-4				1.8 nc	0.17 nc	1.6
2-Nitrophenol [13]	88-75-5						0.33
3,3'-Dichlorobenzidine	91-94-1				3.8 ca	1.1 ca	1.6
3-Nitroaniline	99-09-2						1.6
4-Bromophenyl phenyl ether	101-55-3						0.33
4-Chloro-3-methylphenol	59-50-7						0.33
4-Chloroaniline	106-47-8				250 nc	24 nc	0.33
4-Chlorophenyl phenyl ether	7005-72-3						0.33
4-Methylphenol (p-Cresol)	106-44-5				310 nc	31 nc	0.33

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SOIL

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		NMED Soil Screening Levels			EPA Region 9 PRGs Industrial #	EPA Region 9 PRGs Residential #	Solids MQL
		Residential	Industrial/ Occupational	Construction Worker	Risk-Based		
4-Nitroaniline	100-01-6						1.6
4-Nitrophenol	100-02-7						1.6
Acenaphthene	83-32-9				2900 nc	370 nc	0.33
Acenaphthylene [14]	208-96-8						0.33
Acetophenone	98-86-2						0.33
Anthracene	120-12-7	16000 nc	34000 nc	62000 nc	100000 max	2200 nc	0.33
Atrazine	1912-24-9				7.8 ca	2.2 ca	0.33
Benzaldehyde	100-52-7				6200 nc	610 nc	0.33
Benzo(a)anthracene	56-55-3	6.2 ca	26 ca	0.94 ca	2.1 ca	0.62 ca	0.33
Benzo(a)pyrene	50-32-8	0.62 ca	2.6 ca	0.094 ca	0.21 ca	0.062 ca	0.33
Benzo(b)fluoranthene	205-99-2	6.2 ca	26 ca	0.94 ca	2.1 ca	0.62 ca	0.33
Benzo(g,h,i)perylene [15]	191-24-2				2900 nc	230 nc	0.33
Benzo(k)fluoranthene	207-08-9	62 ca	260 ca	9.4 ca	21 ca	6.2 ca	0.33
bis(2-Chloroethoxy)methane	111-91-1						0.33
bis(2-Chloroethyl)ether	111-44-4	4.4 ca	19 ca	0.25 ca	0.55 ca	0.21 ca	0.33
bis(2-Chloroisopropyl)ether [2,2'-oxybis(1-chloropropane)]	108-60-1	69 ca	290 ca	8.3 ca	7.4 ca	2.9 ca	0.33
bis(2-ethylhexyl)phthalate	117-81-7				120 ca	35 ca	0.33
Butyl benzyl phthalate	85-68-7				100000 max	1200 nc	0.33
Semi-Volatiles Organics: Method 8270C							
Caprolactam	105-60-2				100000 max	3100 nc	0.33
Carbazole	86-74-8				86 ca	24 ca	0.33
Chrysene	218-01-9	610 ca	2500 ca	6400 nc	210 ca	62 ca	0.33
Dibenz(a,h)anthracene	53-70-3	0.62 ca	2.6 ca	0.094 ca	0.21 ca	0.062 ca	0.33
Dibenzofuran	132-64-9				310 nc	29 nc	0.33
Diethyl phthalate	84-66-2	49000 nc	100000 max	430 nc	100000 max	49000 nc	0.33
Dimethyl phthalate	131-11-3	100000 max	100000 max	5400 nc	100000 max	100000 max	0.33
Di-n-butyl phthalate	84-74-2	6100 nc	15000 nc	54 nc	6200 nc	610 nc	0.33
Di-n-octyl phthalate	117-84-0				2500 nc	240 nc	0.33
Fluoranthene	206-44-0	2300 nc	5300 nc	21 nc	2200 nc	230 nc	0.33
Fluorene	86-73-7	2100 nc	4000 nc	8000 nc	2600 nc	270 nc	0.33
Hexachlorobenzene	118-74-1	3 ca	13 ca	0.18 ca	1.1 ca	0.3 ca	0.33
Hexachlorobutadiene	87-68-3	12 nc	30 nc	0.11 nc	22 ca	6.2 ca	0.33
Hexachlorocyclopentadiene	77-47-4	420 nc	1000 nc	0.011 nc	370 nc	37 nc	0.33

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		Residential		Industrial/ Occupational		Construction Worker		Risk-Based			
Hexachloroethane	67-72-1	61	nc	150	nc	0.054	nc	120	ca	35 ca	0.33
Indeno(1,2,3-cd)pyrene	193-39-5	6.2	ca	26	ca	0.94	ca	2.1	ca	0.62 ca	0.33
Isophorone	78-59-1	5100	ca	22000	ca	110	nc	1800	ca	510 ca	0.33
Naphthalene	91-20-3	53	nc	43	nc	220	nc	19	nc	5.6 nc	0.33
Nitrobenzene	98-95-3	17	nc	21	nc	66	nc	10	nc	2 nc	0.33
N-Nitroso-di-n-propylamine	621-64-7							0.25	ca	0.069 ca	0.33
N-Nitrosodiphenylamine	86-30-6							350	ca	99 ca	0.33
Pentachlorophenol	87-86-5							9	ca	3 ca	1.6
Phenanthrene [16]	85-01-8	1800	nc	4400	nc	16	nc	2900	nc	230 nc	0.33
Phenol	108-95-2	37000	nc	89000	nc	320	nc	100000	max	3700 nc	0.33
Pyrene	129-00-0	1800	nc	4300	nc	6700	nc	2900	nc	230 nc	0.33

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Dioxins: Method 8290							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) [17]	1746-01-6				0.000016 ca	0.0000039 ca	~ 0.000001
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD) [17]	40321-76-4						~ 0.000001
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	57653-85-7						~ 0.0000025
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	39227-28-6						~ 0.0000025
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD) [17]	19408-74-3						~ 0.0000025
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD) [17]	35822-39-4						~ 0.0000025
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD) [17]	3268-87-9						~ 0.000005
2,3,7,8-Tetrachlorodibenzofuran (TCDF) [17]	51207-31-9						~ 0.0000025
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF) [17]	57117-41-6						~ 0.0000025
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF) [17]	57117-31-4						~ 0.0000025
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF) [17]	57117-44-9						~ 0.0000025
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF) [17]	72918-21-9						~ 0.0000025
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF) [17]	70648-26-9						~ 0.0000025
Dioxins: Method 8290							
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF) [17]	60851-34-5						~ 0.0000025
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF) [17]	67562-39-4						~ 0.0000025
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF) [17]	55673-89-7						~ 0.0000025
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) [17]	39001-02-0						~ 0.000005
PAHs: Method 8310							
1-Methylnaphthalene	90-12-0						0.05
2-Methylnaphthalene	91-57-6						0.05
Acenaphthene	83-32-9	2800 nc	4900 nc	11000 nc	2900 nc	370 nc	0.05
Acenaphthylene [14]	208-96-8				2900 nc	370 nc	0.05
Anthracene	120-12-7	16000 nc	34000 nc	62000 nc	100000 max	2200 nc	0.05
Benzo(a)anthracene	56-55-3	6.2 ca	26 ca	0.94 ca	2.1 ca	0.62 ca	0.005
Benzo(a)pyrene	50-32-8	0.62 ca	2.6 ca	0.094 ca	0.21 ca	0.062 ca	0.005
Benzo(b)fluoranthene	205-99-2	6.2 ca	26 ca	0.94 ca	2.1 ca	0.62 ca	0.005
PAHs: Method 8310							
Benzo(g,h,i)perylene [15]	191-24-2				2900 nc	230 nc	0.005
Benzo(k)fluoranthene	207-08-9	62 ca	260 ca	9.4 ca	21 ca	6.2 ca	0.005
Chrysene	218-01-9	610 ca	2500 ca	6400 nc	210 ca	62 ca	0.005
Dibenz(a,h)anthracene	53-70-3	0.62 ca	2.6 ca	0.094 ca	0.21 ca	0.062 ca	0.005

TABLE C-3
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SOIL

Analyte Name	CAS Number	Soil (mg/kg)									
		NMED Soil Screening Levels						EPA Region 9 PRGs Industrial #		EPA Region 9 PRGs Residential #	Solids MQL
		Residential		Industrial/ Occupational		Construction Worker		Risk-Based			
Fluoranthene	206-44-0	2300	nc	5300	nc	21	nc	2200	nc	230 nc	0.005
Fluorene	86-73-7	2100	nc	4000	nc	8000	nc	2600	nc	270 nc	0.005
Indeno(1,2,3-cd)pyrene	193-39-5	6.2	ca	26	ca	0.94	ca	2.1	ca	0.62 ca	0.005
Naphthalene	91-20-3	53	nc	43	nc	220	nc	19	nc	5.6 nc	0.005
Phenanthrene [16]	85-01-8	1800	nc	4400	nc	16	nc	2900	nc	230 nc	0.005
Pyrene	129-00-0	1800	nc	4300	nc	6700	nc	2900	nc	230 nc	0.005
Explosives: Method 8330											
1,3,5-Trinitrobenzene	99-35-4							1800	nc	180 nc	0.25
1,3-Dinitrobenzene	99-65-0							6.2	nc	0.61 nc	0.25
2,4,6-Trinitrotoluene	118-96-7	31	nc	74	nc	0.27	nc	57	ca	16 ca	0.25
2,4-Dinitrotoluene	121-14-2							120	nc	12 nc	0.25
2,6-Dinitrotoluene	606-20-2							62	nc	6.1 nc	0.25
2-Amino-4,6-dinitrotoluene	35572-78-2										0.25
2-Nitrotoluene	88-72-2							1000	sat	36.7 nc	0.25
3-Nitrotoluene	99-08-1							1000	sat	37 nc	0.25
4-Amino-2,6-dinitrotoluene	19406-51-0										0.25
4-Nitrotoluene	99-99-0							1000	sat	37 nc	0.25
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	44	ca	190	ca	1.6	nc	16	ca	4.4 ca	1
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8							620	nc	61 nc	0.65
Nitrobenzene	98-95-3	17	nc	21	nc	66	nc	10	nc	2 nc	0.25
Explosives: Method 8330											
Nitroglycerin	55-63-0	350	ca	1500	ca	21	ca	120	ca	35 ca	5
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	3100	nc	7400	nc	11	nc	3100	nc	310 nc	2.5
Pentaerythritol tetranitrate	78-11-5										5
Cyanide: Method 9010B											
Cyanide	57-12-5	1200	nc	3000	nc	11	nc	1200	nc	120 nc	0.5
Total Organic Halides: Method 9020B											
Total Organic Halides	TOX										10
Total Organic Carbon: Method 9060											
Total Organic Carbon	TOC										5
Method 300.0											
Chloride	16887-00-6										5
Sulfate	14808-79-8										5

TABLE C-3
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SOIL

List of Analytes

1 - The value for hexavalent chromium (CAS No. 18540-29-9) is used as a surrogate SCTL value for this compound.
2 - The value for thallium and compounds (CAS No. 7446-18-6) is used as a surrogate Region 9 PRG value for this compound.
3 - The value for mercury chloride (CAS No. 7487-94-7) is used as a surrogate Region 9 PRG value for this compound.
4 - The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
5 - The value for endosulfan (CAS No. 115-29-7) is used as a surrogate value for this compound.
6 - The value for endrin (CAS No. 72-20-8) is used as a surrogate value for this compound.
7 - The value for chlordane (CAS No. 54-74-9) is used as a surrogate value for this compound.
The value for technical chlordane (CAS No. 12789-03-6) is used as a surrogate Region 9 PRG value for this compound.
8 - The value for gamma-BHC (CAS No. 58-89-9) is used as surrogate Region 9 PRG, and Region 4 SSV values for this compound.
9 - The value for total PCBs (CAS No. 1336-36-3) is used as surrogate SCTL, and Region 4 SSV values for this compound.
10 - The value for methyl isobutyl ketone (CAS No. 108-10-1) is used as a surrogate Region 9 PRG value for this compound.
11 - The value for bromodichloromethane (CAS No. 75-27-4) is used as a surrogate Region 9 PRG value for this compound.
12 - The value for 1,3-dichloropropene (CAS No. 542-75-6) is used as surrogate SCTL and Region 9 PRG values for this compound.
13 - The value for 4-nitrophenol (CAS No. 100-02-7) is used as a surrogate value for this compound.
14 - The value for acenaphthene (CAS No. 83-32-9) is used as surrogate Region 9 PRG and Region 4 SSV values for this compound.
15 - The value for pyrene (CAS No. 129-00-0) is used as surrogate Region 9 PRG, and Region 4 SSV values for this compound.
16 - The value for pyrene (CAS No. 129-00-0) is used as a surrogate Region 9 PRG value for this compound.
17 - This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/high resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte.

NMED Soil Screening Levels "Technical Background Document for Development of Soil Screening Levels, Appendix A"

ca carcinogenic effect basis
nc noncarcinogenic effect basis
sat soil saturation limit basis
max low toxicity, health based SSL exceeds [10^5] mg/kg

EPA Region 9 PRGs (10/01/02)

Values for noncarcinogens are adjusted by a Hazard Index (HI) of 0.1 to account for additive effects.
ca Cancer PRG
ca* Cancer PRG (where nc < 100X ca)
ca** Cancer PRG (where nc < 10X ca)
ca/nc Cancer PRG / Noncancer PRG (no need to make a decision here.)
max Ceiling limit
nc Noncancer PRG
nc ** Noncancer PRG is more stringent than cancer PRG set at one-in-one-million risk.
sat Soil Saturation
+++ Non-Standard Method
Note: Significant figures are based on electronic download from the EPA Region 9 website (www.epa.gov/region09/waste/sfund/prg/)

EPA Region 4 Soil Screening Values (6/23/00)

None

Solid MQLs

The MQL is defined as the lowest level that can be reliably detected within specified limits of precision and accuracy during routine laboratory operating conditions.
The **MQL** will be set at 3 to 5 times the MDL and shall be the **lowest standard used during calibration procedures for each analytical method.**

Acronyms:

TABLE C-3
COMPREHENSIVE ANALYTE AND DATA QUALITY OBJECTIVES
SOIL

DQO - Data Quality Objective
FAC - Florida Administrative Code
MQL - Method Quantitation Limit
PRG - Preliminary Remediation Goal

United States
Environmental Protection
Agency

This document contains the tables from the EPA "OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)," published in November 2002. The reference number is EPA 530-D-02-004. You can find the entire document at http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor.htm.

OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)

Tables

November 2002

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? [1]	Is Chemical Sufficiently Volatile? [2]	Check Here if Known or Reasonably Suspected To Be Present [3]
83329	Acenaphthene	YES	YES	
75070	Acetaldehyde	YES	YES	
67641	Acetone	YES	YES	
75058	Acetonitrile	YES	YES	
98862	Acetophenone	YES	YES	
107028	Acrolein	YES	YES	
107131	Acrylonitrile	YES	YES	
309002	Aldrin	YES	YES	
319846	alpha-HCH (alpha-BHC)	YES	YES	
62533	Aniline	YES	NO	NA
120127	Anthracene	NO	YES	NA
56553	Benz(a)anthracene	YES	NO	NA
100527	Benzaldehyde	YES	YES	
71432	Benzene	YES	YES	
50328	Benzo(a)pyrene	YES	NO	NA
205992	Benzo(b)fluoranthene	YES	YES	
207089	Benzo(k)fluoranthene	NO	NO	NA
65850	Benzoic Acid	NO	NO	NA
100516	Benzyl alcohol	YES	NO	NA
100447	Benzylchloride	YES	YES	
91587	beta-Chloronaphthalene	YES	YES	
319857	beta-HCH (beta-BHC)	YES	NO	NA
92524	Biphenyl	YES	YES	
111444	Bis(2-chloroethyl)ether	YES	YES	
108601	Bis(2-chloroisopropyl)ether	YES	YES	
117817	Bis(2-ethylhexyl)phthalate	NO	NO	NA
542881	Bis(chloromethyl)ether	YES	YES	
75274	Bromodichloromethane	YES	YES	
75252	Bromoform	YES	YES	
106990	1,3-Butadiene	YES	YES	
71363	Butanol	YES	NO	NA
85687	Butyl benzyl phthalate	NO	NO	NA
86748	Carbazole	YES	NO	NA
75150	Carbon disulfide	YES	YES	
56235	Carbon tetrachloride	YES	YES	
57749	Chlordane	YES	YES	
126998	2-Chloro-1,3-butadiene (chloroprene)	YES	YES	
108907	Chlorobenzene	YES	YES	
109693	1-Chlorobutane	YES	YES	
124481	Chlorodibromomethane	YES	YES	
75456	Chlorodifluoromethane	YES	YES	
75003	Chloroethane (ethyl chloride)	YES	YES	
67663	Chloroform	YES	YES	
95578	2-Chlorophenol	YES	YES	
75296	2-Chloropropane	YES	YES	
218019	Chrysene	YES	YES	
156592	cis-1,2-Dichloroethylene	YES	YES	
123739	Crotonaldehyde (2-butenal)	YES	YES	
98828	Cumene	YES	YES	
72548	DDD	YES	NO	NA
72559	DDE	YES	YES	
50293	DDT	YES	NO	NA
53703	Dibenz(a,h)anthracene	YES	NO	NA
132649	Dibenzofuran	YES	YES	
96128	1,2-Dibromo-3-chloropropane	YES	YES	
106934	1,2-Dibromoethane (ethylene dibromide)	YES	YES	
541731	1,3-Dichlorobenzene	YES	YES	
95501	1,2-Dichlorobenzene	YES	YES	
106467	1,4-Dichlorobenzene	YES	YES	
91941	3,3-Dichlorobenzidine	YES	NO	NA
75718	Dichlorodifluoromethane	YES	YES	

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? [1]	Is Chemical Sufficiently Volatile? [2]	Check Here if Known or Reasonably Suspected To Be Present [3]
75343	1,1-Dichloroethane	YES	YES	
107062	1,2-Dichloroethane	YES	YES	
75354	1,1-Dichloroethylene	YES	YES	
120832	2,4-Dichlorophenol	YES	NO	NA
78875	1,2-Dichloropropane	YES	YES	
542756	1,3-Dichloropropene	YES	YES	
60571	Dieldrin	YES	YES	
84662	Diethylphthalate	YES	NO	NA
105679	2,4-Dimethylphenol	YES	NO	NA
131113	Dimethylphthalate	NA	NO	NA
84742	Di-n-butyl phthalate	NO	NO	NA
534521	4,6-Dinitro-2-methylphenol (4,6-dinitro-o-cresol)	YES	NO	NA
51285	2,4-Dinitrophenol	YES	NO	NA
121142	2,4-Dinitrotoluene	YES	NO	NA
606202	2,6-Dinitrotoluene	YES	NO	NA
117840	Di-n-octyl phthalate	NO	YES	NA
115297	Endosulfan	YES	YES	
72208	Endrin	YES	NO	NA
106898	Epichlorohydrin	YES	YES	
60297	Ethyl ether	YES	YES	
141786	Ethylacetate	YES	YES	
100414	Ethylbenzene	YES	YES	
75218	Ethylene oxide	YES	YES	
97632	Ethylmethacrylate	YES	YES	
206440	Fluoranthene	NO	YES	NA
86737	Fluorene	YES	YES	
110009	Furan	YES	YES	
58899	gamma-HCH (Lindane)	YES	YES	
76448	Heptachlor	YES	YES	
1024573	Heptachlor epoxide	YES	NO	NA
87683	Hexachloro-1,3-butadiene	YES	YES	
118741	Hexachlorobenzene	YES	YES	
77474	Hexachlorocyclopentadiene	YES	YES	
67721	Hexachloroethane	YES	YES	
110543	Hexane	YES	YES	
74908	Hydrogen cyanide	YES	YES	
193395	Indeno(1,2,3-cd)pyrene	NO	NO	NA
78831	Isobutanol	YES	YES	
78591	Isophorone	YES	NO	NA
7439976	Mercury (elemental)	YES	YES	
126987	Methacrylonitrile	YES	YES	
72435	Methoxychlor	YES	YES	
79209	Methyl acetate	YES	YES	
96333	Methyl acrylate	YES	YES	
74839	Methyl bromide	YES	YES	
74873	Methyl chloride (chloromethane)	YES	YES	
108872	Methylcyclohexane	YES	YES	
74953	Methylene bromide	YES	YES	
75092	Methylene chloride	YES	YES	
78933	Methylethylketone (2-butanone)	YES	YES	
108101	Methylisobutylketone	YES	YES	
80626	Methylmethacrylate	YES	YES	
91576	2-Methylnaphthalene	YES	YES	
108394	3-Methylphenol (m-cresol)	YES	NO	NA
95487	2-Methylphenol (o-cresol)	YES	NO	NA
106455	4-Methylphenol (p-cresol)	YES	NO	NA
99081	m-Nitrotoluene	YES	NO	NA
1634044	MTBE	YES	YES	
108383	m-Xylene	YES	YES	
91203	Naphthalene	YES	YES	
104518	n-Butylbenzene	YES	YES	

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? [1]	Is Chemical Sufficiently Volatile? [2]	Check Here if Known or Reasonably Suspected To Be Present [3]
98953	Nitrobenzene	YES	YES	
100027	4-Nitrophenol	YES	NO	NA
79469	2-Nitropropane	YES	YES	
924163	N-Nitroso-di-n-butylamine	YES	YES	
621647	N-Nitrosodi-n-propylamine	YES	NO	NA
86306	N-Nitrosodiphenylamine	YES	NO	NA
103651	n-Propylbenzene	YES	YES	
88722	o-Nitrotoluene	YES	YES	
95476	o-Xylene	YES	YES	
106478	p-Chloroaniline	YES	NO	NA
87865	Pentachlorophenol	YES	NO	NA
108952	Phenol	YES	NO	NA
99990	p-Nitrotoluene	YES	NO	NA
106423	p-Xylene	YES	YES	
129000	Pyrene	YES	YES	
110861	Pyridine	YES	NO	NA
135988	sec-Butylbenzene	YES	YES	
100425	Styrene	YES	YES	
98066	tert-Butylbenzene	YES	YES	
630206	1,1,1,2-Tetrachloroethane	YES	YES	
79345	1,1,2,2-Tetrachloroethane	YES	YES	
127184	Tetrachloroethylene	YES	YES	
108883	Toluene	YES	YES	
8001352	Toxaphene	YES	NO	NA
156605	trans-1,2-Dichloroethylene	YES	YES	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane	YES	YES	
120821	1,2,4-Trichlorobenzene	YES	YES	
79005	1,1,2-Trichloroethane	YES	YES	
71556	1,1,1-Trichloroethane	YES	YES	
79016	Trichloroethylene	YES	YES	
75694	Trichlorofluoromethane	YES	YES	
95954	2,4,5-Trichlorophenol	YES	NO	NA
88062	2,4,6-Trichlorophenol	YES	NO	NA
96184	1,2,3-Trichloropropane	YES	YES	
95636	1,2,4-Trimethylbenzene	YES	YES	
108678	1,3,5-Trimethylbenzene	YES	YES	
108054	Vinyl acetate	YES	YES	
75014	Vinyl chloride (chloroethene)	YES	YES	

[1] A chemical is considered sufficiently toxic if the vapor concentration of the pure component (see Appendix D) poses an incremental lifetime cancer risk greater than 10^{-6} or a non-cancer hazard index greater than 1.

[2] A chemical is considered sufficiently volatile if its Henry's Law Constant is 1×10^{-5} atm-m^3/mol or greater (US EPA, 1991).

[3] Users should check off compounds that meet the criteria for toxicity <u>and</u> volatility and are known or reasonably suspected to be present.

Table 2a: Question 4 Generic Screening Levels and Summary Sheet [1]

Risk = 1 x 10^{-4}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-4}, HI=1) C_{target} (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		NC	9.0E+00	5.0E+00		9.0E+01	5.0E+01		9.0E+02	5.0E+02		2.8E+03	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		NC	2.0E+00	9.2E-01		2.0E+01	9.2E+00		2.0E+02	9.2E+01		4.7E+02	
309002	Aldrin		C	5.0E-02	3.3E-03		5.0E-01	3.3E-02		5.0E+00	3.3E-01		7.1E+00	
319846	alpha-HCH (alpha-BHC)		C	1.4E-01	1.1E-02		1.4E+00	1.1E-01		1.4E+01	1.1E+00		3.1E+02	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E+01	9.8E+00		3.1E+02	9.8E+01		3.1E+03	9.8E+02		1.4E+02	
205992	Benzo(b)fluoranthene	X	C	1.2E+00	1.1E-01		**	**		**	**		**	
100447	Benzylchloride	X	C	5.0E+00	9.7E-01		5.0E+01	9.7E+00		5.0E+02	9.7E+01		3.0E+02	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-01	1.3E-01		7.4E+00	1.3E+00		7.4E+01	1.3E+01		1.0E+03	
108601	Bis(2-chloroisopropyl)ether		C	2.4E+01	3.5E+00		2.4E+02	3.5E+01		2.4E+03	3.5E+02		5.1E+03	
542881	Bis(chloromethyl)ether		C	3.9E-03	8.4E-04		3.9E-02	8.4E-03		3.9E-01	8.4E-02		4.5E-01	
75274	Bromodichloromethane	X	C	1.4E+01	2.1E+00		1.4E+02	2.1E+01		1.4E+03	2.1E+02		2.1E+02	
75252	Bromoform		C	2.2E+02	2.1E+01		2.2E+03	2.1E+02		2.2E+04	2.1E+03		8.3E-01	
106990	1,3-Butadiene		C	8.7E-01	3.9E-01		8.7E+00	3.9E+00		8.7E+01	3.9E+01		2.9E-01	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E+01	2.6E+00		1.6E+02	2.6E+01		1.6E+03	2.6E+02		1.3E+01	
57749	Chlordane		NC	7.0E-01	4.2E-02		7.0E+00	4.2E-01		7.0E+01	4.2E+00		**	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E+01	1.2E+00		1.0E+02	1.2E+01		1.0E+03	1.2E+02		3.2E+02	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E+01	2.2E+00		1.1E+02	2.2E+01		1.1E+03	2.2E+02		8.0E+01 †	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	*	*	*		*	*		*	*		*	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-01	1.6E-01		4.5E+00	1.6E+00		4.5E+01	1.6E+01		5.6E+02	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-4}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-4}, HI=1) C_{target} (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
72559	DDE	X	C	2.5E+00	1.9E-01		2.5E+01	1.9E+00		**	**		**	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		NC	2.0E-01	2.6E-02		2.0E+00	2.6E-01		2.0E+01	2.6E+00		6.6E+00	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E+00	2.3E+00		9.4E+01	2.3E+01		9.4E+02	2.3E+02		2.3E+02	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		NC	2.0E+01	4.4E+00		2.0E+02	4.4E+01		2.0E+03	4.4E+02		2.8E+01	
60571	Dieldrin		C	5.3E-02	3.4E-03		5.3E-01	3.4E-02		5.3E+00	3.4E-01		8.6E+01	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+02	5.1E+01		2.2E+03	5.1E+02		2.2E+04	5.1E+03		7.0E+02 [†]	
75218	Ethylene oxide		C	2.4E+00	1.4E+00		2.4E+01	1.4E+01		2.4E+02	1.4E+02		1.1E+02	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-01	5.5E-02		6.6E+00	5.5E-01		6.6E+01	5.5E+00		1.1E+03	
76448	Heptachlor		C	1.9E-01	1.2E-02		1.9E+00	1.2E-01		1.9E+01	1.2E+00		4.0E-01 [†]	
87683	Hexachloro-1,3-butadiene		C	1.1E+01	1.0E+00		1.1E+02	1.0E+01		1.1E+03	1.0E+02		3.3E+01	
118741	Hexachlorobenzene		C	5.3E-01	4.5E-02		5.3E+00	4.5E-01		5.3E+01	4.5E+00		**	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 [†]	
67721	Hexachloroethane		C	6.1E+01	6.3E+00		6.1E+02	6.3E+01		6.1E+03	6.3E+02		3.8E+02	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
7439976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-4}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-4}, HI=1) C_{target} (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		NC	9.0E+01	4.4E+01		9.0E+02	4.4E+02		9.0E+03	4.4E+03		2.5E+02	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+02	1.5E+02		5.2E+03	1.5E+03		5.2E+04	1.5E+04		5.8E+03	
78933	Methylethylketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methylisobutylketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methylmethacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-02	2.5E-02		9.0E-01	2.5E-01		9.0E+00	2.5E+00		1.8E+01	
924163	N-Nitroso-di-n-butylamine		C	1.5E-01	2.4E-02		1.5E+00	2.4E-01		1.5E+01	2.4E+00		1.2E+01	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E+01	4.8E+00		3.3E+02	4.8E+01		3.3E+03	4.8E+02		3.3E+02	
79345	1,1,2,2-Tetrachloroethane		C	4.2E+00	6.1E-01		4.2E+01	6.1E+00		4.2E+02	6.1E+01		3.0E+02	
127184	Tetrachloroethylene		C	8.1E+01	1.2E+01		8.1E+02	1.2E+02		8.1E+03	1.2E+03		1.1E+02	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E+01	2.8E+00		1.5E+02	2.8E+01		1.5E+03	2.8E+02		4.1E+02	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene [11]	X	C	2.2E+00	4.1E-01		2.2E+01	4.1E+00		2.2E+02	4.1E+01		5.3E+00	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet [1]

Risk = 1 x 10^{-4}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-4}, HI=1) C_{target} (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m^3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E+01	1.1E+01		2.8E+02	1.1E+02		2.8E+03	1.1E+03		2.5E+01	

[1] AF = 0.1 for Shallow Soil Gas Target Concentration
AF = 0.01 for Deep Soil Gas Target Concentration
AF = 0.001 for Groundwater Target Concentration

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)

† The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 2b: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-5}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-5}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		NC	9.0E+00	5.0E+00		9.0E+01	5.0E+01		9.0E+02	5.0E+02		2.8E+03	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		C	3.6E-01	1.7E-01		3.6E+00	1.7E+00		3.6E+01	1.7E+01		8.5E+01	
309002	Aldrin		C	5.0E-03	3.3E-04		5.0E-02	3.3E-03		5.0E-01	3.3E-02		7.1E-01	
319846	alpha-HCH (alpha-BHC)		C	1.4E-02	1.1E-03		1.4E-01	1.1E-02		1.4E+00	1.1E-01		3.1E+01	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E+00	9.8E-01		3.1E+01	9.8E+00		3.1E+02	9.8E+01		1.4E+01	
205992	Benzo(b)fluoranthene	X	C	1.2E-01	1.1E-02		1.2E+00	1.1E-01		**	**		**	
100447	Benzylchloride	X	C	5.0E-01	9.7E-02		5.0E+00	9.7E-01		5.0E+01	9.7E+00		3.0E+01	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-02	1.3E-02		7.4E-01	1.3E-01		7.4E+00	1.3E+00		1.0E+02	
108601	Bis(2-chloroisopropyl)ether		C	2.4E+00	3.5E-01		2.4E+01	3.5E+00		2.4E+02	3.5E+01		5.1E+02	
542881	Bis(chloromethyl)ether		C	3.9E-04	8.4E-05		3.9E-03	8.4E-04		3.9E-02	8.4E-03		4.5E-02	
75274	Bromodichloromethane	X	C	1.4E+00	2.1E-01		1.4E+01	2.1E+00		1.4E+02	2.1E+01		2.1E+01	
75252	Bromoform		C	2.2E+01	2.1E+00		2.2E+02	2.1E+01		2.2E+03	2.1E+02		8.3E-02	
106990	1,3-Butadiene		C	8.7E-02	3.9E-02		8.7E-01	3.9E-01		8.7E+00	3.9E+00		2.9E-02	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E+00	2.6E-01		1.6E+01	2.6E+00		1.6E+02	2.6E+01		5.0E+00 [1]	
57749	Chlordane		C	2.4E-01	1.5E-02		2.4E+00	1.5E-01		2.4E+01	1.5E+00		**	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E+00	1.2E-01		1.0E+01	1.2E+00		1.0E+02	1.2E+01		3.2E+01	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E+00	2.2E-01		1.1E+01	2.2E+00		1.1E+02	2.2E+01		8.0E+01 [1]	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	C	1.2E+01	1.2E+00		**	**		**	**		**	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-02	1.6E-02		4.5E-01	1.6E-01		4.5E+00	1.6E+00		5.6E+01	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-5}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-5}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
72559	DDE	X	C	2.5E-01	1.9E-02		2.5E+00	1.9E-01		2.5E+01	1.9E+00		**	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		C	1.1E-01	1.4E-02		1.1E+00	1.4E-01		1.1E+01	1.4E+00		3.6E+00	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E-01	2.3E-01		9.4E+00	2.3E+00		9.4E+01	2.3E+01		2.3E+01	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		C	6.1E+00	1.3E+00		6.1E+01	1.3E+01		6.1E+02	1.3E+02		8.4E+00	
60571	Dieldrin		C	5.3E-03	3.4E-04		5.3E-02	3.4E-03		5.3E-01	3.4E-02		8.6E+00	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+01	5.1E+00		2.2E+02	5.1E+01		2.2E+03	5.1E+02		7.0E+02 [†]	
75218	Ethylene oxide		C	2.4E-01	1.4E-01		2.4E+00	1.4E+00		2.4E+01	1.4E+01		1.1E+01	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-02	5.5E-03		6.6E-01	5.5E-02		6.6E+00	5.5E-01		1.1E+02	
76448	Heptachlor		C	1.9E-02	1.2E-03		1.9E-01	1.2E-02		1.9E+00	1.2E-01		4.0E-01 [†]	
87683	Hexachloro-1,3-butadiene		C	1.1E+00	1.0E-01		1.1E+01	1.0E+00		1.1E+02	1.0E+01		3.3E+00	
118741	Hexachlorobenzene		C	5.3E-02	4.5E-03		5.3E-01	4.5E-02		5.3E+00	4.5E-01		1.0E+00 [†]	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 [†]	
67721	Hexachloroethane		C	6.1E+00	6.3E-01		6.1E+01	6.3E+00		6.1E+02	6.3E+01		3.8E+01	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
7439976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-5}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-5}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		C	2.4E+01	1.2E+01		2.4E+02	1.2E+02		2.4E+03	1.2E+03		6.7E+01	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+01	1.5E+01		5.2E+02	1.5E+02		5.2E+03	1.5E+03		5.8E+02	
78933	Methylethylketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methylisobutylketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methylmethacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-03	2.5E-03		9.0E-02	2.5E-02		9.0E-01	2.5E-01		1.8E+00	
924163	N-Nitroso-di-n-butylamine		C	1.5E-02	2.4E-03		1.5E-01	2.4E-02		1.5E+00	2.4E-01		1.2E+00	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E+00	4.8E-01		3.3E+01	4.8E+00		3.3E+02	4.8E+01		3.3E+01	
79345	1,1,2,2-Tetrachloroethane		C	4.2E-01	6.1E-02		4.2E+00	6.1E-01		4.2E+01	6.1E+00		3.0E+01	
127184	Tetrachloroethylene		C	8.1E+00	1.2E+00		8.1E+01	1.2E+01		8.1E+02	1.2E+02		1.1E+01	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E+00	2.8E-01		1.5E+01	2.8E+00		1.5E+02	2.8E+01		4.1E+01	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene [††]	X	C	2.2E-01	4.1E-02		2.2E+00	4.1E-01		2.2E+01	4.1E+00		5.0E+00 [†]	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet [1]

Risk = 1 x 10^{-5}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-5}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E+00	1.1E+00		2.8E+01	1.1E+01		2.8E+02	1.1E+02		2.5E+00	

[1] AF = 0.1 for Shallow Soil Gas Target Concentration
AF = 0.01 for Deep Soil Gas Target Concentration
AF = 0.001 for Groundwater Target Concentration

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)

† The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 2c: Question 4 Generic Screening Levels and Summary Sheet [1]
Risk = 1 x 10^{-6}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-6}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		C	1.1E+00	6.1E-01		1.1E+01	6.1E+00		1.1E+02	6.1E+01		3.4E+02	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		C	3.6E-02	1.7E-02		3.6E-01	1.7E-01		3.6E+00	1.7E+00		8.5E+00	
309002	Aldrin		C	5.0E-04	3.3E-05		5.0E-03	3.3E-04		5.0E-02	3.3E-03		7.1E-02	
319846	alpha-HCH (alpha-BHC)		C	1.4E-03	1.1E-04		1.4E-02	1.1E-03		1.4E-01	1.1E-02		3.1E+00	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E-01	9.8E-02		3.1E+00	9.8E-01		3.1E+01	9.8E+00		5.0E+00 †	
205992	Benzo(b)fluoranthene	X	C	1.2E-02	1.1E-03		1.2E-01	1.1E-02		1.2E+00	1.1E-01		**	
100447	Benzylchloride	X	C	5.0E-02	9.7E-03		5.0E-01	9.7E-02		5.0E+00	9.7E-01		3.0E+00	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-03	1.3E-03		7.4E-02	1.3E-02		7.4E-01	1.3E-01		1.0E+01	
108601	Bis(2-chloroisopropyl)ether		C	2.4E-01	3.5E-02		2.4E+00	3.5E-01		2.4E+01	3.5E+00		5.1E+01	
542881	Bis(chloromethyl)ether		C	3.9E-05	8.4E-06		3.9E-04	8.4E-05		3.9E-03	8.4E-04		4.5E-03	
75274	Bromodichloromethane	X	C	1.4E-01	2.1E-02		1.4E+00	2.1E-01		1.4E+01	2.1E+00		2.1E+00	
75252	Bromoform		C	2.2E+00	2.1E-01		2.2E+01	2.1E+00		2.2E+02	2.1E+01		8.3E-03	
106990	1,3-Butadiene		C	8.7E-03	3.9E-03		8.7E-02	3.9E-02		8.7E-01	3.9E-01		2.9E-03	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E-01	2.6E-02		1.6E+00	2.6E-01		1.6E+01	2.6E+00		5.0E+00 †	
57749	Chlordane		C	2.4E-02	1.5E-03		2.4E-01	1.5E-02		2.4E+00	1.5E-01		1.2E+01	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E-01	1.2E-02		1.0E+00	1.2E-01		1.0E+01	1.2E+00		3.2E+00	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E-01	2.2E-02		1.1E+00	2.2E-01		1.1E+01	2.2E+00		8.0E+01 †	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	C	1.2E+00	1.2E-01		1.2E+01	1.2E+00		**	**		**	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-03	1.6E-03		4.5E-02	1.6E-02		4.5E-01	1.6E-01		5.6E+00	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2c: Question 4 Generic Screening Levels and Summary Sheet [1]

Risk = 1 x 10^{-6}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-6}, HI=1] C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
72559	DDE	X	C	2.5E-02	1.9E-03		2.5E-01	1.9E-02		2.5E+00	1.9E-01		2.9E+01	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		C	1.1E-02	1.4E-03		1.1E-01	1.4E-02		1.1E+00	1.4E-01		3.6E-01	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E-02	2.3E-02		9.4E-01	2.3E-01		9.4E+00	2.3E+00		5.0E+00 †	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		C	6.1E-01	1.3E-01		6.1E+00	1.3E+00		6.1E+01	1.3E+01		8.4E-01	
60571	Dieldrin		C	5.3E-04	3.4E-05		5.3E-03	3.4E-04		5.3E-02	3.4E-03		8.6E-01	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+00	5.1E-01		2.2E+01	5.1E+00		2.2E+02	5.1E+01		7.0E+02 †	
75218	Ethylene oxide		C	2.4E-02	1.4E-02		2.4E-01	1.4E-01		2.4E+00	1.4E+00		1.1E+00	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-03	5.5E-04		6.6E-02	5.5E-03		6.6E-01	5.5E-02		1.1E+01	
76448	Heptachlor		C	1.9E-03	1.2E-04		1.9E-02	1.2E-03		1.9E-01	1.2E-02		4.0E-01 †	
87683	Hexachloro-1,3-butadiene		C	1.1E-01	1.0E-02		1.1E+00	1.0E-01		1.1E+01	1.0E+00		3.3E-01	
118741	Hexachlorobenzene		C	5.3E-03	4.5E-04		5.3E-02	4.5E-03		5.3E-01	4.5E-02		1.0E+00 †	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 †	
67721	Hexachloroethane		C	6.1E-01	6.3E-02		6.1E+00	6.3E-01		6.1E+01	6.3E+00		3.8E+00	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
7439976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

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Risk = 1 x 10^{-6}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-6}, HI=1) C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		C	2.4E+00	1.2E+00		2.4E+01	1.2E+01		2.4E+02	1.2E+02		6.7E+00	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+00	1.5E+00		5.2E+01	1.5E+01		5.2E+02	1.5E+02		5.8E+01	
78933	Methylethylketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methylisobutylketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methylmethacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-04	2.5E-04		9.0E-03	2.5E-03		9.0E-02	2.5E-02		1.8E-01	
924163	N-Nitroso-di-n-butylamine		C	1.5E-03	2.4E-04		1.5E-02	2.4E-03		1.5E-01	2.4E-02		1.2E-01	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E-01	4.8E-02		3.3E+00	4.8E-01		3.3E+01	4.8E+00		3.3E+00	
79345	1,1,2,2-Tetrachloroethane		C	4.2E-02	6.1E-03		4.2E-01	6.1E-02		4.2E+00	6.1E-01		3.0E+00	
127184	Tetrachloroethylene		C	8.1E-01	1.2E-01		8.1E+00	1.2E+00		8.1E+01	1.2E+01		5.0E+00 [†]	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E-01	2.8E-02		1.5E+00	2.8E-01		1.5E+01	2.8E+00		5.0E+00 [†]	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene [††]	X	C	2.2E-02	4.1E-03		2.2E-01	4.1E-02		2.2E+00	4.1E-01		5.0E+00 [†]	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2c: Question 4 Generic Screening Levels and Summary Sheet [1]

Risk = 1 x 10^{-6}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10^{-6}, HI=1] C_{target} (ug/m3)	(ppbv)	Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 $C_{soil-gas}$ (ug/m3)	(ppbv)	Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C_{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E-01	1.1E-01		2.8E+00	1.1E+00		2.8E+01	1.1E+01		2.0E+00 †	

[1] AF = 0.1 for Shallow Soil Gas Target Concentration
AF = 0.01 for Deep Soil Gas Target Concentration
AF = 0.001 for Groundwater Target Concentration

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)

† The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α) DRAFT

Risk = 1 x 10^{-6}

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	α = 2x10^{-3} $C_{soil-gas}$		α = 1x10^{-3} $C_{soil-gas}$		α = 7x10^{-4} $C_{soil-gas}$		α = 4x10^{-4} $C_{soil-gas}$		α = 2x10^{-4} $C_{soil-gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		NC	4.5E+03	2.5E+03	9.0E+03	5.0E+03	1.3E+04	7.1E+03	2.2E+04	1.2E+04	4.5E+04	2.5E+04
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		NC	1.0E+03	4.6E+02	2.0E+03	9.2E+02	2.9E+03	1.3E+03	5.0E+03	2.3E+03	1.0E+04	4.6E+03
309002	Aldrin		C	2.5E+01	1.7E+00	5.0E+01	3.3E+00	7.1E+01	4.8E+00	**	**	**	**
319846	alpha-HCH (alpha-BHC)		C	6.8E+01	5.7E+00	1.4E+02	1.1E+01	1.9E+02	1.6E+01	3.4E+02	2.8E+01	6.8E+02	5.7E+01
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+04	4.9E+03	3.1E+04	9.8E+03	4.5E+04	1.4E+04	7.8E+04	2.4E+04	1.6E+05	4.9E+04
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+03	4.8E+02	5.0E+03	9.7E+02	7.2E+03	1.4E+03	1.3E+04	2.4E+03	2.5E+04	4.8E+03
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	3.7E+02	6.3E+01	7.4E+02	1.3E+02	1.1E+03	1.8E+02	1.8E+03	3.2E+02	3.7E+03	6.3E+02
108601	Bis(2-chloroisopropyl)ether		C	1.2E+04	1.7E+03	2.4E+04	3.5E+03	3.5E+04	5.0E+03	6.1E+04	8.7E+03	1.2E+05	1.7E+04
542881	Bis(chloromethyl)ether		C	2.0E+00	4.2E-01	3.9E+00	8.4E-01	5.6E+00	1.2E+00	9.8E+00	2.1E+00	2.0E+01	4.2E+00
75274	Bromodichloromethane	X	C	6.9E+03	1.0E+03	1.4E+04	2.1E+03	2.0E+04	2.9E+03	3.4E+04	5.1E+03	6.9E+04	1.0E+04
75252	Bromoform		C	1.1E+05	1.1E+04	2.2E+05	2.1E+04	3.2E+05	3.1E+04	5.5E+05	5.4E+04	1.1E+06	1.1E+05
106990	1,3-Butadiene		C	4.3E+02	2.0E+02	8.7E+02	3.9E+02	1.2E+03	5.6E+02	2.2E+03	9.8E+02	4.3E+03	2.0E+03
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+03	1.3E+03	1.6E+04	2.6E+03	2.3E+04	3.7E+03	4.1E+04	6.5E+03	8.1E+04	1.3E+04
57749	Chlordane		NC	**	**	**	**	**	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+03	6.0E+02	1.0E+04	1.2E+03	1.4E+04	1.7E+03	2.5E+04	3.0E+03	5.1E+04	6.0E+03
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+03	1.1E+03	1.1E+04	2.2E+03	1.5E+04	3.1E+03	2.6E+04	5.4E+03	5.3E+04	1.1E+04
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	*	*	*	*	*	*	*	*	*	*	*
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+02	7.8E+01	4.5E+02	1.6E+02	6.4E+02	2.2E+02	1.1E+03	3.9E+02	2.2E+03	7.8E+02
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	**	**	**	**	**	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		NC	1.0E+02	1.3E+01	2.0E+02	2.6E+01	2.9E+02	3.7E+01	5.0E+02	6.5E+01	1.0E+03	1.3E+02
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

DRAFT

Risk = 1 x 10^{-4}

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	α = 2x10^{-3} $C_{soil-gas}$		α = 1x10^{-3} $C_{soil-gas}$		α = 7x10^{-4} $C_{soil-gas}$		α = 4x10^{-4} $C_{soil-gas}$		α = 2x10^{-4} $C_{soil-gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+03	1.2E+03	9.4E+03	2.3E+03	1.3E+04	3.3E+03	2.3E+04	5.8E+03	4.7E+04	1.2E+04
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		NC	1.0E+04	2.2E+03	2.0E+04	4.4E+03	2.9E+04	6.3E+03	5.0E+04	1.1E+04	1.0E+05	2.2E+04
60571	Dieldrin		C	2.6E+01	1.7E+00	5.3E+01	3.4E+00	7.6E+01	4.9E+00	**	**	**	**
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
106898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+05	2.5E+04	2.2E+05	5.1E+04	3.2E+05	7.3E+04	5.5E+05	1.3E+05	1.1E+06	2.5E+05
75218	Ethylene oxide		C	1.2E+03	6.8E+02	2.4E+03	1.4E+03	3.5E+03	1.9E+03	6.1E+03	3.4E+03	1.2E+04	6.8E+03
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+02	2.8E+01	6.6E+02	5.5E+01	9.4E+02	7.9E+01	1.6E+03	1.4E+02	3.3E+03	2.8E+02
76448	Heptachlor		C	9.4E+01	6.1E+00	1.9E+02	1.2E+01	2.7E+02	1.8E+01	4.7E+02	3.1E+01	9.4E+02	6.1E+01
87683	Hexachloro-1,3-butadiene		C	5.5E+03	5.2E+02	1.1E+04	1.0E+03	1.6E+04	1.5E+03	2.8E+04	2.6E+03	5.5E+04	5.2E+03
118741	Hexachlorobenzene		C	2.6E+02	2.3E+01	**	**	**	**	**	**	**	**
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+04	3.1E+03	6.1E+04	6.3E+03	8.7E+04	9.0E+03	1.5E+05	1.6E+04	3.0E+05	3.1E+04
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		NC	4.5E+04	2.2E+04	9.0E+04	4.4E+04	1.3E+05	6.2E+04	2.3E+05	1.1E+05	4.5E+05	2.2E+05
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+05	7.5E+04	5.2E+05	1.5E+05	7.4E+05	2.1E+05	1.3E+06	3.7E+05	2.6E+06	7.5E+05
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α) DRAFT

Risk = 1 x 10^{-4}

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	α = 2x10^{-3} $C_{soil\text{-}gas}$		α = 1x10^{-3} $C_{soil\text{-}gas}$		α = 7x10^{-4} $C_{soil\text{-}gas}$		α = 4x10^{-4} $C_{soil\text{-}gas}$		α = 2x10^{-4} $C_{soil\text{-}gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E+01	1.2E+01	9.0E+01	2.5E+01	1.3E+02	3.5E+01	2.3E+02	6.2E+01	4.5E+02	1.2E+02
924163	N-Nitroso-di-n-butylamine		C	7.6E+01	1.2E+01	1.5E+02	2.4E+01	2.2E+02	3.4E+01	3.8E+02	5.9E+01	7.6E+02	1.2E+02
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+04	2.4E+03	3.3E+04	4.8E+03	4.7E+04	6.8E+03	8.2E+04	1.2E+04	1.6E+05	2.4E+04
79345	1,1,2,2-Tetrachloroethane		C	2.1E+03	3.1E+02	4.2E+03	6.1E+02	6.0E+03	8.7E+02	1.0E+04	1.5E+03	2.1E+04	3.1E+03
127184	Tetrachloroethylene		C	4.1E+04	6.0E+03	8.1E+04	1.2E+04	1.2E+05	1.7E+04	2.0E+05	3.0E+04	4.1E+05	6.0E+04
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+03	1.4E+03	1.5E+04	2.8E+03	2.2E+04	4.0E+03	3.8E+04	7.0E+03	7.6E+04	1.4E+04
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ††	X	C	1.1E+03	2.1E+02	2.2E+03	4.1E+02	3.2E+03	5.9E+02	5.5E+03	1.0E+03	1.1E+04	2.1E+03
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+04	5.4E+03	2.8E+04	1.1E+04	4.0E+04	1.5E+04	6.9E+04	2.7E+04	1.4E+05	5.4E+04

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1 x 10^{-5}

DRAFT

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	α = 2x10^{-3} $C_{soil\text{-}gas}$		α = 1x10^{-3} $C_{soil\text{-}gas}$		α = 7x10^{-4} $C_{soil\text{-}gas}$		α = 4x10^{-4} $C_{soil\text{-}gas}$		α = 2x10^{-4} $C_{soil\text{-}gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		NC	4.5E+03	2.5E+03	9.0E+03	5.0E+03	1.3E+04	7.1E+03	2.2E+04	1.2E+04	4.5E+04	2.5E+04
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		C	1.8E+02	8.3E+01	3.6E+02	1.7E+02	5.1E+02	2.4E+02	8.9E+02	4.1E+02	1.8E+03	8.3E+02
309002	Aldrin		C	2.5E+00	1.7E-01	5.0E+00	3.3E-01	7.1E+00	4.8E-01	1.2E+01	8.3E-01	2.5E+01	1.7E+00
319846	alpha-HCH (alpha-BHC)		C	6.8E+00	5.7E-01	1.4E+01	1.1E+00	1.9E+01	1.6E+00	3.4E+01	2.8E+00	6.8E+01	5.7E+00
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+03	4.9E+02	3.1E+03	9.8E+02	4.5E+03	1.4E+03	7.8E+03	2.4E+03	1.6E+04	4.9E+03
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+02	4.8E+01	5.0E+02	9.7E+01	7.2E+02	1.4E+02	1.3E+03	2.4E+02	2.5E+03	4.8E+02
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	3.7E+01	6.3E+00	7.4E+01	1.3E+01	1.1E+02	1.8E+01	1.8E+02	3.2E+01	3.7E+02	6.3E+01
108601	Bis(2-chloroisopropyl)ether		C	1.2E+03	1.7E+02	2.4E+03	3.5E+02	3.5E+03	5.0E+02	6.1E+03	8.7E+02	1.2E+04	1.7E+03
542881	Bis(chloromethyl)ether		C	2.0E-01	4.2E-02	3.9E-01	8.4E-02	5.6E-01	1.2E-01	9.8E-01	2.1E-01	2.0E+00	4.2E-01
75274	Bromodichloromethane	X	C	6.9E+02	1.0E+02	1.4E+03	2.1E+02	2.0E+03	2.9E+02	3.4E+03	5.1E+02	6.9E+03	1.0E+03
75252	Bromoform		C	1.1E+04	1.1E+03	2.2E+04	2.1E+03	3.2E+04	3.1E+03	5.5E+04	5.4E+03	1.1E+05	1.1E+04
106990	1,3-Butadiene		C	4.3E+01	2.0E+01	8.7E+01	3.9E+01	1.2E+02	5.6E+01	2.2E+02	9.8E+01	4.3E+02	2.0E+02
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+02	1.3E+02	1.6E+03	2.6E+02	2.3E+03	3.7E+02	4.1E+03	6.5E+02	8.1E+03	1.3E+03
57749	Chlordane		C	**	**	**	**	**	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+02	6.0E+01	1.0E+03	1.2E+02	1.4E+03	1.7E+02	2.5E+03	3.0E+02	5.1E+03	6.0E+02
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+02	1.1E+02	1.1E+03	2.2E+02	1.5E+03	3.1E+02	2.6E+03	5.4E+02	5.3E+03	1.1E+03
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	C	**	**	**	**	**	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+01	7.8E+00	4.5E+01	1.6E+01	6.4E+01	2.2E+01	1.1E+02	3.9E+01	2.2E+02	7.8E+01
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	**	**	**	**	**	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.5E+01	7.2E+00	1.1E+02	1.4E+01	1.6E+02	2.1E+01	2.8E+02	3.6E+01	5.5E+02	7.2E+01
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-5}

DRAFT

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	$\alpha = 2x10^{-3}$ $C_{soil-gas}$		$\alpha = 1x10^{-3}$ $C_{soil-gas}$		$\alpha = 7x10^{-4}$ $C_{soil-gas}$		$\alpha = 4x10^{-4}$ $C_{soil-gas}$		$\alpha = 2x10^{-4}$ $C_{soil-gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+02	1.2E+02	9.4E+02	2.3E+02	1.3E+03	3.3E+02	2.3E+03	5.8E+02	4.7E+03	1.2E+03
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		C	3.0E+03	6.7E+02	6.1E+03	1.3E+03	8.7E+03	1.9E+03	1.5E+04	3.4E+03	3.0E+04	6.7E+03
60571	Dieldrin		C	2.6E+00	1.7E-01	5.3E+00	3.4E-01	7.6E+00	4.9E-01	1.3E+01	8.5E-01	2.6E+01	1.7E+00
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
106898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+04	2.5E+03	2.2E+04	5.1E+03	3.2E+04	7.3E+03	5.5E+04	1.3E+04	1.1E+05	2.5E+04
75218	Ethylene oxide		C	1.2E+02	6.8E+01	2.4E+02	1.4E+02	3.5E+02	1.9E+02	6.1E+02	3.4E+02	1.2E+03	6.8E+02
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+01	2.8E+00	6.6E+01	5.5E+00	9.4E+01	7.9E+00	1.6E+02	1.4E+01	3.3E+02	2.8E+01
76448	Heptachlor		C	9.4E+00	6.1E-01	1.9E+01	1.2E+00	2.7E+01	1.8E+00	4.7E+01	3.1E+00	9.4E+01	6.1E+00
87683	Hexachloro-1,3-butadiene		C	5.5E+02	5.2E+01	1.1E+03	1.0E+02	1.6E+03	1.5E+02	2.8E+03	2.6E+02	5.5E+03	5.2E+02
118741	Hexachlorobenzene		C	2.6E+01	2.3E+00	5.3E+01	4.5E+00	7.6E+01	6.5E+00	1.3E+02	1.1E+01	2.6E+02	2.3E+01
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+03	3.1E+02	6.1E+03	6.3E+02	8.7E+03	9.0E+02	1.5E+04	1.6E+03	3.0E+04	3.1E+03
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		C	1.2E+04	5.9E+03	2.4E+04	1.2E+04	3.5E+04	1.7E+04	6.1E+04	2.9E+04	1.2E+05	5.9E+04
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+04	7.5E+03	5.2E+04	1.5E+04	7.4E+04	2.1E+04	1.3E+05	3.7E+04	2.6E+05	7.5E+04
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

DRAFT

Risk = 1 x 10^{-5}

				Target Soil Gas Concentrations for Different Attenuation Factors									
				$\alpha = 2x10^{-3}$		$\alpha = 1x10^{-3}$		$\alpha = 7x10^{-4}$		$\alpha = 4x10^{-4}$		$\alpha = 2x10^{-4}$	
				$C_{soil-gas}$		$C_{soil-gas}$		$C_{soil-gas}$		$C_{soil-gas}$		$C_{soil-gas}$	
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E+00	1.2E+00	9.0E+00	2.5E+00	1.3E+01	3.5E+00	2.3E+01	6.2E+00	4.5E+01	1.2E+01
924163	N-Nitroso-di-n-butylamine		C	7.6E+00	1.2E+00	1.5E+01	2.4E+00	2.2E+01	3.4E+00	3.8E+01	5.9E+00	7.6E+01	1.2E+01
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+03	2.4E+02	3.3E+03	4.8E+02	4.7E+03	6.8E+02	8.2E+03	1.2E+03	1.6E+04	2.4E+03
79345	1,1,2,2-Tetrachloroethane		C	2.1E+02	3.1E+01	4.2E+02	6.1E+01	6.0E+02	8.7E+01	1.0E+03	1.5E+02	2.1E+03	3.1E+02
127184	Tetrachloroethylene		C	4.1E+03	6.0E+02	8.1E+03	1.2E+03	1.2E+04	1.7E+03	2.0E+04	3.0E+03	4.1E+04	6.0E+03
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+02	1.4E+02	1.5E+03	2.8E+02	2.2E+03	4.0E+02	3.8E+03	7.0E+02	7.6E+03	1.4E+03
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ††	X	C	1.1E+02	2.1E+01	2.2E+02	4.1E+01	3.2E+02	5.9E+01	5.5E+02	1.0E+02	1.1E+03	2.1E+02
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+03	5.4E+02	2.8E+03	1.1E+03	4.0E+03	1.5E+03	6.9E+03	2.7E+03	1.4E+04	5.4E+03

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1 x 10^{-6}

DRAFT

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	$\alpha = 2x10^{-3}$ $C_{soil\text{-}gas}$		$\alpha = 1x10^{-3}$ $C_{soil\text{-}gas}$		$\alpha = 7x10^{-4}$ $C_{soil\text{-}gas}$		$\alpha = 4x10^{-4}$ $C_{soil\text{-}gas}$		$\alpha = 2x10^{-4}$ $C_{soil\text{-}gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		C	5.5E+02	3.1E+02	1.1E+03	6.1E+02	1.6E+03	8.8E+02	2.8E+03	1.5E+03	5.5E+03	3.1E+03
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		C	1.8E+01	8.3E+00	3.6E+01	1.7E+01	5.1E+01	2.4E+01	8.9E+01	4.1E+01	1.8E+02	8.3E+01
309002	Aldrin		C	2.5E-01	1.7E-02	5.0E-01	3.3E-02	7.1E-01	4.8E-02	1.2E+00	8.3E-02	2.5E+00	1.7E-01
319846	alpha-HCH (alpha-BHC)		C	6.8E-01	5.7E-02	1.4E+00	1.1E-01	1.9E+00	1.6E-01	3.4E+00	2.8E-01	6.8E+00	5.7E-01
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+02	4.9E+01	3.1E+02	9.8E+01	4.5E+02	1.4E+02	7.8E+02	2.4E+02	1.6E+03	4.9E+02
205992	Benzo(b)fluoranthene	X	C	5.8E+00	5.6E-01	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+01	4.8E+00	5.0E+01	9.7E+00	7.2E+01	1.4E+01	1.3E+02	2.4E+01	2.5E+02	4.8E+01
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	3.7E+00	6.3E-01	7.4E+00	1.3E+00	1.1E+01	1.8E+00	1.8E+01	3.2E+00	3.7E+01	6.3E+00
108601	Bis(2-chloroisopropyl)ether		C	1.2E+02	1.7E+01	2.4E+02	3.5E+01	3.5E+02	5.0E+01	6.1E+02	8.7E+01	1.2E+03	1.7E+02
542881	Bis(chloromethyl)ether		C	2.0E-02	4.2E-03	3.9E-02	8.4E-03	5.6E-02	1.2E-02	9.8E-02	2.1E-02	2.0E-01	4.2E-02
75274	Bromodichloromethane	X	C	6.9E+01	1.0E+01	1.4E+02	2.1E+01	2.0E+02	2.9E+01	3.4E+02	5.1E+01	6.9E+02	1.0E+02
75252	Bromoform		C	1.1E+03	1.1E+02	2.2E+03	2.1E+02	3.2E+03	3.1E+02	5.5E+03	5.4E+02	1.1E+04	1.1E+03
106990	1,3-Butadiene		C	4.3E+00	2.0E+00	8.7E+00	3.9E+00	1.2E+01	5.6E+00	2.2E+01	9.8E+00	4.3E+01	2.0E+01
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+01	1.3E+01	1.6E+02	2.6E+01	2.3E+02	3.7E+01	4.1E+02	6.5E+01	8.1E+02	1.3E+02
57749	Chlordane		C	1.2E+01	7.3E-01	2.4E+01	1.5E+00	3.5E+01	2.1E+00	6.1E+01	3.6E+00	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+01	6.0E+00	1.0E+02	1.2E+01	1.4E+02	1.7E+01	2.5E+02	3.0E+01	5.1E+02	6.0E+01
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+01	1.1E+01	1.1E+02	2.2E+01	1.5E+02	3.1E+01	2.6E+02	5.4E+01	5.3E+02	1.1E+02
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	C	**	**	**	**	**	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+00	7.8E-01	4.5E+00	1.6E+00	6.4E+00	2.2E+00	1.1E+01	3.9E+00	2.2E+01	7.8E+00
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	1.3E+01	9.6E-01	2.5E+01	1.9E+00	3.6E+01	2.8E+00	6.3E+01	4.8E+00	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.5E+00	7.2E-01	1.1E+01	1.4E+00	1.6E+01	2.1E+00	2.8E+01	3.6E+00	5.5E+01	7.2E+00
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1 x 10^{-6}

DRAFT

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrapolated	Basis of Target Concentration C=cancer risk	α = $2x10^{-3}$ $C_{soil-gas}$		α = $1x10^{-3}$ $C_{soil-gas}$		α = $7x10^{-4}$ $C_{soil-gas}$		α = $4x10^{-4}$ $C_{soil-gas}$		α = $2x10^{-4}$ $C_{soil-gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+01	1.2E+01	9.4E+01	2.3E+01	1.3E+02	3.3E+01	2.3E+02	5.8E+01	4.7E+02	1.2E+02
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		C	3.0E+02	6.7E+01	6.1E+02	1.3E+02	8.7E+02	1.9E+02	1.5E+03	3.4E+02	3.0E+03	6.7E+02
60571	Dieldrin		C	2.6E-01	1.7E-02	5.3E-01	3.4E-02	7.6E-01	4.9E-02	1.3E+00	8.5E-02	2.6E+00	1.7E-01
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
106898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+03	2.5E+02	2.2E+03	5.1E+02	3.2E+03	7.3E+02	5.5E+03	1.3E+03	1.1E+04	2.5E+03
75218	Ethylene oxide		C	1.2E+01	6.8E+00	2.4E+01	1.4E+01	3.5E+01	1.9E+01	6.1E+01	3.4E+01	1.2E+02	6.8E+01
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+00	2.8E-01	6.6E+00	5.5E-01	9.4E+00	7.9E-01	1.6E+01	1.4E+00	3.3E+01	2.8E+00
76448	Heptachlor		C	9.4E-01	6.1E-02	1.9E+00	1.2E-01	2.7E+00	1.8E-01	4.7E+00	3.1E-01	9.4E+00	6.1E-01
87683	Hexachloro-1,3-butadiene		C	5.5E+01	5.2E+00	1.1E+02	1.0E+01	1.6E+02	1.5E+01	2.8E+02	2.6E+01	5.5E+02	5.2E+01
118741	Hexachlorobenzene		C	2.6E+00	2.3E-01	5.3E+00	4.5E-01	7.6E+00	6.5E-01	1.3E+01	1.1E+00	2.6E+01	2.3E+00
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+02	3.1E+01	6.1E+02	6.3E+01	8.7E+02	9.0E+01	1.5E+03	1.6E+02	3.0E+03	3.1E+02
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		C	1.2E+03	5.9E+02	2.4E+03	1.2E+03	3.5E+03	1.7E+03	6.1E+03	2.9E+03	1.2E+04	5.9E+03
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+03	7.5E+02	5.2E+03	1.5E+03	7.4E+03	2.1E+03	1.3E+04	3.7E+03	2.6E+04	7.5E+03
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1 x 10^{-6}

DRAFT

				Target Soil Gas Concentrations for Different Attenuation Factors									
		Compounds with Provisional Toxicity Data Extrepolated	Basis of Target Concentration C=cancer risk	$\alpha = 2x10^{-3}$ $C_{soil-gas}$		$\alpha = 1x10^{-3}$ $C_{soil-gas}$		$\alpha = 7x10^{-4}$ $C_{soil-gas}$		$\alpha = 4x10^{-4}$ $C_{soil-gas}$		$\alpha = 2x10^{-4}$ $C_{soil-gas}$	
CAS No.	Chemical	From Oral Sources	NC=noncancer risk	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)	(ug/m^3)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E-01	1.2E-01	9.0E-01	2.5E-01	1.3E+00	3.5E-01	2.3E+00	6.2E-01	4.5E+00	1.2E+00
924163	N-Nitroso-di-n-butylamine		C	7.6E-01	1.2E-01	1.5E+00	2.4E-01	2.2E+00	3.4E-01	3.8E+00	5.9E-01	7.6E+00	1.2E+00
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+02	2.4E+01	3.3E+02	4.8E+01	4.7E+02	6.8E+01	8.2E+02	1.2E+02	1.6E+03	2.4E+02
79345	1,1,2,2-Tetrachloroethane		C	2.1E+01	3.1E+00	4.2E+01	6.1E+00	6.0E+01	8.7E+00	1.0E+02	1.5E+01	2.1E+02	3.1E+01
127184	Tetrachloroethylene		C	4.1E+02	6.0E+01	8.1E+02	1.2E+02	1.2E+03	1.7E+02	2.0E+03	3.0E+02	4.1E+03	6.0E+02
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+01	1.4E+01	1.5E+02	2.8E+01	2.2E+02	4.0E+01	3.8E+02	7.0E+01	7.6E+02	1.4E+02
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ††	X	C	1.1E+01	2.1E+00	2.2E+01	4.1E+00	3.2E+01	5.9E+00	5.5E+01	1.0E+01	1.1E+02	2.1E+01
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+02	5.4E+01	2.8E+02	1.1E+02	4.0E+02	1.5E+02	6.9E+02	2.7E+02	1.4E+03	5.4E+02

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathwey incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-4}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		NC	4.0E+03	5.6E+03	9.3E+03	1.4E+04	2.8E+04
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		NC	6.8E+02	9.5E+02	1.6E+03	2.4E+03	4.7E+03
309002	Aldrin		C	1.0E+01	1.4E+01	**	**	**
319846	alpha-HCH (alpha-BHC)		C	4.5E+02	6.2E+02	1.0E+03	1.6E+03	**
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	2.0E+02	2.7E+02	4.6E+02	6.9E+02	1.4E+03
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+02	5.9E+02	9.8E+02	1.5E+03	3.0E+03
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+03	2.0E+03	3.3E+03	5.0E+03	1.0E+04
108601	Bis(2-chloroisopropyl)ether		C	7.3E+03	1.0E+04	1.7E+04	2.5E+04	5.1E+04
542881	Bis(chloromethyl)ether		C	6.4E-01	9.0E-01	1.5E+00	2.3E+00	4.5E+00
75274	Bromodichloromethane	X	C	3.0E+02	4.2E+02	7.0E+02	1.1E+03	2.1E+03
75252	Bromoform		C	1.2E+00	1.7E+00	2.8E+00	4.2E+00	8.3E+00
106990	1,3-Butadiene		C	4.1E-01	5.8E-01	9.6E-01	1.4E+00	2.9E+00
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	1.9E+01	2.6E+01	4.3E+01	6.5E+01	1.3E+02
57749	Chlordane		NC	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+02	6.3E+02	1.1E+03	1.6E+03	3.2E+03
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	1.0E+02	1.4E+02	2.3E+02	3.5E+02	7.0E+02
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-4}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	*	*	*	*	*	*
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		NC	9.4E+00	1.3E+01	2.2E+01	3.3E+01	6.6E+01
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	3.3E+02	4.7E+02	7.8E+02	1.2E+03	2.3E+03
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		NC	3.9E+01	5.5E+01	9.2E+01	1.4E+02	2.8E+02
60571	Dieldrin		C	1.2E+02	1.7E+02	**	**	**
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	9.8E+02	1.4E+03	2.3E+03	3.4E+03	6.9E+03
75218	Ethylene oxide		C	1.5E+02	2.1E+02	3.6E+02	5.4E+02	1.1E+03
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+03	2.3E+03	3.8E+03	5.7E+03	**
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E+01	6.6E+01	1.1E+02	1.7E+02	3.3E+02
118741	Hexachlorobenzene		C	**	**	**	**	**
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+02	7.6E+02	1.3E+03	1.9E+03	3.8E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-4}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		NC	3.6E+02	5.0E+02	8.3E+02	1.2E+03	2.5E+03
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+03	1.2E+04	1.9E+04	2.9E+04	5.8E+04
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E+01	3.6E+01	6.0E+01	9.0E+01	1.8E+02
924163	N-Nitroso-di-n-butylamine		C	1.7E+01	2.4E+01	3.9E+01	5.9E+01	1.2E+02
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+02	6.6E+02	1.1E+03	1.7E+03	3.3E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-4}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+02	5.9E+02	9.9E+02	1.5E+03	3.0E+03
127184	Tetrachloroethylene		C	1.5E+02	2.2E+02	3.6E+02	5.4E+02	1.1E+03
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+02	8.1E+02	1.4E+03	2.0E+03	4.1E+03
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ††	X	C	7.5E+00	1.1E+01	1.8E+01	2.6E+01	5.3E+01
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	3.6E+01	5.0E+01	8.3E+01	1.3E+02	2.5E+02

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-5}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		NC	4.0E+03	5.6E+03	9.3E+03	1.4E+04	2.8E+04
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		C	1.2E+02	1.7E+02	2.8E+02	4.2E+02	8.5E+02
309002	Aldrin		C	1.0E+00	1.4E+00	2.4E+00	3.6E+00	7.1E+00
319846	alpha-HCH (alpha-BHC)		C	4.5E+01	6.2E+01	1.0E+02	1.6E+02	3.1E+02
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	2.0E+01	2.7E+01	4.6E+01	6.9E+01	1.4E+02
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+01	5.9E+01	9.8E+01	1.5E+02	3.0E+02
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+02	2.0E+02	3.3E+02	5.0E+02	1.0E+03
108601	Bis(2-chloroisopropyl)ether		C	7.3E+02	1.0E+03	1.7E+03	2.5E+03	5.1E+03
542881	Bis(chloromethyl)ether		C	6.4E-02	9.0E-02	1.5E-01	2.3E-01	4.5E-01
75274	Bromodichloromethane	X	C	3.0E+01	4.2E+01	7.0E+01	1.1E+02	2.1E+02
75252	Bromoform		C	1.2E-01	1.7E-01	2.8E-01	4.2E-01	8.3E-01
106990	1,3-Butadiene		C	4.1E-02	5.8E-02	9.6E-02	1.4E-01	2.9E-01
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	6.5E+00	1.3E+01
57749	Chlordane		C	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+01	6.3E+01	1.1E+02	1.6E+02	3.2E+02
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-5}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	C	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+01	1.1E+02	1.9E+02	2.8E+02	5.6E+02
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.2E+00	7.3E+00	1.2E+01	1.8E+01	3.6E+01
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	3.3E+01	4.7E+01	7.8E+01	1.2E+02	2.3E+02
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		C	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
60571	Dieldrin		C	1.2E+01	1.7E+01	2.9E+01	4.3E+01	8.6E+01
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †
75218	Ethylene oxide		C	1.5E+01	2.1E+01	3.6E+01	5.4E+01	1.1E+02
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+02	2.3E+02	3.8E+02	5.7E+02	1.1E+03
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E+00	6.6E+00	1.1E+01	1.7E+01	3.3E+01
118741	Hexachlorobenzene		C	1.4E+00	2.0E+00	3.3E+00	4.9E+00	**
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+01	7.6E+01	1.3E+02	1.9E+02	3.8E+02

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-5}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		C	9.6E+01	1.3E+02	2.2E+02	3.4E+02	6.7E+02
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+02	1.2E+03	1.9E+03	2.9E+03	5.8E+03
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E+00	3.6E+00	6.0E+00	9.0E+00	1.8E+01
924163	N-Nitroso-di-n-butylamine		C	1.7E+00	2.4E+00	3.9E+00	5.9E+00	1.2E+01
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+01	6.6E+01	1.1E+02	1.7E+02	3.3E+02

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-5}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+01	5.9E+01	9.9E+01	1.5E+02	3.0E+02
127184	Tetrachloroethylene		C	1.5E+01	2.2E+01	3.6E+01	5.4E+01	1.1E+02
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+01	8.1E+01	1.4E+02	2.0E+02	4.1E+02
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ††	X	C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.3E+00
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	3.6E+00	5.0E+00	8.3E+00	1.3E+01	2.5E+01

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-6}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		C	4.9E+02	6.9E+02	1.1E+03	1.7E+03	3.4E+03
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		C	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.5E+01
309002	Aldrin		C	1.0E-01	1.4E-01	2.4E-01	3.6E-01	7.1E-01
319846	alpha-HCH (alpha-BHC)		C	4.5E+00	6.2E+00	1.0E+01	1.6E+01	3.1E+01
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	6.9E+00	1.4E+01
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+00	5.9E+00	9.8E+00	1.5E+01	3.0E+01
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+01	2.0E+01	3.3E+01	5.0E+01	1.0E+02
108601	Bis(2-chloroisopropyl)ether		C	7.3E+01	1.0E+02	1.7E+02	2.5E+02	5.1E+02
542881	Bis(chloromethyl)ether		C	6.4E-03	9.0E-03	1.5E-02	2.3E-02	4.5E-02
75274	Bromodichloromethane	X	C	3.0E+00	4.2E+00	7.0E+00	1.1E+01	2.1E+01
75252	Bromoform		C	1.2E-02	1.7E-02	2.8E-02	4.2E-02	8.3E-02
106990	1,3-Butadiene		C	4.1E-03	5.8E-03	9.6E-03	1.4E-02	2.9E-02
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †
57749	Chlordane		C	1.7E+01	2.4E+01	4.1E+01	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+00	6.3E+00	1.1E+01	1.6E+01	3.2E+01
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-6}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	C	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+00	1.1E+01	1.9E+01	2.8E+01	5.6E+01
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	4.2E+01	5.8E+01	9.7E+01	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.2E-01	7.3E-01	1.2E+00	1.8E+00	3.6E+00
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	5.0E+00 †	5.0E+00 †	7.8E+00	1.2E+01	2.3E+01
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		C	1.2E+00	1.7E+00	2.8E+00	4.2E+00	8.4E+00
60571	Dieldrin		C	1.2E+00	1.7E+00	2.9E+00	4.3E+00	8.6E+00
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †
75218	Ethylene oxide		C	1.5E+00	2.1E+00	3.6E+00	5.4E+00	1.1E+01
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+01	2.3E+01	3.8E+01	5.7E+01	1.1E+02
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E-01	6.6E-01	1.1E+00	1.7E+00	3.3E+00
118741	Hexachlorobenzene		C	1.0E+00 †	1.0E+00 †	1.0E+00 †	1.0E+00 †	1.0E+00 †
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+00	7.6E+00	1.3E+01	1.9E+01	3.8E+01

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-6}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		C	9.6E+00	1.3E+01	2.2E+01	3.4E+01	6.7E+01
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+01	1.2E+02	1.9E+02	2.9E+02	5.8E+02
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E-01	3.6E-01	6.0E-01	9.0E-01	1.8E+00
924163	N-Nitroso-di-n-butylamine		C	1.7E-01	2.4E-01	3.9E-01	5.9E-01	1.2E+00
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+00	6.6E+00	1.1E+01	1.7E+01	3.3E+01

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)
Risk = 1 x 10^{-6}

				Target Groundwater Concentrations at Different Attenuation Factors				
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7x10^{-4}$ C_{gw} (ug/L)	$\alpha = 5x10^{-4}$ C_{gw} (ug/L)	$\alpha = 3x10^{-4}$ C_{gw} (ug/L)	$\alpha = 2x10^{-4}$ C_{gw} (ug/L)	$\alpha = 1x10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+00	5.9E+00	9.9E+00	1.5E+01	3.0E+01
127184	Tetrachloroethylene		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.4E+00	1.1E+01
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+00	8.1E+00	1.4E+01	2.0E+01	4.1E+01
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ††	X	C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	2.0E+00 †	2.0E+00 †	2.0E+00 †	2.0E+00 †	2.5E+00

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

APPENDIX D

HAFB SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP)

STONE ENVIRONMENTAL INC

SITE SPECIFIC HEALTH AND SAFETY PLAN

SECTION 1: GENERAL INFORMATION AND DISCLAIMER		PROJECT NUMBER:	051687-R
PROJECT NAME:	HAFB SWMU183 - RCRA RFI Work 49 CES/CEV Holloman Air Force Base, New Mexico	CLIENT NAME:	Bhate Environmental Associates, Frank Gardner, P.G.
PROJECT MANAGER:	Jody Edwards, PG	SITE SAFETY OFFICER	TBD
PREPARED BY:	Kim B. Watson	DATE:	8/15/07

NOTE: This site specific Health and Safety Plan - Short Form (HASP-SF) has been prepared for use by Stone Environmental, Inc. (Stone) employees for work at this site / facility. **The HASP-SF has been written for the specific site / facility conditions, purposes, tasks, dates and personnel specified, and must be amended and reviewed by those personnel named in Section 4 if these conditions change.** Stone Environmental, Inc., is not responsible for its use by others.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Stone Environmental, Inc. will inform subcontractors of the site / facility emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Health and Safety Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan, including a written Hazard Communication Program and any other written hazard specific or safety programs required by federal, state and local laws and regulations, that details subcontractor tasks, potential or actual hazards identified as a result of a risk analysis of those tasks, and the engineering controls, work practices and personal protective equipment to be utilized to minimize or eliminate employee exposure to the hazard; (2) providing their own personal protective equipment; (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer responsible for ensuring that their employees comply with their own Health and Safety plan and taking any other additional measures required by their site activities.

Providing a copy of this Stone Environmental, Inc. HASP-SF to subcontractors, does not establish, nor is it intended to establish a "joint employer" relationship between the Contractor and Stone Environmental, Inc.. This allowance does not establish, nor is it intended to establish, a direct or indirect employer/employee relationship with subcontractor's employees.

SECTION 2: EMERGENCY INFORMATION

(A) LOCAL RESOURCES	SERVICE NAME	TELEPHONE NUMBER
EMERGENCY MEDICAL SERVICES	HAFB Emergency (using HAFB phone system	9-911

HOSPITAL (Map attached)	HAFB 49th Medical Group (Main Switchboard); Civilian Hospital (Alamogordo) Gerald Champion Medical Center	(505) 572-2778 (505) 439-6100
FIRE DEPARTMENT	HAFB Fire Protection	(505) 572-1117 (505) 572-5037
POLICE / SECURITY	HAFB Security Force	(505) 572-5037
HAZMAT/ SPILL / OTHER RESPONSE	HAFB FIRE Protection	9-911

(B) CORPORATE RESOURCES

STONE ENVIRONMENTAL, INC. INCIDENT TELEPHONE NUMBERS (802) 229-4541

		OFFICE	CELL PHONE
CORPORATE HEALTH AND SAFETY	Kim B. Watson	(802) 229-2196	(802) 249-7753
PROJECT OFFICER	Seth Pitkin	(802) 229-2192	(802) 249-8700
PROGRAM MANAGER	Frank Gardner, Bhate	(303) 597-2450	(303) 386-6454
PROJECT MANAGER	Jody Edwards	(802) 229-1881	(802) 578-3231
SITE SAFETY OFFICER	TBD-Stone	(802)	(802)

SECTION 3: PROJECT INFORMATION

(A) SITE / FACILITY INFORMATION:

SITE NAME:	HAFB SWMU183 RCRA RCI Work	SITE CLIENT CONTACT:	Craig McGriff
ADDRESS	Holloman AFB, 490 First Street	PHONE NUMBER:	205-910-0712
TOWNSHIP / COUNTY:	Holloman AFB	SITE SAFETY CONTACT:	TBD
STATE	New Mexico		TBD

CLIENT TYPE: ☒ FEDERAL ☐ STATE ☐ MUNICIPAL / REGIONAL ☐ PRIVATE

(B) SITE / FACILITY TYPE:

☒ HAZARDOUS (RCRA)	☐ UST / LUST	☐ WTP / WWTP
☐ HAZARDOUS (CERCLA / STATE)	☐ BROWNFIELD	☐ FIFRA
☐ CONSTRUCTION	☐ CHEMICAL PLANT	☐ OTHER:
☐ LANDFILL (NON-HAZARDOUS)	☐ REFINERY	
☒ ACTIVE	☐ INACTIVE	

(C) INVESTIGATION TYPE:

☐ HAZARDOUS WASTE	☐ SOLID WASTE	☐ WASTE WATER
☐ HYDROGEOLOGY	☒ ENVIRONMENTAL	☒ WASTE STREAM
☐ WASTE WATER	☐ AUDIT	☐ AIR/ODOR
☐ PRE-JOB VISIT	☐ CONSTRUCTION	☒ SEDIMENT

☐ (SUB) CONTRACTOR OVERSIGHT	☐ LANDFILL	☒ SURFACE SOIL
☐ CONSTRUCTION MGMT	☐ AIR	☒ OTHER
☐ INSPECTION	☒ SURFACE WATER	**Confirm Potential Release areas on the existing sewer lines**
☒ INVESTIGATION SURVEY	☒ GROUND WATER	

DATE(S) OF FIELD ACTIVITIES: **TBD**

(D) **FIELD TASKS**

STONE ENVIRONMENTAL TASKS (List field tasks to be performed by Stone Environmental, Inc. staff)

S1	**Mobilization of Equipment: Geoprobes, On-site Laboratory, Field Trucks**
S2	**Mark out sampling locations along existing sewer lines for utility clearance**
S3	**Soil Cores: Geoprobe, subsurface soil sampling, sampling and screening**
S4	**Temporary monitoring well installation (piezometers), groundwater Sampling**
S5	**Survey water elevations**
S6	**Soil Gas Surveys for Vapor Instrusion Studies**
S7	**Well Decommissioning - IDW Management**
S8	**Demobilization of Equipment**

TASKS PERFORMED BY OTHERS (List field tasks to be performed by client, subcontractors, or contractors)

O1	**Utility Clearance, Air Force Form (AF FM) 332 approval,**
O2	**Radiation Monitoring**

SECTION 4: PROJECT SAFETY ORGANIZATION, HEALTH AND SAFETY TRAINING, AND MEDICAL MONITORING

(A) PROJECT HEALTH AND SAFETY ROLES, RESPONSIBILITIES AND COORDINATION

PROJECT OFFICER: **Seth Pitkin**	The Project Officer (PO) is ultimately responsible for project performance. The PO seeks and gets appropriate approvals for risk management decisions (e.g. from Regional/Practice Director(s), Legal Council, Corporate Health and Safety), and selects an effective and qualified project team. The PO supports the Project Manager or Deputy Project Manager with appropriate resources.
PROGRAM MANAGER: **Frank Gardner (Bhate)**	The Program Manager is the chief liaison with the client and will coordinate Stone Environmental, Inc Project Managers and Resources to respond to the client's needs.
PROJECT MANAGER: **Jody Edwards**	The Project Manager (PM) has the responsibility for executing the project in accordance with the scope of work and good engineering practice. The PM will supervise the allocation of resources and staff to implement specific aspects of this HASP-SF and may delegate authority to expedite and facilitate any application of the program. The PM implements and executes an effective program of site-specific personnel protection and accident prevention. The Project Manager reports to the Program Manager.
CORPORATE HEALTH & SAFETY: **Kim B. Watson**	Corporate Health and Safety is responsible for Stone Environmental, Inc.'s overall Health and Safety Program and provides project guidance on air monitoring methodology, data interpretation and assistance in determining appropriate project engineering controls, work practices, and personal protective equipment. Corporate Health and Safety also reviews and approve HASPs in accordance with Section 1.
SITE SAFETY OFFICER: **Mike Rossi, Stone** ALTERNATE SITE SAFETY OFFICER (S): **TBD - Stone**	The Site Safety Officer (SSO) is responsible for interpreting and implementing the site health and safety provisions set out in this HASP-SF, and will guide the efforts of field team personnel in their day-to-day compliance with this HASP-SF. The SSO has the ability and authority to make necessary changes or additions to this HASP-SF and provide technical assistance to field team personnel on problems relating to worksite safety. The SSO has the authority to correct safety-related deficiencies in materials or practice and to call a Project STOP in the most serious cases. Alternate Site Safety Officer (ASSO) is assigned all duties and responsibilities of the Site Safety Officer in his/her absence.
FIELD TEAM PERSONNEL: **TBD**	Field personnel have the following health and safety responsibilities: • Implement the procedures set forth in the HASP-SF; • Take all reasonable precautions to prevent injury to themselves and their fellow employees; and • Perform only those tasks that they believe they can do safely, and immediately report any accidents and/or unsafe conditions in accordance with Section 1.

PROJECT TEAM - The following Stone Environmental, Inc. personnel are designated to carry out the stated project job functions on site. THE SITE SAFETY OFFICER OR A DESIGNATED ALTERNATE WILL BE ON-SITE DURING **ALL** SITE ACTIVITIES. (NOTE: One person may carry out more than one job function.)

PROJECT MANAGER: **Jody Edwards, PG**

SITE SAFETY OFFICER: **Mike Rossi - Stone**

ALTERNATE SAFETY OFFICER(S): **TBD - Stone**

The following subcontractors and governmental agencies have been informed by Stone Environmental, Inc. of emergency response procedures, and any potential fire, explosion, health, safety or other hazards of the site / facility by making this Site Specific Health and Safety Plan and site information obtained by others available during regular business hours. Subcontractors and governmental agencies shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations as described in **Section 1** of this plan.

SUBCONTRACTOR(S): **Craig McGriff - Bhate, Site Safety Contact**

FEDERAL AND STATE AGENCY REPS: **New Mexico - DEP**

OTHER AGENCY REPS: _____

_____

(B) HEALTH AND SAFETY TRAINING, MEDICAL MONITORING, AND FIT TESTING PROGRAM

The following project staff members are included in the Stone Environmental, Inc. Health and Safety Training and Medical Monitoring programs. The details of these programs can be found in the Health and Safety Policies and Written Programs.

	HAZWOPER TRAINING		MEDICAL MONITORING	
NAME	INITIAL 40HR (DATE)	8HR (DATE)	MEDICAL (DATE)	FIT TEST (DATE)
Michael Rossi	**3/15/1991**	**9/18/2007**	**01/19/2007**	**na**
David Crosby	**06/21/2002**	**9/18/2007**	**09/19/2007**	**na**
Morgan Greenwald	**03/12/2007**	**na**	**03/20/2007**	**na**
Lee Rosberg	**03/28/2007**	**na**	**02/28/2007**	**na**
Dan Merritt	**12/4/2003**	**08/15/2006**	**01/11/2007**	**na**
ny DeLeone	**07/09/2001**	**09/18/2007**	**01/04/2007**	**na**
Dan Voisin	**8/17/2001**	**9/18/2007**	**01/9/2007**	**na**

SECTION 5: HAZARD ANALYSIS

(A) ACTUAL OR POTENTIAL PHYSICAL HAZARDS – (Check all that apply to Stone Environmental, Inc. activities)

☒ ANIMALS / PLANTS	☒ ELECTRICAL	☐ HUNTING SEASON	☐ POWERED PLATFORMS
☒ ASBESTOS / LEAD	☒ EXCAVATIONS (See Section 13)	☐ IMMERSION	☐ POOR VISIBILITY
☒ CHEMICAL EXPOSURE (See Section 5B/5C)	☐ EXTREME COLD (See Section 10)	☒ IONIZING RADIATION	☐ ROLLING OBJECTS
☐ CONFINED SPACE (See section 5b/5c)	☐ FALL >6' VERTICAL	☐ LIGHT RADIATION (i.e., Welding, High Intensity)	☐ SCAFFOLDING
☐ DEMOLITION	☐ FALLING OBJECTS	☐ LIMITED CONTACT	☐ SHARP OBJECTS
☒ DRILLING	☒ HEAT STRESS	☐ MOVING PARTS (LO / TO)	☒ TRAFFIC (STRUCK BY)
☐ DRUM HANDLING	☒ HEAVY EQUIPMT	☒ NOISE (> 85 dB)	☒ STEEP / UNEVEN TERRAIN
☐ DUST, HARMFUL	☒ HEAVY LIFTING	☐ NON-IONIZING RADIATION	☒ OTHER: See Activity Hazard Analysis (AHA)-Table 3
☒ DUST, NUISANCE	☐ HOT WORK	☐ OVERHEAD OBJECTS	

(B) PRESENCE OF HAZARDOUS MATERIALS STORED OR USED ON SITE

TYPE	CURRENTLY	FORMERLY	
	☐ YES	☒ YES	☐ NO

☐ EXPLOSIVES	☐ FLAMMABLE/ COMBUSTIBLE LIQUIDS	☐ OXDIZERS	☐ CORROSIVE
☐ COMPRESSED GASES	☐ FLAMMABLE/ REACTIVE SOLIDS	☐ TOXIC/INFECTIOUS	☒ MISCELLANEOUS
		☒ RADIOACTIVE	☒ HAZARDOUS WASTE (STORED)

(C) CHEMICAL HAZARDS OF CONTAMINANTS INFORMATION

(1) IDENTIFIED CONTAMINANTS - Known or suspected hazardous/toxic materials (attach historical information, physical description, map of contamination and tabulated data, if available)

Characteristics: CA (corrosive, acid), CC (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe)

Media types: GW (ground water), SW (surface water), WW (wastewater), AIR (air), SG (soil, gas), SL (soil), SD (sediment), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas), OT (other, describe).

SUBSTANCES INVOLVED	CHARACTERISTICS	MEDIA	ESTIMATED CONCENTRATIONS	LOWEST PEL, or TLV
See Attached Table 1	VO	SG, SL, GW	Table 1 from Basewide H&S Plan	☐ PPM ☐ mg/m³
				☐ PPM ☐ mg/m³
				☐ PPM ☐ mg/m³
				☐ PPM ☐ mg/m³

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE MPI TASKS LISTED IN SEC 3 (E):

MPI TASK	ROUTE OF EXPOSURE (INHAL/INGEST/CONTACT/ABSORB)	POTENTIAL FOR CONTACT (HIGH / MEDIUM / LOW)	METHOD OF CONTROL
S1	none	low	PPE - Level D
S2	contact	low	PPE - Level D
S3	inhale, contact	low	PPE - Level D
S4	inhale, contact	low	PPE - Level D
S5	inhale, contact	low	PPE - Level D
S6	inhale, contact	low	PPE - Level D
S7	none	low	PPE - Level D
S8	none	low	PPE - Level D

The Site Safety Officer will brief the field team on symptoms and signs of overexposure to chemical hazards

SECTION 6: SITE CONTROL MEASURES

(A) **WORK ZONES – EXCAVATIONS, DRILLING OPERATIONS AND HEAVY EQUIPMENT**

Stone - Site Safety Officer has been designated to coordinate access control and security for operations on site.

(B) **WORK ZONES - CONTAMINATION**

The prevailing wind conditions are Westerly. A wind direction indicator is used to determine daily wind direction. The Command Post is located from the Exclusion Zone or at sufficient distance to prevent exposure should a release occur.

Control boundaries are identified by cones and caution tape.

NO UNAUTHORIZED PERSON SHOULD BE WITHIN THIS AREA

SECTION 7: SAFETY PROCEDURES/EQUIPMENT REQUIRED

Identify all procedures and equipment needed to eliminate or minimize exposure to hazards identified in Section 5.

☒ AIR MONITORING EQUIPMENT (see Section 9)	☒ FIRST AIDKIT	☐ EMERGENCY AIR HORN
☒ BARRIER TAPE	☐ FLOTATION DEVICE (USCG)	☒ PPE – PHYSICAL HAZARDS (see section 15)
☒ COMMUNICATIONS - ONSITE	☐ GFCI EXTENSION CORDS	☒ PPE – PHYSICAL HAZARDS (see section 15)
☒ COMMUNICATIONS – OFFSITE (i.e. cell/digital phones if no other means)	☐ HARNESS(S) / LIFELINE(S)	☐ RESPIRATORY PROTECTION PROGRAM & EQUIPMENT (APR) (see Section 15)
☐ CONFINED SPACE PROGRAM & EQUIP (see Section 12)	☒ INSECT/TICK REPELLENT	☐ RESPIRATORY PROTECTION PROGRAM & EQUIPMENT (SAR) (see Section 15)
☐ VENTILATION EQUIPMENT	☒ SAFETY VESTS	☒ TRAFFIC CONES
☐ EMERGENCY SHOWERS	☐ LADDER(S)	☒ MSDS (Site Specific)

☒ EYE WASH	☐ LIGHTIING – HANDHELD	☒ MSDS (Stone Environmental)
☐ FALL PROTECTION PROGRAM & EQUIPMENT	☐ LIGHTING – FIXED EMERGENCY	☒ OTHER: air borne - particulate masks
☒ FIRE EXTINGUISHER(S) - ABC	☐ LOCKOUT/TAGOUT PROGRAM & EQUIPMENT	

SECTION 8: COMMUNICATIONS AND SAFE WORK PRACTICES

(A) COMMUNICATIONS - ONSITE

Whenever possible, communications between site personnel should be face-to-face. When verbal communications is not possible, radio communications shall be established.

In case of radio communications failure, or when respiratory protection is in use, the following hand signals will be used:

OK; I AM ALL RIGHT; I UNDERSTAND	THUMBS UP
NO; NEGATIVE	THUMBS DOWN
NEED ASSISTANCE	BOTH HANDS ON TOP OF HEAD
DANGER - NEED TO LEAVE AREA, NO QUESTIONS	GRIP PARTNERS WRIST WITH BOTH HANDS
HAVING DIFFICULTY BREATHING	HANDS TO THROAT

(B) COMMUNICATIONS – OFF SITE

If applicable, telephone communication to the Home Office should be established as soon as practical.

Telephone numbers that can be used to reach the command post are: (802) 229-4541 and 800 959-9987

(C) SAFE WORK PRACTICES

1. A "BUDDY SYSTEM" IN WHICH ANOTHER WORKER IS CLOSE ENOUGH TO RENDER IMMEDIATE AID WILL BE IN EFFECT. CLIENTS AND/OR CONTRACTORS MAY SERVE AS A "DESIGNATED BUDDY."
2. WHERE THE EYES OR BODY MAY BE EXPOSED TO CORROSIVE MATERIALS, SUITABLE FACILITIES FOR QUICK DRENCHING OR FLUSHING SHALL BE AVAILABLE FOR IMMEDIATE USE (SEE SECTION 7).
3. DO NOT KNEEL ON THE GROUND WHEN CHEMICAL PROTECTIVE CLOTHING IS BEING USE.
4. IF DRILLING EQUIPMENT IS INVOLVED, HAVE A CURRENT UTILITY SURVEY, AND KNOW WHERE THE 'KILL SWITCH' IS.
5. CONTACT WITH SAMPLES, EXCAVATED MATERIALS, OR OTHER CONTAMINATED MATERIALS MUST BE MINIMIZED.
6. ALL ELECTRICAL EQUIPMENT USED IN OUTSIDE LOCATIONS, WET AREAS OR NEAR WATER MUST BE PLUGGED INTO GROUND FAULT CIRCUIT INTERRUPTER (GFCI) PROTECTED OUTLETS (SEE SECTION 7).
7. IN THE EVENT OF TREACHEROUS WEATHER-RELATED WORKING CONDITIONS (I.E., THUNDERSTORM, LIMITED VISIBILITY, EXTREME COLD OR HEAT) FIELD TASKS WILL BE SUSPENDED UNTIL CONDITIONS IMPROVE OR APPROPRIATE PROTECTION FROM THE ELEMENTS IS PROVIDED.
8. SMOKING, EATING, CHEWING GUM OR TOBACCO, OR DRINKING ARE FORBIDDEN EXCEPT IN CLEAN OR DESIGNATED AREAS.
9. USE OF CONTACT LENSES NEAR CHEMICALS OR DURING USE OF RESPIRATORY PROTECTION IS PROHIBITED AT ALL TIMES.
10. GOOD HOUSEKEEPING PRACTICES ARE TO BE MAINTAINED.
11. SITE / FACILITY SPECIFIC SAFE WORK PRACTICES: (example, hard hat, steel toe work shoes; protective eyewear)

SECTION 9: ENVIRONMENTAL MONITORING ☐ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

(A) The following environmental monitoring instruments shall be used on site at the specified intervals and recorded in the site logbook. (NOTE: If monitoring period is "OTHER", monitoring schedule will be attached to this plan.)

EQUIPMENT	MONITORING PERIOD				ACTION LEVEL
☐ Combustible Gas Indicator	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ O_2 Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Toxics: ☐ CO ☐ H_2S	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Other: _____	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☒ PID (Lamp 10.6 eV)	☐ Continuous	☐ Hourly	☐ x Day	☒ Other	See Table 4
☐ FID					
☐ Colorimetric tubes:					
_____	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
_____	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☒ Radiation: ☒ α ☒ β ☐ γ	☐ x Day	☐ Hourly	☐ x Day	☒ Other	>1 mR
☐ Respirable Dust Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Noise Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	

☒ Other:□	☐ Continuous	☐ Hourly	☐ x Day	☐ Other
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other

(B) Monitoring equipment is calibrated according to manufacturers' instructions. Record calibration data and air concentrations in the Health and Safety on-site log book.

(C) Recommended Action Levels for Upgrade or Downgrade of Respiratory Protection, or Site Shutdown and Evacuation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistent (> 10 min) breathing zone measurements in non-confined spaces. **For unexpected conditions, stop all work and contact Corporate Health and Safety.**

Oxygen Levels	
Less than 19.5%	Level B necessary for work to start / continue. Consider toxicity potential.
19.5% to 23.5%	Work may start / continue. Investigate changes. Continuous monitoring.
Greater than 23.5%	PROHIBITED WORK CONDITION
Flammability / Explosive Hazards	
Less than 10% of LEL	Work may start / continue. Consider toxicity potential.
10% to 25% of LEL	Work may start / continue. Continuous monitoring.
Greater than 25% of LEL	PROHIBITED WORK CONDITION.
Uncharacterized Airborne Organic Vapors or Gases	
Background*	Work may start / continue. Continue to monitor conditions.
Up to 5 meter units (m.u. or "ppm") above background	Level C necessary for work to start / continue. Continuous monitoring. Use Colorimetric tubes to characterize vapors.
Up to 50 m.u. above background	Level B necessary for work to start / continue. Continuous monitoring.
Greater than 50 m.u.	PROHIBITED WORK CONDITION.

*** Off-site clean air measurement**

Characterized Airborne Organic Vapors or Gases**	
Up to 50% of TLV, or PEL or REL	Work may start / continue. Continue to monitor conditions.
Up to 25 times the TLV, or PEL or REL	Level C necessary for work to start / continue. Continuous monitoring.
Up to 500 times the TLV, or PEL or REL	Level B necessary for work to start / continue. Continuous monitoring.
Greater than 500 times the TLV, or PEL or REL	PROHIBITED WORK CONDITION.

**** Use mixture calculations (% allowed = $\sum C_N EL_N$) if more than one contaminant is present.**

Radiation	
Less than 0.5 mR/Hour (500 μR)	Work may start / continue. Continue to monitor conditions.
Up to 1 mR/Hour above background	Work may start / continue with Radiation Safety Officer present on site.
Greater than 1 mR/Hour above background	PROHIBITED WORK CONDITION.

SECTION 10: PERSONAL MONITORING

☐ THIS SECTION IS NOT APPLICABLE TO SITE ACTIVITIES

(A) PERSONAL EXPOSURE SAMPLING (Consider if high levels of noise or high concentrations of lead, mercury or arsenic are present)

The following personal monitoring will be in effect on site:

As needed and appropriate; PID readings in the breathing zone, and radiation monitoring Ledlum 44.9 for alpha/beta radiation. See Table 4

A copy of personal monitoring results is to be sent to Corporate Health and Safety for inclusion in the Employee's Confidential Exposure Record File.

(B) HEAT / COLD STRESS MONITORING

The expected air temperature range will be **75-104**°F. If it is determined that heat stress or cold stress monitoring is required (mandatory for heavy exertion in PPE at temperatures over 70°F, or at temperatures under 40°F or wind chill equivalent), the following procedures shall be followed (describe procedures in effect, for heat stress i.e., monitoring body temperature, body weight, pulse rate; for cold stress i.e., appropriate clothing, shelter breaks):

There will be chilled water available in a contaminate free zone at all times. Work will be performed using the buddy system with each person watching for signs of heat stress from themselves and their buddy. In the event of heat stress the person shall be moved to a climate environment and given basic first aid for heat stress. Hearing protection must be worn during drilling operations.

SECTION 11: HAZARD COMMUNICATION PROGRAM

☐ THIS SECTION IS NOT APPLICABLE TO SITE ACTIVITIES

If chemicals are introduced to the site by Stone Environmental, Inc. (e.g., decontamination liquids, preservatives, etc.), a copy of the Stone Environmental, Inc. Hazard Communication Program and Material Safety Data Sheets (MSDSs) of chemicals introduced by Stone Environmental, Inc. to the site is attached to this plan. The Site Safety Officer will review this information with all field personnel prior to the start of the project, and will inform other employers (e.g., Owner, Contractor and Subcontractors) the availability and location of this information. The Comprehensive List of Chemicals introduced by Stone Environmental, Inc. to this site is:

ON-SITE LABORATORY MATERIALS

REFERENCE STANDARDS AND SOLUTIONS

CONTAINED ON-SITE WITHIN THE LABORATORY

All chemicals being introduced to the site, hazardous/potentially hazardous samples prepared at the site, and/or any hazardous materials previously sent to the site, that will be stored at the site or will be transported from the site by common carrier, will be packaged, labeled and identified as hazardous materials in accordance with U.S. Department of Transportation (DOT) and/or International Air Transport Association (IATA) regulations by a trained HazMat employee.

(NOTE: At multi-employer sites, the Site Safety Officer will obtain information, if applicable, on hazardous chemicals other employers may produce or introduce to the job site to which Stone Environmental, Inc. employees may be exposed, including the location of their written hazard communication program(s), labeling program(s), and Material Safety Data Sheet(s).

SECTION 12: CONFINED SPACE ENTRY

☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

If a permit-required confined space entry will be made on site, a copy of the Stone Environmental, Inc. Confined Space Entry Program, and a completed Stone Environmental, Inc. Confined Space Pre-Entry Inspection Check List will be attached to this plan. A Confined Space Entry Permit must be completed and posted outside the confined space prior to entry, and the entry will follow the Stone Environmental, Inc. Confined Space Entry written program. Permits are to be saved and logged with project documentation.

SECTION 13: EXCAVATION SAFETY

☐ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

Excavations being created in order to accomplish Stone Environmental, Inc. tasks or in progress during Stone Environmental, Inc. inspection of other activities or tasks, shall be shored or slopped or otherwise protected to prevent accidental collapse prior to entry, in accordance with Subpart F of 29 CFR 1926. It is Stone Environmental, Inc. policy that Stone Environmental, Inc. personnel will not enter trench or excavated areas without approval of Corporate Health and Safety. If an entry into an excavation by Stone Environmental, Inc. personnel is necessary, a Competent Person will be designated by the Corporate Health and Safety Officer. Excavations will not be left open overnight unless absolutely necessary.

COMPETANT PERSON

Print Name	Signature	Date

SECTION 14: DECONTAMINATION PROCEDURES

☐ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

Personnel and equipment leaving the Exclusion Zone shall be thoroughly decontaminated. The Site Safety Officer is responsible for monitoring adherence with this decontamination plan.

A **Equipment (SOP SEI-5.1.5)** decontamination protocol shall be used with the following decontamination stations:

(1) **Follow all procedures outlined in the Base Wide H&S Plan, Alconox Wash**

(2) **Equipment: Clean off all debris with contaminant free water, alconox rinse, clean water rinse.**

(3)

(4)

(5)

(6)

(7)

(8)

(Other)

The following decontamination equipment is required:

☒ Decon Pad (Plastic Sheet) <u>if necessary</u> ☐ Dry Brushes ☒ Buckets Other

☒ Trash Cans/Bags ☒ Wet Brushes ☒ Hose / Spray

Will be used as the decontamination solution

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT

1 - List all that apply, i.e., FF w/ OV/AG/P

2 - Use same codes for clothing and boots of same material

TASK *	RESPIRATORS & CARTRIDGE[1]	USE ** (See Section 16)	CLOTHING	GLOVES	BOOTS	OTHER
S1	na		N/S			
S2	na		N/S	N	SL	HH, G, GP
S3	na		N/S	N	SL	HH, G, GP
S4	na		N/S	N	SL	HH, G, GP
S5	na		N/S	N	SL	HH, G, GP
S6	na		N/S	N	SL	HH, G, GP
S7	na		N/S	N	SL	HH, G, GP
S8	na		N/S			

* Same as Section 3E

**UP = Upgrade
CONT = Continuous

NOTE: PPE use will be in accordance with Stone Environmental, Inc.'s Health and Safety Policy and Written Programs

CODES:

RESPIRATORS[1]	CARTRIDGES[1]	CLOTHING	GLOVES[2]	BOOTS	OTHER
IF = Half Face APR	P = Particulate	N/S = No Special	Co = Cotton	SL = Leather Safety	HH = Hard Hat
FF = Full Face APR	OV = Organic Vapors	C = Coveralls	Le = Leather	H = Hip (Fireman)	G = Safety Glasses
ESCBA = Escape Bottle	AG = Acid Gas	T = Tyvek	L = Latex		GP = Glare Protection
SAR = Airline	Multi = Multi-Gas/Vapor	Sx = Saranex	N = Nitrile		Gl = Goggles - Impact
SCBA = SCBA	Other	PT = PE Tyvek	B = Butyl		GS = Goggles - Splash
			Neo = Neoprene	O = Latex overboots	FS = Face Shield
			V = Viton		HP = Hearing Protection
			PVC = Polyvinyl Chloride		
			PVA = Polyvinyl Alcohol	CHM = Chemical Resistant	PFD=Personal Flotation Device
			T = Teflon		
			Other:		

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT (CONTINUED)

Respiratory protection will be upgraded under the following conditions:

> 10ppm in the breathing zone, See Table 4.

The following cartridge change out schedule is to be followed onsite (attach any calculations to plan):

not applicable

SECTION 16: EMERGENCY ACTION PLAN

The following standard emergency response procedures will be used by onsite personnel. The Site Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedures are followed. Additional Action Plan summarized in Table 2.

(A) EVACUATION

All work activities are suspended and the site is to be EVACUATED IMMEDIATELY, when there is a threat to life or health as determined by individual good judgment, i.e. fire, hazardous chemical spill, dangerous gas leak, severe weather (i.e., tornado); or when notified by other site / facility staff and local fire or police officials.

- If an evacuation is called for, the emergency alarm system for weather-related, medical, fire and other evacuation emergencies is:
- 3 short blasts on a compressed air horn
- Evacuation from the Exclusion Zone should whenever possible occur through the decontamination line. In those situations where egress in this manner cannot occur, the following emergency escape routes have been designated (document on map if possible):

Once off site, all staff should gather at the **TBD** which is a minimum of 250 feet away from the incident

(B) FIRE OR EXPLOSION

Upon discovery of a fire or an explosion, the above-designated emergency signal shall be sounded and all personnel shall assemble at the **TBD**. The fire department is to be notified and all personnel moved to a safe distance (minimum 250') from the involved area.

If a person's clothing should catch fire, burning clothing may be extinguished by having the individual drop to the floor and roll. If necessary, physically restrain the person and roll them around on the floor to smother the flames. Use a fire blanket or extinguisher if one is readily available and you have been trained in its use. Call emergency medical services if not already done so.

If a person's clothing should become saturated with a chemical, douse the individual with water from the nearest safety shower if available. Consult the chemical Material Safety Data Sheets (MSDSs) for further information. Call emergency medical services if indicated by the MSDSs.

NEVER RE-ENTER THE SITE / FACILITY until the emergency has been declared over and permission to re-enter has been given by site / facility health and safety staff or local fire or police officials. If any staff is unaccounted for, notify an individual in charge.

(C) MEDICAL EMERGENCY

If you discover a medical emergency and are by yourself, CALL OUT FOR HELP. When someone arrives, tell them to call for help. If no one comes or you know you are alone, provide whatever care you can for 1 minute, and then make the call yourself. (See Section 2)

Upon notification of an injury the SSO or alternate should evaluate the nature of the injury and shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or a symptom is determined.

The hospital is **18** Minutes from the site. Ambulance response time is **TBD** minutes. _____ of _____ was contacted on _____. A and briefed on the situation, the potential hazards and the substances involved. When IDLH conditions exist, arrangements should be made for onsite standby of emergency services. A map for directions to the nearest hospital is attached to this plan.

(E) FOLLOW UP

In all situations, when an on site / facility emergency results in evacuation of the work area, or a "large spill" has occurred, staff shall not resume work until:

- The conditions resulting in the emergency have been corrected;
- The hazards reassessed by the SSO and Corporate Health and Safety;
- The HASP has been reviewed by the SSO and Corporate Health and Safety; and
- Site personnel have been briefed on any changes in the HASP by the SSO.

SECTION 17: SPILL CONTAINMENT / CONTROL

☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

For most chemicals introduced to the worksite, or under control of Stone Environmental, Inc. employees, spills of chemicals would be considered incidental and would be controlled in the immediate area of the spill. Such spills shall be handled utilizing precautions appropriate for the chemical characteristics specified in the MSDS for the chemical including spill control methods and selection and use of minimum personal protective equipment.

For chemicals introduced to the worksite, or under control of Stone Environmental, Inc. employees, that would cause a "large spill" (greater than 55 gallons), a copy of the appropriate Emergency Response Guidebook (ERG) guide shall be attached to this plan, and a spill response contractor shall be identified in Section 2.

SECTION 18: EMPLOYEE ACKNOWLEDGEMENTS

PLAN REVIEWED BY:	NAME	DATE
Project Officer:	Seth Pitkin	
Project Manager:	Jody Edwards, PG	
Site Safety Officer:	TBD	
Corporate H & S	Kim B. Watson	

I acknowledge that I have read the information on this HASP-SF, attached Material Safety Data Sheets (MSDSs), DOT Emergency Response Guides, and Health and Safety Programs.
I understand the site / facility hazards as described and agree to comply with the contents of the plan.

EMPLOYEE (Print Name/Signature/Date)

/	/	/	/
/	/	/	/
/	/	/	/
/	/	/	/
/	/	/	/
/	/	/	/

VISITORS (Print Name/Signature/Date)

/	/	/	/
/	/	/	/
/	/	/	/
/	/	/	/

ATTACHED DOCUMENTS

☐ MSDS(s)	☐ Hazard Communication Written Program	☐ Confined Space Entry Written Program	☐ Respiratory Protection Program
☒ Site Map	☐ Personal Protective Equipment Written Program	☐ DOT ERG Guides	☐ Respiratory Protection Program
☒ Hospital Directions	☒ Emergency Action Plan	☐ Evacuation Routes	☒ Other Basewide H&S Plan

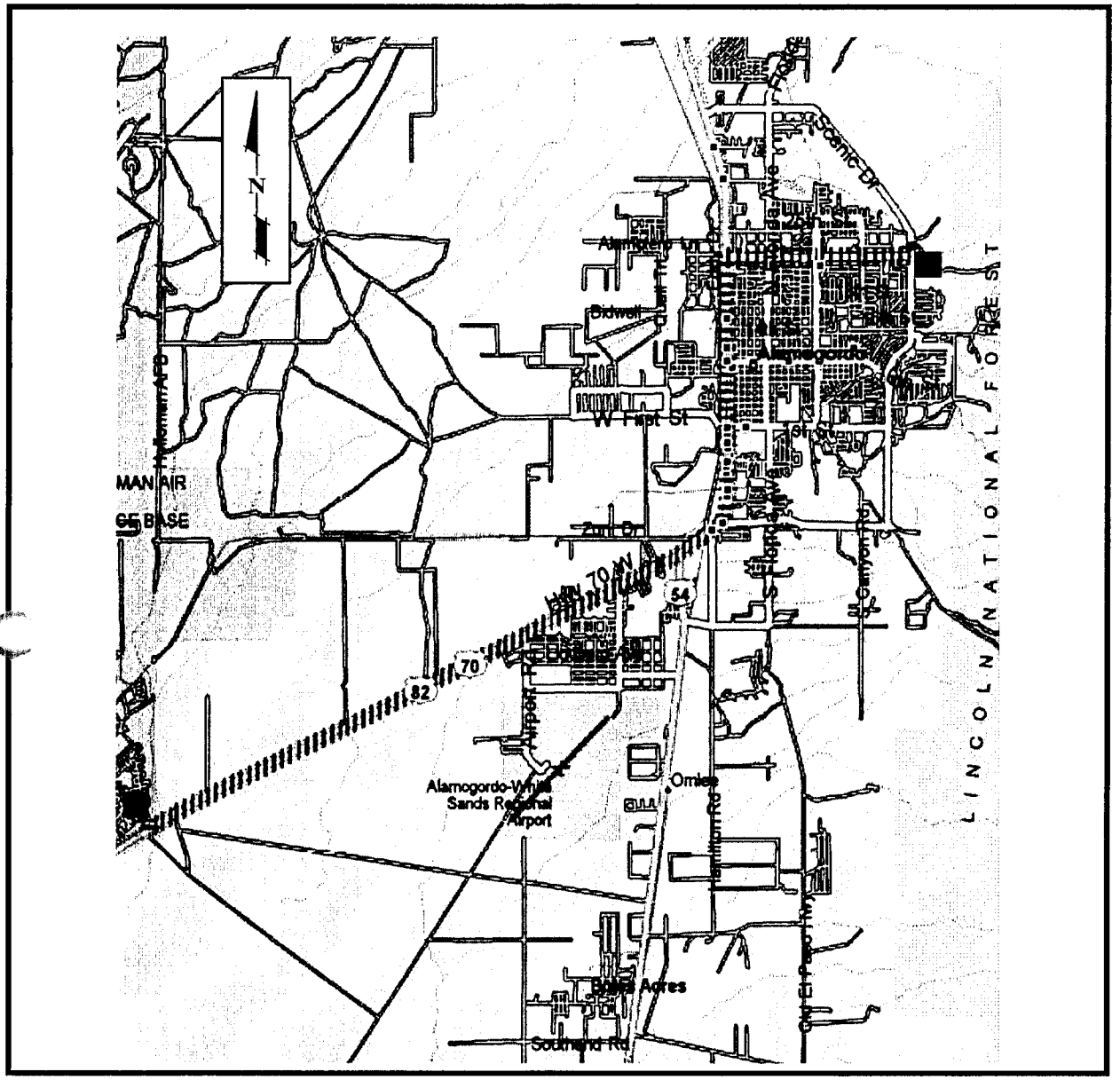

Figure 1: HOSPITAL ROUTE MAP: Holloman Air Force Base to Gerald Champion Regional Hospital
Source: Microscoft Expedia Street Map, Bhate Associates Site HASP, June 2006

Directions: From HAFB, exit the Main Gate and proceed east on US-70 onto US-54, continue north on US-54 to Indian Wells Road, turn right heading east to Scenic Drive, and turn left on Scenic proceed to the medical center. A map to this hospital is presented Figure 1.

Table 1. Properties of the Primary Contaminants of Concern

Contaminant	PEL	TLV	Route(s) of Exposure	Signs and Symptoms of Exposure			IP	Specific Gravity	VP (mm)	Flash Point	LEL %	UEL %
				Acute	Chronic	Target Organs						
Arsenic Inorganic PEL = 0.1 mg/m^3	0.5 mg/m^3	0.01 mg/m^3	Inhalation Absorption Contact Ingestion	Ulceration of nasal septum, dermatitis, respiratory irritation	GI disturbances, peripheral neuropathy, cancer	Liver, kidney, skin, lungs, lymphatic system	N/A	5.73	0.0	N/A	N/A	N/A
Barium	0.5 mg/m^3	0.5 mg/m^3	Inhalation Ingestion Contact	Irritation of eyes, skin, and upper respiratory system, gastroenteritis, muscle spasm, slow pulse	Respiratory system and CNS damage	Eyes, skin, respiratory system, heart, CNS	N/A	3.86	Low	N/A	N/A	N/A
Benzene	1 ppm	0.5 ppm (skin) 2.5 ppm STEL	Inhalation Contact Absorption	Irritation of eyes, nose, and respiratory system, dermatitis, headache, nausea	Bone marrow depression, anorexia, leukemia	Blood, CNS, skin, bone marrow, eyes, respiratory tract	9.24	0.88	75	12	1.3	7.9
Cadmium	0.005 mg/m^3	0.01 mg/m^3 0.002 mg/m^3 Cmpds resp.Frac.	Inhalation Ingestion	Dyspnea, nausea, headache, tight chest, pulmonary edema	Cancer, muscle aches, vomiting, diarrhea, kidney, lung damage	Lungs, kidneys, blood, respiratory system, prostrate	N/A	8.65	.0	N/A	N/A	N/A
Carbon tetrachloride	10 ppm (skin)	5 ppm (skin) 10 ppm STEL	Inhalation Absorption Ingestion Contact	Irritation of eyes, skin, respiratory system, CNS depression, drowsiness dizziness, nausea, vomiting	Liver and kidney injury, (known to cause cancer in animals)	CNS, eyes, lungs, liver, kidneys, skin	11.47	1.59	91	N/A	N/A	N/A
Chlorobenzene	75 ppm	10 ppm	Inhalation Ingestion Contact	Irritation of eyes, skin, nose; drowsiness, incoherence, CNS	Liver, lung, and kidney injury	Eyes, skin, respiratory system, CNS, Liver	9.07	1.11	9	82	1.3	9.6

Table 1 Properties of the Primary Contaminants of Concern (continued)

Contaminant	PEL	TLV	Route(s) of Exposure	Signs and Symptoms of Exposure			IP	Specific Gravity	VP (mm)	Flash Point	LEL %	UEL %
				Acute	Chronic	Target Organs						
Chromium	1.0 mg/m^3	0.5 mg/m^3 0.01 mg/m^3 Insol Cr VI	Inhalation Ingestion	GI irritation, nausea, diarrhea	Fibrotic formation in the lungs	Respiratory system	N/A	varies	varies	N/A	N/A	N/A
Ethylbenzene	100 ppm	100 ppm 125 ppm STEL	Inhalation Ingestion Contact	Irritation of eyes, skin, and mucous membranes, headache, dermatitis, narcosis, coma	CNS Damage	Eyes, skin, respiratory system, CNS,	8.76	0.87	7	55	0.8	6.7
Lead	0.05 mg/m^3	0.05 mg/m^3	Inhalation Ingestion Contact	Eye irritation	Weakness, anorexia, tremors, neuropathy, Hypo-tension	GI tract, CNS, kidneys, blood, gingival tissue	N/A	11.34	0	N/A	N/A	N/A
Mercury	0.1 mg/m^3 (C)	0.025 mg/m^3	Inhalation Ingestion Contact Absorption	CNS damage depending on group of mercurial compounds	Same as acute effects	CNS, kidneys, eyes, skin, respiratory system	N/A	13.6	0.0012	N/A	N/A	N/A
Methylene chloride	25 ppm	50 ppm	Inhalation Ingestion Contact	Fatigue, Weakness, numb limbs	CNS damage	Skin, CNS, CVS, eyes	11.32	1.33	350	N/A	14	22
Selenium	0.2 mg/m^3	0.2 mg/m^3	Inhalation Ingestion Contact	Irritation of eyes, skin, nose, and throat, visual disturbances, dermatitis, eye and skin burns	Liver, kidney, and spleen damage	Eyes, skin. respiratory system, kidneys, blood, spleen	N/A	4.28	0	N/A	N/A	N/A
Silver	0.01 mg/m^3	0.01 mg/m^3	Inhalation Ingestion Contact	Irritation of eyes, skin, nose, and throat, GI disturbances	Nasal septum, skin and eye damage	Nasal septum. skin, eyes	N/A	10.49	0	N/A	N/A	N/A

Table 1 Properties of the Primary Contaminants of Concern (continued)

Contaminant	PEL	TLV	Route(s) of Exposure	Signs and Symptoms of Exposure			IP	Specific Gravity	VP (mm)	Flash Point	LEL %	UEL %
				Acute	Chronic	Target Organs						
1,1,2,2-Tetrachloroethane	5 ppm (skin)	1 ppm (skin)	Inhalation Ingestion Contact Absorption	Nausea, vomiting, abdominal pain, jaundice, hepatitis, dermatitis	Kidney damage	Skin, liver, kidneys, CNS, GI tract	11.1	1.59	5	N/A	N/A	N/A
Tetrachloroethylene	100 ppm	25 ppm 100 ppm STEL	Inhalation Ingestion Contact Absorption	Irritation of eyes, nose, throat; nausea, flushed face, vertigo, dizziness, incoherence	Liver damage	Eyes, skin, respiratory system, liver, kidneys, CNS	9.32	1.62	14	N/A	N/A	N/A
Toluene	200 ppm	50 ppm (skin)	Inhalation Contact Absorption	Dermatitis, fatigue, weakness, confusion, muscular fatigue	Insomnia	CNS, liver, kidneys, skin	8.82	0.87	20	40	1.2	7.1
Trichloroethylene	100 ppm	50 ppm 100 ppm STEL	Inhalation Ingestion Contact Absorption	Irritation of the eyes and skin; headache, visual disturbances, fatigue, giddiness, tremors, nausea, vomiting, dermatitis	Liver injury	Eyes, skin, respiratory system, heart, liver, kidneys, CNS (causes cancer in animals)	9.45	1.46	58	N/A	8	10.5
Vinyl chloride	1 ppm 5 ppm (C)	1 ppm	Inhalation Contact (liquid)	Weakness, abdominal pain, GI bleeding, cyanosis of extremities	Liver and CNS damage, liver cancer	Liver, CNS, blood, respiratory system, lymphatic system	9.99	Relative density of gas 2.21	3.3 atm.	N/A (Gas)	3.6	33.0

Table 1 Properties of the Primary Contaminants of Concern (continued)

Contaminant	PEL	TLV	Route(s) of Exposure	Signs and Symptoms of Exposure			IP	Specific Gravity	VP (mm)	Flash Point	LEL %	UEL %
				Acute	Chronic	Target Organs						
1,1-Dichloroethlyene (Vinylidene chloride)	N/A	5 ppm	Inhalation Contact	Dizziness, headache, nausea. Frostbite may occur with skin contact in liquid form.	Liver, kidney damage	CNS	10.29	2.21	500	N/A (Gas)	5.5	21.3
Xylenes (o, m, & p isomers)	100 ppm	100 ppm 150 STEL	Inhalation Ingestion Contact Absorption	Irritation of the eyes, skin, nose, throat, dizziness, drowsiness, corneal vacuolization, anorexia, nausea, vomiting, dermatitis	GI disturbances, blood and liver damage, CNS damage	Eyes, skin, respiratory system, heart, liver, kidneys, CNS	8.56	0.86	9	82	1.1	7.0

Notes:

atm	=	atmosphere
IP	=	Ionization Potential
GI	=	Gastrointestinal
LEL	=	Lower Explosive Limit
UEL	=	Upper Explosive Limit
PEL	=	Permissible Exposure Limit
TLV	=	Threshold Limit Value
STEL	=	Short Term Exposure Limit
mg/m^3	=	milligrams per cubic meter of air
ppm	=	parts per million
CNS	=	Central Nervous System
VP	=	Vapor Pressure
mm	=	millimeter
C	=	ceiling

Table 2: Summarizes Potential Emergency Action Plan

Emergency Situations

In case of	Response actions
Injury or illness	Treat injury with applicable First Aid. All work related injuries beyond first aid will result in notification of Emergency Services and notification of the employee supervisor. Any employee requiring advanced medical treatment will be accompanied by a knowledgeable company employee that can answer potential questions on job duties and hazards. Make notifications in accordance with the Incident Reporting and Investigation Procedure (found in Section 10.2.2 of the *Basewide Health and Safety Plan*, Bhate, December, 2003).
Chemical exposure	First Aid shall be provided such as but not limited to: move victim to fresh air, remove contaminated clothing, flush affected skin with water, and seek medical attention.
Fire or explosion	Notify emergency services immediately. All personnel shall evacuate the immediate area of the fire and move to an upwind location. Personnel shall not engage in fire fighting activities use of fire extinguisher) unless trained to do so and only in the incipient stages of fire.
Adverse weather	Tornados, lightning, or other threatening weather conditions will result in an immediate shut down of operations and evacuation of personnel. Lightning proximity will be determined by measuring the time interval between the visually observed lightning flash and the subsequent sound of thunder. An interval less than 30 seconds will prompt the shut down. Operations will be shut down for the period of the storm passing plus an additional 20 minutes.
Material spill or release	Vehicles and equipment will be maintained and inspected so as to prevent fluid leaks. Should any vehicle fluid leaks occur, the equipment will be taken out of service to make necessary repairs and any contaminated material will be cleaned-up and disposed of properly. Spill kits will be available to facilitate prompt containment and clean-up of spills. Notification will be made in accordance with the Incident Reporting and Investigation Procedure. Storage areas will be designed to have secondary containment as required, and work plans will be executed to accommodate stormwater runoff and minimize the potential for contamination spread.

Table 3. Activity Hazard Analysis (AHA)

Task: Additional Investigation Requirements for SWMU183		**Bhate Project Number:** XXX	
Minimum Personal Protective Equipment (PPE): Level D PPE (Long pants, shirts with minimum 4" sleeve, steel toe boots, safety glasses, hard hat for overhead hazards, leather work gloves, and hearing protection, as required)		**Location:** Holloman Air Force Base, New Mexico	
		Analysis Approved by:	**Date:**
Activity	**Potential Hazards**	**Recommended Controls**	
Soil Boring and Sampling Hazards and recommended controls from AHA – 01 apply	Drill Rig Hazards Including but not limited to: Flying debris, falling objects, noise, hydraulic failures, unguarded machinery, equipment rollover, movement of large, heavy drilling tools, etc.	• Drill rig is to be operated and maintained by qualified operators • A Drill Rig Inspection Checklist should be completed daily to ensure that the rig is operating properly • The inspection will include fittings, cables, pins, connections, lubrication points, controls, emergency stops, etc. • To the extent possible, the terrain should be level and the condition of the ground such that unexpected movement of the rig is unlikely • Stabilize the rig prior to boring • Wear required PPE (hard hat, safety glasses, work gloves, ear muffs or plugs, steel toe work boots), ensure loose clothing is secured • Maintain good housekeeping on and around drill rig	
	Overhead/buried utilities	• Conduct a utility locate to identify the location of underground utilities in boring locations and complete any required dig permits • Overhead utilities should be considered live until determined otherwise • Maintain a minimum distance of 15 feet from overhead utilities • All underground utilities must be clearly marked before beginning work • No borings shall be made within a 4 foot "Buffer Zone" of any utility marking	
	Exposure to soil contaminants	• To the extent feasible, limit contact with subsurface materials • Wear required PPE when conducting intrusive activities • SSHO shall conduct breathing zone monitoring for VOCs with a PID in accordance with requirements for site monitoring • SSHO may require an upgrade in PPE or modification to work based on monitoring results • Use appropriate decontamination methods	

Table 3. Activity Hazard Analysis (AHA) (continued)

Activity	Potential Hazards	Recommended Controls
Monitoring Well Installation	Pinch points	• Utilize appropriate PPE (leather gloves) when handling well casings and tools
	Dust	• Use care when installing well materials (sand, bentonite, Portland cement) into monitoring well to prevent dust generation • Position body in an upwind location
Well Development / Groundwater depth measurement / Groundwater sampling	Exposure to groundwater contaminants	• Position body upwind from monitoring well prior to opening cap • Wear appropriate PPE including chemical resistant gloves and Tyvek coveralls to minimize potential contact with groundwater, as appropriate • Conduct work activities in a manner that minimizes potential contact with groundwater • Collect all PPE and disposable sampling equipment and dispose of properly • Wash hands and face prior to eating, drinking, or smoking
Safety Equipment Used	**Inspection Requirements**	**Training Requirements**
Level D PPE First Aid Kit Fire Extinguisher	Informal daily work area inspections to be conducted by the SSHO	Site personnel have read and understand the SSHP Site personnel possess all of the required training as specified in the SSHP Site personnel received site specific safety indoctrination At least two individuals on-site will have current CPR and First Aid training

Table 3. Activity Hazard Analysis (AHA) (continued)

Task: Excavation and Soil Loading for SWMU183		**Bhate Project Number:** XXXX	
Minimum Personal Protective Equipment (PPE): Level D PPE (Long pants, shirts with minimum 4" sleeve, steel toe boots, safety glasses, hard hat for overhead hazards, leather work gloves, and hearing protection, as required)		**Location:** Holloman Air Force Base, New Mexico	
		Analysis Approved by:	**Date:**
Activity	**Potential Hazard(s)**	**Recommended Controls**	
Excavation and Confirmation Soil Sampling Hazards and recommended controls from AHA – 01 apply	Overhead/buried utilities	• Completion of an HAFB Excavation Permit is required prior to the start of excavation activities • Overhead utilities should be considered live until determined otherwise • Maintain a minimum distance of 15 feet from overhead utilities • All underground utilities must be clearly marked before beginning work	
	Heavy equipment operation	• Access to the work area shall be coordinated with the Site Manager • Equipment (including trucks) shall be inspected and documented at the beginning of each shift • Maintain awareness of vehicle movement in work area • Exercise caution when approaching heavy equipment • Equipment will be equipped with functioning back-up alarms, signal lamps, and alerting horns • Operators are required to use seat belts • Signs, barricades, flagmen, and/or other traffic control devices will be used to control traffic in the work area • Buckets and attachments shall be placed on the ground if operator not at controls or if ground personnel approach	
	Excavation Safety	• Ensure equipment is placed so as to not contribute to a cave-in situation • No personnel will be allowed to enter the excavation unless the excavation has been properly inspected, shoring and means of egress installed as necessary, all heavy equipment has been moved away from the affected edges, and any spoils have been removed from the edge • Do not place spoil piles closer than 2 feet from the edge of the excavation	
	Exposure to soil contaminants	• Utilize appropriate PPE and decontamination procedures • Conduct work activities in a manner that minimizes potential contact with excavated materials	

Table 3. Activity Hazard Analysis (AHA) (continued)

Activity	Potential Hazard(s)	Recommended Controls
Soils Loading Hazards and Controls associated with Excavation apply	Falling materials and flying debris striking personnel	• Loading equipment must have cab protection, functioning back-up alarms, signal lamps, and alerting horns • Operators are required to use seat belts • Ground personnel are not permitted to approach equipment in motion or while materials being handled • Maintain clear radius of machine • Operator must minimize the amount of materials spilled on the exterior of trucks during loading operations
	Dust	• Adequate dust suppression with water should be utilized to minimize visible dust emissions • If visible dust is prevalent, utilize personal dust monitor to evaluate
	Striking heavy equipment and operators	• Only experienced personnel will operate equipment • Equipment will be operated with cab doors and windows closed
	Overloading capacity	• Load charts of all equipment will be reviewed and followed
Equipment Used	**Inspection Requirements**	**Training Requirements**
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Heavy Equipment (Loader, Excavator, Haul Trucks)	Weekly inspections will be performed on fire extinguishers Weekly inspections will be performed on first aid kits Portable eye wash will be inspected weekly	Personnel have read and understand the work plan and AHA Site specific briefing At least two individuals on-site will have current CPR and First Aid training

Table 4. Personnel Monitoring

Activity(s)	Compound / Instrument	Action Level(s) and Frequency	Actions
Soil boring and well installation, Excavation, Confirmation Soil Sampling and Screening	Total VOCs / Photoionization Detector (PID)	0 - 9 parts per million (ppm) Every 15 minutes during intrusive activities	Continue work in required PPE and continue monitoring.
		≥10 ppm (sustained for more than 5 minutes)	Cease work and ensure personnel are upwind, notify the Site Manager. SSHO may upgrade PPE to Level C respiratory protection with organic vapor cartridge, as necessary.
	Particulates / Personal DataRam or similar particulate monitor	≥1.5 milligrams per cubic meter of air (mg/m^3) particulates (average) not to exceed 5.0 mg/m^3 5 minute monitoring periods as necessary if visible dust is present	Stop work and increase dust suppression.