FINAL

WORK PLAN
SUPPLEMENTAL SITE INVESTIGATION
FORMER ORION PARK HOUSING AREA

Former Naval Air Station Moffett Field
Moffett Field, California

November 5, 2010

Prepared for:
U.S. Army Corps of Engineers
Sacramento District, California

Prepared by:

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Prepared under:
U.S. Army Corps of Engineers, Sacramento District
Contract Number W91238-06-D-0018 DO 0004
Task Order Option 1

SIGNATURE SHEET

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Kelly Stater
AIS Vice President

Signature

11/5/2010
Date

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS iv

1.0 INTRODUCTION 1

1.1 SITE BACKGROUND 2

1.2 FIELD INVESTIGATION PURPOSE 2

1.3 WORK PLAN ORGANIZATION 4

2.0 PROJECT MANAGEMENT 4

2.1 SUBCONTRACTOR COORDINATION 9

2.2 SUBCONTRACTOR ROLES 9

2.3 SUBCONTRACTOR SUBMITTALS 9

2.4 WORK PLAN SCHEDULE AND USACE COORDINATION 10

2.5 FIELD SUBMITTALS, DATA MANAGEMENT, AND USE 10

3.0 PLANNED ACTIVITIES 14

3.1 PERMITTING AND NOTIFICATION 14

3.2 MOBILIZATION AND SITE PREPARATION 14

3.2.1 Utility Clearance 15

3.2.2 Work Areas 15

3.3 FIELD INVESTIGATION 15

3.3.1 Phase 1 – Groundwater Monitoring and Groundwater Elevation Monitoring 16

3.3.2 Phase 2 – Cone Penetrometer Borings with Membrane Interface Probe Tool 16

3.3.3 Phase 3 – Direct Push Technology Borings and HydroPunch Groundwater and Soil Grab Samples 16

3.3.4 Phase 4 – Groundwater Well Installation, Monitoring Well Development, Groundwater Sampling, and Well Surveying 17

3.3.5 Phase 5 – Demobilization and IDW Management 17

4.0 REFERENCES 19

FIGURES

1 Site Location 3

2 Project Organizational Chart 5

3 Supplemental Site Investigation Schedule 11

TABLE

1 Former OPHA Project Team Roles and Responsibilities 6

APPENDICES

A Sampling and Analysis Plan

B Accident Prevention Plan / Site Safety and Health Plan

C Field Forms

ACRONYMS AND ABBREVIATIONS

AEC	Army Environmental Command
AFRC	Armed Forces Reserve Center
AIS	American Integrated Services
APP	Accident Prevention Plan
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COR	Contracting Officer's Representative
CPT	Cone penetrometer test
DO	Delivery order
DOT	Department of Transportation
DPT	Direct-push technology
ECD	Electron capture detector
EPA	U.S. Environmental Protection Agency
EVS	Environmental Visualization Software
FID	Flame ionization detector
FPM	Field Project Manager
GPS	Global positioning system
HSA	Hollow-stem auger
HASM	Health and safety manager
HAZWOPER	Hazardous work operations and emergency response
IDW	Investigation-derived waste
IMS	Information management system
KO	Contracting officer
LOC	Locations of concern
MIP	Multiphase interface probe
Moffett	Naval Air Station Moffett Field
NASA	National Aeronautics and Space Administration
NIOSH	National Institute for Occupational Safety and Health
OPHA	Orion Park Housing Area
OSHA	Occupational Safety and Health Administration

ACRONYMS AND ABBREVIATIONS (Continued)

PID	Photoionization detector
PPE	Personal protective equipment
PQO	Project quality objective
PVC	Polyvinyl chloride
QA	Quality assurance
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and analysis plan
SrSc	Senior scientist
SSC	Site safety coordinator
SSHP	Site safety and health plan
SSI	Supplemental site investigation
TCE	Trichloroethene
Tetra Tech	Tetra Tech EM Inc.
TOM	Task order manager
USACE	U.S. Army Corps of Engineers
VOC	Volatile organic compound
Water Board	San Francisco Bay Regional Water Quality Control Board

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) will conduct a supplemental site investigation (SSI) to identify potential on-site sources of trichloroethene (TCE)-contaminated groundwater at the former Orion Park Housing Area (OPHA) (Site) in Moffett Field, California. The SSI will include a hydrogeologic study, soil and groundwater sampling, and subsequent identification of preferential pathways to assess movement of contamination through the Site. The SSI is being conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act, and the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan, with regulatory oversight of U.S. Environmental Protection Agency (EPA) Region 9 and support from the San Francisco Regional Water Quality Control Board (Water Board).

Under contract to USACE, American Integrated Services (AIS) and Tetra Tech EM Inc. (Tetra Tech), a subcontractor to AIS, will perform the following field activities as part of the SSI:

- Collect groundwater elevation measurements from on- and off-site wells to verify the potentiometric surface and groundwater flow direction at the Site.
- Collect groundwater samples from the 11 existing on-site wells for analysis of volatile organic compounds (VOC) to verify current VOC concentrations in groundwater;
- Advance between 28 and 50 cone penetrometer test (CPT) borings equipped with a membrane interface probe (MIP) to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through the Site.
- Advance up to 18 direct push technology (DPT) borings, if warranted, to define on-site sources of contamination. Collect one soil sample associated with FW41A.
- Install, develop, sample, and survey up to nine new groundwater monitoring wells, if warranted, to monitor concentrations of TCE at the Site at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells and new wells.
- Dispose of investigation-derived waste (IDW) off site.

This SSI Work Plan documents the AIS/Tetra Tech team's approach for implementing the SSI field activities at the Site. The Work Plan describes the project management approach for field activities and the planned work activities at the Site before, during and after the investigation. The Work Plan will be used in conjunction with the sampling and analysis plan (SAP) and the accident prevention plan (APP), which are included as Appendix A and Appendix B.

The SAP describes the investigation and sampling activities associated with the CPTs, DPTs, and monitoring wells during the SSI. The SAP provides the project quality objectives (PQO), field sampling procedures, quality assurance/quality control (QA/QC) requirements, and data gathering methods. The SAP addresses all elements of a quality assurance project plan (QAPP) required by the following EPA guidance documents: "EPA Requirements for Quality Assurance

Project Plans, EPA QA/R-5" (EPA 2001), and the "Uniform Federal Policy for Quality Assurance Project Plans" (EPA 2005).

The APP and associated site safety and health plan (SSHP) describe the field activities, the planned health and safety management approach, and activities for the AIS/Tetra Tech team. All field personnel and site visitors will be required to read and sign the APP. The on-site health and safety officer will give a health and safety briefing each work day before any field activities begin.

1.1 SITE BACKGROUND

The Site is part of USACE's recently demolished Moffett Community Housing and was part of the former Naval Air Station Moffett Field (Moffett), California (Figure 1). The Site covers approximately 77 acres. In 1994, the Navy transferred the Community Housing to the Air Force. In 2000, the Community Housing was transferred to USACE.

Pursuant to the Base Realignment and Closure Commission recommendations in 2005, the USACE Reserves demolished existing housing units and associated structures over a 30-acre area in the northern part of the Site so that a new Armed Forces Reserve Center (AFRC) and associated support facilities could be constructed. Demolition was completed in 2009. Construction of additional associated structures is ongoing.

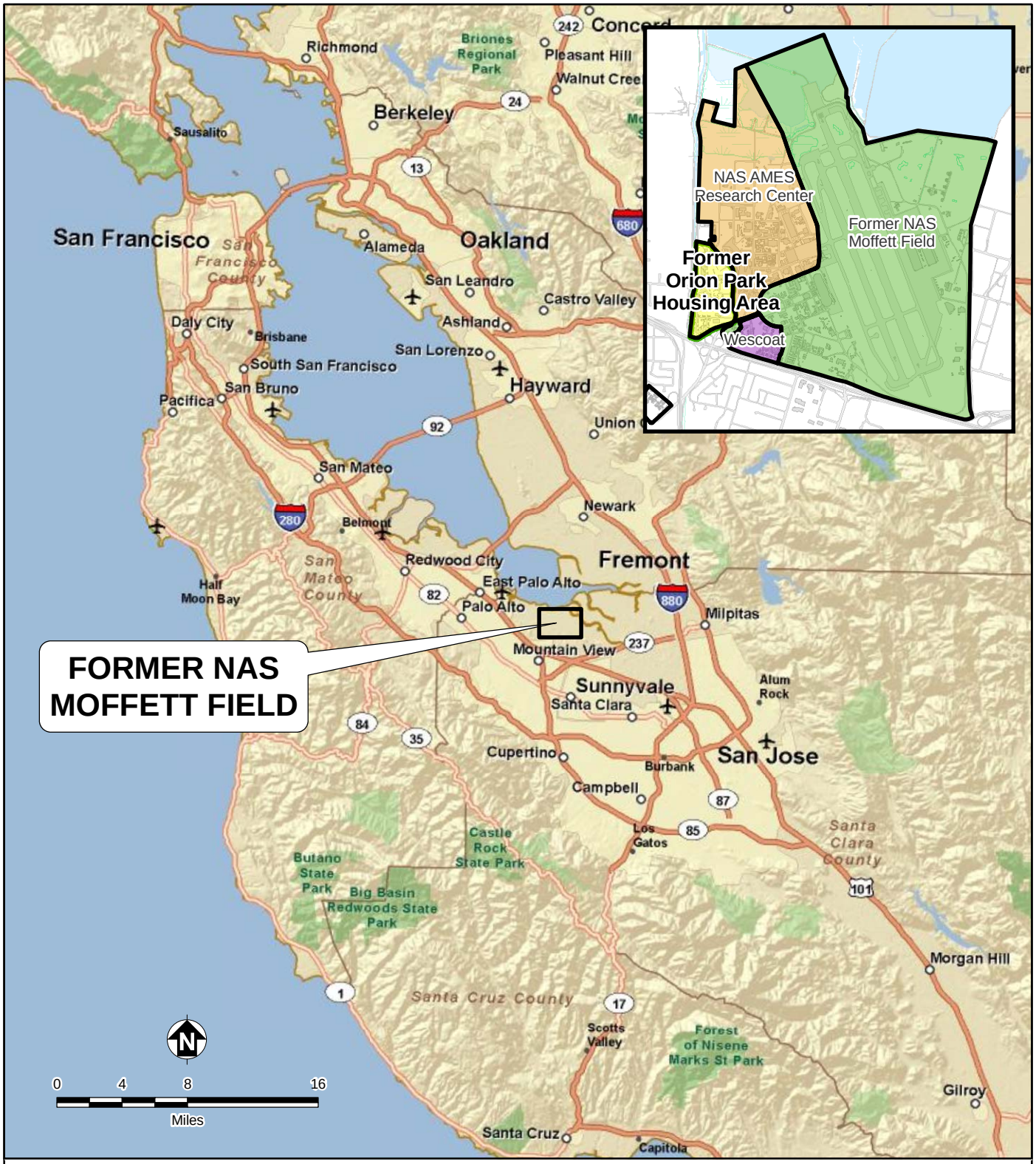
Additional information about the history and background of the Site is included in Worksheet #10 of the SAP, titled "summary of previous investigations" (see Appendix A).

1.2 FIELD INVESTIGATION PURPOSE

The purpose of the SSI field investigation is to assess whether sources on site cause elevated concentrations of TCE in groundwater. Locations of concern (LOC) have been identified through review of historical groundwater sampling data, historical aerial photographs, and contractor's reports. This field investigation will evaluate whether an on-site source of TCE is present. If no on-site source of TCE is present, the Army will seek site closure.

The field investigation will be implemented in five phases:

- **Phase 1 – Non-intrusive activities:** Obtain permits, notify the proper personnel, mobilize to the site, prepare the site; clear utilities; collect groundwater samples from the 11 existing wells for analysis of VOCs; collect groundwater elevation measurements from on- and off-site wells (see Appendix A)
- **Phase 2 – Intrusive activities:** Advance between 28 and 50 CPT borings equipped with a MIP to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through the Site.
- **Phase 3 - Intrusive activities:** Advance up to 18 DPT borings, if warranted, to define on-site sources of contamination. Collect one soil sample associated with FW41A.



Area of Interest

NAS Naval Air Station

American Integrated Services, Inc.

TETRA TECH

Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE 1
SITE LOCATION

Work Plan for the Supplemental Site Investigation

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- **Phase 4 - Intrusive activities:** Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at the Site at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells.
- **Phase 5 – Non-intrusive activities:** Dispose of IDW off-site.

1.3 WORK PLAN ORGANIZATION

This Work Plan is organized as follows:

- Section 1.0 provides an introduction and short site background, summarizes the overall purpose and objectives for the project, and the Work Plan organization
- Section 2.0 describes the project organization, provides the project schedule, including document submittals, and summarizes data management and use
- Section 3.0 describes the planned investigation activities
- Section 4.0 provides a list of documents used in compiling this Work Plan.

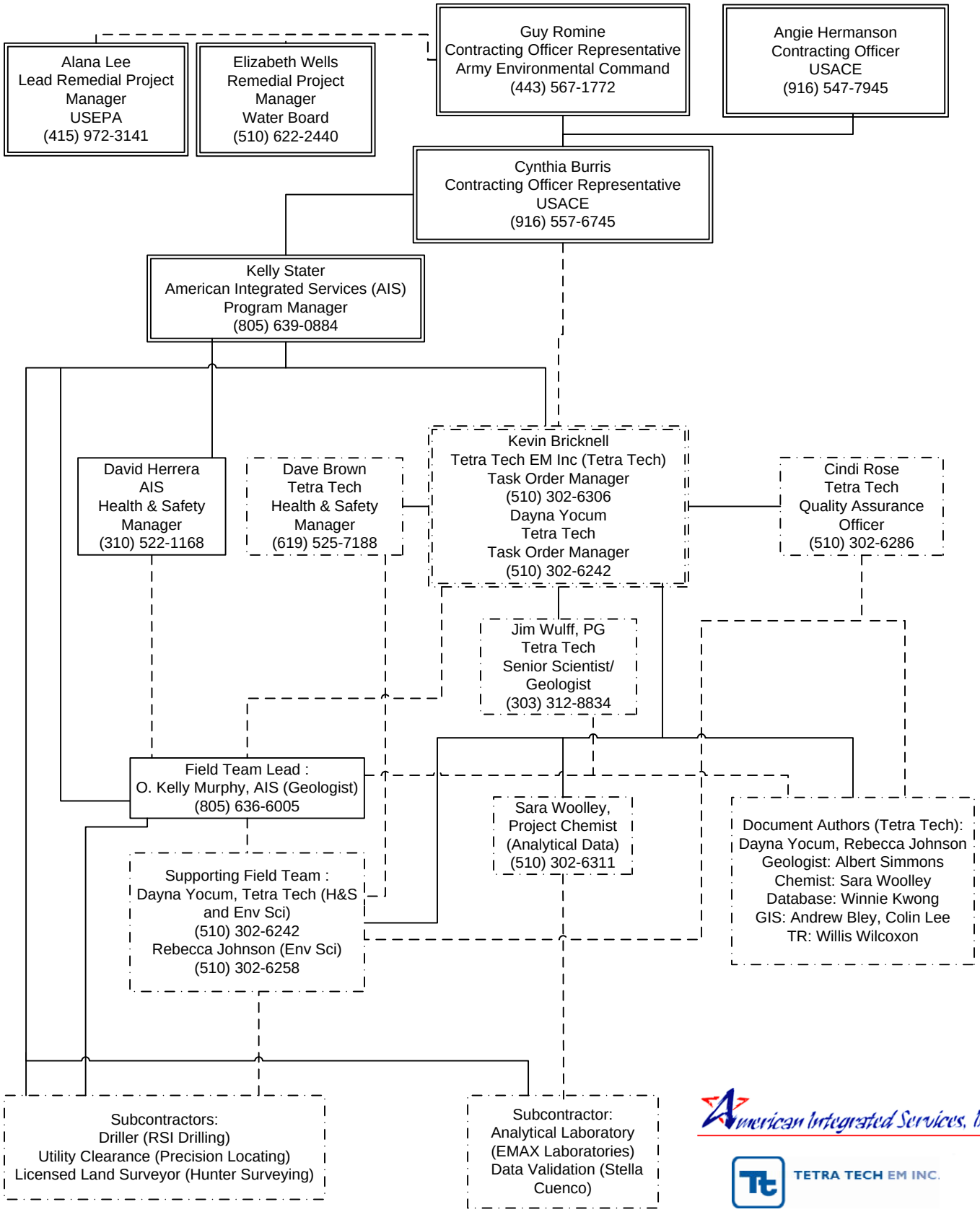
Figures and tables are embedded in the text. Appendices follow the text; Appendix A contains the SAP, Appendix B contains the APP/SSHP, and Appendix C contains field forms for use during the field activities.

2.0 PROJECT MANAGEMENT

The AIS/Tetra Tech Team will implement the field investigation. Figure 2 presents the overall organization of the project team and the communication pathways and lines of authority for the project. Table 1 presents the roles and responsibilities of each project team member.

Tetra Tech's task order managers (TOM) will provide direction to the team implementing the SSI. The AIS/Tetra Tech Team will coordinate with all contractors before on-site activities, begin to arrange all necessary permits, and mobilize appropriate equipment, materials, and labor to the site. The AIS field project manager (FPM) will implement field activities and will be on site to direct the site layout and the investigation. The FPM will oversee and direct field activities and will have day-to-day responsibility for ensuring implementation of the Work Plan. The on-site site safety coordinators (SSC) for AIS and Tetra Tech will be responsible for implementing health and safety program (see Appendix B) and for verifying that the subcontractors are implementing their individual SSHPs. All subcontractors will report directly to the FPM.

The SAP (Appendix A) provides further detail on the project organization, describes the roles of key personnel on the project, and provides additional contact information. Standard forms will be used throughout field activities (Appendix C).



key

Subcontractors to AIS are shown in dashed boxes.
Lines of authority are shown as solid lines, and lines of communication are dashed.

Former Orion Park Housing Area
Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE 2

PROJECT ORGANIZATIONAL CHART

Work Plan for the Supplemental Site Investigation

TABLE 1: FORMER OPHA PROJECT TEAM ROLES AND RESPONSIBILITIES
Work Plan for Supplemental Site Investigation, Former Orion Park Housing Area, Former Naval Air Station Moffett Field, Moffett Field, California

Name & Telephone	Title/Role	Organizational Affiliation	Responsibilities
Guy Romine (443) 567-1772	Army Remedial Project Manager	Army Environmental Command (AEC)	Responsible for all technical decisions relating to the project and for overseeing Cynthia Burris, COR.
Angie Hermanson (916) 557-7945	Contracting Officer (KO)	USACE, Sacramento District	Overall responsibility for overseeing the AIS/Tetra Tech Team's performance for contract compliance and administration; reviews COR's assessment of AIS/Tetra Tech Team's performance.
Cynthia Burris (916) 557-6745	Contracting Officer's Representative (COR)	USACE, Sacramento District	Responsible for providing management and technical oversight of the project. Responsible for all QA issues for all Site work. Has authority to suspend affected project or site activities if approved technical or quality requirements are not adequately met. Reviews and approve technical deliverables. Approves payment milestone schedule. Reviews status reports.
Kelly Stater (805) 639-0884	Program Manager (PRM)	AIS	Has ultimate authority and responsibility for all technical, contractual, safety, and administrative matters for the project. Monitors contract and task funds and schedules and ensures implementation of the QA/QC processes.
Kevin Bricknell, PE, QEP (510) 302-6306 and Dayna Yocum (510) 302-6242	Task Order Manager (TOM)	Tetra Tech	Provide management oversight and assistance in completing the technical work; act as liaison with AEC COR and USACE COR; oversee administrative and technical performance, and maintain compliance with schedules and budgets.
Cindi Rose (510) 302-6286	Quality Assurance Officer (QAO)	Tetra Tech	Provides QA/QC of technical work at the site; works closely with, and reviews work by the project Tetra Tech team; and reviews deliverables to verify conformance with QA/QC procedures.
Jim Wulff, PG, CEG (303) 312-8834	Senior Scientist/ Professional Geologist (SrSc)	Tetra Tech	Develops technical approach and conceptual site model. Participates in development of SAP and supplemental SSI report. Attends meetings with USACE, AEC, and the regulatory agencies.

TABLE 1: OPHA PROJECT TEAM ROLES AND RESPONSIBILITIES (CONTINUED)
Work Plan for Supplemental Site Investigation, Orion Park Housing Area, Former Naval Air Station Moffett Field, Moffett Field, California

Name & Telephone	Title/Role	Organizational Affiliation	Responsibilities
David Herrera (310) 522-1168	Health and Safety Manager (HASM)	AIS	Responsible for administration of AIS's APP, and acts as an advisor to Tetra Tech's TOM and AIS' Field Project Manager to implement the APP.
Dave Brown (619) 525-7188	HASM	Tetra Tech	Responsible for administration of Tetra Tech's APP and acts as an advisor to Tetra Tech's TOM and AIS' Field Project Manager to implement the APP.
O. Kelly Murphy (805) 636-6005	Field Project Manager (FPM) and Site Safety Coordinator (SSC)	AIS	As FPM, directs the day-to-day field activities and oversees all subcontractors; verifies field measurement and sampling procedures are conducted in accordance with the SSI Work Plan and SAP; and reports directly to the TOM on planning, cost and schedule control, and data management information needs. As SSC, responsible for implementing AIS APP in the field, and has authority to correct and change site control measures; the required level of health and safety protection; enforce the AIS APP policies and provisions; and stop work for any unsafe condition.
Dayna Yocum (510) 302-6242 and Rebecca Johnson (510) 302-6258	Supporting Field Team Members	Tetra Tech	Support in field activities when needed. Collects groundwater samples and supports FPM with field tasks.
Dayna Yocum, Rebecca Johnson, Albert Simmons, Sara Woolley, Winnie Kwong, Willis Wilcoxon	Document Authors	Tetra Tech	Develop draft and final SSI Work Plan, SAP, QAPP, and SSI report, including evaluating MIP and groundwater monitoring results.
Sara Woolley (510) 302-6311	Project Chemist	Tetra Tech	Coordinates analytical tests required in the SAP; verifies the laboratory implements the requirements of the SAP; and reviews laboratory data before they are released.
Julie Bates (925) 516-2860	Utility Locator	Precision Locating, LLC	Screens the ground surface around each of 20 proposed subsurface borings for the presence of subsurface utilities using geophysical techniques.

TABLE 1: OPHA PROJECT TEAM ROLES AND RESPONSIBILITIES (CONTINUED)
Work Plan for Supplemental Site Investigation, Orion Park Housing Area, Former Naval Air Station Moffett Field, Moffett Field, California

Name & Telephone	Title/Role	Organizational Affiliation	Responsibilities
David Boggs (530) 668-2424	Driller	RSI Drilling	Conducts cone penetrometer testing, including membrane interface probe (MIP) sampling, HydroPunch sampling, and direct-push borings. Installs and develops monitoring wells.
James White (916) 988-5600	Land Surveyor	Hunter Surveying	Surveys horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of 10 groundwater monitoring wells.
Kelly Stater (805) 639-0884	Investigation-Derived Waste (IDW) Characterization and Transport	AIS	Characterizes and transports IDW from the Site to waste facility.
To Be Determined	Nonhazardous or Hazardous Waste Disposal Facility	To Be Determined	Receives and disposes of waste from the Site.
Ye Myint (310) 618-8889 x 121	Analytical Laboratory	EMAX Laboratories	Conducts off-site chemical analysis of all samples.

2.1 SUBCONTRACTOR COORDINATION

The FPM will be responsible for daily subcontractor coordination during each phase. The FPM will verify proper safety measures are in place before the investigation begins. All subcontractors to AIS will work in coordination with each other, but will be independent of one another. All subcontractors will be solely responsible for their conduct and work product. The FPM will understand the subcontractor obligations and specifications according to the contract, and will document all activities in accordance with the specifications and project schedule.

2.2 SUBCONTRACTOR ROLES

The subcontractors will have the following roles throughout the project:

- **Utility Clearance:** Before any intrusive investigation begins, the ground surface around each of the proposed subsurface boring locations will be examined for the presence of subsurface utilities using geophysical techniques. An area of approximately 5-foot radius will be cleared and staked at each location. Any utilities identified will be marked on the ground with paint. Sampling locations will be adjusted in the field to avoid underground utilities.
- **Driller:** The drilling subcontractor will provide one CPT rig equipped with a MIP, a DPT rig equipped with HydroPunch technology to collect groundwater samples, and a hollow-stem auger (HSA) rig for installation of 4-inch-diameter groundwater monitoring wells. The driller will also provide all equipment and materials necessary to complete and develop the groundwater monitoring wells.
- **Land Surveyor:** A licensed land surveyor will survey the top of casings of the monitoring wells, once completed.
- **Disposal Facilities:** Disposal facilities will receive and dispose of IDW in accordance with all federal, state and local regulations.

2.3 SUBCONTRACTOR SUBMITTALS

Before field crews mobilize to the site, the AIS/Tetra Tech Team's subcontractors listed in Section 2.2 will submit the following documents for approval (as appropriate):

- Machinery inspection reports and certificates (driller only)
- Employee's Occupational Safety and Health Administration (OSHA) 40-hour hazardous work operations and emergency response (HAZWOPER) training certification (driller only)
- Supervisor's 8-hour Construction Supervisor training certification (driller only)
- Employee's cardiopulmonary resuscitation and first aid certification (driller only)
- Employee's respirator fit test certification (driller only)

The AIS/Tetra Tech Team will review and accept each submittal.

During field activities, the AIS/Tetra Tech Team's driller will submit the following data to the FPM each work day:

- MIP and CPT data in electronic format
- Boring logs (during monitoring well installation)
- Pump test records (during well development)

The AIS/Tetra Tech Team will use the data to make field decisions.

2.4 WORK PLAN SCHEDULE AND USACE COORDINATION

Figure 3 presents the proposed schedule for implementing the Work Plan. The schedule will be regularly updated with the progress of the project. AIS/Tetra Tech anticipates that USACE will inform all key project personnel of any known or anticipated delays or acceleration of field activities required to coordinate with other activities at the site. If schedule modifications are needed or anticipated, the AIS/Tetra Tech Team will develop and outline to USACE the revised field activity methods needed to maintain the schedule.

2.5 FIELD SUBMITTALS, DATA MANAGEMENT, AND USE

The FPM will submit QC reports to the TOM daily, USACE representatives weekly, and regulatory agencies after the completion of the investigation of a set of LOCs. For each LOC, the QC reports will explain the steps in the decision logic used to select MIP/CPT locations. Appendix C includes a sample QC report field form.

The AIS/Tetra Tech Team's driller will submit the following data to the FPM after each day of work; data can be transmitted either via e-mail or directly onto the FPM's flash drive:

- MIP and CPT data in electronic format.
- Driller's logs for DPTs and monitoring well installation.
- Well development records.

The MIP and CPT data will be transmitted to the TOM, input into the Environmental Visualization Software (EVS), and used by the AIS/Tetra Tech Team to make field decisions for locating additional MIPs and DTP borings. The SAP in Appendix A describes the field decision logic.

As field and analytical data collected for this project are critical to making decisions, an information management system (IMS) will be used necessary to ensure efficient access to field data for the EVS.

FIGURE 3. SUPPLEMENTAL SITE INVESTIGATION SCHEDULE
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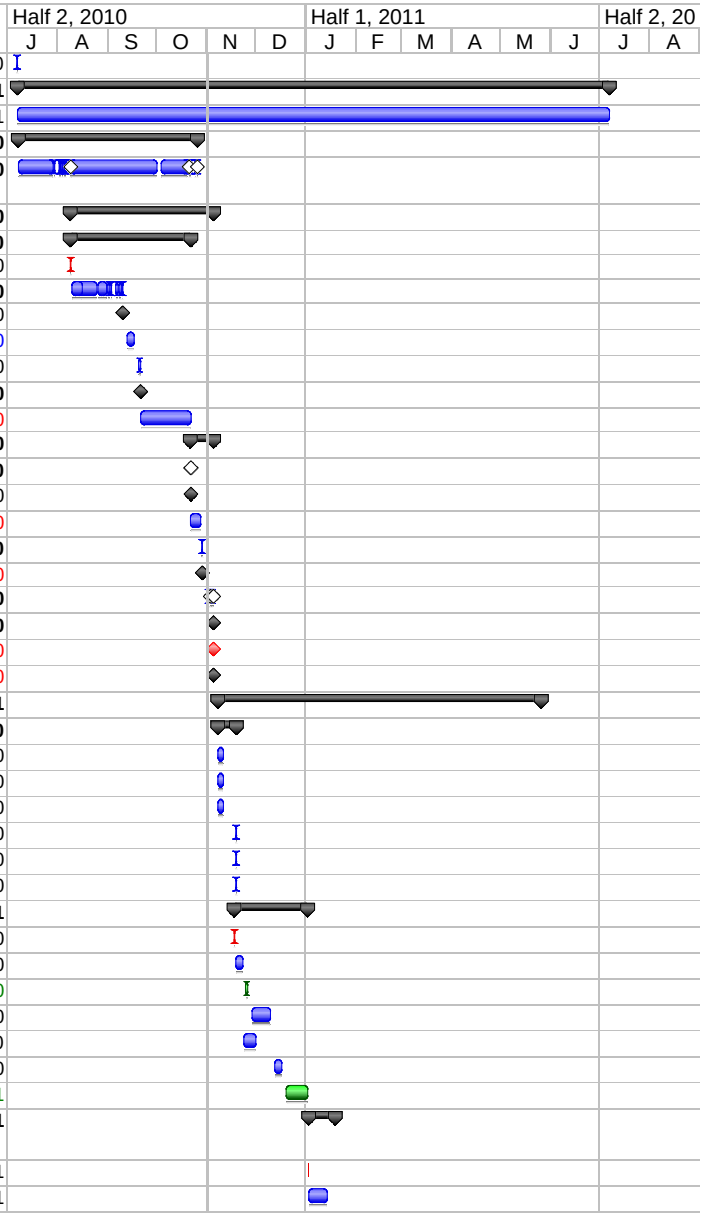
ID	Payment Milestone	Task Name (1)	Predecessors	Calendar Days	Start	Finish
1		Contract Award		1 day	Wed 7/7/10	Wed 7/7/10
2		**Project Management**	**1**	**265 days**	**Wed 7/7/10**	**Thu 7/7/11**
3		PM coordination	1	365 edays	Wed 7/7/10	Thu 7/7/11
4		**Approved PMP and QASP**	**1**	**79 days**	**Thu 7/8/10**	**Tue 10/26/10**
5		Project Management Plan (PMP) and Quality Assurance Surveillance Plan (QASP)		**79 days**	**Thu 7/8/10**	**Tue 10/26/10**
28		**Work Plan**		**65 days**	**Mon 8/9/10**	**Fri 11/5/10**
29		**Draft SSI Work Plan, HASP, QASP/SAP**		**55 days**	**Mon 8/9/10**	**Fri 10/22/10**
30		Kickoff/Scoping Meeting	1	1 day	Mon 8/9/10	Mon 8/9/10
31		**Draft SSI Work Plan, HASP, QASP/SAP**	**1**	**24 days**	**Tue 8/10/10**	**Fri 9/10/10**
40		E-submittal to Army	39	0 days	Fri 9/10/10	Fri 9/10/10
41		Army Review	40	5 days	Mon 9/13/10	Fri 9/17/10
42		Revise per Army Comments	41	2 days	Mon 9/20/10	Tue 9/21/10
44	2	**Submit to Regulatory Agencies**	**43**	**0 days**	**Tue 9/21/10**	**Tue 9/21/10**
45		Regulator Review of Draft SSI Work Plan	44	31 edays	Tue 9/21/10	Fri 10/22/10
46		**Final SSI Work Plan, HASP, QASP/SAP**		**11 days**	**Fri 10/22/10**	**Fri 11/5/10**
47		**RTC Development**		**0 days**	**Fri 10/22/10**	**Fri 10/22/10**
59		Submit to Regulators	58	0 days	Fri 10/22/10	Fri 10/22/10
60		Regulatory Review of RTCs	58FS-1 day	5 days	Fri 10/22/10	Thu 10/28/10
61		**RTC Teleconference with Regulators**	**60**	**1 day**	**Fri 10/29/10**	**Fri 10/29/10**
62		Regulator Approval of RTCs	61	0 days	Fri 10/29/10	Fri 10/29/10
63		**Final SSI Work Plan, HASP, QASP/SAP**		**5 days**	**Mon 11/1/10**	**Fri 11/5/10**
76		**Submit to Regulatory Agencies**	**75**	**0 days**	**Fri 11/5/10**	**Fri 11/5/10**
77		Regulatory Agency Review of Final SSI Work Plan	76	0 days	Fri 11/5/10	Fri 11/5/10
78	3	Regulator Approval of Final SSI Work Plan	77	0 days	Fri 11/5/10	Fri 11/5/10
79		**Field Investigation**		**148 days**	**Mon 11/8/10**	**Thu 5/26/11**
80		**Field Work Preparation**		**10 days**	**Mon 11/8/10**	**Fri 11/19/10**
81		Procure subcontractors	78	4 days	Mon 11/8/10	Thu 11/11/10
82		Notify site personnel	78	4 days	Mon 11/8/10	Thu 11/11/10
83		Permits	78	4 days	Mon 11/8/10	Thu 11/11/10
84		Locate and mark borings	88	1 day	Fri 11/19/10	Fri 11/19/10
85		USA Alert	88	1 day	Fri 11/19/10	Fri 11/19/10
86		Utilty locator, underground, overhead review, water	88	1 day	Fri 11/19/10	Fri 11/19/10
87		**GW Elevation Monitoring and Sampling**		**36 days**	**Thu 11/18/10**	**Sun 1/2/11**
88		Black Thursday GW Elevation Monitoring		1 day	Thu 11/18/10	Thu 11/18/10
89		GW Sampling	88	3 days	Fri 11/19/10	Tue 11/23/10
90		Thanksgiving Holiday	89	2 days	Thu 11/25/10	Fri 11/26/10
91		Laboratory Chemical Analysis	90	10 days	Mon 11/29/10	Fri 12/10/10
92		GW Contour Analysis	89	6 days	Wed 11/24/10	Wed 12/1/10
93		Data Validation	91	5 days	Mon 12/13/10	Fri 12/17/10
94		Holiday Season		14 days	Mon 12/20/10	Sun 1/2/11
95		**Site-wide Cone Penetration Testing (CPT with MIP at between 28 and 50 locations)**		**13 days**	**Mon 1/3/11**	**Wed 1/19/11**
96		Kickoff safety meeting	94	0.5 days	Mon 1/3/11	Mon 1/3/11
97		CPT/MIP Investigation of 9 LOCs	94	10 days	Mon 1/3/11	Fri 1/14/11



Notes:
Blue text: Army Task
Red text: Regulatory Agency Task

FIGURE 3. SUPPLEMENTAL SITE INVESTIGATION SCHEDULE
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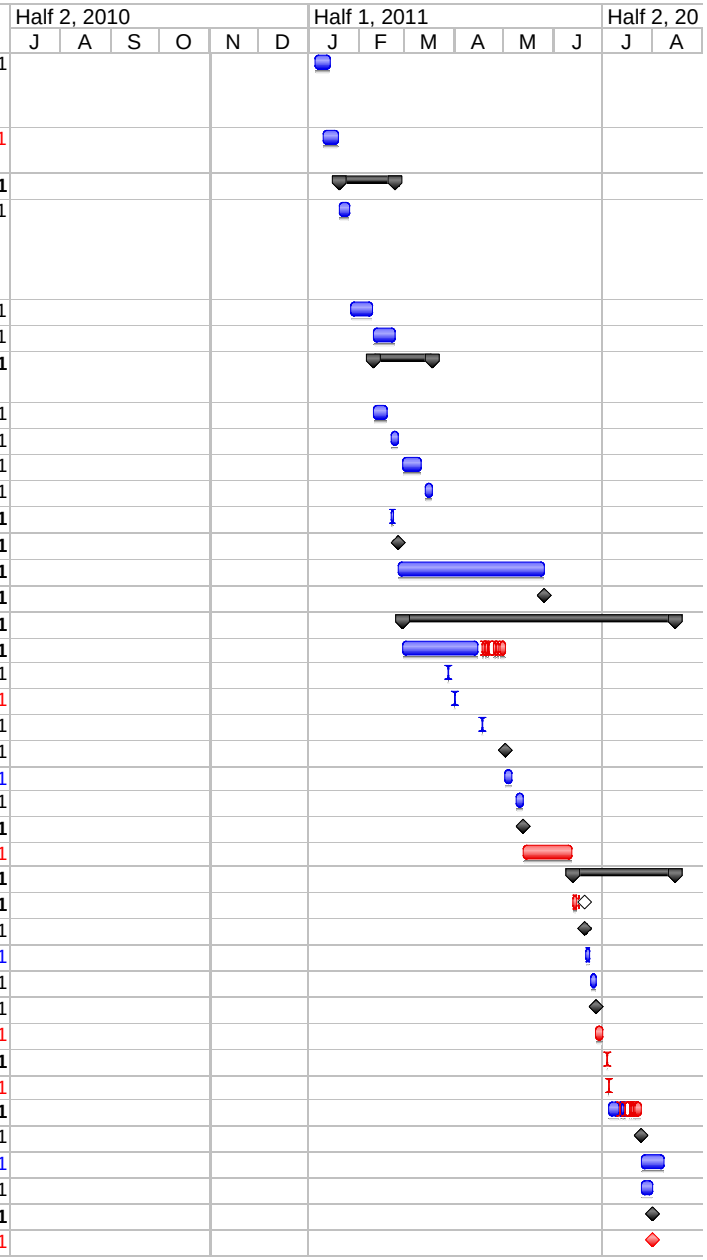
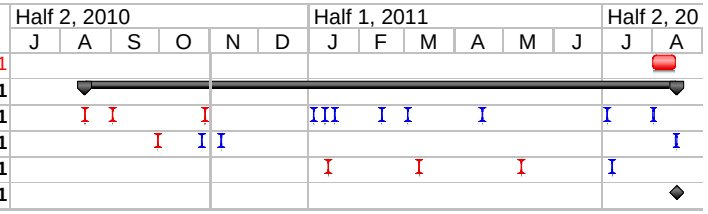
ID	Payment Milestone	Task Name (1)	Predecessors	Calendar Days	Start	Finish
98		LOC Data Package to Regulatory Agencies (Multiple Email Submittals by LOC)	96SS+2 days	8 days	Wed 1/5/11	Fri 1/14/11
99		Army Review and Concurrence of Recommended DPT Locations (by LOC)	98SS+3 days	8 days	Mon 1/10/11	Wed 1/19/11
100		**DPT/Hydropunch at up to 18 locations**		**25 days**	**Thu 1/20/11**	**Wed 2/23/11**
101		DPT/Hydropunch, 2 stepout borings at each source area indicated by MIP, w/ 2 discrete-depth GW samples; 1 soil sample at FW41A	99	5 days	Thu 1/20/11	Wed 1/26/11
102		Laboratory Chemical Analysis	101	10 days	Thu 1/27/11	Wed 2/9/11
103		Data Validation	102	10 days	Thu 2/10/11	Wed 2/23/11
104		**Monitoring Well Installation and GW Elevation Monitoring**		**27 days**	**Thu 2/10/11**	**Fri 3/18/11**
105		Install up to 9 GW monitoring wells	102	7 days	Thu 2/10/11	Fri 2/18/11
106		Well Development & GW Monitoring	105	5 days	Mon 2/21/11	Fri 2/25/11
107		Laboratory Chemical Analysis	106	10 days	Mon 2/28/11	Fri 3/11/11
108		Data Validation	107	5 days	Mon 3/14/11	Fri 3/18/11
109		**Surveying**	**105**	**2 days**	**Mon 2/21/11**	**Tue 2/22/11**
110		**Complete Field Work**	**106**	**0 days**	**Fri 2/25/11**	**Fri 2/25/11**
111		**Storage, Transport and IDW Disposal**	**101,106**	**90 edays**	**Fri 2/25/11**	**Thu 5/26/11**
112	**4**	**Complete Field Investigation**	**111**	**0 days**	**Thu 5/26/11**	**Thu 5/26/11**
113		**SSI Report**		**120.5 days**	**Mon 2/28/11**	**Mon 8/15/11**
114		**Draft SSI Report**		**46 days**	**Mon 2/28/11**	**Mon 5/2/11**
122		Validated Data Summary Submitted to Regulatory Agencies	07FS+10 days	1 day	Mon 3/28/11	Mon 3/28/11
123		Conference Call to Discuss Validated Data Summary	122FS+3 days	1 day	Fri 4/1/11	Fri 4/1/11
124		Submittal of Draft Conclusions to Regulatory Agencies	115	1 day	Mon 4/18/11	Mon 4/18/11
125		E-submittal of Draft SSI Report to Army	121	0 days	Mon 5/2/11	Mon 5/2/11
126		Army Review	125FS-1 day	5 days	Mon 5/2/11	Fri 5/6/11
127		Revise per Army Comments and Publish	126	5 days	Mon 5/9/11	Fri 5/13/11
128	**5**	**Submit to Regulatory Agencies**	**127**	**0 days**	**Fri 5/13/11**	**Fri 5/13/11**
129		Regulator Review of Draft SSI Report	128	30 edays	Fri 5/13/11	Sun 6/12/11
130		**Final SSI Report**		**45.5 days**	**Mon 6/13/11**	**Mon 8/15/11**
131		**RTC Development**		**6 days**	**Mon 6/13/11**	**Mon 6/20/11**
140		E-submittal to Army for Review	139	0 days	Mon 6/20/11	Mon 6/20/11
141		Army Review	140	3 days	Tue 6/21/11	Thu 6/23/11
142		Revise RTCs per Army Comments	141	2 days	Fri 6/24/11	Mon 6/27/11
143		Submit to Regulators	142	0 days	Mon 6/27/11	Mon 6/27/11
144		Regulatory Agency Review of RTCs	143FS-1 day	5 days	Mon 6/27/11	Fri 7/1/11
145		**RTC Teleconference**	**144**	**1 day**	**Mon 7/4/11**	**Mon 7/4/11**
146		Regulator Approval of RTCs	145	1 day	Tue 7/5/11	Tue 7/5/11
147		**Final SSI Report**		**14.5 days**	**Tue 7/5/11**	**Mon 7/25/11**
158		E-submittal to Army	157	0 days	Mon 7/25/11	Mon 7/25/11
159		Army Review	157	10 days	Mon 7/25/11	Mon 8/8/11
160		Revise per Army Comments and Publish	158	5 days	Mon 7/25/11	Mon 8/1/11
161		**Submit to Regulators**	**160**	**0 days**	**Mon 8/1/11**	**Mon 8/1/11**
162		Review of Final SI Report by Regulatory Agencies	161	0 days	Mon 8/1/11	Mon 8/1/11



Notes:
Blue text: Army Task
Red text: Regulatory Agency Task

FIGURE 3. SUPPLEMENTAL SITE INVESTIGATION SCHEDULE
Rev 9:06 AM Mon 11/1/10

ID	Payment Milestone	Task Name (1)	Predecessors	Calendar Days	Start	Finish
163	6	Regulatory Agency Approval of Final SSI Report	162	10 days	Mon 8/1/11	Mon 8/15/11
164	7	**Public Involvement**	**1**	**265.5 days**	**Mon 8/16/10**	**Tue 8/16/11**
165		Regulatory Meetings		**255.5 days**	**Mon 8/16/10**	**Tue 8/2/11**
177		Milestone In-person Meetings (4)		**232.5 days**	**Thu 9/30/10**	**Tue 8/16/11**
182		RAB Meeting Updates		**126 days**	**Thu 1/13/11**	**Thu 7/7/11**
187		**End**	**6,114,79,46,29**	**0 days**	**Tue 8/16/11**	**Tue 8/16/11**



Notes:
Blue text: Army Task
Red text: Regulatory Agency Task

The IMS contains data for the following uses:

- Summarizing observations on contamination and geologic conditions
- Preparing reports and graphics
- Using with geographic information systems
- Transmitting in an electronic format compatible with the USACE Mapper Database, the Environmental Restoration Information System (ERIS) (a web-based database system for the storage of Army environmental restoration and range field data that serves as a central repository for the Army installation chemical, geological, and geographical data), and the Army Environmental Database Restoration module (AEDB-R) (a centralized and integrated collection of Army environmental data).

Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The field team also will use various field forms included in this Work Plan (Appendix C) and the SAP (Appendix A) to record field activities.

After the field and laboratory chemical analytical data reports are reviewed and validated, the data will be used to complete the SSI report and create 3-dimensional maps displaying subsurface hydrostratigraphy as well as contaminant distribution.

Section 14.4.6 of the SAP describes the AIS/Tetra Tech Team's data management procedures in more detail (Appendix A). The chemical analytical summary data packages, provided as an appendix to the SSI report, will consist of copies of all associated chain-of-custody records, sample results, and QA/QC summaries, original field forms, logbooks, and other field documentation.

3.0 PLANNED ACTIVITIES

This section describes the specific activities and procedures involved in completing the SSI at the Site.

3.1 PERMITTING AND NOTIFICATION

Before any field work begins, the AIS/Tetra Tech Team's FPM will obtain permits from the Santa Clara Valley Water District for each planned boring deeper than 45 feet below ground surface (bgs). Permits obtained from the Santa Clara Valley Water District will also be obtained for each planned monitoring well.

3.2 MOBILIZATION AND SITE PREPARATION

A kickoff meeting will be held after permits are obtained and notifications are completed. All equipment and materials required for the field work will be mobilized to the site after the kickoff meeting. Intrusive investigations will begin only after mobilization has been completed.

Regular site work hours will be 7:00 a.m. to 5:00 p.m., Monday through Friday. Activities will be conducted only during daylight. Work outside of regular site work hours must be approved by appropriate USACE personnel. The AIS/Tetra Tech Team subcontractors will report progress and any schedule changes to the AIS/Tetra Tech Team FPM. The following subsections detail mobilization and site preparation.

3.2.1 Utility Clearance

The AIS/Tetra Tech Team will notify Underground Service Alert at least 2 working days before any intrusive activities to verify the absence or presence of utilities. In addition, a utility clearance subcontractor will survey the ground surface around each of the proposed subsurface borings for the presence of subsurface utilities using non-intrusive geophysical techniques. The FPM or another AIS/Tetra Tech Team field staff will accompany the utility locator and will locate the background calibration, initial, and secondary CPT/MIP sampling locations (see Appendix A) in the field using a hand-held global positioning system (GPS) device. An area with a 5-foot radius will be cleared around each location. Each cleared location will be staked or marked. The FPM will be present to adjust locations in the field, as needed, during intrusive field activities. Any utilities identified by the utility locator will be marked on the ground with paint.

If additional borings are required, a utility locator will also survey the ground surface around each of the additional borings before the subsurface investigation.

3.2.2 Work Areas

While intrusive drilling is ongoing, an exclusion zone will be established around the work areas. This exclusion zone will be managed in accordance with guidance for hazardous waste sites (NIOSH/OSHA/USCG/EPA 1985). Only trained persons conducting the investigation will be allowed to enter the exclusion zone. The area will be roped off to warn and prevent unauthorized entry. A support zone will be established outside the work area for a portable sanitation facility and for storage of equipment and supplies.

3.3 FIELD INVESTIGATION

The field investigation will take place in five consecutive phases, as described below. Decisions concerning sampling locations will be based on data collected during each phase, as described in the SAP (Appendix A). The subcontractor will abandon all borings in accordance with local and state regulations, and all pavement destroyed will be repaired to existing conditions. All drill cuttings will be placed in Department of Transportation (DOT)-approved drums or roll-off bins and temporarily stored on site before disposal. The driller will decontaminate drill augers and tools between each boring. Decontamination water will be captured, placed in drums separate from the drill cuttings, and stored on site.

3.3.1 Phase 1 – Groundwater Monitoring and Groundwater Elevation Monitoring

Elevation measurements will be collected from the on-site wells by the Navy during the November 18, 2010, Black Thursday regional groundwater elevation monitoring event. On the same day, AIS/Tetra Tech will collect water level measurements at the off-site wells south of the Site at the former vector control yard currently owned by the City of Mountain View and previously operated by Santa Clara County. The Navy will also collect elevation measurements from additional off-site wells located to the east of the Site, and NASA will collect elevation measurements from its off-site wells, located to the north of the Site. Groundwater elevation measurements collected during the Black Thursday event will be used to verify or modify the groundwater contours at the Site.

Groundwater samples will be collected and analyzed for VOCs from the 11 existing wells on-site prior to intrusive investigations using the low-flow micropurge method described in the SAP (Appendix A). VOC concentrations and potentiometric surface elevations will be used to verify or modify the groundwater concentrations and contours at the Site. CPT/MIP boring locations will be adjusted based on the resulting groundwater concentrations and contours.

3.3.2 Phase 2 – Cone Penetrometer Borings with Membrane Interface Probe Tool

After the utility clearance is complete, the drilling subcontractor will advance CPT borings to depths corresponding to the depths of the A1 or A2 aquifer (approximately to 35 feet bgs or 65 feet bgs) to support lithological investigations. The driller will use a MIP to obtain a profile of VOC contamination. The MIP will be equipped with a photoionization detector (PID), flame ionization detector (FID) and an electron capture detector (ECD) and will produce continuous logs of the output of each detector.

Data collected during this initial CPT/MIP phase will be used to advance additional CPT/MIP and DPT borings to assess each LOC. The decision logic for this investigation is presented in the PQOs in the SAP (Appendix A).

3.3.3 Phase 3 – Direct Push Technology Borings and HydroPunch Groundwater and Soil Grab Samples

Once CPT/MIP borings are completed, the driller will advance DPTs to allow collection of up to two discrete-depth grab groundwater samples in each boring using a HydroPunch. New tubing will be used to collect each groundwater samples. Groundwater samples will be analyzed for VOCs. One soil sample will be collected at one location (FW41A) to determine if a high PID detection that was recorded while advancing the boring in 2002 was caused by elevated concentrations of TCE at that location. The soil sample will be analyzed for VOCs and total petroleum hydrocarbons (TPH). The depths of the discrete-depth groundwater samples will be determined by data collected during the CPT/MIP investigation.

3.3.4 Phase 4 – Groundwater Well Installation, Monitoring Well Development, Groundwater Sampling, and Well Surveying

After the chemical analytical laboratory results from DPT and HydroPunch groundwater and soil sampling have been analyzed and evaluated, monitoring wells will be installed if deemed necessary. The driller will install and develop groundwater monitoring wells using a hollow-stem auger (HSA) drill rig. If utilities are anticipated, the driller may hand auger the top 5 feet before drilling. The HSA auger will be outfitted with a cage to prevent workers from contacting rotating or spinning equipment.

Wells will be constructed of 4-inch-diameter, schedule 40 polyvinyl chloride (PVC). Well screens will be 5-feet long, 4-inch-diameter, schedule 40 PVC with 0.010-inch slot-size. Borings around the well screen will be filled with Number 2 sand from the bottom of the screened interval up to a minimum of 2 feet above the top of the screening interval. A 2-foot-thick seal of bentonite chips will be placed directly above the sand, and a Portland cement and bentonite grout seal will be placed from the top of bentonite chips to the ground surface. Each well will be completed with a flush-mounted cover secured in a concrete cap. Well covers will be closed with a lockable casing plug.

The drillers will develop the wells a minimum of 24 hours after the wells have been installed and completed. The subcontractor will develop each well by surging and pumping water from the well. A volume equal to three times the volume of well casing and filter pack, plus a volume equal to three volumes of all water added to the augers during well installation, will be pumped from the well.

After it has been developed, each newly installed monitoring well will be allowed to recover for a minimum of 48 hours before groundwater sampling begins. Samples will be collected using the low-flow micropurge method described in the SAP (Appendix A).

Concurrently with well development and groundwater sampling, a licensed land surveyor will survey the horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of the newly installed groundwater monitoring wells. Horizontal coordinates (easting and northing) of the surveyed locations will be supplied in U.S. survey feet in California State Plane Coordinates, Zone III, using the North American Datum of 1984. Vertical elevations shall be supplied in U.S. survey feet relative to mean sea level, based on the North American Vertical Datum of 1988. All elevations will be supplied to the nearest 0.01 foot.

3.3.5 Phase 5 – Demobilization and IDW Management

After all field work has been completed, all drill rigs and equipment will be demobilized from the site. The AIS/Tetra Tech Team will perform a thorough site inspection at the end of the project field work to ensure all trash and construction materials have been removed from the site.

Three types of IDW will be generated during the field work:

- Soil from borings
- Monitoring well purge water
- Well development groundwater
- Disposable sampling equipment and personal protective equipment (PPE).

As waste is generated, it will be classified, labeled, managed, and disposed of in accordance with EPA guidance and applicable state and federal regulations. The soil is anticipated to be shipped as Resource Conservation and Recovery Act (RCRA) hazardous waste or non-RCRA hazardous waste, or nonhazardous waste. Purge water and development groundwater is anticipated to be treated at the Navy West-Side Aquifers Treatment System, located at Former Naval Air Station Moffett Field, Moffett Field, California. The waste will be tracked using hazardous waste and nonhazardous waste manifests, as appropriate. This waste classification will be made after the soil has been characterized by the AIS/Tetra Tech Team and profiled by the disposal facility. The IDW will be transported by the AIS/Tetra Tech Team to the disposal facility within 90 days after the first IDW is produced.

4.0 REFERENCES

National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, U.S. Coast Guard, and U.S. Environmental Protection Agency (NIOSH/OSHA/USCG/EPA). 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." October. Available at National Institute of Occupational Safety and Health (NIOSH).

U.S. Environmental Protection Agency (EPA). 2001. "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5." Office of Environmental Information. Washington, DC. EPA/240/B-01/003. March. Available on-line at: <http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf>.

EPA. 2005. "Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs." Intergovernmental Data Quality Task Force. EPA-505-B-04-900A. Final Version 1. March. Available on-line at: <http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf>.

APPENDIX A
SAMPLING AND ANALYSIS PLAN

FINAL

SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN) SUPPLEMENTAL SITE INVESTIGATION FORMER ORION PARK HOUSING AREA

Former Naval Air Station Moffett Field
Moffett Field, California

November 5, 2010

Prepared for:
U.S. Army Corps of Engineers
Sacramento District, California

Prepared by:

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Telephone: (510) 302-6300

Prepared under:
U.S. Army Corps of Engineers, Sacramento District
Contract Number W91238-06-D-0018 DO 0004
Task Order Option 1

SAP WORKSHEET #1 — TITLE AND APPROVAL PAGE

Final

Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)
Supplemental Site Investigation
Former Orion Park Housing Area
Former Naval Air Station Moffett Field, Moffett Field, California

November 5, 2010

Prepared for:
U.S. Army Corps of Engineers
Sacramento District
Moffett Field, California

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Contract Number W91238-06-D-0018 DO 0004
Task Order Option 1

Kelly Stater
AIS Vice President

Signature

11/5/2010
Date

SAP WORKSHEETS

SAP WORKSHEET #1 — TITLE AND APPROVAL PAGE 1

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION 9

SAP WORKSHEET #3 — DISTRIBUTION LIST 11

SAP WORKSHEET #4 — PROJECT PERSONNEL SIGN-OFF SHEET 12

SAP WORKSHEET #5 — PROJECT ORGANIZATIONAL CHART 13

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS 14

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE 16

SAP WORKSHEET #8 — SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE 19

SAP WORKSHEET #9 — PROJECT SCOPING SESSION PARTICIPANTS SHEET 20

SAP WORKSHEET #10 — PROBLEM DEFINITION 24

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS 37

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA TABLE 43

SAP WORKSHEET #13 — SECONDARY DATA CRITERIA AND LIMITATIONS TABLE 46

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS 48

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE 55

SAP WORKSHEET #16 — PROJECT SCHEDULE / TIMELINE TABLE 61

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE 62

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE 69

SAP WORKSHEET #19 — ANALYTICAL SOP REQUIREMENTS TABLE 71

SAP WORKSHEET #20 — FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE 72

SAP WORKSHEET #21 — PROJECT SAMPLING SOP REFERENCES TABLE 73

SAP WORKSHEET #22 — FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE 74

SAP WORKSHEETS (Continued)

SAP WORKSHEET #23 — ANALYTICAL SOP REFERENCES TABLE 75

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE 76

SAP WORKSHEET #25 — ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE 78

SAP WORKSHEET #26 — SAMPLE HANDLING SYSTEM 79

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE 80

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE 85

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE 88

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE 89

SAP WORKSHEET #31 — PLANNED PROJECT ASSESSMENTS TABLE 93

SAP WORKSHEET #32 — ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES 94

SAP WORKSHEET #33 — QA MANAGEMENT REPORTS TABLE 95

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE 96

SAP WORKSHEET #35 — VALIDATION (STEPS IIA AND IIB) PROCESS TABLE 98

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE 100

SAP WORKSHEET #37 — USABILITY ASSESSMENT 103

REFERENCES 107

FIGURES

A-1 Former Orion Park Housing Area Developments

A-2 Previous Investigation Sample Locations

A-3 Potentiometric Surface Map, Upper A-Aquifer (A1 Zone), August 2005

A-4 Potentiometric Surface Map, Lower A-Aquifer (A2 Zone), August 2005

A-5 TCE Distribution, Upper A-Aquifer (A1 Zone)

A-6 TCE Distribution, Lower A-Aquifer (A2 Zone)

A-7 Conceptual Site Model for Potential On-Site Residential and Agricultural Sources

A-8 Conceptual Site Model for Potential On-Site Construction and Commercial/Agricultural Sources

A-9 Historical Sewer and Storm Drainages

A-10 Fate and Transport Model for Groundwater Contamination

A-11 Proposed MIP/CPT Locations, Upper A-Aquifer (A1 Zone)

A-12 Proposed MIP/CPT Locations, Lower A-Aquifer (A2 Zone)

A-13 Decision Logic for Indefinite Source Areas

A-14 Decision Logic for the Paint Locker (Suspected Source)

A-15 Decision Logic for DPT/Hydropunch Samples and Monitoring Well Installation

TABLE

A-1 Conceptual Site Model for On-Site Sources

ATTACHMENTS

A1 Decision Logic for MIP Test Locations at the Former OPHA

A2 Field Forms

A3 Standard Operating Procedures

ACRONYMS AND ABBREVIATIONS

µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
µV	Microvolt
%R	Percent recovery
AEC	Army Environmental Command
AEDB-R	Army Environmental Database Restoration
AIS	American Integrated Services, Inc.
APP	Accident prevention plan
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylene
CD	Compact disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHPPM	Center for Health Promotion and Preventative Medicine
CLP	Contract Laboratory Program
COC	Chain-of-custody
COR	Contract Officer's Representative
CPT	Cone penetrometer test
CSM	Conceptual site model
DCC	Daily continuing calibration
DCE	cis-1,2-Dichloroethene
DO	Dissolved oxygen
DQA	Data quality assessment
DQI	Data quality indicator
DPT	Direct push technology
ECD	Electron capture device
EDD	Electronic data deliverable
Eh	Oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
ER	Equipment rinsate
ERIS	Environmental Restoration Information System
ESA	Environmental site assessment
EVS	Environmental Visualization Software
FID	Flame ionization detector
FPM	Field Project Manager
GC/MS	Gas chromatograph/mass spectrometer
GPS	Global positioning system

ACRONYMS AND ABBREVIATIONS (Continued)

ICAL	Initial calibration
ICP	Inductively coupled plasma
ICV	Initial calibration verification
ID	Identification
IDL	Instrument detection limit
IDW	Investigation-derived waste
IR	Installation Restoration
LCS	Laboratory control sample
LOC	Location of concern
MB	Method blank
MDL	Method detection limit
MIP	Membrane interface probe
mg/kg	Milligrams per kilogram
mL	Milliliter
MOTCO	Military Ocean Terminal Concord
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level
NAPL	Non-aqueous phase liquid
NASA	National Aeronautics and Space Administration
Navy	Department of the Navy
OPHA	Orion Park Housing Area
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCE	Tetrachloroethene
PGM	Program manager
PID	Photoionization detector
PM	Project manager
ppm	Parts per million
PQL	Practical quantitation limit
PQO	Project quality objective
PRC	PRC Environmental Management, Inc.
PRRL	Project-required reporting limit
PT	Proficiency testing (previously, performance evaluation [PE] sample)
PVC	Polyvinyl chloride
QA	Quality assurance
QAC	Quality Assurance Coordinator
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer

ACRONYMS AND ABBREVIATIONS (Continued)

QAPP	Quality assurance project plan
QC	Quality control
QL	Quantitation limit
RL	Reporting limit
RPD	Relative percent difference
RPM	Remedial Project Manager
RSD	Relative standard deviation
SAP	Sampling and analysis plan
SC	Specific conductance
SCVWD	Santa Clara Valley Water District
SDG	Sample delivery group
SFS	Supplemental feasibility study
SOP	Standard operating procedure
SrSc	Senior Scientist
SOW	Statement of work
SSI	Supplemental site investigation
SWB	Source water blank
TBD	To be determined
TCE	Trichloroethene
Tetra Tech	Tetra Tech EM Inc.
TOM	Task Order Manager
TPH	Total petroleum hydrocarbon
TPH-p	Total petroleum hydrocarbon-purgeable
TPH-e	Total petroleum hydrocarbon-extractable
TSA	Technical Systems Audit
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
VOC	Volatile organic compound
Water Board	San Francisco Bay Regional Water Quality Control Board

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION

Site Name/Number:	**Former Naval Air Station Moffett Field**
Operable Unit:	**Former Orion Park Housing Area**
Contractor Name:	**American Integrated Services, Inc (AIS) / Tetra Tech EM Inc. (Tetra Tech)**
Contract Number:	**W91238-06-D-0018 DO 0004**
Delivery Order:	**0004**

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the "Uniform Federal Policy for Implementing Environmental Quality Systems. Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs" (UFP-QAPP) (U.S. Environmental Protection Agency [EPA] 2005b) and "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, QAMS" (EPA 2001).

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
AIS/Tetra Tech team draft decision logic package submittal to Army	8/13/2010
AIS/Tetra Tech team draft decision logic package submittal to regulatory agencies	8/16/2010
Decision logic discussion with the Army and regulatory agencies	8/16/2010
AIS/Tetra Tech team draft project quality objectives (PQO) submittal to Army	8/27/2010
Comments from Army on Draft PQOs	8/30/2010
Draft PQO submittal to regulatory agencies	8/31/2010
PQO discussion and approval with regulatory agencies and Army	9/2/2010

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM). 2009a. *Work Plan. Geophysical Survey, Membrane Interface Probe Investigation and Subsurface-Soil Sampling, Abandoned Septic Tank and Drain Field, Orion Park Housing Area, Moffett Field, Mountain Home, California.* May.

Tetra Tech FW, Inc. 2005. *Final Groundwater Monitoring Well Installation and Sampling Work Plan for Orion Park Housing Area.* July.

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION (CONTINUED)

Science Applications International Corporation (SAIC). 1999. *Soil and Groundwater Investigation Workplan, Area of Investigation 4, Orion Park*. NASA Ames Research Center, Moffett Field, California. February.

Erler & Kalinowski, Inc. (EKI). 1994. *Center-Wide Sampling and Analysis Program, Volume IV: Work Plan for Area of Investigation*. NASA Ames Research Center, Moffett Field, California.

Foster Wheeler Environmental Corporation (FWENC). 2002. *Final Site Characterization and Baseline Human Health Risk Assessment for Orion Park and Wescoat Housing Areas, Phase 2 Work Plan Addendum.* Moffett Community Housing, Moffett Field, California. August.

FWENC. 2003. *Final Site Characterization and Baseline Human Health Risk Assessment Work Plan for Orion Park and Westcoat Housing Areas*. Moffett Community Housing, Moffett Field, California. February 11.

6. List organizational partners (stakeholders) and connection with lead organization:

   The Former Orion Park Housing Area (OPHA) (Site) Installation Restoration (IR) Project Team includes representatives from the lead agencies, the U.S. Environmental Protection Agency, and the San Francisco Bay Regional Water Quality Control Board (Water Board)

7. Lead organization: U.S. Army Corps of Engineers (USACE)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below.

SAP WORKSHEET #3 — DISTRIBUTION LIST

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address
Cynthia Burris	Contract Officer's Representative (COR)	USACE	(916) 557-6745	Cynthia.S.Burris@usace.army.mil
Guy Romine	COR	Army Environmental Command (AEC)	(443) 567-1772	Guy.romine1@us.army.mil
Thomas Kellogg	Quality Assurance Officer (QAO)	USACE	(916) 557-6943	Thomas.f.kellogg@usace.army.mil
Gaelle Glickfield	Environmental Scientist	U.S. Army 63rd Reserve	(650) 965-4276	gaelle.j.glickfield@usar.army.mil
Alana Lee	Lead Agency Remedial Project Manager (RPM)	EPA	(415) 972-3141	lee.alana@epa.gov
Elizabeth Wells	RPM	Water Board	(510) 622-2440	ewells@waterboards.ca.gov
Sara Woolley	Program QA Manager and Coordinator (QAM)	Tetra Tech	(510) 302- 6311	sara.woolley@tetratech.com
Kelly Stater	Program Manager (PGM)	AIS	(805) 639-0884	kstater@americanintegrated.com
Kevin Bricknell	Task Order Manager (TOM)	Tetra Tech	(510) 302-6306	kevin.bricknell@tetratech.com
Dayna Yocum	TOM	Tetra Tech	(510) 302- 6242	dayna.yocum@tetratech.com
Cindi Rose	Quality Assurance (QA) / Quality Control (QC) Officer	Tetra Tech	(510) 302- 6286	cindi.rose@tetratech.com
O. Kelly Murphy	Field Project Manager	AIS	(805) 636-6005	omurphy@americanintegrated.com
Sara Woolley	Analytical Coordinator	Tetra Tech	(510) 302-6311	sara.woolley@tetratech.com
Ye Myint	Laboratory Project Manager	EMAX	(310) 618-8889	ymyint@emaxlabs.com
Stella Cuenco	Data Validation Project Manager	Laboratory Data Consultants	(760) 634-0437	scuenco@lab-data.com

SAP WORKSHEET #4 — PROJECT PERSONNEL SIGN-OFF SHEET

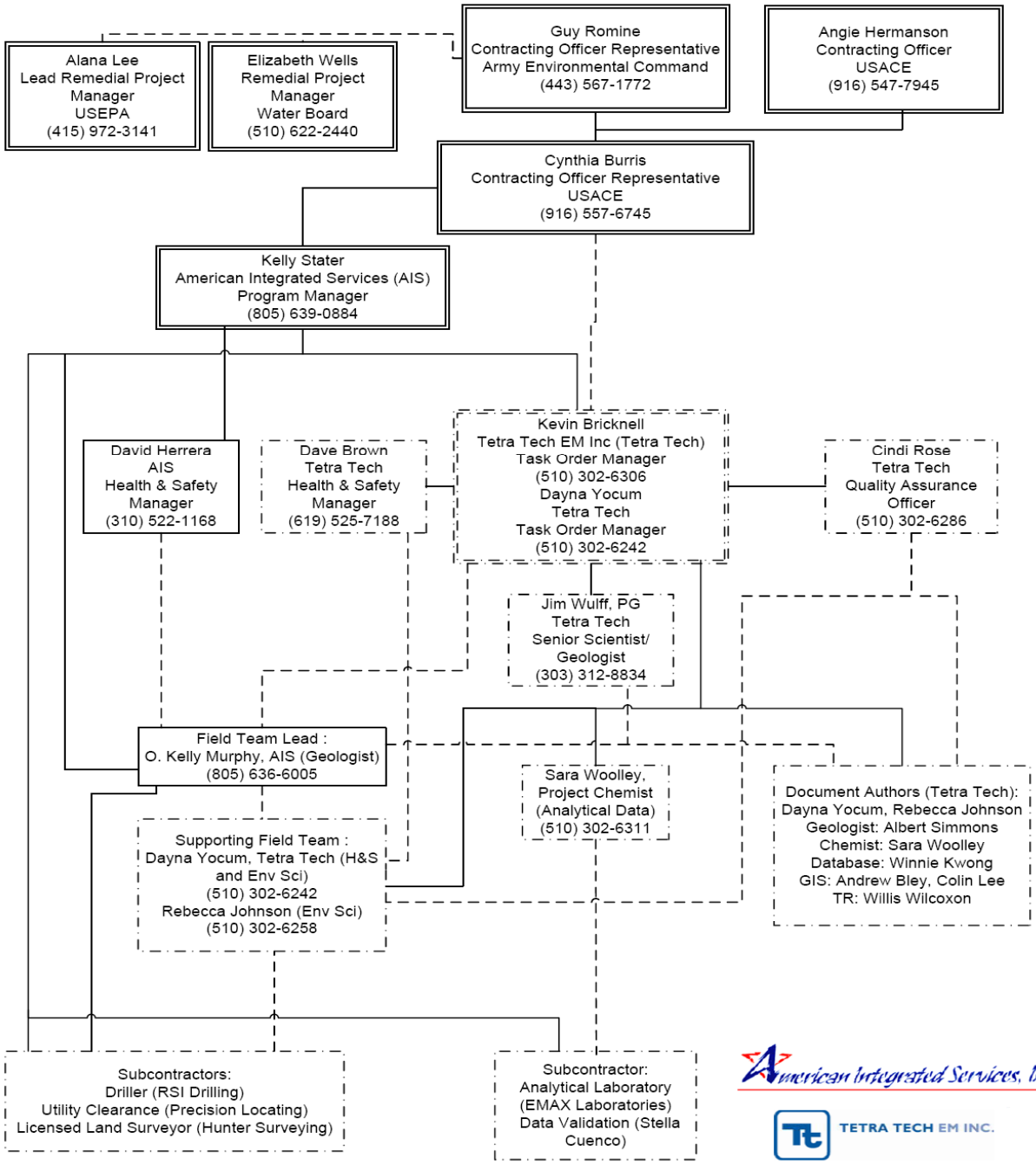
The Project Personnel Sign-Off Sheet documents that all key project personnel performing work have read this site-specific SAP and will carry out the tasks as described. The PM, site safety coordinator, and other oversight personnel are responsible for communicating the requirements of the applicable portions of the SAP to all field personnel. To ensure that on-site field personnel have read and understood the SAP, the supervisory personnel will meet with each and review the SAP before any work is conducted on site. The sign-off sheet, which will be included in the central project file, will be signed by all on-site personnel after they read the SAP. However, if only a portion of the SAP was reviewed, then personnel will note which sections were reviewed on the sign-off sheet.

Name	Organization/Title/Role	Telephone Number (optional)	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Kelly Stater	AIS/PGM	(805) 639-0884			
Kevin Bricknell	Tetra Tech/TOM	(510) 302-6306			
Dayna Yocum	Tetra Tech/TOM	(510) 302- 6242			
O. Kelly Murphy	AIS/Field Project Manager	(805) 636-6005			
Sara Woolley	Tetra Tech/Analytical Coordinator	(510) 302-6311			
Ye Myint[1]	EMAX Laboratory/ PM	(310) 618-8889			
Stella Cuenco[1]	Laboratory Data Consultants/ PM	(760) 634-0437			

Note: Before the SAP is finalized and crews mobilize to the field, all missing information in Worksheet #4 will be updated.

1 Personnel will only be responsible for reviewing and signing off on select sections of the SAP.

SAP WORKSHEET #5 — PROJECT ORGANIZATIONAL CHART



key

Subcontractors to AIS are shown in dashed boxes.
Lines of authority are shown as solid lines, and lines of communication are dashed.

Former Orion Park Housing Area
Former Naval Air Station Moffett Field, Moffett Field, CA

SAP WORKSHEET #5

PROJECT ORGANIZATIONAL CHART

Sampling and Analysis Plan for the Supplemental Site Investigation

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS

Communication Drivers	Responsible Affiliation	Name	Phone Number or E-Mail	Procedure
Point of contact for Army quality issues	USACE QAO	Tom Kellogg	(916) 557-6943	QAO will review and approve this SAP and all amendments to this SAP. Communicates with Tetra Tech Program QAM (Sara Woolley).
Manage all project phases	USACE and AEC CORs	Cynthia Burris and Guy Romine	(916) 557-6745 and (443) 567-1772	Will communicate the results of the investigation to interested parties.
Program management	AIS PGM	Kelly Stater	(805) 639-0884	PGM will manage contractual issues and ensures implementation of the quality assurance (QA)/quality control (QC) processes.
Task order management	Tetra Tech TOMs	Kevin Bricknell and Dayna Yocum	(510) 302-6306 and (510) 302-6242	TOMs will manage field and project personnel, and serve as liaison to the Army and team members.
Quality control (QC) management	Tetra Tech QAM	Sara Woolley	(510) 302-6311	QAM will ensure implementation of the SAP by performing on-site field QC audits, as appropriate. QAM will be the point of contact with the Army QAO for quality-related matters.
Coordination and communication of field work activities related to sampling	AIS Field Project Manager (FPM)	O. Kelly Murphy	(805) 636-6005	FPM will communicate relevant field information to the TOM and analytical coordinator. FPM will also report all drilling or sampling equipment problems to the TOM immediately via phone or e-mail. The FPM will serve as liaison to subcontractors.
Daily QC reports	AIS FPM	O. Kelly Murphy	(805) 636-6005	FPM will e-mail QC reports daily to the Army CORs and Tetra Tech TOMs.
Coordination of laboratory supplies for field activities	Tetra Tech Analytical Coordinator	Sara Woolley	(510) 302-6311	The analytical coordinator will contact the laboratory to provide all necessary sample containers and appropriate shipping materials (such as coolers and bubble wrap) to be delivered on site before field sampling begins and throughout the project.

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number or E-Mail	Procedure
Submittal of samples to the laboratory	AIS FPM	O. Kelly Murphy	(805) 636-6005	Sampling personnel will package and ship samples in accordance with this SAP.
Daily chain-of-custody (COC) records and shipping documentation	AIS FPM	O. Kelly Murphy	(805) 636-6005	COC records and shipping documentation will be submitted via fax or e-mail to the analytical coordinator at the end of each day that samples are collected.
Sample shipping/receipt issues	EMAX Laboratory PM	Ye Myint	(310) 618-8889	The laboratory PM will report all sample shipping and receipt issues associated with the investigation at Sites 32 and 33 to Tetra Tech's analytical coordinator within 2 business days.
Reporting laboratory data quality issues	EMAX Laboratory PM	Ye Myint	(310) 618-8889	All QA and QC issues will be reported by the laboratory PM to the analytical coordinator in writing within 2 business days.
Field and analytical corrective actions	Tetra Tech Analytical Coordinator	Sara Woolley	(510) 302-6311	The analytical coordinator will immediately notify the quality assurance coordinator (QAC) in writing of any field or analytical procedures that were not performed in accordance with this SAP. The analytical coordinator, in coordination with the QAC, will complete documentation of the non-conformance and corrective actions to be taken. The analytical coordinator will verify that the corrective actions have been implemented.
Minor deviations from SAP procedures identified during field activities	AIS FPM	O. Kelly Murphy	(805) 636-6005	The FPM will prepare a field change request for any minor changes in sampling procedures that occur as a result of conditions in the field. This request will be submitted to the QAC for approval before the change is initiated.
SAP amendments	Tetra Tech QAM	Sara Woolley	(510) 302-6311	Substantive changes to the SAP will require the QAM to prepare an addendum that will be approved by the Army QAO before any field activities begin.

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

Name / Phone Number	Title/Role	Organizational Affiliation	Responsibilities
Guy Romine (443) 567-1772	Army Remedial Project Manager	AEC	Responsible for all technical decisions relating to the project and for overseeing Cynthia Burris, COR.
Angie Hermanson (916) 557-7945	Contracting Officer (KO)	USACE	Overall responsibility for overseeing the AIS/Tetra Tech team's performance for contract compliance and administration; reviews COR's assessment of AIS/Tetra Tech team's performance.
Cynthia Burris (916) 557-6745	Contracting Officer's Representative (COR)	USACE	Responsible for providing management and technical oversight of the project. Responsible for all quality assurance (QA) issues for all Site work. Has authority to suspend affected project or site activities if approved technical or quality requirements are not adequately met. Reviews and approve technical deliverables. Approves payment milestone schedule. Reviews status reports.
Kelly Stater (805) 639-0884	PGM	AIS	Has ultimate authority and responsibility for all technical, contractual, safety, and administrative matters for the project. Monitors contract and task funds and schedules and ensures implementation of the QA/QC processes.
Kevin Bricknell, PE, QEP (510) 302-6306 and Dayna Yocum, MESM (510) 302-6242	Task Order Manager (TOM)	Tetra Tech	Provide management oversight and assistance in completing the technical work; act as liaison with AEC COR and USACE COR; oversee administrative and technical performance, and maintain compliance with schedules and budgets.
Cindi Rose (510) 302-6286	QC/QA Officer	Tetra Tech	Provides QA/QC of technical work at the site; works closely with and reviews work by the project AIS/Tetra Tech team; and reviews deliverables to verify conformance with QA/QC procedures.
Jim Wulff, PG (303) 312-8834	Senior Scientist/ Professional Geologist (SrSc)	Tetra Tech	Develops technical approach and conceptual site model. Participates in development of SAP and SSI report. Attends meetings with USACE, AEC, and the regulatory agencies. Reviews all boring logs and technical deliverables related to geochemistry and hydrogeology interpretation and oversees relevant field activities.

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name / Phone Number	Title/Role	Organizational Affiliation	Responsibilities
David Herrera (310) 522-1168	Health and Safety Manager (HASM)	AIS	Responsible for administration of AIS's APP, and acts as an advisor to Tetra Tech's TOM and AIS' Field Project Manager to implement the APP.
Dave Brown (619) 525-7188	HASM	Tetra Tech	Responsible for administration of Tetra Tech's APP and acts as an advisor to Tetra Tech's TOM and AIS' Field Project Manager to implement the APP.
O. Kelly Murphy (805) 636-6005	Field Project Manager (FPM) and Site Safety Coordinator (SSC)	AIS	As FPM, directs the day-to-day field activities and oversees all subcontractors; verifies field measurement and sampling procedures are conducted in accordance with the SSI work plan and SAP; and reports directly to the TOM on planning, cost and schedule control, and data management information needs. As SSC, responsible for implementing AIS APP in the field, and has authority to correct and change site control measures; the required level of health and safety protection; enforce the AIS APP policies and provisions; and stop work for any unsafe condition.
Dayna Yocum (510) 302-6242 and Rebecca Johnson (510) 302-6258	Supporting Field Team Members	Tetra Tech	Support in field activities when needed. Collects groundwater samples and supports FPM with field tasks.
Dayna Yocum, Rebecca Johnson, Albert Simmons, Sara Woolley, Winnie Kwong, Willis Wilcoxon, Jim Wulff	Document Authors	Tetra Tech	Develop draft and final SSI work plan, SAP, quality assurance project plan (QAPP), and SSI report, including evaluating membrane interface probe (MIP) and groundwater monitoring results.
Sara Woolley (510) 302-6311	Project Chemist	Tetra Tech	Coordinates analytical tests required in the SAP; verifies the laboratory implements the requirements of the SAP; and reviews laboratory data before they are released.
Julie Bates (925) 516-2860	Utility Locator	Precision Locating, LLC	Screens the ground surface around each of 20 proposed subsurface borings for the presence of subsurface utilities using geophysical techniques.

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name / Phone Number	Title/Role	Organizational Affiliation	Responsibilities
To Be Determined	Driller	To Be Determined	Conducts cone penetrometer testing, including MIP sampling, Hydropunch sampling, and direct-push borings. Installs and develops monitoring wells.
James White (916) 988-5600	Land Surveyor	Hunter Surveying	Surveys horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of 10 groundwater monitoring wells.
Kelly Stater (805) 639-0884	Investigative-Derived Waste (IDW) Characterization and Transport	AIS	Characterizes and transports IDW from the Site to waste facility.
To Be Determined	Nonhazardous or Hazardous Waste Disposal Facility	To Be Determined	Receives and disposes of waste from the Site.
Ye Myint (310) 618-8889 x 121	Analytical Laboratory	EMAX Laboratories	Conducts off-site chemical analysis of all samples.

Note: Before the SAP is finalized and crews mobilize to the field, all missing information in Worksheet #7 will be updated.

SAP WORKSHEET #8 — SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

This section outlines the training and certification required to complete the activities described in this SAP.

Additional specialized training will not be required for this investigation for most personnel involved in this investigation, other than the health and safety training requirements.

AIS or Tetra Tech personnel experienced in logging soils will log soils from all borings in accordance with the techniques described in this SAP. Likewise, AIS or Tetra Tech personnel experienced in collecting groundwater samples will collect all samples in accordance with the techniques described in this SAP. In addition to the requirements in the following sections, personnel involved in field tasks are required to read the accident prevention plan (APP) / Site Safety and Health Plan (Appendix B of the Work Plan) and the SAP and sign their name and requested information on the "Compliance Agreement Form" and "Daily Site Log" as provided in Appendix B of the Work Plan. All employees will attend a safety briefing and complete the "Tailgate Meeting Sign-Off Sheet" before they conduct on-site work. The following sections describe the requirements for the AIS/Tetra Tech team and subcontractor personnel working on site.

All samples will be collected by personnel experienced with all sampling procedures. All personnel who work at hazardous waste project sites are required to meet the Occupational Safety and Health Administration training requirements defined in Title 29 Code of Federal Regulations Part 1910.120(e). These requirements include (1) 40 hours of formal off-site instruction; (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor; and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training. Site safety coordinators receive 30 hours of construction training. At least two members of the on-site AIS/Tetra Tech and subcontractor field team will maintain current certification in the American Red Cross "Multimedia First Aid" and "Cardiopulmonary Resuscitation Modular," or equivalent. All sampling will be performed by personnel experienced with sampling procedures.

SAP WORKSHEET #9a — PROJECT SCOPING SESSION PARTICIPANTS SHEET

Project Name: Supplemental Site Investigation **Projected Date(s) of Sampling:** December 2010 – February 2011 **Project Manager:** Kelly Stater (PRG); Kevin Bricknell, and Dayna Yocum (TOMs)	**Site Name:** Former Orion Park Housing Area **Site Location:** Former Naval Air Station, Moffett Field, California

Date of Sessions: August 10, 2010; **Scoping Session Purpose:** Scoping Meeting

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Cynthia Burris	COR	USACE	(916) 557-6745	cynthia.s.burris@usace.army.mil	RPM
Guy Romine	COR	AEC	(443) 567-1772	guy.romine1@us.army.mil	RPM
Alana Lee	Lead RPM	EPA	(415) 972-3141	lee.alana@epa.gov	Lead RPM
Elizabeth Wells	RPM	Water Board	(510) 622-2440	ewells@waterboards.ca.gov	RPM
Kelly Stater	PGM	AIS	(805) 639-0884	kstater@americanintegrated.com	PGM
Kevin Bricknell	TOM	Tetra Tech	(510) 302-6306	kevin.bricknell@tetratech.com	TOM
Dayna Yocum	TOM	Tetra Tech	(510) 302- 6242	dayna.yocum@tetratech.com	TOM
Cindi Rose	QA/QC Officer	Tetra Tech	(510) 302- 6286	cindi.rose@tetratech.com	QA/QC Officer
Rebecca Johnson	Environmental Scientist	Tetra Tech	(510) 302- 6258	rebecca.johnson@tetratech.com	Field personnel, document author
Albert Simmons	SrSc	Tetra Tech	(510) 302- 6265	albert.simmons@tetratech.com	SrSc, document author, geologist
Willis Wilcoxon	Hydrogeologist	Tetra Tech	(303) 312-8822	willis.wilcoxon@tetratech.com	Hydrogeologist
Jim Wulff	Hydrogeologist	Tetra Tech	(303) 312-8834	jim.wulff@tetratech.com	Hydrogeologist

Comments/Decisions: The Conceptual Site Model (CSM) for on-site sources and off-site sources of contamination at the Site was presented to the regulatory agencies in the form of a PowerPoint presentation. Additionally, the proposed technical approach was presented and discussed. Regulatory agency representatives requested that the Army provide for review the investigation decision logic. The meeting participants discussed areas of concern at the site the Army intended to investigate during the supplemental site investigation (SSI).

Action Items (Completed): The AIS/Tetra Tech team provided the regulatory agencies with the draft decision logic before a meeting on August 16, 2010. Additionally, the AIS/Tetra Tech team created figures that show additional sampling locations.

SAP WORKSHEET #9b — PROJECT SCOPING SESSION PARTICIPANTS SHEET

Project Name: Supplemental Site Investigation **Projected Date(s) of Sampling:** December 2010 – February 2011 **Project Manager:** Kelly Stater (PRG); Kevin Bricknell, and Dayna Yocum (TOMs)	**Site Name:** Former Orion Park Housing Area **Site Location:** Former Naval Air Station Moffett Field, Moffett Field, California

Date of Sessions: August 16, 2010; **Scoping Session Purpose:** Discuss Decision Logic

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Cynthia Burris	COR	USACE	(916) 557-6745	cynthia.s.burris@usace.army.mil	RPM
Guy Romine	COR	AEC	(443) 567-1772	guy.romine1@us.army.mil	RPM
Tom Kellogg	Technical Reviewer	USACE	(916) 557-6943	Thomas.f.kellogg@usace.army.mil	Technical Reviewer
James Lukasko	Technical Reviewer	USACE	NA	james.j.lukasko@usace.army.mil	Technical Reviewer
Gaelle Glickfield	Technical Reviewer	U.S. Army 63rd Reserve	(650) 965-4276	gaelle.j.glickfield@usar.army.mil	Technical Reviewer
Alana Lee	Lead RPM	EPA	(415) 972-3141	lee.alana@epa.gov	Lead RPM
Elizabeth Wells	RPM	Water Board	(510) 622-2440	ewells@waterboards.ca.gov	RPM
Kelly Stater	PGM	AIS	(805) 639-0884	kstater@americanintegrated.com	PGM
Kevin Bricknell	TOM	Tetra Tech	(510) 302-6306	kevin.bricknell@tetratech.com	TOM
Dayna Yocum	TOM	Tetra Tech	(510) 302- 6242	dayna.yocum@tetratech.com	TOM
Willis Wilcoxon	Hydrogeologist	Tetra Tech	(303) 312-8822	willis.wilcoxon@tetratech.com	Hydrogeologist
Jim Wulff	Hydrogeologist	Tetra Tech	(303) 312-8834	jim.wulff@tetratech.com	Hydrogeologist

Comments/Decisions: A decision logic describing the Army's approach for selecting sample locations as well as proposed sample locations for the SSI were presented to the regulatory agency representatives on August 15, 2010. A scoping meeting followed on August 16, 2010. Meeting participants reviewed the decision logic and proposed sampling locations. Regulatory agency representatives requested that metrics be added to the decision logic to guide the field team on the location of the subsequent sampling locations. Regulatory agency representatives also requested to review the PQOs, and suggested that the Army add additional sampling locations.

Action Items (Completed): The AIS/Tetra Tech team provided the regulatory agencies with the draft PQOs to agencies before a meeting on September 2, 2010. Additionally, the AIS/Tetra Tech team revised the figures to show additional sampling locations.

SAP WORKSHEET #9c — PROJECT SCOPING SESSION PARTICIPANTS SHEET

Project Name: Supplemental Site Investigation **Projected Date(s) of Sampling:** December 2010 – February 2011 **Project Manager:** Kelly Stater (PRG); Kevin Bricknell, and Dayna Yocum (TOMs)	**Site Name:** Former Orion Park Housing Area **Site Location:** Former Naval Air Station Moffett Field, Moffett Field, California

Date of Sessions: September 2, 2010; **Scoping Session Purpose:** Discuss PQOs

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Cynthia Burris	COR	USACE	(916) 557-6745	cynthia.s.burris@usace.army.mil	RPM
Guy Romine	COR	AEC	(443) 567-1772	guy.romine1@us.army.mil	RPM
James Lukasko	Technical Reviewer	USACE	NA	james.j.lukasko@usace.army.mil	Technical Reviewer
Gaelle Glickfield	Technical Reviewer	U.S. Army 63rd Reserve	(650) 965-4276	gaelle.j.glickfield@usar.army.mil	Technical Reviewer
Alana Lee	Lead RPM	EPA	(415) 972-3141	lee.alana@ epa.gov	Lead RPM
Elizabeth Wells	RPM	Water Board	(510) 622-2440	ewells@waterboards.ca.gov	RPM
Kelly Stater	PGM	AIS	(805) 639-0884	kstater@americanintegrated.com	PGM
Kevin Bricknell	TOM	Tetra Tech	(510) 302-6306	kevin.bricknell@tetratech.com	TOM
Dayna Yocum	TOM	Tetra Tech	(510) 302- 6242	dayna.yocum@tetratech.com	TOM
Jim Wulff	Hydrogeologist	Tetra Tech	(303) 312-8834	jim.wulff@tetratech.com	Hydrogeologist

Comments/Decisions: The draft PQOs for the SSI were presented to the regulatory agency representatives on August 31, 2010. A meeting followed on September 2, 2010. Meeting participants reviewed the PQOs and the regulatory agencies concurred with the proposed approach and made the following requests:

(1) The Army collects one round of groundwater samples for analysis of volatile organic compounds (VOCs) at the 11 existing on-site wells before the cone penetrometer test and membrane interface probe (CPT/MIP) investigation begins to obtain data on current conditions at the Site;

(2) The Army collects groundwater elevation measurements to verify or modify the groundwater contours at the Site at the off-site wells north of the Site owned and operated by the National Aeronautics and Space Administration (NASA), the off-site wells east of the Site owned and operated by the Navy, and the off-site wells south of the Site owned by the City of Mountain View and previously operated by Santa Clara County. The proposed CPT/MIP boring locations will be adjusted based on the resulting groundwater contours. The agencies agreed to obtain permission and logistical information regarding access at the off-site wells.

SAP WORKSHEET #9c — PROJECT SCOPING SESSION PARTICIPANTS SHEET (CONTINUED)

(3) The Army bases the depth of the CPT/MIP borings on the lithology of the A1 and A2 aquifers, rather than on previous investigation depths.

(4) The Army collects a CPT/MIP boring at location FW41A at location of concern (LOC) #4 to support the depth where the soil sample should be collected. These new data from the CPT/MIP response will be used in conjunction with the data from the 2002 boring to evaluate location FW41A.

Action Items (Completed): The Army continued with preparation of the work plan and SAP and would incorporate the agency recommendations listed above. The EPA and Water Board representatives agreed to contact the owners of the off-site wells and gain permission and secure access to the wells.

SAP WORKSHEET #10 — PROBLEM DEFINITION

10.1 DEFINE THE PROBLEM

During prior investigations, chlorinated solvents, primarily trichloroethene (TCE) at concentrations up to 1,200 micrograms per liter [µg/L], have been detected in groundwater samples from the Site. TCE has been detected in upgradient groundwater samples, but at lower concentrations than at some locations on the Site. There are no historical records of TCE use at the Site; however, undocumented releases could have occurred. One location of undocumented use of chlorinated solvents at the Site is the Paint Locker, the location of which is identified in a 1956 Yards and Docks collection drawing (Navy 1956) (see Figure A-2). Previous investigations have not provided sufficient data to conclude that historical releases of TCE did not occur at the site. Additional characterization is needed at the Site to assess whether there were on-site sources that released TCE to groundwater.

Field screening of cores recovered from boring FW41A showed photoionization detector (PID) readings of 9.2 and 3,500 parts per million (ppm) of VOCs in the core at the capillary fringe. Samples were not collected from the soil core to evaluate the compounds that caused the elevated readings, however. A soil sample should be collected at this location to assess the compounds that cause these elevated VOC concentrations.

10.2 FACILITY AND SITE BACKGROUND

The Site is part of the U.S. Army Corps of Engineers (USACE) recently demolished Moffett Community Housing and is part of the former Naval Air Station Moffett Field (Moffett), Moffett Field, California (Figure A-1). The Department of the Navy transferred the Community Housing to the Air Force in 1994. The Community Housing was subsequently transferred to USACE in July 2000. The Site covers approximately 77 acres. Pursuant to the Base Realignment and Closure 2005 recommendations, the USACE Reserves has demolished the existing housing units and associated structures over a 30-acre area in the northern part of the Site so that a new Armed Forces Reserve Center and associated support facilities could be constructed.

Before it was demolished, the Site consisted of housing units and support facilities along with associated streets, parking areas, and green space. Multi-family residences occupied most of the Site. The area is relatively flat, ranging from 15 feet to 36 feet above mean sea level (msl). No wetlands or surface water are located in the Site. Stevens Creek is located due west of the Site. The Site was vacant or used for agriculture before construction of military housing. Housing was constructed between 1941 and 1982. The housing units included Moffett Homes built in 1941, Orion Park built in 1968, and Macon Terrace II and Macon Terrace III built in 1982 (Foster Wheeler Environmental Corporation [FWENC] 2002). The northern and southern rows of Moffett Homes were demolished in 1981 or 1982 to make room for Macon Terrace II and III. The remaining Moffett Homes units were demolished in 2001. The area that had been Moffett Homes is now open green space.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

A portion of the Site was used for agriculture until sometime after 1965 (FWENC 2002a). The approximate location of former farm buildings is shown on Figure A-1. The former farm apparently had at least one potable supply well. Santa Clara Valley Water District (SCVWD) well records indicate that well 06S02W15G01, approximately 160 feet deep, was decommissioned on March 24, 1993. The well was located immediately north of Housing Unit 842. The farmhouse likely had a septic tank and drain lines. Usage by normal household activities would not suggest VOC contamination (Air Force Base Conversion Agency 2000); however, EPA information indicates solvents such as TCE may have been discharged to septic systems as a degreaser. The area around the septic tank was investigated in 2009 by the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM) (USACHPPM 2009b). No VOC contamination in soil samples was detected in the area around the abandoned septic tank, and the report concluded that the septic tank system was not a source of TCE contamination in the aquifer.

10.3 PREVIOUS INVESTIGATIONS

Investigations of the Site and surrounding area were previously conducted to characterize the nature and extent of contaminated groundwater. The following information was reviewed before this SAP for the SSI was prepared:

- NASA – Report of TCE in groundwater at the downgradient boundary of the Site (Science Applications International Corporation [SAIC] 1999)
- Navy – Groundwater samples collected based on the information provided by NASA in 1999 (International Technology Corporation [IT] 2000)
- Navy – Phase 1 and 2 investigations to characterize the site and to conduct a baseline risk assessment (FWENC 2003)
- Army – Investigation of groundwater south (upgradient) and west of the Site (The SI Group [SIG] 2003)
- EPA – Investigation of groundwater south (upgradient) of the Site (EPA 2005a)
- Navy – Groundwater monitoring well installation and sampling (Tetra Tech EC 2007)
- USACHPPM – geophysical survey membrane interface probe investigation and subsurface soil sampling of the former septic tank and drain field (USACHPPM 2009b)

10.3.1 NASA Report, 1999, and Navy Groundwater Investigation, 2000

In 1999, NASA reported detections of TCE in groundwater samples near the northern (downgradient) boundary of the Site (SAIC 1999). The Navy collected groundwater samples along the south and west boundary of the Site in 2000 (IT 2000). TCE was detected in groundwater along the upgradient boundary and downgradient boundary of the Site at similar concentrations (FWENC 2002). Previous investigation sampling locations are shown on Figure A-2.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

10.3.2 Navy Site Characterization, 2002

The Navy completed a two-phased site characterization program in 2002 to evaluate the nature and extent of VOC contamination in groundwater and to collect data needed to conduct a baseline human health risk assessment (FWENC 2003). Phase 1 and Phase 2 field activities were conducted at the Site and the neighboring Wescoat Housing Area (located immediately southeast of the Site). Phase 1 and Phase 2 site characterization-related field activities are described in the following sections.

10.3.2.1 Phase 1 Activities, 2002

Phase 1 was implemented from February 27 through March 12, 2002. The purpose of Phase 1 groundwater sampling was to identify the extent of VOC contamination in the shallow groundwater at the Site. The Phase 1 groundwater samples were collected from wells temporarily installed in the boreholes made by direct push technology (DPT) equipment and from DPT and Hydropunch samples. DPT and temporary well groundwater samples were collected on a sample grid with nodes spaced on 300-foot centers in an attempt to locate potential VOC source areas. The purpose of the Phase 1 temporary well groundwater samples was to characterize the quality of the first-observed groundwater in the upper portion of the A aquifer (A1 zone). The purpose of Phase 1 CPT and DPT and Hydropunch samples was to characterize the geology and quality of groundwater in the lower portion of the A aquifer (A2 zone). Phase 1 sample locations are shown on Figure A-2.

First-observed Groundwater Sampling

Continuous soil cores, from 5 feet below ground surface (bgs) to first-observed groundwater, were collected at 41 locations (FW01A through FW41A) (see Figure A-2). Cores were collected using a limited-access DPT rig to push a nominal 2-inch-diameter, 4-foot-long core barrel to the depth of first-observed groundwater. Cores were collected until saturated soil was observed. Soil core samples were field-screened for organic vapor at 1-foot intervals. Field screening results were recorded on the geologic logs. PID field screening organic vapor results for samples at 40 of 41 Site locations were between 0.0 and 3.0 ppm. PID results between 9.2 and 3,500 ppm were detected from 5 to 13 feet bgs at FW41A located in the southwestern corner of the Site.

Samples of first-observed groundwater were collected from wells temporarily installed in the holes made by the DPT soil core barrel. The DPT and temporary wells consisted of a 5-foot length of 3/4-inch-diameter, polyvinyl chloride (PVC), 0.010-inch slotted screen and casing. DPT and temporary wells were sampled using a nominal 1/2-inch-diameter disposable Teflon bailer. Samples were collected within 30 minutes after wells were installed. Groundwater samples were analyzed for VOCs using EPA Method 8260B. The temporary wells were removed after sample collection and backfilled with a bentonite-cement grout.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

Lower A-Aquifer Groundwater CPT and DPT/Hydropunch Sampling

Groundwater samples were collected from the lower A aquifer at seven Site DPT and temporary well sample locations (FW06A, FW07A, FW15A, FW24A, FW33A, FW34A, and FW41A). The samples were collected using a CPT rig and DPT and HydroPunch sampling equipment as follows:

- An initial boring was advanced to 55 feet bgs using CPT equipment, producing a geologic log.
- The geologic information was used to select a depth-specific groundwater sampling interval.
- A second boring, located about 4 feet away from the initial CPT boring, was advanced using DPT equipment, and a Hydropunch was used to collect the depth-specific groundwater sample.
- The Hydropunch screen, 1 to 2 feet long, was left open to the formation for a minimum of 15 minutes to allow groundwater to enter the screen. Groundwater samples were collected from the Hydropunch using a disposable Teflon bailer.

Samples collected using the above procedures are referred to as DPT/Hydropunch samples. The sample locations are referred to as CPT and DPT/Hydropunch sample locations.

Samples were collected at locations along the southern (upgradient) Site boundary (see Figure A-2). Samples were analyzed for VOCs using EPA Method 8260B.

10.3.2.2 Phase 2 Activities, 2002

Phase 2 sampling was conducted between August 28 and September 26, 2002. The purpose of Phase 2 soil core field screening, soil sampling, and first-observed groundwater DPT and temporary well sampling was primarily to obtain data for use in the baseline human health risk assessment. Results of the baseline human health risk assessment are presented in the Final Site Characterization and Baseline Human Health Risk Assessment Report (FWENC 2003). The purpose of Phase 2 CPT and DPT and Hydropunch sampling was to evaluate the distribution of VOCs in permeable layers throughout the A1 and A2 zones of the A aquifer. Phase 2 DPT/temporary well, CPT, and DPT/Hydropunch sample locations are shown on Figure A-2.

Soil and First-observed Groundwater Sampling

Continuous soil cores from 5 feet bgs to first-observed groundwater were collected at five Site locations (FW03B through FW07B). Field screening results for organic vapors were between zero and 2.9 ppm as measured with a MiniRAE PID. Results were recorded on the geologic logs. Soil samples were analyzed for percent organic carbon by the Walkley-Black method and for bulk density, specific gravity, and percent moisture using American Society for Testing and Materials (ASTM) Methods D2937, D854, and D2216.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

Groundwater samples were collected from each DPT/temporary well location (FW01B through FW07B) as described in Section 10.3.2.1. Groundwater samples were analyzed for VOCs using EPA Method 8260B.

A-Aquifer Groundwater CPT and DPT/Hydropunch Sampling

Phase 2 activities included sampling 20 additional locations (FW8B through FW27B) using a CPT rig and DPT and Hydropunch equipment, as described in Section 10.3.2.1. The CPT geologic logs were used to identify up to five potential water-bearing zones at each location. Samples were analyzed for VOCs using EPA Method 8260B. Phase 2 CPT and DPT and Hydropunch sample locations are shown on Figure A-2.

10.3.3 USACE Off-Site Investigation, 2003

USACE completed an off-site investigation south and west of the Site in September 2003 (SIG 2003). The investigation included collecting groundwater samples at 19 locations (SIG1 through SIG19) using a CPT rig and DPT and Hydropunch equipment. USACE sample locations are shown on Figure A-2. Groundwater samples were collected similarly to the method previously described in Section 10.3.2.1, except the Army used a 5-foot screened interval.

10.3.4 EPA Off-Site Investigation, 2005

EPA completed an off-site investigation in September 2005 (EPA 2005a). The investigation included collecting groundwater samples at 20 locations (HP 01 through HP 20) using a CPT rig and DPT and Hydropunch equipment. Samples were collected primarily south (upgradient) of the Army's area of investigation, south of the Highway 101 and Moffett Boulevard interchange. EPA groundwater samples were analyzed for VOCs using EPA Method 524.2. EPA sample locations are shown on Figure A-2.

10.3.5 Navy Groundwater Investigation and Monitoring Well Installation and Sampling, 2005

The Navy completed additional investigation of the upper and lower A-aquifers from August 2005 to June 2006. Eleven groundwater monitoring wells were installed in August 2005 – six in the upper A-aquifer and five in the lower A-aquifer. The Navy sampled these 11 monitoring wells and three existing wells located east of the Site for analysis of VOCs, anions, cations, and stable isotope ratio in August and December 2005. The same wells were sampled in March and June 2006 for analysis of VOCs; depths to groundwater were also measured. The Navy developed a CSM for TCE and cis-1,2-dichloroethene (DCE) distribution at the Site based on multiple lines of evidence. The Navy concluded that the majority of TCE contamination at the Site originated off site. The Navy further maintained that the TCE migrated downgradient within the upper and lower zones of the A aquifer, with residual contamination from the source extending back to the source area. EPA comments on the draft report indicated that EPA disagreed with the CSM developed by the Navy and commented

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

there was not sufficient information to conclude that contamination originated from off-site sources and that anomalously high concentrations of TCE detected on site indicated potential on-site source areas. EPA requested the Navy conduct additional investigation at the Site in areas where anomalously high concentrations of TCE were detected downgradient of lower concentrations to identify on-site sources of contamination.

10.3.6 Army Investigation of Former Septic Tank and Drain Field, 2009

USACHPPM supervised a MIP investigation, oversaw a geophysical investigation, and conducted subsurface soil sampling to evaluate whether a former septic tank and drain field are a source of VOCs in groundwater beneath the Site. Geophysical data, visual evidence, and engineering drawings indicated the septic tank was formerly located in the central part of the Site but had been removed, most likely contemporaneous with construction of the Orion Park section of the Site in 1968. Significant quantities of demolition debris were scattered around the location of the septic tank, so it was not possible to use geophysical techniques or trenching to confirm the location of the drain field associated with the septic tank. Data from the MIP study and analytical samples indicated VOCs are not present in subsurface soil near the location of the former septic tank; it was concluded that the former septic tank was not a source of VOCs in groundwater.

10.4 GEOLOGY AND HYDROGEOLOGY

This section provides an interpretation of the geologic and hydrogeologic conditions at the Site using the geologic and geochemical data gathered during previous investigations, as described above in Section 10.3. Information on the geology and hydrogeology at Moffett was obtained from the geology and hydrogeology technical memorandum (PRC Environmental Management, Inc. [PRC] and James M. Montgomery Consulting Engineers, Inc. [JMM] 1992), unless otherwise cited.

10.4.1 Regional Geologic Setting

The northwesterly trending Santa Clara Valley Basin contains interbedded alluvial, fluvial, and estuarine deposits to a depth of as much as 1,500 feet (Iwamura 1980). Soils consist of varying combinations of clay, silt, sand, and gravel that represent the interfingering of estuarine and alluvial deposit environments during the late Pleistocene and Holocene epochs. The fluvial soils were derived from the Santa Cruz highlands west of the basin and deposited on an alluvial plain bounded by alluvial fan deposits to the west and the baylands bordering San Francisco Bay to the northeast (Iwamura 1980). In general, thicker intervals of sand and gravel and discontinuous intervals of clays and silt are found near the upper alluvial fan deposits located south, and upgradient, of the Site. The sand and gravel intervals are thin, and clay and silt intervals become thicker and laterally continuous close to the axis of the basin and farther from the fan deposits (as at the Site).

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

The Site is located at the northern end of the Santa Clara Valley Basin, 1 mile south of San Francisco Bay. The land is relatively flat, ranging from 14 to 36 feet above msl.

The upper 65 feet of sediments consist of fine-grained alluvium incised with coarse-grained deposits of gravel and sand (channel deposits), which appear to have distinct vertical and lateral boundaries. These gravel and sand deposits trend north-south and are surrounded by silt, sandy silt, and silty fine-grained sands (splay deposits) in thin blankets that extend laterally from the channel deposits. Splay deposits grade vertically and laterally into fine-grained floodplain deposits composed of silt and clay.

The streams did not meander laterally to the degree that is normally found in a fluvial environment because this area of the drainage basin was subsiding as these channel and splay deposits were being deposited. As a result, channel deposits at the Site have a "stringer-like" morphology, with individual channel deposits that are stacked upon, or incised into, each other. This vertical accretion of channel deposits may be the reason that the clay boundary between the A1 and A2 zones appears to be discontinuous in the area of the Site. There appears to be fewer channel deposits in the A2 zone than in the A1 zone.

The following lithologic descriptions are based on continuous soil cores collected during the 2007 groundwater monitoring well installation and from CPT data generated during previous investigations (Tetra Tech EC 2007).

Clay soils ranged from fines with high plasticity with minor amounts of fine sand, to fines with high plasticity with fine to coarse sand and gravel. Clay was most frequently encountered from near ground surface to approximately 10 feet bgs. The thickest continuous clay interval logged was 9 feet (monitoring well MCH-4LA at a depth interval of 9 to 18 feet bgs and MCH-10LA at a depth interval of 4 to 13 feet bgs). Groundwater was not observed in clay samples.

Silt was the most frequently logged soil type at the Site. Silt ranged from fines with low to medium plasticity with minor amounts of fine sand, to non-plastic fines with fine to coarse sand and gravel. The low to medium plasticity observed in some silt soils was an indication of clay content. The thickest continuous silt interval logged was approximately 38 feet at FW13B at a depth interval of 5 to 43 feet bgs. Groundwater was occasionally observed in sandy silt and silt with minor amounts of sand, allowing some, but not all, attempts at groundwater sample collection in silt layers to succeed.

Sand intervals ranged from fine sand with silt, to medium and coarse-grained, subrounded to subangular sand, with fine subangular gravel. The thickest continuous sand interval was 14 feet at MCH-2LA at a depth interval of 30 to 44 feet bgs). Sand layers were thicker and more prevalent in the upper portion of the A aquifer, from about 10 to 25 feet bgs, than in the lower portion of the A aquifer. In many cases, estimates of sand thickness from lithologic boreholes may be overestimated because of heaving sand conditions.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

10.4.2 Local Hydrogeology

The shallow aquifer (approximately the upper 250 feet) is subdivided into the A-, B-, and C-aquifers. A laterally extensive clay aquitard (B/C aquitard) effectively isolates the C aquifer (approximately 160 to 250 feet bgs) from the upper aquifers. The A/B aquitard, which separates the A- and B-aquifers, may be locally continuous, because the B-aquifer (approximately 70 to 120 feet bgs) at Moffett, located east of the Site is largely free of the solvent contamination that is found in the A-aquifer.

The A-aquifer is estimated to extend to a depth between 55 and 65 feet bgs at the Site. It consists of stringer-like alluvial channel deposits composed of sand and gravel incised in, and interbedded with, fine-grained flood plain deposits. The channels are generally oriented from south to north. These channel deposits provide complex and tortuous pathways for contaminant transport. The A-aquifer is divided into the Al and A2 aquifer zones by a discontinuous, low-permeability horizon (Al/A2 aquitard) located approximately between 27 and 32 feet bgs, based on lithologic logs from piezometer installation.

The AIS/Tetra Tech Team suspects that channel deposits provide preferential flow paths through the aquifer, and the majority of groundwater that flows through the A aquifer at the Site passes through these deposits. Although groundwater flows through the splay deposits and through the clay alluvium in the saturated zone, the low permeability of these finer-grained soils inhibits groundwater flow.

Groundwater occurs at a depth of 8 to 12 feet bgs across the Site, occurring at progressively shallower depths to the north, toward the bay. Low-permeability material (clay and silt) has been observed from ground surface to approximately 10 to 12 feet bgs at most borehole locations. First-observed groundwater was encountered below this relatively impermeable layer. Phase 1 DPT and temporary well sample locations FW19A and FW20A were the only locations where the groundwater was first observed within, rather than right at the upper contact of, permeable sand and gravel deposits.

Water levels in the A1 and A2 permeable zones were measured quarterly from August 2005 to June 2006. Water levels increased 2 to 3 feet at wells in both the A1 and A2 permeable zones from December 2005 to March 2006 and then decreased almost back to December levels in June 2006. This pattern suggests seasonal recharge during the rainy season from December to March. Increases were greatest at wells located in the eastern and southern portions of the Site, in other words, at wells farthest from Stevens Creek. Thus, the primary recharge mechanism is more likely to be direct infiltration from surface water from recharge from leaky storm sewers, rather than from Stevens Creek.

Groundwater gradients estimated from the potentiometric map of the A1 zone in August 2005 range from 0.006, with a north-northwestern direction of groundwater flow inferred throughout the southern and eastern portions of the site, to 0.01 in a northwestern direction of groundwater flow inferred at the west-central portion of the site (near well MCH-9UA). Groundwater

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

gradients estimated from the potentiometric map of the A2 zone in August 2005 range from 0.007 with a north-northwestern direction of groundwater flow inferred throughout the southern and eastern portions of the site to 0.008 in a northwestern direction inferred at the southwestern portion of the site.

Hydraulic gradient calcuations with and without MCH-9UA indicate a steepening of the gradient and the westerly deflection in the inferred flow direction along the western side of the site The flow direction suggests that groundwater discharges from the A1 zone to Stevens Creek in the summer. According to SCVWD, Stevens Creek is a gaining stream during the summer.

As indicated in the Navy report (Tetra Tech EC 2007), groundwater elevations in the A1 and A2 zones are similar across most of the site, indicating little vertical flow potential between the two zones. Furthermore, flow directions estimated from potentiometric surface maps in both the A1 and A2 zones appear to be relatively consistent from season to season, even as water levels rise and fall, indicating a consistent horizontal flow system. The A1 zone appears to have a more uniform gradient than the A2 zone; this may be caused by the higher apparent percentage of channel and splay deposits in the A1 zone than in the A2 zone.

10.5 CONCEPTUAL SITE MODEL

The following sections present the CSM for the Site. The CSM is described by defining the movement of groundwater, potential on-site and off-site sources of the contaminants, and the fate and transport of the contamination.

10.5.1 Groundwater Flow

Section 10.4 describes the groundwater flow at the Site. Figures A-3 and A-4 show potentiometric surfaces in the upper (A1) and lower (A2) portions of the A aquifer as measured in August 2005. A comparison of these figures shows that the potentiometric surface elevation is approximately equal in both aquifers, with the exception of one well in the A2 zone (MCH-8LA) that indicates an anomalously low water elevation. The groundwater flow at the Site is to the north-northwest, and the gradients are somewhat consistent across the site.

The lack of elevation difference of the potentiometric surfaces between the A1 and A2 aquifer zones suggests there is little vertical flow between these two zones. This is consistent with the expected hydrogeology, as the Site is located near the distal end of the aquifer system, and the aquifers are immediately adjacent to each other with discontinuous clay separating them. As a result, there is minimal hydraulic force driving the vertical gradient upward or downward and, thus, relatively little mixing of groundwater between A1 and A2.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

10.5.2 Distribution of Contamination

Groundwater at the Site is primarily contaminated with TCE and its breakdown product, cis-1,2-DCE. TCE concentrations are generally higher in the lower zone (A2) of the A-aquifer than in the upper zone (A1) of the A-aquifer. Concentrations of TCE in the A1 zone are relatively consistent from the south to the north across the Site along the interconnected coarse-grained layers (see Figure A-5). TCE concentrations in the A2 zone generally increase from the southwest to the northeast across the central area of the Site (see Figure A-6).

The distribution patterns for TCE and cis-1,2-DCE in the upper A aquifer are similar. The patterns indicate that both TCE and cis-1,2-DCE in the A1 zone are migrating onto the Site along the upgradient boundary, are similar in concentration from the southern to the northern Site boundary, and then migrate onto NASA property. TCE concentrations at some sample locations, however, are anomalously high, and concentrations at upgradient locations are not as high.

The distribution patterns for TCE and cis-1,2-DCE distribution patterns in the A2 zone are also consistent (Tetra Tech EC 2007). Both TCE and cis-1,2-DCE are migrating onto the Site along the upgradient boundary in the lower A2 zone of the A-aquifer. As with the A1 zone, some sample locations show anomalously high concentrations relative to upgradient sample locations.

10.5.3 Potential Sources of On-Site Releases

As described in Section 10.1, the Site was used as a farm before it was used for military housing. During the 1940s, the military begin to construct housing on the site, and shared the property with the farmland owner until 1965. After 1965, the Navy controlled access to the property and used it for housing until 2001. The military began to raze housing units after 2001, and the last of the military housing was demolished in 2009.

The main potential sources of on-site releases at the Site are agricultural workers (until 1965), residential backyard mechanics living in the military housing area (early 1940s through 2001), construction workers during construction of the Moffett Boulevard and Highway 101 interchange (circa 1963), and commercial workers during construction of the various phases of military housing. Table A-1 and Figures A-7 and A-8 describe and show the potential source-release scenarios for on-site contamination.

10.5.3.1 Agricultural Workers

The potential sources of TCE or other related solvents from an agricultural worker are limited to cleaning farm equipment (Figure A-7). The volume and frequency of solvent used to clean farm equipment are likely to be low and infrequent. Farmers are unlikely to wasting large volumes of TCE by disposing of it down the drain or on the ground surface. Therefore, the potential release volume to ground surface from cleaning farm equipment is likely to be a small volume.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

As mentioned in Section 10.1, the farm at the Site included a septic tank, which could have been degreased with a chlorinated solvent. However, the area of the abandoned septic tank was investigated, and the results of the investigation concluded the septic tank area is not a source of on-site contamination (USACHPPM 2009b).

10.5.3.2 Backyard Mechanic

The backyard mechanic is a potential release source of small volumes of chlorinated solvents (Table A-1 and Figure A-7). Because of the nature of the organization and operation of military personnel, however, it is highly unlikely that a single source area would exist for a long time period. Military personnel customarily move every 4 years, so rarely is one person in a residence for longer than this period. As a result, repeated releases by a backyard mechanic in the housing area would be ephemeral. In addition, backyard mechanics work with small volume of chemicals and any releases would be infrequent or periodic (for example, a half-gallon of TCE released every Saturday for 3 weeks, or once every 3 months). The pathway of contamination of these types of releases is either directly onto the ground or through a storm drain or sanitary sewer. Figure A-9 shows the historical storm drains and sewers at the Site.

10.5.3.3 Construction Worker

Releases by a construction worker (Table A-1 and Figure A-8) would have a short overall duration because the work is temporary. Historical aerial photographs show a potential staging area for construction of the Moffett Boulevard and Highway 101 interchange, which took place in the southern portion of the site around well MCH-1UA (FWENC 2002) (Figure A-2). Releases from construction activities also could have occurred during the construction of the houses and related facilities. Construction of the interchange likely lasted no more than 1 to 2 years. Spills may have occurred at this site as a part of minor maintenance of construction equipment, such as degreasing surfaces of equipment for servicing and cleaning mechanical parts during mechanical repair, resulting in 1 to 5 gallons per release spilled onto the ground surface. Major repairs would most likely not be completed at the site; instead, the equipment would be removed and replaced if major repairs were required. Potential sources of chlorinated solvents from construction would be incidental release of TCE from a storage area (for example, leakage from drums) or disposal of spent TCE to the ground surface. There would not be a subsurface release point of contamination because there were no on-site storm sewers in the area (the structure of the storm drain system is linked directly with construction of Macon Terrace II, built after the interchange, see Figure A-9). Therefore, the volumes of chlorinated solvent released from a construction worker at a staging area would have been irregular and a low to moderate volume and are unlikely to significantly contribute to contamination at the Site.

10.5.3.4 Commercial Workers

Potential releases under the commercial worker scenario (Table A-1 and Figure A-8) at the Site specifically involve the paint storage locker located near the central part of the site (Figure A-2). Since the building was identified as a storage locker, regular activities that would result in a

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

release would not likely occur at the Site. Instead, incidental spills or leaks would be the most likely release mechanism. The volume could range from 1 gallon to 55 gallons, and the initial release point would most likely be to the ground surface via transport through the foundation of the storage locker floor, or through a floor drain in a storage unit, if it existed (possible secondary release point). The Army is unaware of any drawings on record for this building besides a drawing from the Yards and Docks collection (Navy 1956). The releases on Site from the paint storage locker would have been irregular and of low to moderate volumes.

10.5.4 Potential Sources of Off-Site Releases

Potential off-site sources of upgradient contamination have not been identified. There are concentrations of TCE and cis-1,2-DCE in groundwater upgradient of the site. The Middlefield-Ellis-Whisman (MEW) Superfund Site, defined by Middlefield Road, Ellis Street, and Whisman Road, which is south and upgradient of Moffett Field, has a VOC plume (HLA 1998, HLA 1993, both as cited in Tetra Tech EC 2007).

10.5.5 Fate and Transport of Contamination

Especially in the A1 zone, there are three mechanisms that could affect and alter contaminant concentrations in the shallow aquifer, as follows (Figure A-10).

- Leaking storm drain pipes will release fresh water to the unsaturated zone that can leach to the water table.
- Rain or lawn irrigation can infiltrate directly through the unpaved areas to recharge the water table (especially in low areas where rainwater pools).
- Stevens Creek, during high stages in the winter, will lose water to the creek banks, causing water to infiltrate laterally away from the creek in areas where permeable soils intersect the creek (both on-site and in upgradient off-site source areas).

The contaminant concentrations in the A2 zone are less influenced by water inputs to the water table (from annual precipitation that infiltrates the ground and surface water in Stevens Creek that infiltrates during wintertime high stage). The primary leaching mechanism for solvents in the unsaturated zone from an on-site source is limited to infiltrating precipitation during the rainy season (a seasonal pulsed release).

The volumes released by the four potential on-site sources (agricultural worker, backyard mechanic, construction worker, and commercial worker) are likely not sufficient to penetrate the capillary fringe. Agricultural releases, if any, were suspended after 1965, and potential residential releases from the backyard mechanic may have occurred until 2001, when the housing area closed. Residual non-aqueous phase liquid (NAPL) or residual solvents sorbed onto soil in the capillary fringe would continue to release to the aquifer, but the volume released and the magnitudes of concentrations should decrease over time. Volumes released and subsequent concentrations in groundwater from these sources should also continue to decrease with time.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

If the contamination breached the capillary fringe, the volumes released are likely not sufficient to penetrate 20 to 30 feet of the saturated zone to reach the lower (A2) portion of the A-aquifer. The primary leaching mechanism for solvent in unsaturated zone from an on-site source is limited to infiltrating precipitation during the rainy season (a seasonal pulsed release).

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

STEP 1: State the Problem – *Define the problem(s) that necessitates the study (e.g., further characterization).*

During previous investigations, chlorinated solvents, primarily TCE at concentrations up to 1,200 µg/L, have been detected in groundwater samples from the Site. TCE has been detected in upgradient groundwater samples, but at lower concentrations than were detected at some locations on site. There are no historical records of TCE use at the Site; however, undocumented releases could have occurred. One location of undocumented use of chlorinated solvents at the Site is the Paint Locker, the location of which is identified in a 1956 Yards and Docks collection drawing (Navy 1956) (Figure A-11). Previous investigations have not provided sufficient data to conclude that historical releases of TCE did not occur at the Site. Additional characterization is needed at the Site to assess whether there were on-site sources that released TCE to groundwater.

Field screening of cores recovered from boring FW41A showed PID readings as high as 3,500 ppm of VOCs in the core at 11 feet bgs. This interval corresponds to clay, and a clayey silt is just below this interval. The borehole log for this boring indicates that the first saturated zone at this location begins at about 14.5 ft bgs (assumed to be top of the capillary fringe). The grab groundwater results at this location were 210 micrograms per liter (µg/L) at 9.5 ft bgs and 160 and 290 µg/L from 16 to 17 ft bgs (recorded at collocated boring FW12B). As indicated in the log, water from the saturated zone rose to a static level of 9.5 feet, so the TCE in this water sample represented TCE concentrations in the shallow aquifer at this location. The water sample likely did not represent chemical concentrations in the soil interval at 11 feet bgs, because this interval appears to have been above the saturated zone. Samples were not collected from the soil core to evaluate the compounds that caused the elevated readings; therefore, the Army does not know if the elevated concentrations of total VOCs in soil within the capillary fringe at this location (as indicated by field screening) is from a release of TCE at the surface or from another VOC contaminant (such as fuel hydrocarbons).

STEP 2: Identify the Goals of the Study – *Identify the decisions that need to be made and possible actions that may be taken as a result of the decision.*

- Evaluate whether there are on-site sources that contribute to TCE in groundwater, focusing on nine locations of concern (LOC).
- Assess groundwater flow paths to determine if there are preferential pathways for movement of TCE through the Site from upgradient sources.
- If an on-site source area is identified, install monitoring wells to monitor groundwater elevations and TCE concentrations. The Army will be responsible for further investigation.
- Evaluate whether the elevated PID readings in soil core from 11 feet bgs at location FW41A were from chlorinated solvents or total petroleum hydrocarbons (TPH) that remains in soil at the capillary fringe at location FW41A.

STEP 3: Identify Information Inputs – *Identify specific information needed (could be existing or newly generated) to make decisions and achieve study goal.*

The following existing data inputs will be used to determine initial locations for proposed CPT and MIP borings:

- Validated analytical results for VOCs from existing monitoring wells
- Validated analytical results for VOCs from grab groundwater samples
- Lithological data from CPT and hollow-stem auger boring logs
- Historical aerial photographs
- Contractor's reports from historical building and highway construction

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)

STEP 3: Identify Information Inputs – *Identify specific information needed (could be existing or newly generated) to make decisions and achieve study goal. (Continued)*

The following existing data input will be used to select the location and depth of the soil sample at FW41A:

- PID readings from location FW41A

The following new data inputs, accompanied by the existing data inputs, will be used to determine if an on-site source exists:

- Elevation data of groundwater potentiometric surface from eight off-site upgradient former vector control yard wells, to be obtained before the CPT/MIP investigation.
- Validated analytical results for VOCs from 11 existing monitoring wells to be collected before the CPT and MIP investigation.
- Lithologic and MIP response data (measured as total VOC response on the microvolt [µV] scale) from proposed CPT and MIP at up to 50 new locations (see Figures A-11 and A-12) to investigate LOCs
- Lithologic and MIP response data from proposed CPT and MIP borings at up to 6 additional locations to assess preferential flow paths for TCE plumes flowing through the Site using Environmental Visualization Software (EVS).
- Analytical results for VOCs in groundwater collected using DPT and Hydropunch technology at up to two additional locations at each LOC where the MIP response indicates a source. Grab groundwater samples will be collected at discrete depth intervals selected after review of MIP data.
- Validated analytical results for VOCs from up to nine new and existing monitoring wells (location and number of new wells will be selected after a review of analytical data for groundwater collected using DPT and Hydropunch technology)
- Elevation data of groundwater potentiometric surface from up to nine new and existing monitoring wells (location and number of new wells will be indicated by groundwater analytical data collected using DPT and Hydropunch technology)

The following new data input will be used to evaluate whether a TCE or TPH release occurred around location FW41A:

- Validated analytical results for VOCs and TPH in soil from location FW41A at the depth interval where the highest PID reading registered in 2002 (11 feet bgs) in the clay and clayey and silt layer. The soil sample will be collected during the DPT investigation.

STEP 4: Define the Boundaries of the Study – *Define spatial and temporal boundaries considering site-specific contaminants, potential migration pathways, and current and future uses of site.*

- Spatial boundaries –
  - Vertical: A1 and A2 aquifer zones (0 to 65 feet bgs)
  - Lateral: within the boundary of the Site and focused in the areas identified as LOCs through the examination of existing data. At LOCs, sufficient data will be collected and evaluated using the EVS to verify continuity of TCE plumes along preferential flow paths from Site boundaries. Figures A-11 and A-12 present the locations of the comparison (MIP #0 [indefinite source investigation] or MIP #SS0 [paint locker investigation]) and subsequent (MIP #S1-S2, MIP #P1-P3 [indefinite source investigation] or MIP #SS1-SS2, MIP #B1-B2 [paint locker investigation]) CPT/MIP locations, and the LOCs)

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)

STEP 4: Define the Boundaries of the Study – *Define spatial and temporal boundaries considering site-specific contaminants, potential migration pathways, and current and future uses of site. (Continued)*

- Temporal boundaries –
  - From before 1939 (date of first aerial photograph available) through 2011
  - Historical groundwater and lithologic data collected on-site and off-site between 2002 and 2006
  - Additional groundwater, soil, and lithologic data collected as part of this investigation

STEP 5: Develop the Analytic Approach – *Define specific parameters of interest, specify action levels/criteria to be considered, and basis for selected action levels (e.g., "if…then…" decision rules).*

To evaluate the existence of potential on-site sources: Three decision logic sequences (Figures A-13 through A-15) have been developed for this investigation. The first sequence (see Figure A-13) is for investigation of a LOC associated with an indefinite source (an area with anomalously high concentrations of TCE and where there are no upgradient samples with similar concentrations to indicate an off-site source). The second sequence (Figure A-14) is for investigation of the one known suspected source of contamination – the Paint Locker. The third sequence (Figure A-15) follows the first two sequences and describes the follow-on steps for a LOC where the initial phases of the investigation indicate that there may be a source. These three sequences are described qualitatively in Attachment A1, which also includes definitions of terminology important to the field investigation.

Potentiometric maps developed from water level data collected during the sampling event will be used to evaluate MIP/CPT boring locations identified on Figures A-11 and A-12. Locations S1, S2 and P1, P2, and P3 will be adjusted if they are not located upgradient of the unidentified source areas.

The following parameters and criteria will be used to make decisions in the field during Phase 2 of the field investigation (CPT/MIP investigation) (Figures A-13 and A-14), and will be documented on field forms (see Appendix C):

- Parameter: The magnitude of the MIP response (response to total VOC response measured by the MIP on the µV scale) compared with historical sampling concentrations at initial point of investigation (MIP #0) will be qualitatively compared to the magnitude of the TCE concentration collected from the 11 existing on-site wells to evaluate calibration of MIP instrument (a quantitative measurement of the MIP's response to a known standard).
- Parameter: shape of MIP response, to guide decision steps 2a, 4a, $4b_2$, 6a, $6b_2$, and $8b_2$ for indefinite sources (Figure A-13), and to guide decision steps 2b, 4c, 6c, 8c, and 12 for the Paint Locker (Figure A-14); Criteria:
  - MIP response that is greatest in the capillary fringe indicates a source area
  - MIP response $\geq 7e^6$ µV indicates residual or liquid NAPL source
  - MIP response $\geq 4e^6$ µV indicates proximity to residual or liquid NAPL source
  - MIP profile that decreases sharply within the first saturated zone may indicate a source area
  - MIP profile that is highest in finer-grained materials in the first saturated zone may indicate proximity to a source

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)

STEP 5: Develop the Analytic Approach – *Define specific parameters of interest, specify action levels/criteria to be considered, and basis for selected action levels (e.g., "if…then…" decision rules). (Continued)*

- Parameter: Comparison of MIP responses from different locations with a difference of at least one-half order of magnitude on the µV scale will guide decision steps $4b_1$, $6b_1$, and $8b_1$ for indefinite sources (Figure A-13). If the response at the new point is at least one-half an order-of-magnitude less than the source (MIP #0) response, it will indicate a significantly different condition (i.e., "plume" concentration rather than "source" concentration).
- Parameter: Evaluation of MIP and CPT data in EVS to guide placement of (a) CPT/MIPs in decision steps 7b, 9a, 9b, 9c, 10a, and 10b for indefinite sources (Figure A-13); and in decision steps 9b and 9c for the Paint Locker (Figure A-14); and (b) the DPT and Hydropunch locations or monitoring wells in decision steps 13 and 14 (Figure A-15).
- Evaluation of MIP and CPT data from up to 6 additional borings to acquire additional data to better assess the preferential flow paths of off-site sourced contamination through the Site using the Site 3D solid geology model.

The following parameters and criteria will be used to make decisions in the field during Phase 3 of the field investigation (DPT/Hydropunch investigation) (Figure A-15):

- Parameter: VOC concentrations obtained from DPT samples collected at source and upgradient will be used to confirm results of CPT/MIP borings and evaluate whether source areas have been delineated in upgradient direction, in decision step 13 (Figure A-15).
- Parameter: Evaluation of MIP and CPT data from Phase 2 of the field investigation in EVS to guide placement of the monitoring wells in decision step 14 (Figure A-15).
- Evaluation of MIP and CPT data from up to 6 borings to acquire additional data to better assess preferential flow paths through OPHA using the OPHA 3D solid geology model.

To evaluate whether the elevated PID field screening values in soil from 11 feet bgs at location FW41A represent a TCE source area near FW41A:

- If TCE is detected in the soil sample collected from 11 feet bgs (the depth corresponding to the highest PID field screening value in FW41A) at less than 210 µg/kg (the lowest concentration detected in historical groundwater samples collected from the first saturated zone adjacent to the capillary fringe) or TPH are detected at a concentration to suggest a nearby source area of fuel contamination, then it will be concluded that the elevated PID field screening values at 11 feet bgs are caused by something other than TCE and no TCE release occurred at or near this location. The Army will evaluate any detected petroleum contamination.
- Based on a review of the borehole log for location FW41A, the soils from the interval with the elevated PID field screening values are predominantly clay. TCE should readily sorb onto this soil matrix. If the soils at the capillary fringe contain concentrations of TCE that are above 210 µg/kg, (the lowest concentration detected in historical water samples collected from the depth around the capillary fringe), then this area is potentially near a source of TCE and the associated LOC will be investigated as a potential source around according to the decision logic presented in Figure A-13 and Attachment A1.
- However, if TPH or petroleum hydrocarbon compounds (benzene, toluene, ethylbenzene, and xylene [BTEX]) are detected in the soil sample above reporting limits, then the Army will conclude that TPH caused the elevated PID field screening values at FW41A.
- If the TCE concentration in the soil sample is greater than 210 µg/kg and TPH is not detected in the soil sample, then the Army will consider this location as a potential TCE source area, and evaluate the need for a monitoring well at that location (see Figure A-15).

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)

STEP 6: Specify Performance or Acceptance Criteria – *How to address inherent uncertainty? Consider consequences of incorrect conclusions and specify the degree of certainty decisions must achieve by defining acceptance limits.*

Initial CPT/MIP locations are based on a review of historical analytical data and aerial photographs that indicate a potential on-site source of TCE. Secondary CPT/MIP locations will be selected based on evaluation of data collected during this field investigation using the EVS. CPT/MIP locations advanced with the purpose of locating preferential pathways will be selected using the "Drill Pro" module in EVS after evaluation of data collected during Phases 1 and 2 of the field investigation.

The assessment of potential on-site sources will minimize uncertainty and inaccuracy through:

- Use of standard sample collection and test methods and established laboratory performance criteria.
- MIP response will be compared to collocated historic data and groundwater data collected during Phase 1 to verify that detectors are able to detect VOC concentrations at the site.
- The MIP detector will be calibrated against a known standard following standard calibration procedures developed by the equipment vendor.
- For a given location of concern, the MIP response at the upgradient location must be less than one-half order of magnitude or less than the downgradient location for the upgradient location to be considered as a reduced concentration relative to the downgradient location.
- Confirmation of MIP response at source areas through use of DPT and Hydropunch samples, which will generate laboratory quality groundwater data for VOCs.
- MIP responses and the CPT responses will be discretized and kriged in EVS. Geostatistical estimates of uncertainty will be evaluated in "Drill Pro" module in EVS and used to select new CPT/MIP locations to assess potential preferential pathways with the 3D solid geology model
- Further evaluation of the MIP response and the CPT log through the use of EVS.

The assessment of a release at location FW41A will minimize uncertainty and inaccuracy through:

- Use of standard sample collection and test methods and established laboratory performance criteria.
- Knowledge that field screening equipment responds to numerous hydrocarbon and chlorinated solvent VOCs.

STEP 7: Develop the Plan for Obtaining Data – *Develop approaches to achieve the goal of the study in the most resource-effective way.*

For the assessment of potential on-site sources:

1. Collect groundwater samples and analyze for VOCs at 11 existing on-site wells.
2. Collect groundwater elevation measurements at existing on-site wells and neighboring wells to the north, south, and east of the site.
3. Advance up to 27 CPT and MIP borings to 35 feet bgs, and up to 23 CPT/MIP borings to 65 feet bgs following the decision logic sequence in Figures A-13 and A-14. Figures A-11 and A-12 show the proposed estimated sampling locations, and Attachment A1 describes the decision logic qualitatively.
4. Using the data obtained in Phases 1 and 2, advance up to 6 CPT and MIP borings to 65 feet bgs to locate preferential pathways at locations to be determined using the EVS

SAP WORKSHEET #11 — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)

STEP 7: Develop the Plan for Obtaining Data – *Develop approaches to achieve the goal of the study in the most resource-effective way. (Continued)*

5. Using the decision logic (Figure A-15 and Attachment A1), select up to two DPT boring locations for each LOC that has source characteristics and collect grab groundwater samples using Hydropunch technology at up to two discrete depths per location identified by MIP, where depths correspond to the capillary fringe or top of the water table and preferential flow pathways within A1 or A2 zones. Analyze groundwater samples for VOCs.
6. Evaluate results using EVS. If necessary, install monitoring wells. Once wells are developed, collect one round of groundwater samples following low-flow groundwater sampling methodology in 11 existing on-site wells and all new monitoring wells. Analyze groundwater samples for VOCs.

For the assessment of potential on-site sources at FW41A:

1. Collect one soil sample at location FW41A at the depth interval where the highest PID reading registered in 2002 (11 feet bgs) in the clayey and silt layer. Analyze the sample for VOCs and TPH as gasoline, motor oil, and diesel fuel.

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA TABLE

(12a) Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQI)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Duplicate	VOCs (EPA 8260B)	10% (water only)	Precision/ Contamination	Relative percent difference < 25% for water samples	S & A
Equipment Rinsate	VOCs (EPA 8260B)	1 per week per piece of equipment	Accuracy/ Contamination	No target compounds > project required reporting limit (PRRL)	S
Source Blank	VOCs (EPA 8260B)	1 per source	Accuracy/ Contamination	No target compounds > PRRL	S
Trip Blank	VOCs (EPA 8260B), TPH-p (EPA 8015B)	1 per cooler	Contamination	No target VOCs > project required reporting limit (PRRL)	S
Temperature Blank	NA	1 per cooler	Handling	4˚±2˚ C	Shipping and handling

Notes: Soil duplicates will not be collected for this project because they cannot be used directly to assess sampling precision since adjacent soil samples incorporate some spatial variability. Furthermore, it is not practical to set QC limits for the relative percent difference of these samples, which precludes their use for QC.

EPA U.S. Environmental Protection Agency
NA Not applicable
TPH-p Total petroleum hydrocarbon-purgeable
VOC Volatile organic compound

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)

12.1 SUMMARY OF QA/QC TASKS

The AIS/Tetra Tech Team will assess the quality of field data through regular collection and analysis of field quality control (QC) samples. The following sections discuss the types and purposes of field QC samples for this project.

12.1.1 Field Duplicate

Field duplicate samples are collected at the same time and from the same source and then submitted as separate samples to the laboratory for analysis. Field duplicates for groundwater samples collected from monitoring wells and as grab samples will be collected at a rate of 10 percent. Soil duplicate samples will not be collected for this project because these samples cannot be used directly to assess sampling precision since adjacent soil samples incorporate some spatial variability. Furthermore, it is not practical to set QC limits for the relative percent difference (RPD) of these samples, which precludes their use for QC.

Results from the analysis of groundwater duplicates are used to evaluate precision by calculating the RPD.

12.1.2 Equipment Rinsate Samples

Equipment rinsate samples will be collected during sampling at a frequency of once per week of sampling, per team, per type of tool used. Water will be poured over or through the sampling equipment into a sample container and sent to the laboratory for analysis. Certified volatile-free water will be used for organic parameters. The equipment rinsate will allow for verification that the decontamination procedures were appropriately performed. Rinsate samples will be collected on decontaminated equipment that is reused to collect additional samples.

The results for the equipment rinsate samples will be used during data validation to qualify data or to evaluate the levels of analytes in the field samples collected during the sampling event.

12.1.3 Source Water Blank Samples

One source water blank will be collected for each source of water (distilled or deionized) used to decontaminate the soil sampling equipment and collect rinsate blank samples. The source-water blank sample will verify that the water used for decontamination was analyte free. It is anticipated that three source water blanks will be necessary for this investigation. Certified volatile-free water will be used for organic parameters.

12.1.4 Trip Blanks

A trip blank demonstrates that contamination is not originating from sample containers or from any factor during sample transport. A trip blank originates at the laboratory as a 40-milliliter vial and is used for analysis of VOCs and TPH-purgeable (TPH-p). The vial is filled at the laboratory with reagent-grade, organic-free water. The trip blanks are then transported to the site with the empty containers that will be used for sample collection. The trip blanks accompany the samples throughout the event through the final trip to the lab. One trip blank accompanies back to the laboratory each sample transport container that holds samples for analysis of VOCs and TPH-p. The trip blank is not opened until returned to the laboratory. Trip blanks will be analyzed for VOCs and TPH-p.

12.1.5 Temperature Blanks

A temperature blank represents the temperature of water samples within a cooler. The temperature blank originates at the laboratory and is then shipped within each cooler. The temperature blank is opened at the laboratory when the sample is received, and a thermometer is used to record the water temperature in the 40-milliliter vial. The receiving laboratory then records this temperature as the sample temperature for the cooler.

SAP WORKSHEET #13 — SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generator and collection dates)	How Data Will Be Used	Limitations on Data Use
OPHA Analytical data	U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM). 2009a. *Results of Geophysical Survey, Membrane Interface Probe Investigation and Subsurface-Soil Sampling, Abandoned Septic Tank and Drain Field, Orion Park Housing Area, Moffett Field, Mountain View California.* October.	USACHPPM collected data including: • Subsurface soil analyzed for VOCs • Geophysical data around former septic tank location • MIP data to determine whether VOCs are present in the subsurface	Data have been used to eliminate the septic tank area as a source of on-site contamination.	None
OPHA Analytical data	Tetra Tech EC Inc. (Tetra Tech EC). 2007 . *Groundwater Monitoring Well Installation and Sampling Report for Orion Park Housing Area.* September.	The Navy collected data, including: • Installation of groundwater monitoring wells • Sampling of existing and new wells for VOCs • Lithological data from CPT and hollow-stem auger boring logs	Data have been used to guide sample locations and develop a conceptual site model.	None
OPHA Analytical data	U.S. Environmental Protections Agency (EPA) . 2005a. EPA Off-Site Groundwater VOC Data Table Summary. VOC data table created from analytical data collected in 2005 by EPA. VOC data and sample location information provided by Navy. February.	EPA collected off-site data including: • Grab groundwater DPT/Hydropunch samples HP01-HP20 for analysis of VOCs • Lithological data from CPT boring logs	Data have been used to guide sample locations and develop a conceptual site model.	None
OPHA Analytical data	Foster Wheeler Environmental Corporation (FWENC). 2003. *Final Site Characterization and Baseline Human Health Risk Assessment Report.* December.	The Navy performed a Site Characterization at the Site and the Wescoat Housing Area and collected the following data: • Grab groundwater DPT/Hydropunch samples for analysis of VOCs from A1 zone • Lithological data from CPT and DPT boring logs • Soil screening for VOCs	Data have been used to guide sample locations and develop a conceptual site model.	None

SAP WORKSHEET #13 — SECONDARY DATA CRITERIA AND LIMITATIONS TABLE (CONTINUED)

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generator and collection dates)	How Data Will Be Used	Limitations on Data Use
OPHA Analytical data	The SI Group (SIG). 2003. *Potential Responsible Party Study Report, Orion Park Housing Community, Former Naval Air Station Moffett Field*. November.	The Navy collected off-site data including: • Grab groundwater DPT/Hydropunch samples HP01-HP20 for analysis of VOCs • Lithological data from CPT boring logs	Data have been used to guide sample locations and develop a conceptual site model.	None
OPHA Analytical data	International Technology Corporation (IT). 2000. *Report of Verification of Groundwater Conditions at Orion Park, Moffett Federal Airfield, California*. October 30.	The Navy collected the following data from the southern and western boundaries of the Site: • Groundwater samples for analysis of VOC	Data have been used to guide sample locations and develop a conceptual site model.	None
OPHA Analytical data	Science Applications International Corporation (SAIC). 1999. *Soil and Groundwater Investigation Report of Findings, AOI4, Orion Park, NASA Ames Research Center, Moffett Field, California*. March.	NASA collected data from the northern boundary of the Site, including: • Groundwater samples for analysis of VOCs	Data have been used to guide sample locations and develop a conceptual site model.	None

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS

14.1 PROJECT OBJECTIVES

As stated in SAP Worksheet #10, Problem Definition, the primary objectives of additional sampling for the Site are to:

- Evaluate whether there are on-site sources that contribute to TCE in groundwater.
- Assess groundwater flow paths to determine if there are pathways for movement of TCE onto the site from upgradient sources.
- If an on-site source area is identified, install monitoring wells to monitor groundwater elevations and TCE concentrations.
- Evaluate whether there was a release of chlorinated solvents or TPH that remains in soil at the capillary fringe at location FW41A.

Results of this field investigation will be used to determine whether on-site sources of TCE are present at the Site.

To meet the project objectives, the following field activities are planned:

- Collect groundwater elevation measurements from eight off-site former vector control yard wells (south of the Site).
- Collect groundwater samples at 11 on-site existing wells for VOC analysis before the intrusive investigation.
- Conduct a utility survey.
- Conduct the CPT and MIP investigation.
- Collect grab groundwater samples for VOC analysis using DPT and Hydropunch.
- Collect one soil sample at FW41A for analysis of VOCs, TPH-p, and TPH-extractables (TPH-e) analysis using DPT and Hydropunch.
- Install groundwater monitoring wells, if warranted.
- Collect groundwater samples for analysis of VOCs at existing and new on-site monitoring wells.
- Collect groundwater elevation measurements from 11 existing on-site wells and new on-site wells.

Groundwater samples will be analyzed for VOCs (see Worksheet #18). The soil sample collected at FW41A will be analyzed for VOCs and TPH as gasoline (TPH-p) and as diesel fuel and motor oil (TPH-e). Sample locations are shown on Figures A-11 and A-12.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

14.2 SUMMARY OF QUALITY ASSURANCE AND QUALITY CONTROL TASKS

AIS/Tetra Tech Team will assess the quality of field data through regular collection and analysis of field QC samples. Worksheet #12 discusses the types and purposes of field QC samples that will be collected during this investigation. QC will also be evaluated through data assessments (Worksheet #34) and data validation (Worksheet #36).

14.3 SUMMARY OF SURVEYS, INVESTIGATION-DERIVED WASTE, AND EQUIPMENT DECONTAMINATION

The following subsections describe utility and sample location surveys, management of investigation-derived waste (IDW), and equipment decontamination procedures for this investigation.

14.3.1 Utility Clearance Surveying

A geophysical subcontractor will be retained to mark locations of detectable subsurface utilities and structures in the flat areas where DPT and CPT drilling is proposed. The geophysical utility locating survey will consist of electro-magnetic (EM) (if useful) surveying to clear the proposed locations. Utilities will be cleared by a subcontractor that specializes in location of subsurface utilities. The geophysical utility locating survey will be conducted after the proposed sampling areas have been identified and staked before drilling begins.

14.3.2 Sample Location Surveying

CPT, MIP, and DPT boring and monitoring well locations will be located in the field using a hand-held global positioning system (GPS) unit. Horizontal coordinates will be reported in Universal Transverse Mercator Zone 11 coordinates and reported in North American Datum 83 values as a distance in meters along the y-axis (northing) and a distance in meters along the x-axis (easting). Monitoring wells will be professionally surveyed (Worksheet #17).

14.3.3 Equipment Decontamination

All equipment will be decontaminated according to the following procedures. All non-dedicated sampling tools will be decontaminated before sampling begins and between sample locations. Groundwater and soil sampling tools will be decontaminated by scrubbing in a solution of potable water and non-phosphate detergent (Alconox or Liquinox). The tools will then be double-rinsed with distilled or de-ionized water.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

Subcontractors will be responsible for decontamination of borehole CPT/MIP and DPT tools. Decontamination will consists of washing with a non-phosphate detergent and water solution rinsed with potable water. Tools used to collect samples will be rinsed with distilled or deionized water.

14.3.4 Management of Investigated-Derived Waste

IDW is expected from soil borings, monitoring well purge and development water, and decontamination water. Purge, development, and decontamination water will be placed in 55-gallon drums and labeled. Soil tailings from borings will be placed in separate 55-gallon drums and labeled. Drums will be stored next to each sampling location on Army property pending analysis of the characterization samples. At the end of the field event, composite samples will be collected from all drums that contain IDW, and the results of the sample will be used to profile the waste for disposal. The drums will then be shipped off site to the appropriate facility.

Personal protective equipment and miscellaneous waste from sampling (paper towels and gloves) will be placed in large garbage bags, sealed, and disposed of in facility trash receptacles as solid waste.

14.4 DOCUMENTS AND RECORDS

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This section also describes reports that will be generated as a result of this project.

14.4.1 Field Documentation

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in the SAP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the site name, and the names of subcontractors, the service client, and the task order manager (TOM). At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events
- Notes of conversations with coordinating officials
- References to other field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolution

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

- Discussions of deviations from the SAP or other governing documents
- A detailed description of sediment type for each sample collected (Bay Mud, sand, or other)
- Description of all photographs taken

The field team will also use the various field forms included in Attachment A2 to record field activities.

14.4.2 Summary Data Package

The summary data package will consist of a case narrative, copies of all associated COC records, sample results, and quality assurance (QA)/QC summaries. The case narrative will include the following information:

- Subcontractor name, project name, task number, project order number, sample delivery group (SDG) number, and a table that cross-references client and laboratory sample identification (ID) numbers
- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies
- A list of each instance of manual integration or other manual data interpretations on the part of the analyst in the case narrative, and a statement that each such instance of manual interpretation or analyst judgment was approved by a supervisor
- Copies of all associated nonconformance and corrective action forms that will describe the nature of the deficiency and the corrective action taken
- Copies of all associated sample receipt notices

Additional requirements for the summary data package are outlined in Worksheet #30. The subcontracting laboratory will provide AIS/Tetra Tech Team with two copies of the summary data package on compact disk (CD) within 21 days after it receives the last sample in the SDG.

14.4.3 Full Data Package

The laboratory should prepare full data packages in accordance with the instructions provided in the EPA Contract Laboratory Program (CLP) statement of work (SOW) (EPA 2005c). Full data packages will contain all of the information from the summary data package and all associated raw data. Full data package requirements are outlined in Worksheet #30. Full data packages are due to the AIS/Tetra Tech Team within 21 days after the last sample in the SDG is received. The subcontractor will deliver two copies of the full data package on CD.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

14.4.4 Electronic Data Package Format

The subcontracted laboratory will provide electronic data deliverables (EDD) for all analytical results. An automated laboratory information management system must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. Results to be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the COC form
- Method and instrument blanks and preparation and calibration blank results reported for the SDG
- Percent recoveries for the spike compounds in the matrix spike (MS), matrix spike duplicates (MSD), blank spikes, or laboratory control samples (LCS)
- Matrix duplicate results reported for the SDG
- All re-analysis, re-extractions, or dilutions reported for the SDG, including any associated with samples and the specified laboratory QC samples

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The subcontractor will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained on an electronic data archival system.

14.4.5 Reports Generated

The results from this investigation will be incorporated into an SSI report, which will include an evaluation of historical data and data collected during the field investigation. The SSI report will contain an updated CSM, including 3-dimensional maps that display subsurface hydrostratigraphy as well as contaminant distribution to ascertain whether on-site sources exist or if sources are strictly from off site. This report will include data collected during this investigation, summaries of the results of this and previous field activities, field and sampling procedures for this investigation, target analyte concentration and associated QC data, site maps, and conclusions and recommendations. The SSI report will also include IDW transport and disposal records.

14.4.6 Data Management

Field and analytical data collected from this project and other environmental investigations at the Site are critical to site characterization efforts and selection of remedial actions to protect human health and the environment. An information management system is necessary to ensure efficient access so that decisions based on the data can be made in a timely manner.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

After the field and laboratory data reports are reviewed and validated, the data will be entered into AIS/Tetra Tech Team's database for the Site. The database contains data for: (1) summarizing observations on contamination and geologic conditions, (2) preparing reports and graphics, and (3) using with geographic information systems. The AIS/Tetra Tech Team's data tracking procedures, data pathways, and overall data management strategy for the Site are described in the following paragraphs.

14.4.7 Data Tracking Procedures

All data that are generated in support of the Army program at the Site are tracked through a database created by AIS/Tetra Tech Team. Information related to the receipt and delivery of samples, project order fulfillment, and invoicing for laboratory and validation tasks is stored in the Tetra Tech program, SAMTRAK. All data are filed according to the SDG number and document control number once the final document has been submitted.

14.4.8 Data Pathways

Data are generated from three primary pathways at the Site: data derived from field activities, laboratory analytical data, and validated data. Data from all three pathways must be entered into the database. Data pathways must be established and well documented to evaluate whether the data have been accurately loaded into the database in a timely manner.

Data generated during field activities are recorded using field forms (Appendix C of the Work Plan). The analytical coordinator or FPM reviews these forms for completeness and accuracy. Data from the field forms, including the COC record, are entered into SAMTRAK.

Data generated during laboratory analysis are recorded on CD and in EDDs after the samples have been analyzed. The laboratory will send the CD and EDD records to the analytical coordinator. The analytical coordinator reviews the data deliverable for completeness, accuracy, and format. After the format has been approved, the electronic data are manipulated and downloaded into the database. AIS/Tetra Tech Team data entry personnel will then update SAMTRAK with the total number of samples received and number of days required to receive the data.

After validation, the analytical coordinator reviews the data for accuracy. The AIS/Tetra Tech Team will then update the database with the appropriate data qualifiers. SAMTRAK is also updated to record associated laboratory and data validation costs.

14.4.9 Data Management Strategy

AIS/Tetra Tech Team's short- and mid-term data management strategies require that the database for the Site will be updated once the data are collected and validated. The data consist of chemical and field data from Army contractors, entered into an Oracle (Version 7.3) database. The database can be used to generate reports using available computer-aided drafting and design and contouring software. Data will be transmitted within 30 days after the final validation report is received.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

Data will be transmitted to the Army via the following databases:

- Environmental Restoration Information System (ERIS) (a web-based database system for storage of Army environmental restoration and range field data. It serves as a central repository for the Army installation chemical, geological, and geographical data);
- Army Environmental Database Restoration module (AEDB-R) (a centralized and integrated collection of Army environmental data).

The data will be loaded into the database at AIS/Tetra Tech for storage, further manipulation, and retrieval after laboratory and field reports are reviewed and validated to satisfy long-term data management goals. The database will be used to provide data for chemical and geologic analysis and for preparing reports and graphic representations of the data. Additional field activity data are recorded on field forms (see Attachment A2) that the analytical coordinator or field project manager (FPM) reviews for completeness and accuracy (Worksheet #34). Hard copies of forms, data, and COC records are filed in a secure storage area according to project and SDG numbers. Laboratory data packages and reports will be archived at AIS/Tetra Tech offices. Laboratories that generated the data will archive hard-copy data for a minimum of 10 years (Worksheet #30).

14.5 DATA VALIDATION

Analytical data will be validated by an independent third-party contractor in accordance with current EPA National Functional Guidelines (EPA 2008). Validation procedures are detailed in Worksheet #36.

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE

(15a) VOCs

Analytical Group: EPA 8260B
Matrix: Soil

Chemical	CAS Number	Project Quantitation Limit Goal[1] (µg/kg)	Laboratory-Specific	
			Level of Quantitation (LOQ) (µg/kg)	Level of Detection (LOD) (µg/kg)
1,1,1-Trichloroethane	71-55-6	5	5	2
1,1,2,2-Tetrachloroethane	79-34-5	5	5	2
1,1,2-Trichloroethane	79-00-5	5	5	2
1,1-Dichloroethane	75-34-3	5	5	2
1,1-Dichloroethene	75-35-4	5	5	2
1,2,4-Trimethylbenzene	95-63-6	5	5	2
1,2-Dichloroethane	107-06-2	5	5	2
1,3,5-Trimethylbenzene	108-67-8	5	5	2
2-Butanone	78-93-3	10	10	5
2-Hexanone	591-78-6	10	10	5
4-Methyl-2-pentanone	108-10-1	10	10	5
Benzene	71-43-2	5	5	2
Bromodichloromethane	75-27-4	5	5	2
Bromoform	75-25-2	5	5	2
Carbon Disulfide	75-15-0	5	5	2
Carbon Tetrachloride	56-23-5	5	5	2
Chlorobenzene	108-90-7	5	5	2
Chloroethane	75-00-3	5	5	2
Chloroform	67-66-3	5	5	2

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15a) VOCs
Analytical Group: EPA 8260B
Matrix: Soil

Chemical	CAS Number	Project Quantitation Limit Goal[1] (µg/kg)	Laboratory-Specific	
			Level of Quantitation (LOQ) (µg/kg)	Level of Detection (LOD) (µg/kg)
Chloromethane	74-87-3	10	10	2
cis-1,2-Dichloroethene	156-59-2	5	5	2
Dibromochloromethane	124-48-1	5	5	2
Dichlorodifluoromethane	75-71-8	10	10	2
Ethylbenzene	100-41-4	5	5	2
Isopropylbenzene	98-82-8	5	5	2
M,p-xylenes	108-38-3, 106-42-3	10	10	5
Methylene Chloride	75-09-2	10	10	2
Methyl-tert butyl ether (MTBE)	1634-04-4	5	5	2
o-xylene	95-47-6	5	5	2
Tetrachloroethene	127-18-4	5	5	2
Toluene	108-88-3	5	5	2
trans-1,2-Dichloroethene	156-60-5	5	5	2
Trichloroethene	79-01-6	5	5	2
Vinyl chloride	75-01-4	5	5	2

Notes:

1 The project quantitation limit is equal to the laboratory-specific quantitation limit. This investigation is an exploratory investigation and does not have remedial goals.

µg/kg Microgram per kilogram

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15b) VOCs
Analytical Group: EPA 8260B
Matrix: Water

Chemical	CAS Number	Project Quantitation Limit Goal[1] (µg/L)	Laboratory-Specific	
			Level of Quantitation (LOQ) (µg/L)	Level of Detection (LOD) (µg/L
1,1,1-Trichloroethane	71-55-6	1	1	0.2
1,1,2,2-Tetrachloroethane	79-34-5	1	1	0.2
1,1,2-Trichloroethane	79-00-5	1	1	0.2
1,1-Dichloroethane	75-34-3	1	1	0.2
1,1-Dichloroethene	75-35-4	1	1	0.2
1,2,4-Trimethylbenzene	95-63-6	1	1	0.2
1,2-Dichloroethane	107-06-2	1	1	0.2
1,3,5-Trimethylbenzene	108-67-8	1	1	0.2
2-Butanone	78-93-3	10	10	5
2-Hexanone	591-78-6	10	10	5
4-Methyl-2-pentanone	108-10-1	1	10	5
Benzene	71-43-2	1	1	0.2
Bromodichloromethane	75-27-4	1	1	0.3
Bromoform	75-25-2	1	1	0.3
Carbon Disulfide	75-15-0	1	1	0.3
Carbon Tetrachloride	56-23-5	1	1	0.2
Chlorobenzene	108-90-7	1	1	0.2
Chloroethane	75-00-3	1	1	0.3
Chloroform	67-66-3	1	1	0.2
Chloromethane	74-87-3	1	1	0.3

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15b) VOCs
Analytical Group: EPA 8260B
Matrix: Water

Chemical	CAS Number	Project Quantitation Limit Goal[1] (µg/L)	Laboratory-Specific	
			Level of Quantitation (LOQ) (µg/L)	Level of Detection (LOD) (µg/L
cis-1,2-Dichloroethene	156-59-2	1	1	0.2
Dibromochloromethane	124-48-1	1	1	0.2
Dichlorodifluoromethane	75-71-8	1	1	0.3
Ethylbenzene	100-41-4	1	1	0.2
Isopropylbenzene	98-82-8	1	1	0.2
M,p-xylenes	108-38-3, 106-42-3	2	2	0.5
Methylene Chloride	75-09-2	1	1	0.5
Methyl-tert butyl ether (MTBE)	1634-04-4	1	1	0.2
o-xylene	95-47-6	1	1	0.2
Tetrachloroethene	127-18-4	1	1	0.2
Toluene	108-88-3	1	1	0.2
trans-1,2-Dichloroethene	156-60-5	1	1	0.2
Trichloroethene	79-01-6	1	1	0.2
Vinyl chloride	75-01-4	1	1	0.2

Notes:

1 The project quantitation limit is equal to the laboratory-specific quantitation limit. This investigation is an exploratory investigation and does not have remedial goals.

µg/L Microgram per liter

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15c)TPH-purgeable
Analytical Group: EPA 8015B
Matrix: Soil

Analysis	CAS Number	Project Quantitation Limit Goal[1] (mg/kg)	Laboratory-Specific	
			Level of Quantitation (LOQ) (mg/kg)	Level of Detection (LOD) (mg/kg)
TPH as Gasoline	8006-61-9	1	1	0.5

(15d) TPH-extractable
Analytical Group: EPA 8015B
Matrix: Soil

Analysis	CAS Number	Project Quantitation Limit Goal[1] (mg/kg)	Laboratory-Specific	
			Level of Quantitation (LOQ) (mg/kg)	Level of Detection (LOD) (mg/kg)
TPH as Diesel	68334-30-5	10	10	5
TPH as Motor Oil	NA	20	20	5

Notes:
1 The project quantitation limit is equal to the laboratory-specific quantitation limit. This investigation is an exploratory investigation and does not have remedial goals.
mg/kg Milligram per kilogram

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15-e) TPH-purgeable
Analytical Group: EPA 8015B
Matrix: Water

Analyte	CAS Number	Project Quantitation Limit Goal[1] (mg/L)	Laboratory-Specific	
			Level of Quantitation (LOQ) (mg/L)	Level of Detection (LOD) (mg/L)
TPH as Gasoline	8006-61-9	0.1	100	20

Notes:

1 The project quantitation limit is equal to the laboratory-specific quantitation limit. This investigation is an exploratory investigation and does not have remedial goals.

mg/L Milligram per liter

SAP WORKSHEET #16 — PROJECT SCHEDULE / TIMELINE TABLE

Activities	Organization	Deliverable Anticipated Date of Completion
Draft WP/SAP/APP to Regulatory Agencies	AIS/Tetra Tech Team	September 21, 2010
Comments from Agencies	Regulatory Agencies	October 21, 2010
Final SAP	AIS/Tetra Tech Team	November 5, 2010
Field Investigation	AIS/Tetra Tech Team	November 18, 2010 – February 25 2011
Draft Supplemental Site Inspection Report	AIS/Tetra Tech Team	May 13, 2011
Comments from Agencies	AIS/Tetra Tech Team	July 1, 2011
Final Supplemental Site Inspection Report	AIS/Tetra Tech Team	August 1, 2011

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE

17.1 SAMPLING PROCESS DESIGN AND SELECTION OF SAMPLING LOCATIONS

This section describes the sampling design and rationale for each media, the analytical groups, the sampling methods and locations, the number of samples, and the sampling frequency.

Analytical parameters for the sampling were selected to provide the information needed to evaluate if on-site sources of chlorinated solvents are present at the Site. Target analytes include VOCs, particularly TCE in groundwater, and VOCs and TPH in soil.

The field investigation will take place in five consecutive phases; sampling locations will be selected based on data collected during each subsequent phase, as described in detail in Attachment A1. The five field investigation phases and a summary of the manner in which sampling locations are selected are described in the table below.

Field Investigation Phase	Field Investigation Phase Description	Sampling Location Identification Data Input
1	Collect groundwater samples from the 11 existing wells (Figure A-2) for analysis of VOCs to obtain knowledge about current conditions of groundwater. Collect groundwater elevation measurements from the 11 on-site wells and eight off-site former vector control yard wells during the November 18, 2010, Black Thursday groundwater monitoring event to obtain information about the current potentiometric surface at the Site.	Locations that will be monitored are established monitoring wells on and off site. Elevation measurements from the November 18, 2010, Black Thursday event will be used to create updated groundwater elevation (potentiometric surface) contours. Phase 2 sampling locations will be reviewed and adjusted following Phase 1 of the field investigation based on changes in the groundwater elevation contours.
2	Advance between 28 and 50 CPT borings equipped with a MIP to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through the Site.	Proposed sampling locations presented on Figures A-11 and A-12 were selected using the following data inputs: • Validated analytical results for VOCs from existing monitoring wells • Validated analytical results for VOCs from previous grab groundwater samples • Lithological data from CPT/HSA boring logs • Historical aerial photographs • Contractor's reports from historical building and highway construction • Updated groundwater contours created by data collected in Phase 1 of the field investigation

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

Field Investigation Phase	Field Investigation Phase Description	Sampling Location Identification Data Input
3	Advance up to 18 DPT borings, if warranted, to define on-site sources of contamination. Collect one soil sample associated with FW41A.	Locations will be selected using the decision logic presented in Attachment A1 and evaluation of data collected during Phases 1 and 2 of the field investigation.
4	Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at the Site at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis and groundwater elevations at 11 existing on-site wells.	Locations will be selected using the decision logic presented in Attachment A1 and evaluation of data collected during Phases 1 through 3 of the field investigation.
5	Dispose of IDW off site.	NA

17.2 SAMPLE PROCEDURES

The following sections describe the procedures for sampling at the Site. The sampling procedure will be conducted in five phases, described in the table above.

17.2.1 Groundwater Elevation Measurement and Groundwater Sampling

Before any intrusive field activities, the on-site and nearby off-site wells will be measured for groundwater elevation. Additionally, on-site monitoring wells will be sampled for analysis of VOCs.

Monitoring Well Groundwater Elevation Measurements

Water level measurements will be collected at all on-site monitoring wells before they are sampled (Figure A-2). Additionally, elevation measurements will be collected from the on-site wells by the Navy during the November 18, 2010, Black Thursday regional groundwater elevation monitoring event. On the same day, AIS/Tetra Tech will collect water level measurements at the off-site wells south of the Site at the former vector control yard currently owned by the City of Mountain View and previously operated by Santa Clara County. The Navy will also collect elevation measurements from additional wells located to the east of the Site, and NASA will collect elevation measurements from their wells, located to the north of the Site. Groundwater elevation measurements collected during the Black Thursday event will be used to verify or modify the groundwater contours and flow direction at the Site.

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

The proposed CPT and MIP boring locations will be adjusted based on the resulting groundwater contours. The field team will record all water level measurements to the nearest 0.1 inch in field logbooks and groundwater sampling sheets. All water level measurements will be measured with a water level indicator.

Monitoring Well Groundwater Sampling

Samples will be collected from the 11 existing on-site wells (Figure A-2) with peristaltic or non-dedicated submersible bladder pumps (as appropriate for the depth) following low-flow micropurge methodology detailed in standard operating procedure (SOP) 015 developed by Tetra Tech and included in Attachment A3 of this SAP.

Before each well is purged, organic vapor will be measured at the top of the well using a PID. Immediately after the well cap has been removed, PID measurements will be collected from the headspace at the top of the inner casing and recorded in the field notebook and groundwater sampling sheets. The PID will be calibrated daily in accordance with the manufacturer's instructions to provide accurate readings. Background readings will be collected as well. Respiratory protection equipment will be available to each team and will be worn if organic vapors exceed the action levels detailed in the health and safety plan (Appendix B of the Work Plan). The field team will record concentrations of organic vapors in field logbooks and on groundwater sampling sheets. A water level indicator will be used to measure the depth to water from the top of the casing. The volume of groundwater in the well casing will then be calculated using this depth measurement and the total depth of the well. Care will be taken to ensure that the inlet for the tubing or pump is located near the central portion (or below) of the saturated zone so that VOCs within the groundwater sample are not affected by atmospheric conditions.

Groundwater will be slowly purged using an adjustable flow rate peristaltic or bladder pump system and run through a "flow-through" cell where groundwater parameters will be monitored and recorded every 3 to 5 minutes. Groundwater samples will not be collected until parameters have stabilized or a minimum of three casing volumes of water has been removed. Groundwater parameters to be measured include pH, temperature, specific conductance (SC), oxidation-reduction potential (redox potential or Eh), turbidity, and dissolved oxygen (DO). The readings will be considered stable (an indication of representative groundwater) when they do not change by more than 0.1 pH units, 3 percent for SC, 10 millivolts for Eh, and 10 percent for turbidity and DO over three successive readings.

The following equipment is required to collect samples:

- Water level indicator
- Adjustable flow rate peristaltic pump
- Non-dedicated bladder pump
- Dedicated tubing and bladders
- Discharge flow controller

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

- pH probe
- Dissolved oxygen probe
- Turbidity probe
- Oxidation and reduction (redox or Eh) probe
- SC probe
- Temperature probe
- Calibration solutions for pH, SC, turbidity, and dissolved oxygen probes

17.2.2 Cone Penetration Testing/Membrane Interface Probe Investigation

CPT will be employed in conjunction with the MIP readings to yield an overall profile of the lithology. Cone penetration testing provides detailed hydrogeologic logging by pushing an instrumented cone, tip facing down into the ground at a controlled rate. CPT provides a near-continuous log of the site lithology with real-time data capacity.

MIP is a sampling tool that heats adjacent media to 120 degrees Fahrenheit as it penetrates the subsurface. The heat volatilizes VOCs in the immediate area; the MIP then draws the constituents through a gas permeable membrane and into a carrier gas that is circulated to the surface and analyzed with three different detectors: a PID, a flame ionization detector (FID), and an electron capture device (ECD). The MIP will produce a profile of concentrations that is nearly continuous, providing VOC concentrations at intervals down to 1 foot. A separate log is plotted for the concentrations measured by each detector that is used.

MIP results are not medium-specific; constituents may volatilize from soil, soil gas, or the free phase above the water table and from soil, groundwater, or the free phase below the groundwater. This tool will effectively sum VOC concentrations that have partitioned into different media and allow a direct comparison of concentrations in the vadose zone, capillary fringe, and saturated zone.

Detection limits for individual analytes may range from 10 to 200 µg/L, depending on the analytes' boiling point. The resulting VOC concentration is the sum of all analytes that are detected. Detection limits decrease when the rate of penetration is reduced and the adjacent soil is heated to a higher temperature. Under these conditions, TCE may be detected at a level of 10 µg/L, and its daughter products may be detected at slightly higher concentrations. Because the concentration at source areas are anticipated to be several hundred parts per billion (or higher), a slower penetration rate is not required.

MIP and CPT sampling will be implemented as the second phase of the field event, to identify hot spot areas as potential on-site sources of TCE. MIP and CPT sampling will be correlated with, and followed by, discrete interval grab groundwater sampling using DPT.

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

17.2.3 Direct Push Technology/Hydropunch

The following subsections describe the procedures for discrete soil sampling (at FW41A) and discrete grab groundwater sampling using DPT. DPT borings will be offset from a MIP/CPT push by 5 feet, thus providing paired data points.

Discrete Soil Sampling

One subsurface soil sample will be collected to assess a potential hotspot at FW41A. Subsurface soil samples will be collected using DPT methods. The soil sample will be obtained from an acetate sleeve placed inside the core barrel. An EnCore sampler will be used to collect the soil sample from the acetate sleeve for analysis of VOCs and TPH-p. The remainder of the acetate sleeve will be submitted to the laboratory for analysis of TPH-e.

The soil sample will be sent to a California-certified, off-site laboratory. Additional details are provided in the direct-push SOP in Attachment A3.

Discrete Groundwater Sampling

After the Hydropunch tool is installed to the desired depth, the drive pipe will be lifted slightly to open the inlet ports and allow groundwater to enter the sample chamber. The samples will then be collected using a disposable bailer. All samples will be placed in vials, labeled, and kept in an ice-filled cooler until they are analyzed for VOCs at a fixed laboratory.

The DPT core barrel will be decontaminated between holes and just before sample collection so that potential compounds in the upper soil column do not contaminate the sample interval.

Soil generated from borings will be placed in drums at the drill site and labeled with the contents, date of generation, and responsible party. The containers will then be characterized for disposal.

After all samples have been collected, the subcontractor will seal all soil borings in accordance with State of California regulations. Destruction of the boring will include completely sealing the borehole with a bentonite and cement grout. The grout will be emplaced starting from the bottom of the hole and brought to the surface. All borings will then be staked for location surveying by GPS.

All non-disposable sampling tools will be decontaminated according to the procedures outlined in Section 14.3.3 before they are used for the next sample. Each grab groundwater sample will be analyzed for VOCs. All field log book entries will be completed while the field team is at the sampling location.

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

17.2.4 Groundwater Monitoring Well Installation

After the MIP, CPT, and DPT investigations, the collaborative data set will be evaluated. This data set includes previous data for lithology, soil and groundwater, MIP and CPT data, and discrete screening data for soil and groundwater. EVS will be used to optimize monitoring well locations. The following presents the procedures for well installation and development.

Monitoring Well Installation

Hollow-stem auger methods will be used to install all monitoring wells. All wells will be constructed of 4-inch diameter, flush-jointed PVC casing and factory-slotted screen. Well screen intervals will be 10 feet long and will be positioned within the permeable zones identified by CPT. Screen slot size will be 0.010 to 0.020 inch, depending on lithology.

A filter pack of clean sand, which will consist of sand large enough to prevent it from flowing into the screen, will be poured within the annular space between the screen and the borehole wall. The filter pack will extend a minimum of 2 feet, but not more than 3 feet, above the top of the screen. The filter pack will be poured as the auger flights are slowly removed so that the borehole walls do not collapse onto the screen. A 2-foot-thick layer (minimum) of bentonite clay (as granules, chips, pellets, or slurry) will be placed on top of the filter pack and allowed to fully hydrate before the remaining annular space is filled with grout. Cement grout will be emplaced with a tremie pipe from the top of the bentonite seal to the ground surface as the augers are removed. Settlement of grout will be checked 24 hours after it is placed. If needed, grout will be added to bring the top back to ground surface. Additional detail on well installation is provided in the SOPs in Attachment A3.

The wells will be completed as flush-mount installations. Flush-mounted steel boxes will be anchored in aggregate concrete at least 1-foot bgs. The boxes will be installed slightly above grade, and the concrete will slope away from the lid. Grout will be added to the box to ensure that the well annular space is sealed from potential surface contamination. A small notch will be cut on the north side of the top of PVC casing to be used as a reference for future water level measurements. All wells will be secured with locking caps.

17.2.5 Groundwater Monitoring Well Development, Surveying, and Sampling

All newly installed monitoring wells will be developed, surveyed, and sampled according the procedures described in the following subsections.

Monitoring Well Development

After construction, the newly installed wells will be developed by surging and pumping. After the grout has hardened (a minimum of 24 hours after placement), each monitoring well will be developed to promote passage of water from the native formation, through the filter pack, and into the well casing. Each well will be developed according to ASTM International standards

SAP WORKSHEET #17 — SAMPLING LOCATIONS AND METHODS (CONTINUED)

(including surging and pumping) and Tetra Tech SOPs (Attachment A3). At a minimum, a volume equal to the amount of any water used during drilling and monitoring well installation, plus three times the borehole volume (defined as the volume of water in the casing as well as in the pore space of the filter pack), will be removed during development.

The pH, SC, turbidity, and temperature will be regularly monitored during monitoring well development. Development will continue until these parameters are stable over three readings and the required volume has been extracted. The readings will be considered stable when they do not change by more than 10 percent over three consecutive readings. Development data will be recorded on well development forms.

One goal of development is to produce clear water from the monitoring well by removing fine-grained material (clay and silt) from the casing and sand pack. Each monitoring well will be developed sufficiently to obtain clear water; however, development will be halted if, after a reasonable effort, water from the monitoring well does not become clear, as long as the other parameters are stable.

Water produced during well development will be placed in 55 gallon-drums for storage and disposed of as described in Section 14.3.4.

Monitoring Well Surveying

A licensed land surveyor will survey the horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of the newly installed groundwater monitoring wells. Horizontal coordinates (easting and northing) of the surveyed locations will be supplied in U.S. survey feet in California State Plane Coordinates, Zone III, using the North American Datum of 1984. Vertical elevations shall be supplied in U.S. survey feet relative to mean sea level, based on the North American Vertical Datum of 1988. All elevations will be supplied to the nearest 0.01 foot. Worksheet #14 discusses surveying sample locations in the field with a hand-held GPS.

Monitoring Well Sampling

After each newly installed monitoring well has been developed, the well will be allowed to recover for a minimum of 48 hours before groundwater sampling begins. Groundwater samples and groundwater elevation measurements will be collected from the newly installed monitoring wells following the methods described in Section 17.2.1.

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE

Sampling Location	Sample ID	Matrix	Depth - Screened interval (feet bgs)	Analytical Group[a]	Number of Samples	Sampling SOP Reference
Phase 1 Groundwater Monitoring Samples						
MCH-1UA	SSI-GW-001	Groundwater	14-24	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-2LA	SSI-GW-002	Groundwater	32-42	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-3UA	SSI-GW-003	Groundwater	13-23.5	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-4LA	SSI-GW-004	Groundwater	34-44	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-5UA	SSI-GW-005	Groundwater	14-24	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-6LA	SSI-GW-006	Groundwater	41-51	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-7UA	SSI-GW-007	Groundwater	10-20	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-8LA	SSI-GW-008	Groundwater	35-45	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-9UA	SSI-GW-009	Groundwater	16-26	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-10LA	SSI-GW-010	Groundwater	35-45	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-11UA	SSI-GW-011	Groundwater	13-23	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-9UA (Duplicate)	SSI-D-001	Groundwater	16-26	VOCs by EPA SW-846 8260B	1	Worksheet #17
NA	SSI-ER-001	Water	Equipment Rinsate	VOCs by EPA SW-846 8260B	1[b]	Worksheet #17
NA	SSI-SWB-001	Water	Source Water Blank	VOCs by EPA SW-846 8260B	1[b]	Worksheet #17
NA	SSI-TB-002	Water	Trip Blank	VOCs by EPA SW-846 8260B	1	Worksheet #17
Phase 2 Soil Sample Collection at FW41A						
FW41A (existing location)	SSI-SS-001	Soil	11 feet bgs	VOCs by EPA SW-846 8260B TPH-p by EPA SW-846 8015B TPH-e by EPA SW-846 8015B	1	Worksheet #17
NA	SSI-TB-001	Water	Trip Blank	VOCs by EPA SW-846 8260B TPH-p by EPA SW-846 8015B	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Sampling Location	Sample ID	Matrix	Depth - Screened interval (feet bgs)	Analytical Group[a]	Number of Samples	Sampling SOP Reference
Phase 4 Groundwater Monitoring Samples						
MCH-1UA	SSI-GW-012	Groundwater	14-24	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-2LA	SSI-GW-013	Groundwater	32-42	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-3UA	SSI-GW-014	Groundwater	13-23.5	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-4LA	SSI-GW-015	Groundwater	34-44	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-5UA	SSI-GW-016	Groundwater	14-24	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-6LA	SSI-GW-017	Groundwater	41-51	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-7UA	SSI-GW-018	Groundwater	10-20	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-8LA	SSI-GW-019	Groundwater	35-45	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-9UA	SSI-GW-020	Groundwater	16-26	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-10LA	SSI-GW-021	Groundwater	35-45	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-11UA	SSI-GW-022	Groundwater	13-23	VOCs by EPA SW-846 8260B	1	Worksheet #17
MCH-7UA (Duplicate)	SSI-D-002	Groundwater	10-20	VOCs by EPA SW-846 8260B	1	Worksheet #17
NA	SSI-ER-002	Water	Equipment Rinsate	VOCs by EPA SW-846 8260B	1[b]	Worksheet #17
NA	SSI-SWB-002	Water	Source Water Blank	VOCs by EPA SW-846 8260B	1[b]	Worksheet #17
NA	SSI-TB-003	Water	Trip Blank	VOCs by EPA SW-846 8260B	1	Worksheet #17
Additional groundwater samples will be collected using DPT and Hydropunch when warranted. Locations will be determined using the decision logic in Attachment A1. Additional groundwater samples will be collected from newly installed monitoring wells, if installed. Sample IDs of groundwater samples will follow SSI-GW-022. Refer to Section 27.1.1 for the additional grab groundwater sample and point IDs collected using DPT and Hydropunch, and for the names of the newly installed monitoring wells.						

Notes:

a Analyte lists are presented on Worksheet #15. The most current published methodologies for all analytical methods will be used.

b The number of equipment rinsates and source blanks associated with groundwater sampling is estimated. The actual amount will depend on the type of equipment used and the number of sampling days Worksheet #12.

SAP WORKSHEET #19 — ANALYTICAL SOP REQUIREMENTS TABLE

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (Preparation / Analysis)
Soil	VOCs	EPA SW-846 8260B, 5035	3 EnCores collected from acetate liner	15 grams	Cool, 4˚ ±2˚ C	48 hours/14 days
Soil	TPH-p	EPA SW-846 8015B, 5035	3 EnCores collected from acetate liner	15 grams	Cool, 4˚ ±2˚ C	48 hours/14 days
Soil	TPH-e	EPA SW-846 8015B, 3520C	4oz Glass Jar	30-g	Cool, 4˚ ±2˚ C	14 days/40 days
Water	VOCs	EPA SW-846 8260B, 5030	3 x 40 mL vials	120 mL	HCl, 4˚±2˚ C	14 days
Water	TPH-p[a]	EPA SW-846 8015B, 5030	3 x 40 mL vials	120 mL	HCl, 4˚±2˚ C	14 days

Notes: See Worksheet #23 for analytical standard operating procedure references.

a Water samples for analysis of TPH-p will be collected for the quality control sample associated with the soil sample.

SAP WORKSHEET #20 — FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Matrix	Analytical Group	No. of Sampling Locations	No. of Samples[a]	No. of MS/MSDs[b]	No. of Equip. Rinsates[c]	No. of Source Blanks[c]	No. of Trip Blanks	Total No. of Samples to Laboratory
Soil	VOCs (EPA 8260B/5035)	1	1	0	1	1	1	3
Soil	TPH-p (EPA 8015B/5035)	1	1	0	1	1	1	3
Soil	TPH-e (EPA 8015B/3520C)	1	1	0	1	1	1	3
Water	VOCs (EPA 8260B/5030)	11 monitoring wells[d]	22	1	2	2	2	26[d]

Notes:

a Soil duplicates will not be collected for this project because they cannot be used directly to assess sampling precision since adjacent soil samples incorporate some spatial variability. Furthermore, it is not practical to set QC limits for the relative percent difference of these samples, which precludes their use for QC.

b Although the MS/MSD is not typically considered a field QC, it is included here because location is often selected in the field. The laboratory is required to run a MS/MSD on one of every 20 samples. Therefore, MS/MSD needs to be marked on the COC for one of 20 samples. The MS/MSDs are not included in the total number of samples to the laboratory.

c The number of equipment rinsates source blanks, and trip blanks associated with groundwater sampling is estimated. The actual amount will depend on the type of equipment used and the number of sampling days. Trip blanks are included in every ice chest for VOC and TPH-p samples.

d The number of groundwater samples collected will depend on data collected during the investigation. At least 11 monitoring wells will be sampled two times during this investigation.

SAP WORKSHEET #21 — PROJECT SAMPLING SOP REFERENCES TABLE

Reference Number	Title, Revision Date, and Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comment
SOP 005-2	Soil Sampling, 2009	Tetra Tech	See Section 17.2.1	N	
SOP 014-1	Static Water Level, Total Well Depth, and Immiscible Layer Measurement	Tetra Tech	See Section 17.2.1	N	
SOP 015-1	Groundwater Sampling Using Low Flow Methodology, 2009	Tetra Tech	See Section 17.2.1	N	
SOP 020-4	Monitoring Well Installation, 2009	Tetra Tech	Horiba U-22	N	
SOP 021-4	Monitoring Well Development, 2009	Tetra Tech		N	
SOP 061-2	Field Measurement of Groundwater Indicator Parameters, 2009	Tetra Tech	In-Situ, YSI, Hydac, and Horiba meters	N	
	GeoProbe Membrane Interface Probe (MIP), 2009	GeoProbe Systems	GeoProbe, MIP	N	

SAP WORKSHEET #22 — FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference	Comments
PID for groundwater sampling at wells	Calibration	Once per day	Per manufacturer's instructions	Recalibrate	FPM	Manufacturer's SOP	N/A
Water Quality Meter	Calibration	Once per day	Per manufacturer's instructions	Recalibrate	FPM	Manufacturer's SOP	Used to measure pH, SC, ORP, DO, temperature, turbidity
PID on MIP	Calibration	Once per day	Per manufacturer's instructions	Recalibrate	Driller	Manufacturer's SOP	N/A
Flame ionization detector (FID) on MIP	Calibration	Once per day	Per manufacturer's instructions	Recalibrate	Driller	Manufacturer's SOP	N/A
Electron Capture Device (ECD) on MIP	Calibration	Once per day	Per manufacturer's instructions	Recalibrate	Driller	Manufacturer's SOP	N/A

SAP WORKSHEET #23 — ANALYTICAL SOP REFERENCES TABLE

Laboratory SOP Number	Title and Revision Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EMAX-8260	Volatile Organics by GCMS Rev.4	Definitive Data	Soil/Water - VOCs	GC/MS	EMAX	N
EMAX-8015G	Gasoline Range Organics Rev.1	Definitive Data	Soil – TPH-purgeable	GC	EMAX	N
EMAX-8015D	Diesel Range Organics Rev.3	Definitive Data	Soil – TPH-extractable	GC	EMAX	N

Notes:

GC/MS Gas chromatograph/mass spectrometer
VOC Volatile organic compound

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS	ICAL	Initially; as needed	SPCCs average RF ± 0.050 and %RSD for RFs for CCCs < 30% and one option below: (1) Linear -- mean RSD for all analytes ≤15% (2) Linear – least squares regression r ≥ 0.995, when RSD >15% (3) Non-linear – r^2 > 0.990 (6 points shall be used for second order, 7 points shall be used for third)	If SPCC is non-compliant, it could be a result of standard degradation or active presence to active sites in the system. Correct the problem and repeat calibration. If CCC is non-compliant, it could be a result of system leaks, or reactive column sites or standard degradation. Correct the problem and recalibrate. If RSD is non-compliant, check for outlier and repeat that ICAL point; otherwise perform instrument troubleshooting, then repeat calibration.	Laboratory Analyst	EMAX-8260
GC/MS	ICV	Every after ICAL	All analytes within ±25% of expected value [poor performers within ±35% of expected value]	If no data quality indicators are observed in the ICAL, it indicates standard degradation. Prepare a new standard and reanalyze ICV. Otherwise check and correct probable cause of problem and repeat initial calibration.	Laboratory Analyst	EMAX-8260
GC/MS	DCC	Every 12 hours	SPCCs: Min.RF same as ICAL CCCs: %Diff≤ (when using RFs) or drift (when using least squares regression or non-linear calibration)	If SPCC is non-compliant, it could be a result of standard degradation or active presence to active sites in the system. Correct the problem and repeat calibration. If CCC is non-compliant it could be a result of system leaks, or reactive column sites or standard degradation. Correct the problem and recalibrate.	Laboratory Analyst	EMAX-8260

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC	ICAL	Initially; as needed	1) RSD for all analytes ≤20% 2) Linear – least squares regression r > 0.995 3) Non-linear – COD > 0.990 (6 points shall be used for second order, 7 points shall be used for third order)	Correct the problem then repeat initial calibration	Laboratory Analyst	EMAX-8015G EMAX-8015D
GC	ICV	Every after ICAL	All analytes within ±15% of expected value	Correct the problem then repeat initial calibration	Laboratory Analyst	EMAX-8015G EMAX-8015D
GC	DCC	Every 12 hours	All analytes within ±15% of expected value	Correct the problem then repeat initial calibration	Laboratory Analyst	EMAX8015G EMAX-8015D

Notes:

1 Quality control criteria are at least as stringent as laboratory-specific statistically derived limits and limits from DoD QSM 4.1 (DoD Environmental Data Quality Workgroup 2009).

DCC Daily continuing calibration
GC/MS Gas chromatograph/mass spectrometer
ICAL Initial calibration
ICV Initial calibration verification
RSD Relative standard deviation
SOP Standard operating procedure

Reference:

DoD Environmental Data Quality Workgroup. 2009. DoD Quality Systems Manual for Environmental Laboratories, Version 4.1. Based on NELAC Voted Revision, 5 June 2003. April 22.

SAP WORKSHEET #25 — ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS GC	Parameter Setup	Physical check	Physical check	Initially; prior to DCC	Ensure instrument settings match those set forth in the SOP	Reset instrument settings to those set forth in the SOP	Laboratory Analyst	EMAX-8260 EMAX-8015G EMAX-8015D
GC/MS	Tune Check	Instrument Performance	Conformance to instrument tuning	Initially, prior to DCC	Compliance to ion abundance criteria	Repeat tune check to rule out standard degradation or inaccurate injection. If problem persists, retune the instrument and repeat tune check	Laboratory Analyst	EMAX-8260

Notes:

DCC Daily continuing calibration
GC/MS Gas chromatograph/mass spectrometer
SOP Standard operating procedure

SAP WORKSHEET #26 — SAMPLE HANDLING SYSTEM

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/AIS/Tetra Tech Team
Sample Packaging (Personnel/Organization): Field Team/AIS/Tetra Tech Team
Coordination of Shipment (Personnel/Organization): Field Team/AIS/Tetra Tech Team
Type of Shipment/Carrier: Federal Express Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory sample custodian/EMAX
Sample Custody and Storage (Personnel/Organization): Laboratory sample custodian/EMAX
Sample Preparation (Personnel/Organization): Laboratory Analyst/EMAX
Sample Determinative Analysis (Personnel/Organization): Analytical Chemist/EMAX
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 30 days after delivery of the data package
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days after delivery of the data package
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Laboratory sample custodian/EMAX
Number of Days from Analysis: 30 days after delivery of the data package

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE

27.1 SAMPLE HANDLING AND CUSTODY

The following sections describe sample handling procedures, including sample ID and labeling, documentation, COC procedures, and shipping.

27.1.1 Point and Sample Identification

Existing and new point location and sample identification numbers (IDs) will be used for point and sample location identifiers (known as point IDs and sample IDs). The description of the sample type and the point ID will be recorded on the extended COC forms, as well as in the field notes. In general, the point IDs for all sampling locations established by the AIS/Tetra Tech Team were arranged in the following manner:

Point Type	Point ID
CPT/MIP Comparison (MIP #0 or #SS0)	LOCX-0-LA/UA or LOC3-SS0-UA
CPT/MIP Stepout – Source Branch or Paint Locker (MIP #S1/S2 or SS1/SS2)	LOCX-SX-LA/UA or LOC3-SSX-LA/UA
CPT/MIP Stepout- Plume Branch (MIP #P1-P3)	LOCX-PX-UA
CPT/MIP Stepout Background- Paint Locker (MIP #B1/B2)	LOC3-BX-LA/UA
DPT Hydropunch	LOCX-DP-01-LA/UA
Monitoring Well	OP-001-LA/UA

A CPT log and a MIP response profile will be generated, but no sample will be collected, in areas where a CPT/MIP boring is advanced. Each individual groundwater and soil sample collected using Hydropunch or from groundwater monitoring wells will be identified by a unique sample ID number. Sample ID numbers will be listed on the COC records submitted to the laboratory and will be cross-referenced to the point name in permanently bound field logbooks and sample data sheets (Worksheet #18). In general, the sample IDs will be arranged in the following manner:

Field Event ID:	SSI
Sample Type:	HP/SS/GW
Unique Number:	001 through XXX

Where:

HP	=	Hydropunch-grab groundwater samples
SS	=	Direct push soil samples
GW	=	Low flow groundwater monitoring samples

Therefore, the first groundwater sample collected using Hydropunch will have the sample ID SSI-HP-001.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

Point names and corresponding sample IDs are presented on Worksheet #18.

QC samples for this investigation will also be assigned specific sample IDs. The following system will be used for each QC sample.

Field Duplicates	=	SSI-D-001 through XXX
Trip Blank (TB)	=	SSI –TB-001 through XXX
Source water blank (SWB)	=	SSI-SB-001 through XXX
Equipment rinsate (ER)	=	SSI-ER-001 through XXX

27.1.2 Sample Labels

A sample label will be affixed to all sample containers. The label will be completed with the following information written in indelible ink:

- Project name and location
- Sample ID number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Analysis required

After labeling, each sample will be refrigerated or placed in a cooler containing ice to maintain the sample temperature at 4 ± 2 °C.

27.1.3 Sample Documentation

Documentation during sampling is essential to ensure proper sample identification. AIS/Tetra Tech personnel will adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Any serialized documents will be maintained at Tetra Tech and referenced in the site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

27.1.4 Chain-of-Custody

AIS/Tetra Tech Team will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies:

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

COC procedures provide an accurate written record that traces the possession of individual samples from the time they are collected in the field to the time they are accepted at the laboratory. The COC record (see Attachment A2) also will be used to document all samples collected and the analysis requested. Information that the field personnel will record on the COC record includes the following:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample ID number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used (if applicable)
- Filtering (if applicable)
- Sample designation (grab or composite)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Federal Express airbill number (if applicable)
- Project contact and phone number

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

Unused lines on the COC record will be crossed out. Field personnel will sign COC records that are initiated in the field, and the FedEx airbill number will be recorded. The record will be inserted in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills will serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the COC record and the airbill will be retained and filed by field personnel before the containers are shipped.

Laboratory COC begins when samples are received and continues until samples are discarded. Laboratories analyzing samples under the USACE contract will follow custody procedures at least as stringent as are required by the EPA CLP SOWs (EPA 2005c). The laboratory should designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information on the samples, including the persons who delivered the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample ID numbers, and any unique laboratory ID numbers for the samples. This information should be entered into a computerized laboratory information management system. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples that require special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, will be properly stored and maintained prior to analysis.

27.1.5 Sample Shipment

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

- The cooler will be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material will be used to prevent sample containers from breaking during shipment. Enough ice will be added to maintain the sample temperature of below 4 ± 2 °C.
- The COC records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The Federal Express air bill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.
- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, it will be taped shut both inside and outside of the cooler.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

- Signed and dated custody seals will be affixed on the front and side of each cooler. Wide clear tape will be placed over the seals to prevent accidental breakage.
- The COC record will be transported within the taped sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the COC record to document transfer of samples.

Multiple coolers may be sent in one shipment to the laboratory. The airbill will be marked to indicate the number of coolers in the shipment.

SAP Worksheet #27 Example Sample Label

Company: AIS/Tetra Tech Team	**Project Name:** Former OPHA
Sampler: DY, RJ	**Sample ID:** SSI-HP-001
Date: 11/19/10	**Time:** 13:15
Analysis: VOCs	**Preservative:** HCl

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE

Matrix	Soil/Water
Analytical Group	VOCs
Analytical Method / SOP Reference	EPA 8260B/5035 & 5030 EMAX-8260/5035 & 5030

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch	All analytes ≤1/2 QLs	Reprep and reanalyze method blank (MB) and all samples processed with the non-conforming MB.	Laboratory Analyst	Accuracy/Bias-Contamination	No Target Compounds>RL
LCS	One in the absence of MS/MSD	80-120% Recovery	Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.	Laboratory Analyst	Accuracy/Bias	80-120 % Recovery RPD 20
MS/MSD	Will be designated in the field	75-125% Recovery	Discuss in the case narrative.	Laboratory Analyst	Interferences - Accuracy/Bias - Precision	75-125% Recovery RPD 20
Dilution Test	Per sample preparation batch	1:5 dilution must agree within + 10% of the original determination	Perform post-digestion spike addition.	Laboratory Analyst	Accuracy/Bias	1:5 dilution must agree within + 10% of the original determination
Analytical Spike	When MS/MSD failed	Recovery within 75-125% of expected value	Discuss in the case narrative.	Laboratory Analyst	Interferences - Accuracy/Bias - Precision	75-125% Recovery
PT	Bi-annual	Within PT Study Limits	Review source of error; perform corrective action on PT sample.	Laboratory Analyst	Accuracy/Bias	Within PT Study Limits

Notes:

1 Quality control criteria are at least as stringent as laboratory-specific statistically derived limits and limits from DoD QSM 4.1 (DoD Environmental Data Quality Workgroup 2009).

Reference:

DoD Environmental Data Quality Workgroup. 2009. DoD Quality Systems Manual for Environmental Laboratories, Version 4.1. Based on NELAC Voted Revision, 5 June 2003. April 22.

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Matrix	Soil/Water
Analytical Group	TPH-e, TPH-p
Analytical Method / SOP Reference	8015B EMAX-8015G EMAX-8015D

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	All analytes <1/2 QLs	Reprep and reanalyze LCS and all samples processed with the no-conforming LCS.	Laboratory Analyst	Apply “B” flag on associated analyte(s)	All compounds less than ½ the reporting limit.
Surrogate	Every analytical sample	Refer to QC Limit Table below	Reprep and reanalyze LCS and all samples processed with the no-conforming LCS.	Laboratory Analyst	Apply “*” flag on non-conforming analyte(s)	Refer to QC Limit Table below
LCS	One per sample preparation batch	Refer to QC Limit Table below	Reprep and reanalyze LCS and all samples processed with the no-conforming LCS.	Laboratory Analyst	Apply “*” flag on non-conforming analyte(s)	Refer to QC Limit Table below
MS/MSD	Project designated sample matrix QC.	Refer to QC Limit Table below	Discuss in the case narrative.	Laboratory Analyst	Apply “*” flag on non-conforming analyte(s)	Refer to QC Limit Table below
PT	Bi-annual	Within PT Study Limits	Review source of error perform corrective action PT sample.	Laboratory Analyst	Apply “Not-acceptable” to non-conforming analyte(s)	Within Study Limits

Notes:

1 Quality control criteria are at least as stringent as laboratory-specific statistically derived limits and limits from DoD QSM 4.1 (DoD Environmental Data Quality Workgroup 2009).

Reference:

DoD Environmental Data Quality Workgroup. 2009. DoD Quality Systems Manual for Environmental Laboratories, Version 4.1. Based on NELAC Voted Revision, 5 June 2003. April 22.

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Analyte	LCS(W)	MS(W)	RPD	LCS(SW)	MS(SW)	RPD
Gasoline	60-130	50-130	30	60-130	50-130	50
4- Bromofluorobenzene (Surr)	70-130	60-140		70-140	70-140	
Diesel	60-140	70-140	30	60-140	40-150	50
Bromobenzene (Surr1)	50-140	50-130		50-150	40-160	
Hexacosane (Surr2)	70-150	70-140		70-140	70-160	

Notes:

1 Quality control criteria at least as stringent as laboratory specific statistically derived limits and limits from DoD QSM 4.1.

Reference:

DoD Environmental Data Quality Workgroup. 2009. DoD Quality Systems Manual for Environmental Laboratories, Version 4.1. Based on NELAC Voted Revision, 5 June 2003. April 22.

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE

Document	Where Maintained
SAP, Work Plan, and Health and Safety Plan	Field office, Project file
Field notes/logbook	Project file
COC records	Project file
Field forms	Project file
Laboratory raw data package (hard copy)	Project file (CD)
Audit/assessment checklists/reports	Project file and laboratory
Corrective action forms/reports	Project file and laboratory
Laboratory equipment calibration logs	Laboratory
Sample preparation logs	Laboratory
Run logs	Laboratory
Sample disposal records	Laboratory
Validated data	Project file

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
Soil / Water	VOCs, TPH-p, and TPH-e	See Worksheet #18	EPA SW-846 8260B, EPA SW-846 8015B	21 days	EMAX; Ye Myint 1835 West 205th Street Torrance, CA 90501 (310) 618-8889	TestAmerica; Karen Sellers 880 Riverside Parkway West Sacramento, CA 95605 (800) 753-4225

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

Requirements for Summary Data Packages – Inorganic Analysis	
Section I **Case Narrative**	**Sections I, II, III** **Summary Package**
1. Case narrative	**Section IV** **Instrument Raw Data - Sequential measurement readout records for ICP, graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:**
2. Copies of nonconformance and corrective action forms	1. Environmental samples, including dilutions and re-analysis
3. COC forms	2. Initial calibration
4. Copies of sample receipt notices	3. Initial and continuing calibration verifications
5. Internal tracking documents, as applicable	4. Detection limit standards
Section II **Sample Results – Form I for the following:**	5. Method blanks, continuing calibration blanks, and preparation blanks
1. Environmental sample including dilutions and re-analysis	6. ICP interference check samples
	7. MS and post-digestion spikes
Section III **QA/QC Summaries – Forms II through XIV for the following:**	8. Sample duplicates
1. Initial and continuing calibration verifications (Form II)	9. LCSs
2. Project-required reporting limit (PRRL) standard (Form II)	10. Method of standard additions
3. Detection limit standard (Form II-Z)	11. ICP serial dilution
4. Method blanks, continuing calibration blanks, and preparation blanks (Form III)	**Section V** **Other Raw Data**
5. Inductively coupled plasma (ICP) interference-check samples (Form IV)	1. Percent moisture for sediment samples
6. MS and post-digestion spikes (Forms V and V-Z)	2. Sample digestion, distillation, and preparation logs, as necessary
7. Sample duplicates (Form VI)	3. Instrument analysis log for each instrument used
8. LCSs (Form VII)	4. Standard preparation logs, including initial and final concentrations for each standard used
9. Method of standard additions (Form VIII)	5. Formula and a sample calculation for the initial calibration
10. ICP serial dilution (Form IX)	6. Formula and a sample calculation for sediment sample results
11. Instrument detection limit (IDL) (Form X)	
12. ICP interelement correction factors (Form XI)	
13. ICP linear working range (Form XII)	

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

30.1 SELECTION OF ANALYTICAL LABORATORIES

Laboratories for this USACE investigation have been selected from a list of prequalified laboratories that were developed by Tetra Tech to support Government contracts. Prequalification streamlines laboratory selection by reducing the need to compile and review detailed bid and qualification packages for each individual investigation. Prequalification also improves flexibility in the program by allowing analysis to be directed to a number of different capable laboratories with available capacity when samples are collected.

Tetra Tech's laboratory prequalification and selection process relies on: (1) a standard procedure to evaluate and prequalify laboratories for work under the contract, and (2) the Tetra Tech "Laboratory Analytical Statement of Work" for Government contracts (Tetra Tech 2006), a contractual document that specifies standard requirements for analyses that are routinely conducted. Tetra Tech establishes a basic ordering agreement that incorporates and enforces the laboratory SOW with each prequalified laboratory. Individual purchase orders can then be written for specific investigations. These aspects of laboratory selection are further described in the following sections, along with Tetra Tech's procedures for selecting laboratories when the laboratory SOW does not specifically address project-specific analytical methods or QC requirements.

30.2 LABORATORY EVALUATION AND PREQUALIFICATION

Laboratories that support the Army directly or through subcontracts were evaluated and approved for Government contracts under the "the "Tetra Tech EM Inc. Laboratory Analytical Statement of Work" for Government contracts (Tetra Tech 2006). Laboratories that support Tetra Tech under government contracts were selected from the list of laboratories and evaluated by Tetra Tech to assure that the laboratory can meet the technical requirements of the laboratory SOW and produce data of acceptable quality. The laboratory evaluation includes the following elements:

- **Certification and approval**. Laboratories must be currently certified by the California State Health Department, Environmental Laboratory Accreditation Program, for analysis of each method specified.
- **Performance evaluation samples**. Each laboratory must initially and yearly demonstrate its ability to satisfactorily analyze single-blind performance evaluation samples for all analytical services it will provide under Tetra Tech's government contracts. At its discretion, Tetra Tech may submit one or more double-blind performance evaluation samples at Tetra Tech's cost. When the results for the performance evaluation sample are deficient, the laboratory must correct any problems and analyze (at its own cost) a subsequent round of performance evaluation samples for the deficient analysis.

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

- **Audits**. Laboratories must initially and yearly demonstrate their qualifications by submitting to one or more audits by Tetra Tech. The audits may consist of (1) an on-site review of laboratory facilities, personnel, documentation, and procedures, or (2) an off-site review of hard copy and electronic deliverables, or magnetic tapes. When deficiencies are identified, the laboratory must correct the problem and provide Tetra Tech with a written summary of the corrective action that was taken.

SAP WORKSHEET #31 — PLANNED PROJECT ASSESSMENTS TABLE

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Field Readiness Review	Before mobilization for the project and before major phases of work are initiated	Internal	AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team	Project QAM, AIS/Tetra Tech Team
Field Sampling Surveillance	Once at the beginning of field sampling	Internal	AIS/Tetra Tech Team	Analytical Coordinator, AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team	TOM,AIS/Tetra Tech Team	Project QAM and Analytical Coordinator, AIS/Tetra Tech Team
Management Review	Once	Internal	AIS/Tetra Tech Team	Project QAM, AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team	TOM,AIS/Tetra Tech Team	Project QAM, AIS/Tetra Tech Team
Laboratory Technical Systems Audit	Will be implemented if deemed necessary by Army or AIS/Tetra Tech Team QAC	External	AIS/Tetra Tech Team	Project QAM, AIS/Tetra Tech Team	PM, EMAX Lab	PM, EMAX Lab	Project QAM, AIS/Tetra Tech Team
Laboratory Data Validation	Once; approximately 2 weeks after final receipt of data	External	Laboratory Data Consultants	PM, Laboratory Data Consultants	Analytical Coordinator, AIS/Tetra Tech Team	PM, EMAX Lab	Analytical Coordinator, AIS/Tetra Tech Team

SAP WORKSHEET #32 — ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Assessment	Technical Systems Audit (TSA) Report	TOM, Project QAM, FPM, and Analytical Coordinator, AIS/Tetra Tech	2 days	TSA Status Report, Electronic format	TOM and QAM, AIS/Tetra Tech	2 days
Laboratory Assessment	TSA Report	TOM, Project QAM, FPM, AIS/Tetra Tech	5 days	TSA Report, Electronic format	PM and QAM, AIS/Tetra Tech PM, EMAX Laboratory	5 days

SAP WORKSHEET #33 — QA MANAGEMENT REPORTS TABLE

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Daily Progress Report	Daily	At the end of each field day	Field Project Manager (FPM), AIS/Tetra Tech Team	TOM, AIS/Tetra Tech Team
Weekly Status Report	Weekly	At the end of each field week	FPM, AIS/Tetra Tech Team	QA Manager, AIS/Tetra Tech Team COR, USACE
QC Summary Report	With Report Submittal	Submitted in Final Report	TOM, AIS/Tetra Tech Team	COR, USACE

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Audit reports	When the report is complete, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week and when the site work is complete, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the TOM will be notified to ensure action is taken.	I	TOM, AIS/Tetra Tech Team
Field notes/logbook	Field notes will be reviewed internally and placed in the project file. A copy of the field notes will be attached to the final report.	I	FPM, AIS/Tetra Tech Team
Sample receipt	For samples shipped via commercial carrier, the analytical coordinator will verify receipt of samples by the laboratory the day following shipment.	I	Analytical coordinator, AIS/Tetra Tech Team
Sample logins	Sample login information will be reviewed and verified for completeness in accordance with the COC forms.	I,E	Analytical coordinator, AIS/Tetra Tech Team Laboratory PM, EMAX
COC records	COC forms will be reviewed internally when they are completed and verified against the packed sample coolers they represent. The shipper's signature on the COC form should be initialed by the reviewer, a copy of the COC form will be retained in the project file, and the original and remaining copies will be taped inside the cooler for shipment.	I	FPM, AIS/Tetra Tech Team
Laboratory data prior to release	Laboratory data will be reviewed and verified for completeness against analyses requested on the COC forms.	E	Laboratory PM, EMAX
Laboratory data due at turnaround time listed on COC	Laboratory data will be verified that the analyses reported are consistent with the analytical suite requested on the COC forms.	I	Analytical coordinator, AIS/Tetra Tech Team

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE (CONTINUED)

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Laboratory data packages	All laboratory data packages will be verified for completeness by the laboratory performing the work. Data packages will then be reviewed by the analytical coordinator for completeness. Subsequently, data packages will be evaluated externally by undergoing data validation.	I,E	Laboratory PM, EMAX Analytical coordinator, AIS/Tetra Tech Team Third-party data validator, Laboratory Data Consultants
Laboratory data	All laboratory data packages will be verified for completeness and technical accuracy internally by the laboratory performing the work before they are submitted. All received data packages will be verified externally according to the data validation procedures specified in Worksheet #36.	I, E	Laboratory PM, EMAX Third-party data validator, Laboratory Data Consultants
Field and electronic data	One hundred percent of manual entries will be reviewed against the hardcopy information, and 10 percent of electronic uploads will be checked against the hardcopy.	I	Analytical Coordinator, AIS/Tetra Tech Team

SAP WORKSHEET #35 — VALIDATION (STEPS IIA AND IIB) PROCESS TABLE

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Field logbook	Field logbooks will be reviewed weekly for accuracy associated with each sampling event. The inspection will be documented in daily QC reports.	TOM, AIS/Tetra Tech Team
IIa	COC forms	COC forms will be reviewed daily to ensure that project information, sample analyses requested, number of field QC samples collected, and percent level III or IV validation chosen is accurate and in accordance with the requirements in this SAP.	Analytical Coordinator, AIS/Tetra Tech Team
IIa	Sample receipt	The sample cooler will be checked for compliance with temperature and packaging requirements.	Laboratory sample custodian, EMAX
IIa	Sample logins	Sample login will be reviewed for accuracy against the COC form.	Analytical Coordinator, AIS/Tetra Tech Team Laboratory PM, EMAX
IIa	Laboratory data prior to release	Laboratory data will be reviewed to ensure that the data is accurate and meets the requirements in this SAP. Before they are released, data will be validated as follows:	Laboratory PM, EMAX
		100 percent of the data comply with the method- and project-specific requirements; any deviations or failure to meet criteria are documented for the project file.	Laboratory Analyst, EMAX
		100 percent of manual entries are free of transcription errors and manual calculations are accurate; computer calculations are spot-checked to verify program validity; data reported are compliant with method- and project-specific QC requirements; raw data and supporting materials are complete; spectral assignments are confirmed; descriptions of deviations from method or project requirements are documented; significant figures and rounding have been appropriately used; reported values include dilution factors; and results are reasonable.	Laboratory Peer Analyst, EMAX
		Data reported comply with method- and project-specific QC requirements; the reported information is complete; the information in the report narrative is complete and accurate; and results are reasonable.	Laboratory Supervisor, EMAX

SAP WORKSHEET #35 — VALIDATION (STEPS IIA AND IIB) PROCESS TABLE (CONTINUED)

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Laboratory data prior to release	Data reported comply with method- and project-specific QC; analytical methods are performed in compliance with approved SOPs. This review may be conducted after release of data since they are done only on 10 percent of the data.	Laboratory QAM, EMAX
IIa	Laboratory data due at turnaround time listed on COC	Laboratory data will be reviewed to ensure that the data reported met the analyte list and limits listed in Worksheet #15.	Analytical Coordinator, AIS/Tetra Tech Team
	Laboratory data packages	All laboratory data packages will be validated by the laboratory performing the work for technical accuracy before they are submitted.	Laboratory PM, EMAX
		Data packages will then be reviewed for accuracy against the laboratory data that was faxed or e-mailed at the turnaround time listed on the COC.	Analytical Coordinator, AIS/Tetra Tech Team
		Data packages will be evaluated externally by undergoing data validation.	Third-party data validator, Laboratory Data Consultants
IIb	Data validation reports	Data validation reports will be reviewed in conjunction with the project PQOs and data quality indicators.	Analytical Coordinator, AIS/Tetra TechTeam

Note:

1 IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
IIb=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (Title and Organizational Affiliation)
IIa	Water/Soil	VOC	In accordance with this SAP, EPA 8260B/EMAX SOP "Volatile Organics by GCMS Rev.4"	QA Manager, EMAX
IIa	Water/Soil	TPH-p	In accordance with this SAP, EPA 8015B/EMAX SOP "Gasoline Range Organics Rev.1"	QA Manager, EMAX
IIa	Soil	TPH-e	In accordance with this SAP, EPA 8015B/EMAX SOP "Diesel Range Organics Rev.3"	QA Manager, EMAX
IIb	Water/Soil	VOC	In accordance with this SAP, EPA 8260B/ EMAX SOP "Volatile Organics by GCMS Rev.4"	Stella Cuenco, Project Manager, Laboratory Data Consultants
IIb	Water/Soil	TPH-p	In accordance with this SAP, EPA 8015B/EMAX SOP "Gasoline Range Organics Rev.1"	Stella Cuenco, Project Manager, Laboratory Data Consultants
IIb	Soil	TPH-e	In accordance with this SAP, EPA 8015B/EMAX SOP "Diesel Range Organics Rev.3"	Stella Cuenco, Project Manager, Laboratory Data Consultants

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE (CONTINUED)

36.1 DATA VALIDATION AND USABILITY

This section describes the procedures planned to review, verify, and validate field and laboratory data. This section also discusses procedures for verifying the data are adequate to meet PQOs and measurement quality objectives for the project.

36.1.1 Data Review, Verification, and Validation

Validation and verification of the data generated during field and laboratory activities are essential to obtaining defensible data of acceptable quality. Verification and validation methods for field and laboratory activities are presented below.

36.1.2 Field Data Verification

Project personnel will verify field data through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in this SAP so that defensible and justifiable data are obtained.

Data values that are significantly different from the population are called "outliers." A systematic effort will be made to identify any outliers or errors before field personnel report the data. Outliers can result from improper sampling or measurement methodology, data transcription errors, calculation errors, or natural causes. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

36.1.3 Laboratory Data Verification

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any nonconformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE (CONTINUED)

36.1.4 Laboratory Data Validation

An independent third-party contractor will validate all laboratory data in accordance with current EPA national functional guidelines (EPA 2008). The data validation strategy will be consistent with DOD guidelines. The validation contractor will conduct cursory validation (Level 3) of 90 percent of the data and full validation (Level 4) of 10 percent of the data for this investigation for this project. Requirements for cursory and full validation are listed below.

36.1.5 Data Validation Criteria

Worksheets #12, #24, #25, #28, and #36 list the QC checks and criteria that will be reviewed for both cursory and full data validation. The data validation will be consistent with the project-specific analytical methods referenced in Worksheet #19.

SAP WORKSHEET #37 — USABILITY ASSESSMENT

37.1 MEASUREMENT QUALITY OBJECTIVES

All analytical results will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. Of these PARCC parameters, precision and accuracy will be evaluated quantitatively by collecting the QC samples listed in Worksheet #12.

The following subsections describe each of the PARCC parameters and how they will be assessed within this project.

37.1.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision are evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as an RPD:

$$RPD = \frac{|A-B|}{(A+B)/2} \quad x \quad 100\%$$

where:

A	=	First duplicate concentration
B	=	Second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples.

Laboratory analytical precision is evaluated by comparing analytical results of field samples with those of field duplicates, laboratory matrix duplicates, or by analyzing MS of field samples along with MSD. The results of the analysis of each MS/MSD or duplicate pair will be used to calculate an RPD for evaluating precision. Worksheet #28 presents the precision goals for this project.

37.1.2 Accuracy

Field accuracy will be assessed by collecting and analyzing equipment rinsate and source water blank QC samples. These QC samples will be used to evaluate the potential for target analytes to enter samples as a result of sampling processes.

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, LCS or blank spikes, and method blanks. LCS or blank spikes are also analyzed at a frequency of 5 percent or per extraction batch, whichever is most frequent. The results of the spiked samples are used to calculate the percent recovery (%R) for evaluating accuracy.

$$\% \ R = \frac{S - C}{T} \ x \ 100$$

where:

S	=	Measured spike sample concentration
C	=	Sample concentration
T	=	True or actual concentration of the spike

Worksheet #28 presents accuracy goals for this investigation based on the percent recovery of laboratory and matrix spikes. Results that fall outside the accuracy goals will be evaluated further on the basis of the results of other QC samples.

37.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

37.1.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

As discussed further in Section 37.2, completeness will also be evaluated as part of the data quality assessment process (EPA 2000). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

37.1.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Field procedures will be standardized to ensure comparability. The comparability of laboratory data will be assured by use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, or similar units), and consistency in reporting units (parts per million, parts per billion, and so forth).

37.1.6 Detection and Quantitation Limits

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The quantitation limit (QL) represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a specific sample matrix. Laboratory QLs are contractually specified maximum quantitation limits for specific analytical methods and sample matrices, such as water, and are typically several times higher than the MDL to allow for matrix effects. Practical quantitation limits (PQL), which are established by AIS/Tetra Tech in the scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

Analytical methods have been selected for this project so that the PQL for each target analyte is below the applicable comparison criteria wherever practical. Worksheet #15 compares the PQLs for the selected analytical methods with comparison criteria. This comparison shows that the analytical methods selected and the associated laboratory QLs and PQLs are capable of quantifying the contaminants of concern at concentrations below the applicable screening criteria, in most cases. The laboratory QL listed reflects the maximum sensitivity of current, routinely used analytical methods. All analytes will be reported as estimated values if concentrations are less than QLs but greater than MDLs. This procedure is being adopted to help ensure that analytical results can effectively be compared with comparison criteria for certain compounds where the screening criteria are near or below the QL. This procedure also will help to ensure that subsequent statistical evaluations of the data will not be biased by high-value nondetect results.

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

37.2 RECONCILIATION WITH USER REQUIREMENTS

After environmental data have been reviewed, verified, and validated in accordance with the procedures, the data must be further evaluated to determine whether PQOs have been met.

To the extent possible, the AIS/Tetra Tech Team will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Guidance for Data Quality Assessment, Practical Methods for Data Analysis" (EPA 2000). The DQA process includes five steps: (1) review the PQOs and sampling design; (2) conduct a preliminary data review; (3) select a statistical test; (4) verify the assumptions of the statistical test; and (5) draw conclusions from the data.

Tetra Tech will systematically assess data quality and data usability when the five-step DQA process is not completely followed because the PQOs are qualitative. This assessment will include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives
- A review of project-specific data quality indicators for PARCC and quantitation limits to evaluate whether acceptance criteria have been met
- A review of project-specific PQOs to determine whether they have been achieved by the data collected
- An evaluation of any limitations associated with the decisions to be made based on the data collected

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

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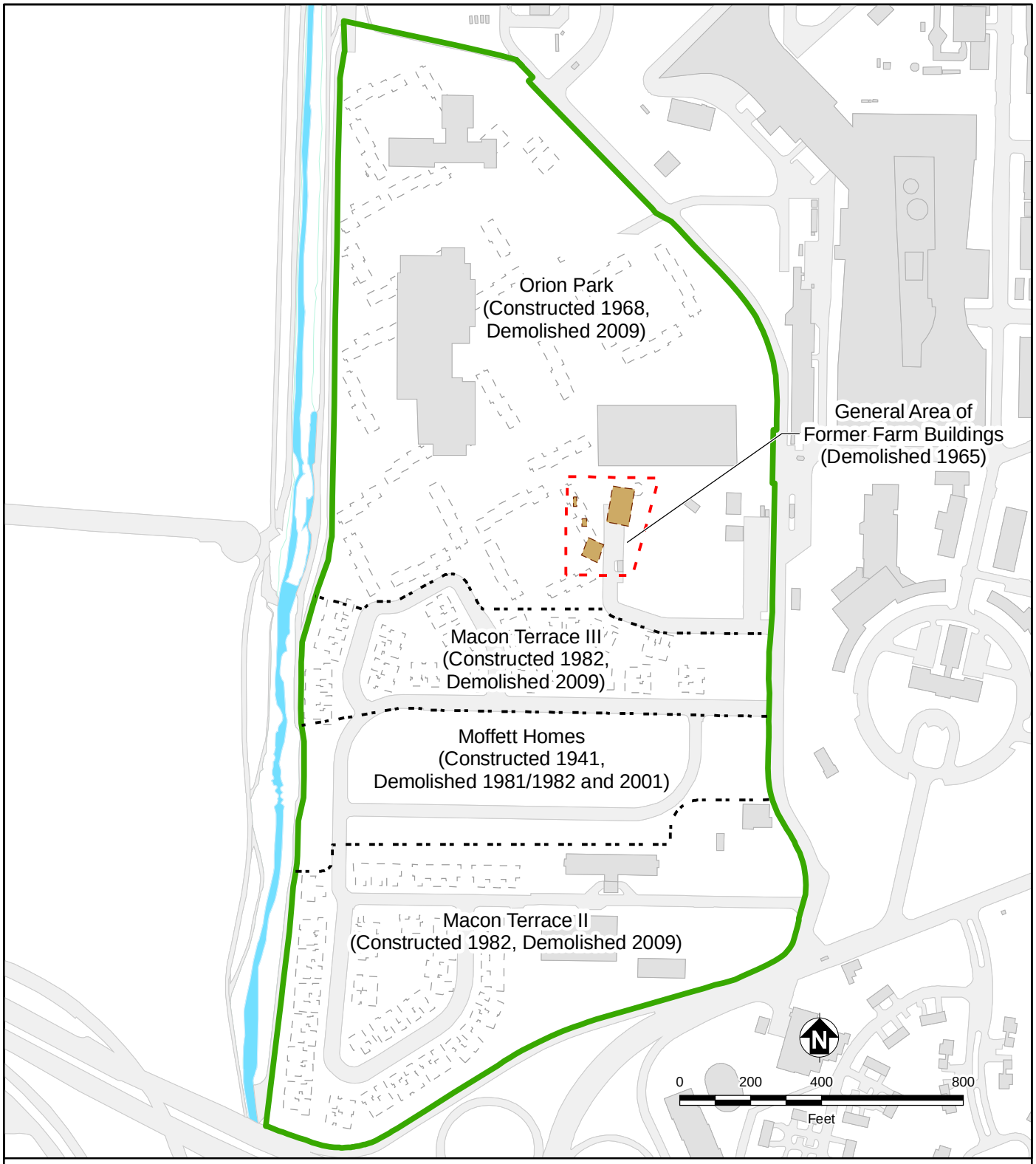
FIGURES



Former Orion Park Housing Area Boundary

Former Farm Building

Building/Structure

Road

Water

Housing Development Boundary

American Integrated Services, Inc.

TETRA TECH

Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE A-1

FORMER ORION PARK HOUSING AREA DEVELOPMENTS

Sampling and Analysis Plan for the Supplemental Site Investigation

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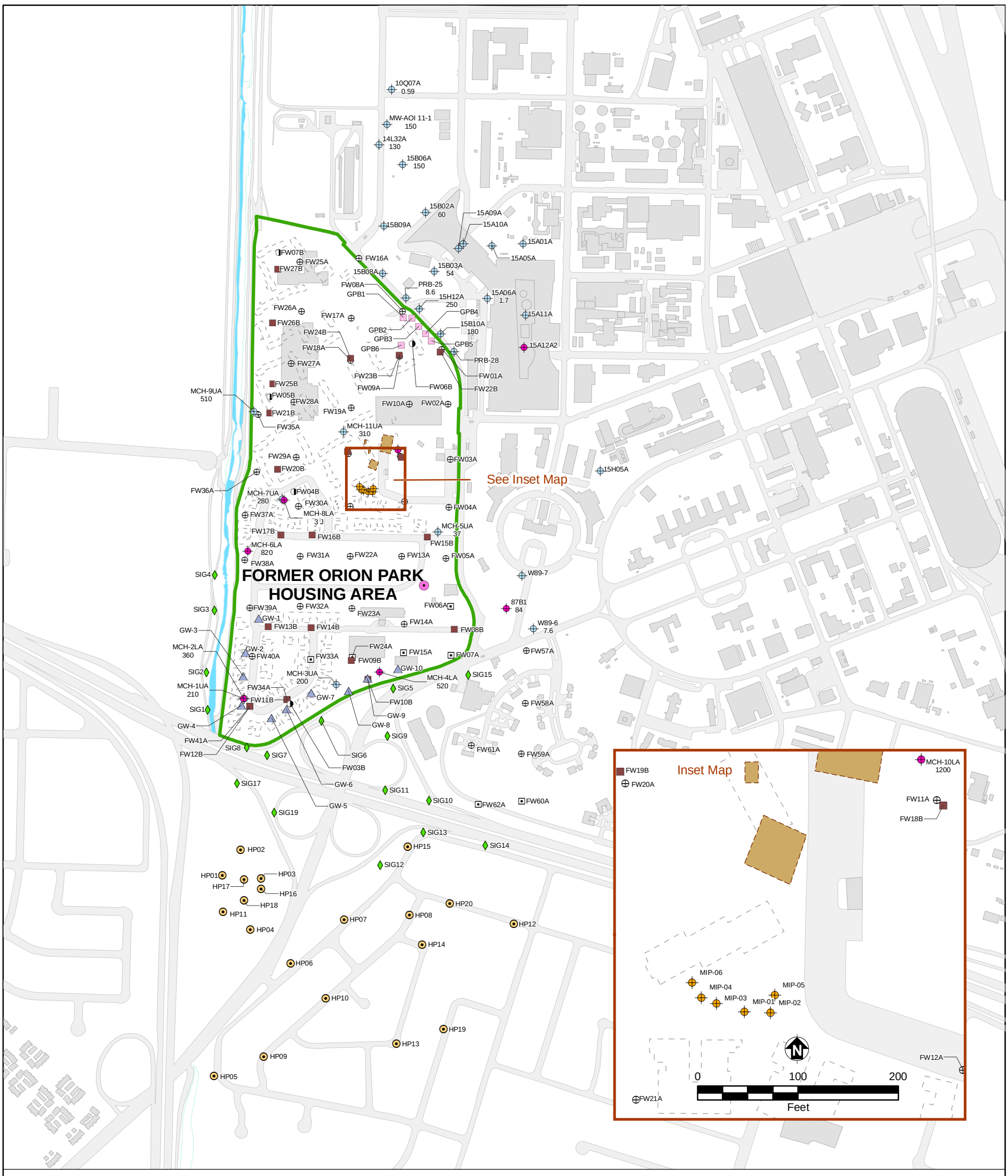

Phase 1 DPT/Temporary Well Sample Location, 2002

Phase 1 DPT/Temporary Well, CPT, and DPT/Hydropunch Sample Location, 2002

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Phase 2 DPT/Temporary Well Sample Location, 2002

Upper A Aquifer (A1 Zone) Well Location

Lower A Aquifer (A2 Zone) Well Location

Army MIP Boring for Septic Tank Investigation, 2009

Army CPT and DPT/Hydropunch Sample Location, 2003

SAIC DPT/Hydropunch Sample Location, 1999

IT Corp DPT/Hydropunch Sample Location, 2000

EPA CPT and DPT/Hydropunch Sample Location, 2005

Location of Former Paint Locker

Former Orion Park Housing Area Boundary

Former Farm Building

Building/Structure

Road

Water

0 600 1,200
Feet

Notes:

CPT	Cone penetrometer test
DPT	Direct push technology
EPA	U.S. Environmental Protection Agency
IT	International Technology Corporation
MIP	Membrane interface probe
SAIC	Science Applications International Corporation

American Integrated Services, Inc.

TETRA TECH

Former Orion Park Housing Area
Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE A-2
PREVIOUS INVESTIGATION SAMPLE LOCATIONS
Sampling and Analysis Plan for the Supplemental Site Investigation

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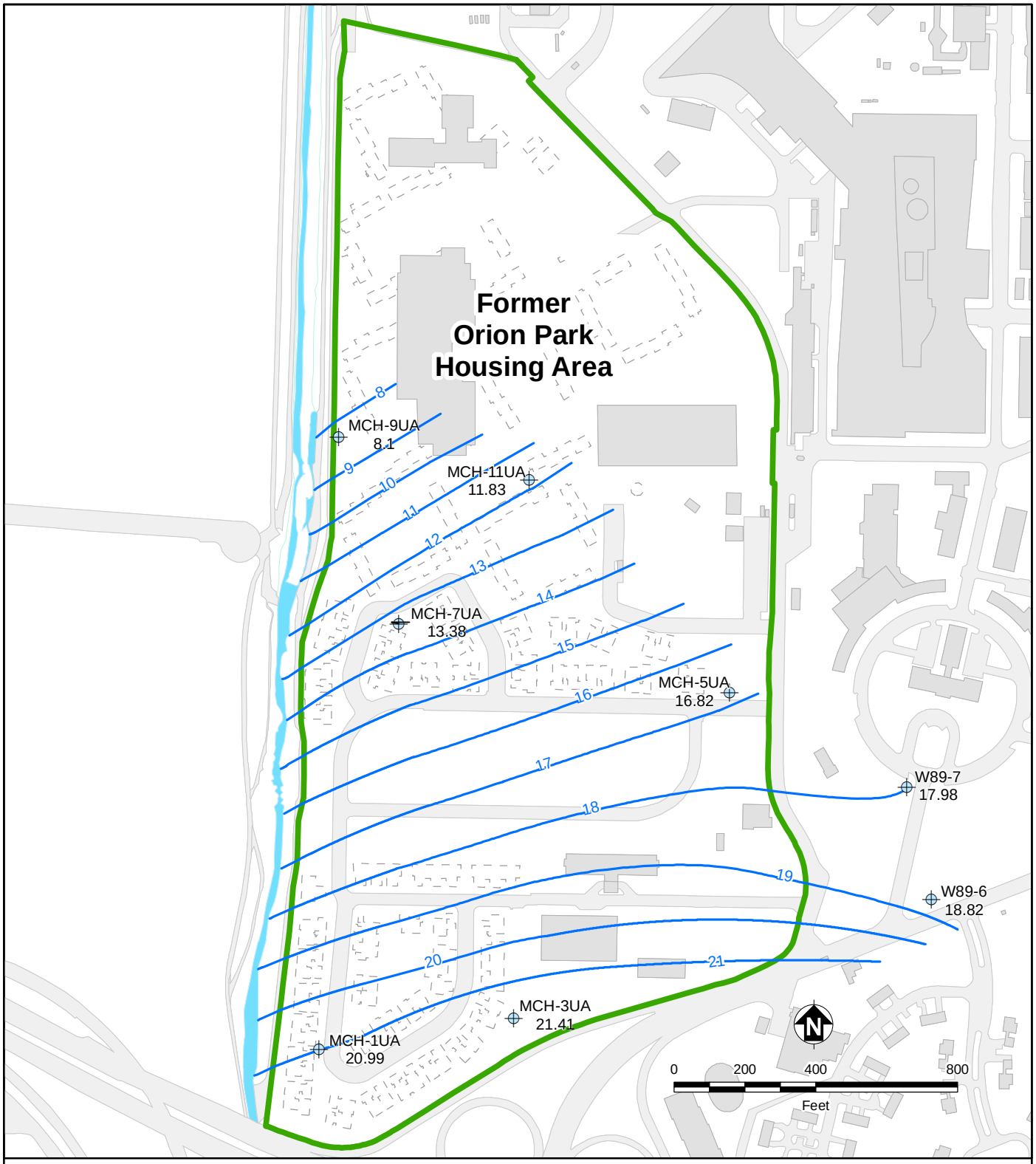

Upper A Aquifer (A1 Zone) Well

Former Orion Park Housing Area Boundary

Building/Structure

Road

Water

8 Groundwater Elevation Contour in Feet, Upper A Aquifer (A1 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

MSL Mean Sea Level

American Integrated Services, Inc.

TETRA TECH

Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE A-3

POTENTIOMETRIC SURFACE MAP, UPPER A AQUIFER (A1 ZONE), AUGUST 2005

Sampling and Analysis Plan for the Supplemental Site Investigation

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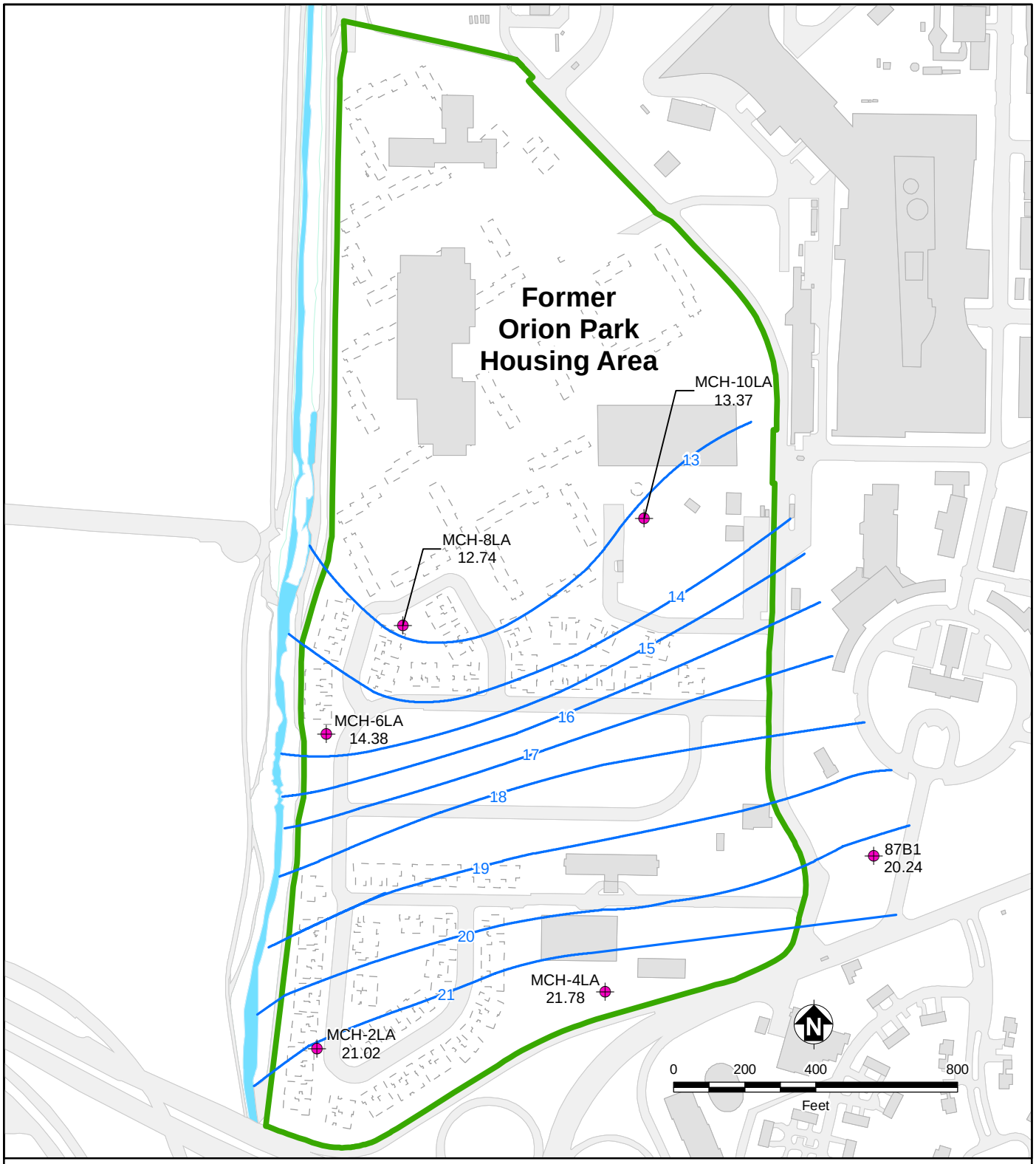

Lower A Aquifer (A2 Zone) Well

Former Orion Park Housing Area Boundary

Building/Structure

Road

Water

21 Groundwater Elevation Contour in Feet, Lower A Aquifer (A2 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

MSL Mean Sea Level

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FIGURE A-4
POTENTIOMETRIC SURFACE MAP, LOWER A AQUIFER (A2 ZONE), AUGUST 2005

Sampling and Analysis Plan for the Supplemental Site Investigation

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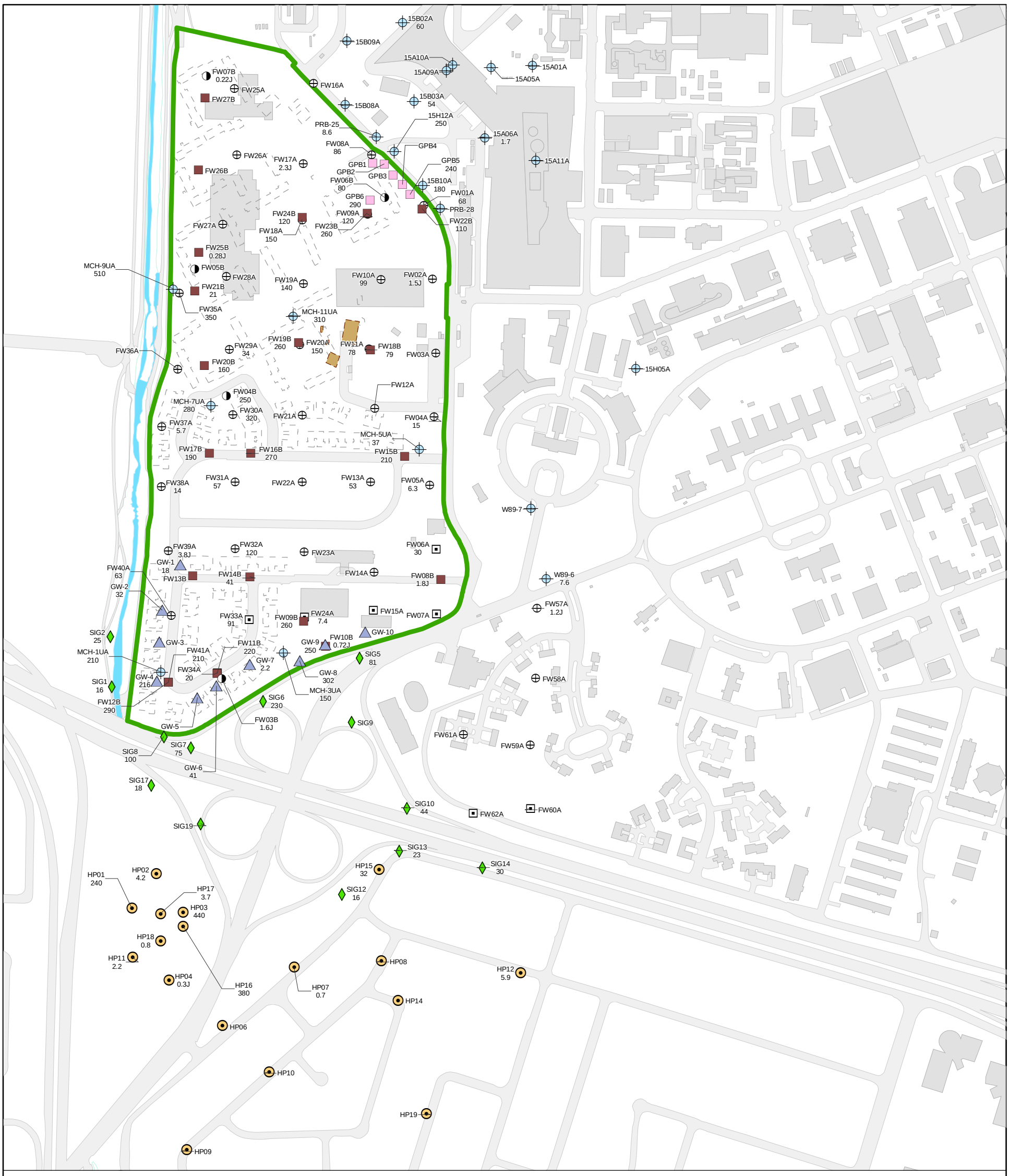

- Phase 1 DPT/Temporary Well Sample Location, 2002
- Phase 1 DPT/Temporary Well, CPT, AND DPT/Hydropunch Sample Location, 2002
- Phase 2 CPT and DPT/Hydropunch Sample Location, 2002
- Phase 2 DPT/Temporary Well Sample Location, 2002
- Upper A Aquifer Well Location
- Army CPT and DPT/Hydropunch Sample Location, 2003
- SAIC DPT/Hydropunch Sample Location, 1999
- IT Corp DPT/Hydropunch Sample Location, 2000
- EPA CPT and DPT/Hydropunch Sample Location, 2005
- Former Orion Park Housing Area Boundary
- Former Farm Building
- Building/Structure
- Road
- Water

N

0 450 900
Feet

Notes:
The highest concentration detected during the 3rd quarter of 2000 (GW borings), 2002 (FW DPT borings), 2003 (SIG borings) or 2005 (MCH borings) within the A1 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

CPT	Cone penetrometer test
DPT	Direct push technology
EPA	U.S. Environmental Protection Agency
IT	International Technology Corporation
SAIC	Science Applications International Corporation
TCE	Trichloroethene
µg/L	Micrograms per liter

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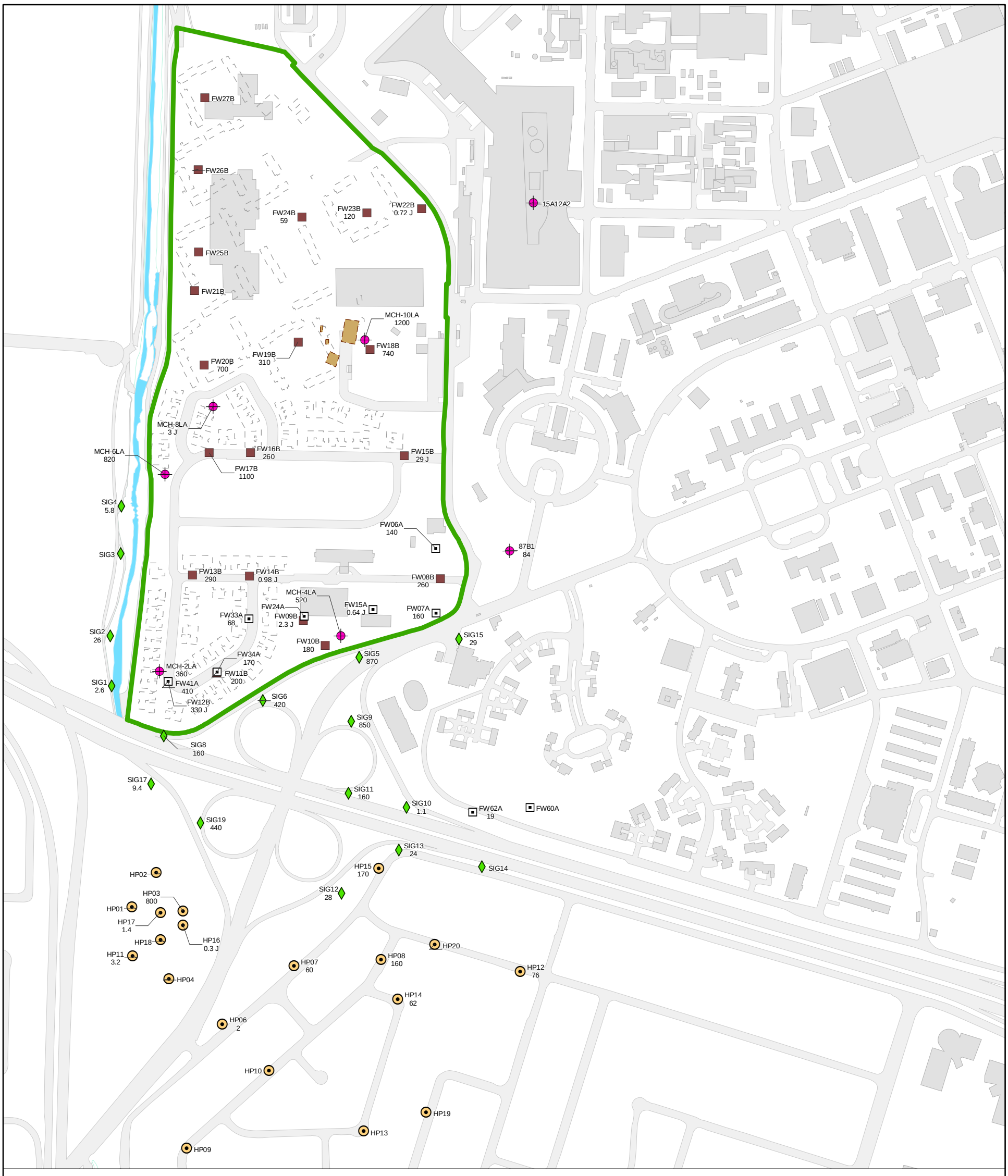
FIGURE A-5
TCE DISTRIBUTION,
UPPER A AQUIFER (A1 ZONE)
Sampling and Analysis Plan for the Supplemental Site Investigation



Phase 1 CPT and DPT/Hydropunch Sample Location, 2002

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Lower A Aquifer (A2 Zone) Well Location

Army CPT and DPT/Hydropunch Sample Location, 2003

EPA CPT and DPT/Hydropunch Sample Location, 2005

Former Orion Park Housing Area Boundary

Former Farm Building

Building/Structure

Road

Water

N

0 450 900
Feet

Notes:
The highest concentration detected during the 3rd quarter of 2002 (FW DPT borings), 2003 (SIG borings), or 2005 (HP boring and MCH wells) within the A2 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

CPT	Cone penetrometer test
DPT	Direct push technology
EPA	U.S. Environmental Protection Agency
IT	International Technology Corporation
J	Estimated
SAIC	Science Applications International Corporation
TCE	Trichloroethene

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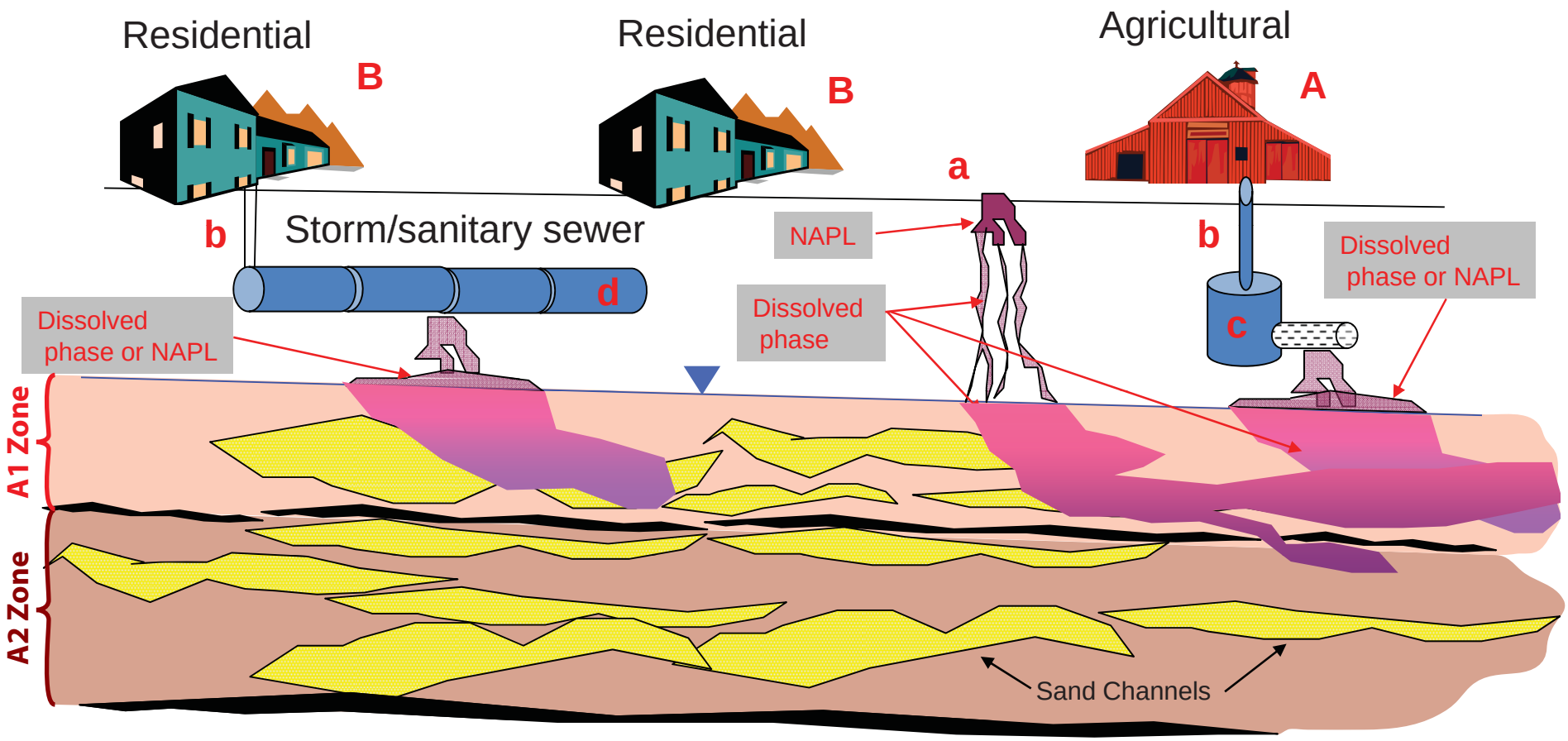
FIGURE A-6
TCE DISTRIBUTION,
LOWER A AQUIFER (A2 ZONE)
Sampling and Analysis Plan for the Supplemental Site Investigation



Notes:

A = Agricultural: Farmer or Worker

B = Residential: Backyard Mechanic

NAPL = Non-aqueous phase liquid

Agricultural worker(A)/backyard mechanic(B), who either releases directly to ground surface (a), or to a drain (b), which leads to a secondary release point, such as septic tank/leach field (c), or sanitary sewer (d).

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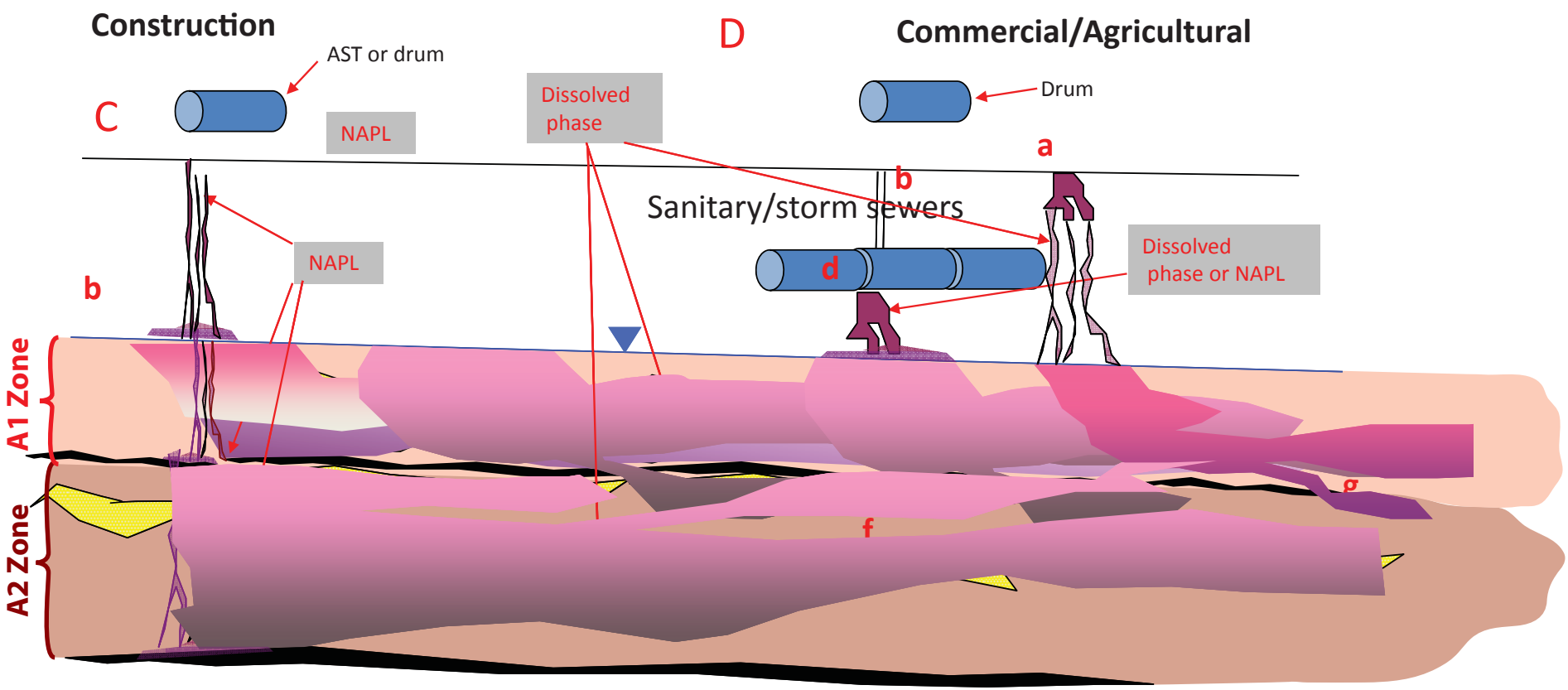
FIGURE A-7

CONCEPTUAL SITE MODEL FOR POTENTIAL ON-SITE RESIDENTIAL AND AGRICULTURAL SOURCES

Sampling and Analysis Plan for the Supplemental Site Investigation



Notes:

C = Construction Worker
D = Commercial Worker
NAPL = Non-aqueous phase liquid
AST = Aboveground storage tank

On-site construction spill(C), discharge to ground surface, (a) NAPL of sufficient volume penetrates aquifer and moves down through permeable sediments (g) to deeper A2 zone (f).

On-site commercial(D) (paint storage locker) discharge to ground (a) or drain (b) and leaks from sanitary sewer (d).

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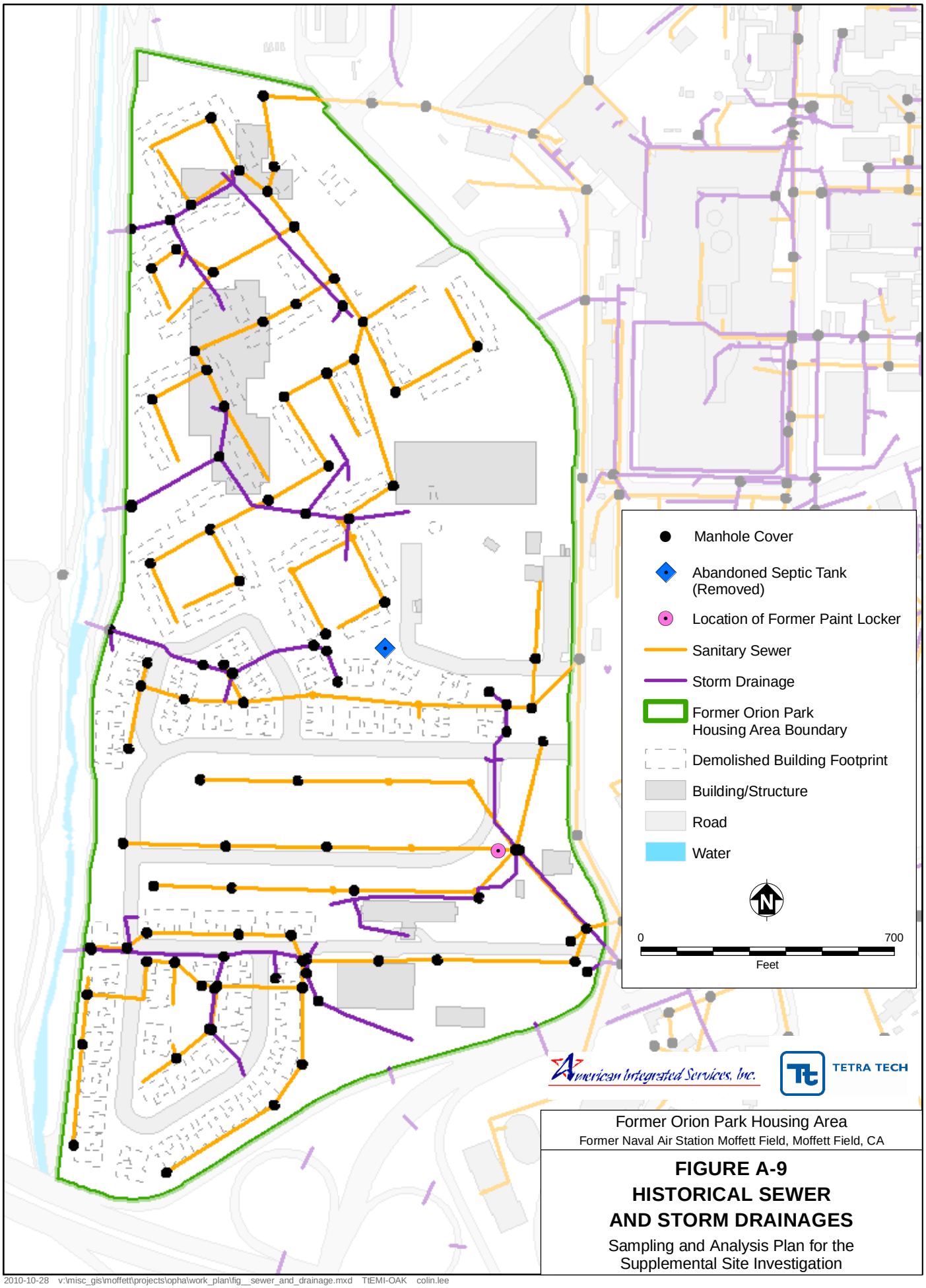
FIGURE A-8
CONCEPTUAL SITE MODEL FOR POTENTIAL ON-SITE CONSTRUCTION AND COMMERCIAL/AGRICULTURAL SOURCES
Sampling and Analysis Plan for the Supplemental Site Investigation



Former Orion Park Housing Area

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FIGURE A-9

HISTORICAL SEWER AND STORM DRAINAGES

Sampling and Analysis Plan for the Supplemental Site Investigation

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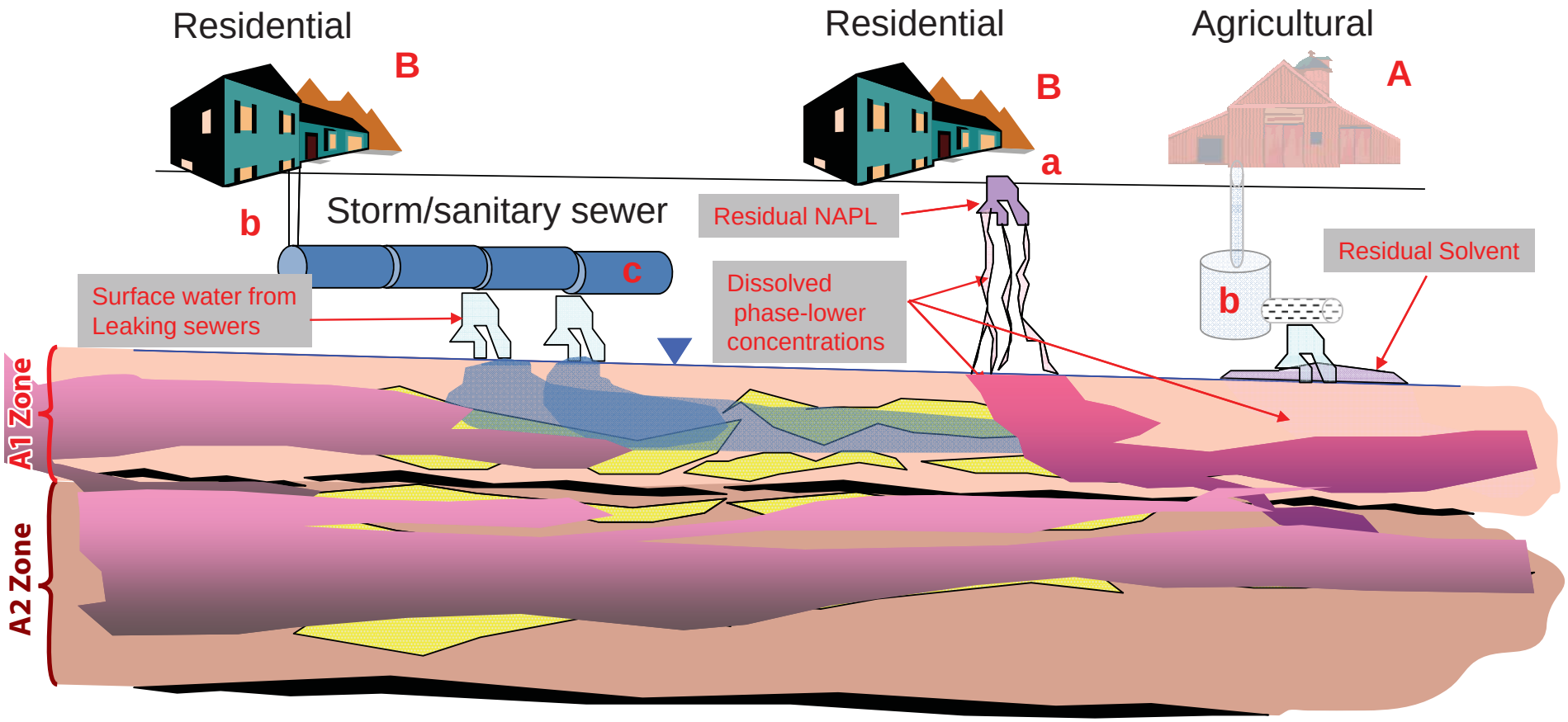

Notes:

A = Agricultural: Farmer or Worker

B = Residential: Backyard Mechanic

NAPL = Non-aqueous phase liquid

Water from rain or lawn irrigation (a) or from septic tank (b) continues to leach solvent through vadose zone to water table. Water from leaks in storm sewers (c) and infiltrating rainwater dilute concentration of solvents in A1 zone of aquifer. Water losses from Stevens Creek to A1 zone during rainy season dilute A1 zone on western side of site.

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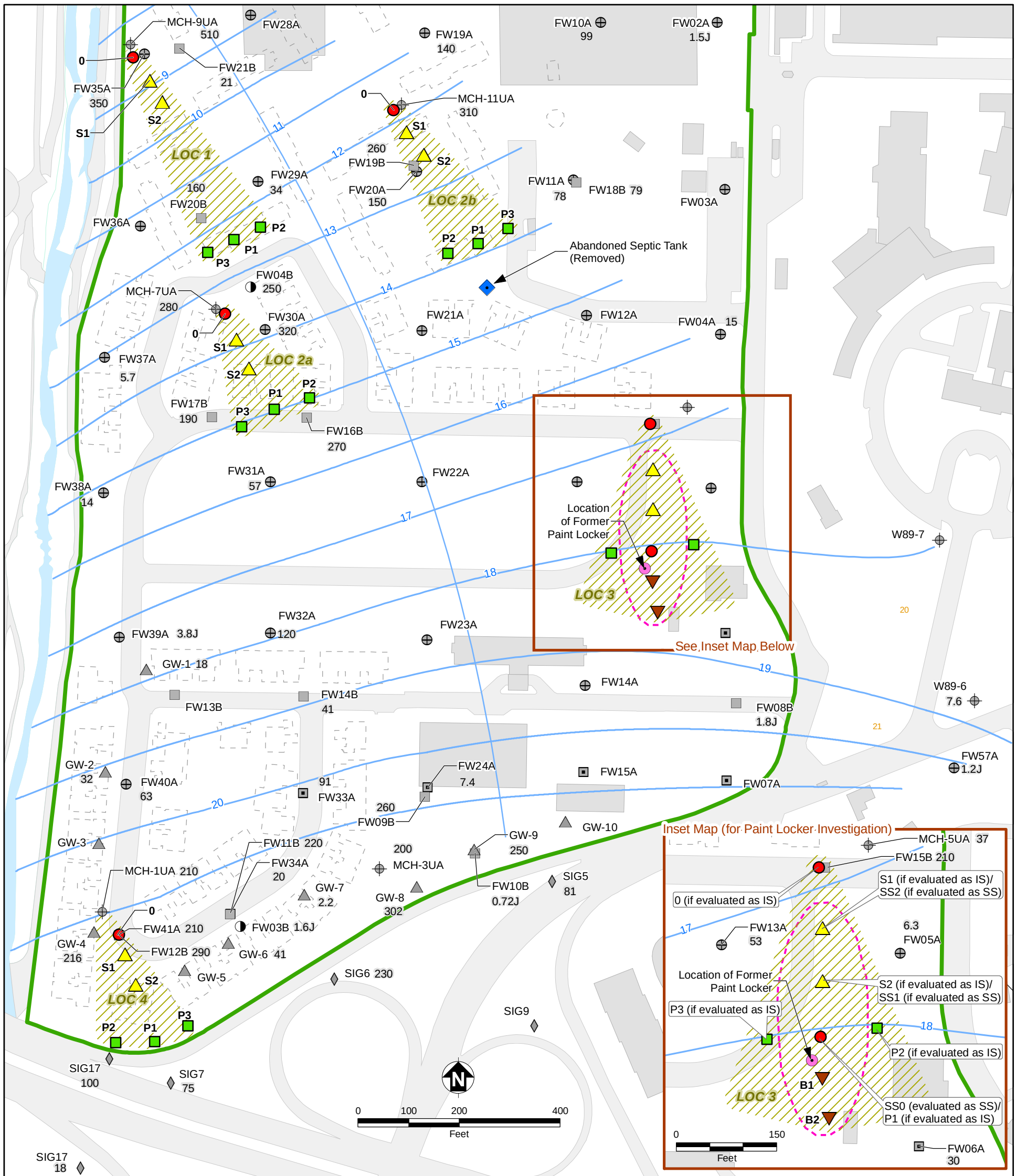
FIGURE A-10
FATE AND TRANSPORT MODEL
FOR GROUNDWATER CONTAMINATION

Sampling and Analysis Plan for the
Supplemental Site Investigation



MIP #0 (or MIP #SS0) - Proposed LOC Comparison MIP/CPT

MIP #S1-S2 - Proposed Step-out MIP/CPT for Source Branch

MIP #P1-P3 - Proposed Step-out MIP/CPT for Plume Branch

MIP # B1-B2 - Proposed Background Step-out MIP/CPT for Paint Locker (Suspected Source) Branch

Army CPT and DPT/Hydropunch Sample Location, 2003

Phase 1 DPT/Temporary Well, CPT, and DPT/Hydropunch

Phase 1 DPT/Temporary Well Sample Location, 2002

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Phase 2 DPT/Temporary Well Sample Location, 2002

EPA CPT and DPT/Hydropunch

IT Corp DPT/Hydropunch Sample Location, 2000

Upper A Aquifer (A1 Zone) Well Location

SAIC DPT/Hydropunch Sample Location, 1999

Abandoned Septic Tank (Removed)

Location of Former Paint Locker

15 Groundwater Elevation Contour in Feet, Upper A Aquifer (A1 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

General Flow Direction Upper A Aquifer (A1 Zone)

Location of Concern

Paint Locker (Suspected Source) Evaluation Area

Former Orion Park Housing Area Boundary

Demolished Building Footprint

Building/Structure

Road

Water

B	Background
CPT	Cone Penetrometer Test
DPT	Direct Push Technology
EPA	U.S. Environmental Protection Agency
IS	Indefinite Source
IT	International Technology Corporation
LOC	Location of Concern
MIP	Membrane Interface Probe
MSL	Mean Sea Level
SAIC	Science Applications International Corporation
SS	Suspected Source
TCE	Trichloroethene
µg/L	Micrograms per liter

Note: The highest concentration detected during the 3rd quarter of 2002 (FW DPT borings), 2003 (SIG borings), or 2005 (HP boring and MCH wells) within the A2 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

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FIGURE A-11
PROPOSED MIP/CPT LOCATIONS, UPPER A AQUIFER (A1 ZONE)

Sampling and Analysis Plan for the Supplemental Site Investigation

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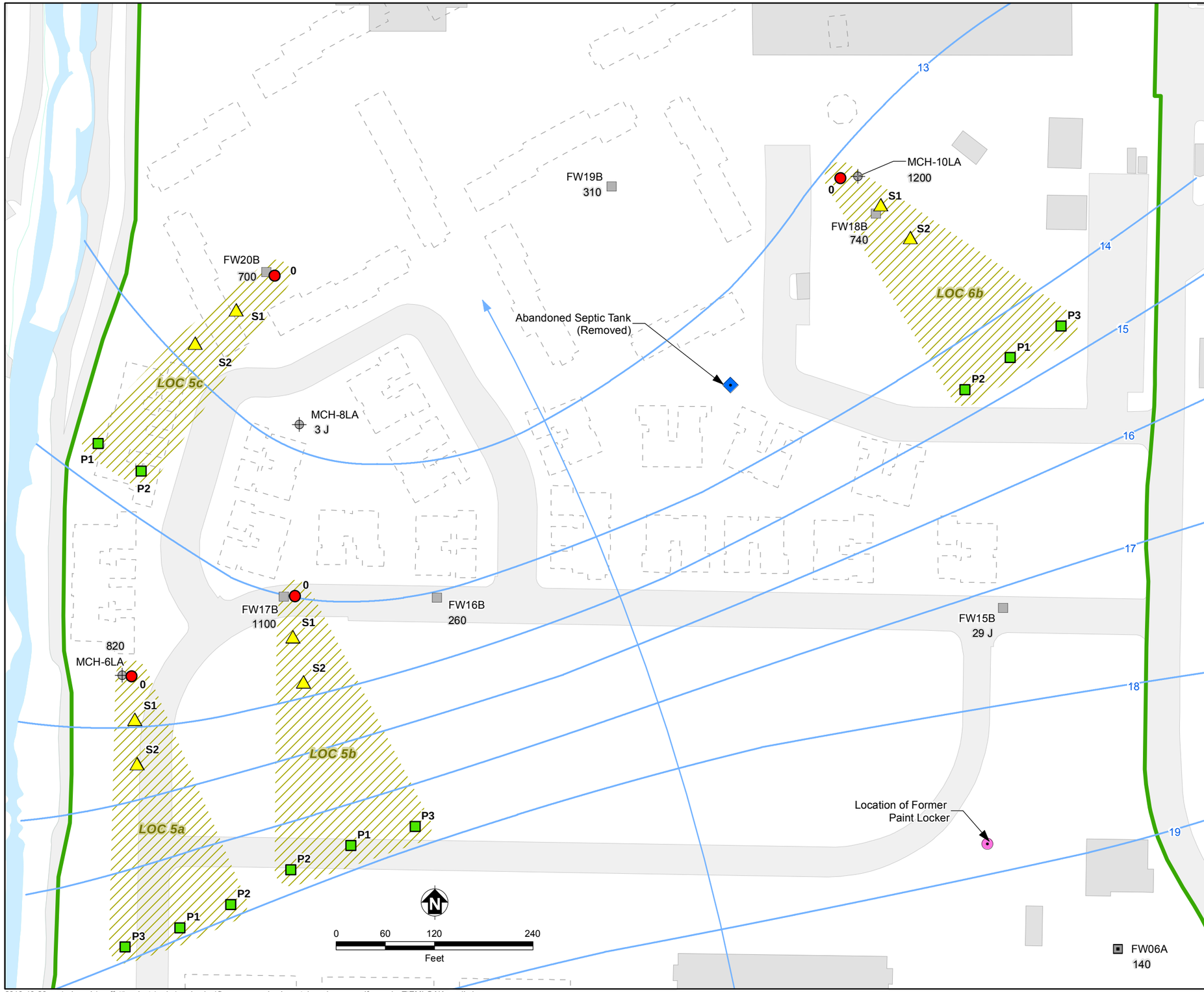

MIP #0 - Proposed LOC Comparison MIP/CPT

MIP #1-2 - Proposed Step-out MIP/CPT for Source Branch

MIP #1-3 - Proposed Step-out MIP/CPT for Plume Branch

Army CPT and DPT/Hydropunch Sample Location, 2003

Phase 1 DPT/Temporary Well, CPT, and DPT/Hydropunch

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Lower A Aquifer (A2 Zone) Well Location

Abandoned Septic Tank (Removed)

Location of Former Paint Locker

15 Groundwater Elevation Contour in Feet, Lower A Aquifer (A2 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

General Flow Direction Lower A Aquifer (A2 Zone)

Location of Concern

Former Orion Park Housing Area Boundary

Demolished Building Footprint

Building/Structure

Road

Water

CPT	Cone Penetrometer Test
DPT	Direct Push Technology
LOC	Location of Concern
MSL	Mean Sea Level
MIP	Membrane Interface Probe
µg/L	Micrograms per liter
TCE	Trichloroethene

Note: The highest concentration detected during the 3rd quarter of 2002 (FW DPT borings), 2003 (SIG borings), or 2005 (HP boring and MCH wells) within the A2 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

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FIGURE A-12

PROPOSED MIP/CPT LOCATIONS, LOWER A AQUIFER (A2 ZONE)

Sampling and Analysis Plan for the Supplemental Site Investigation

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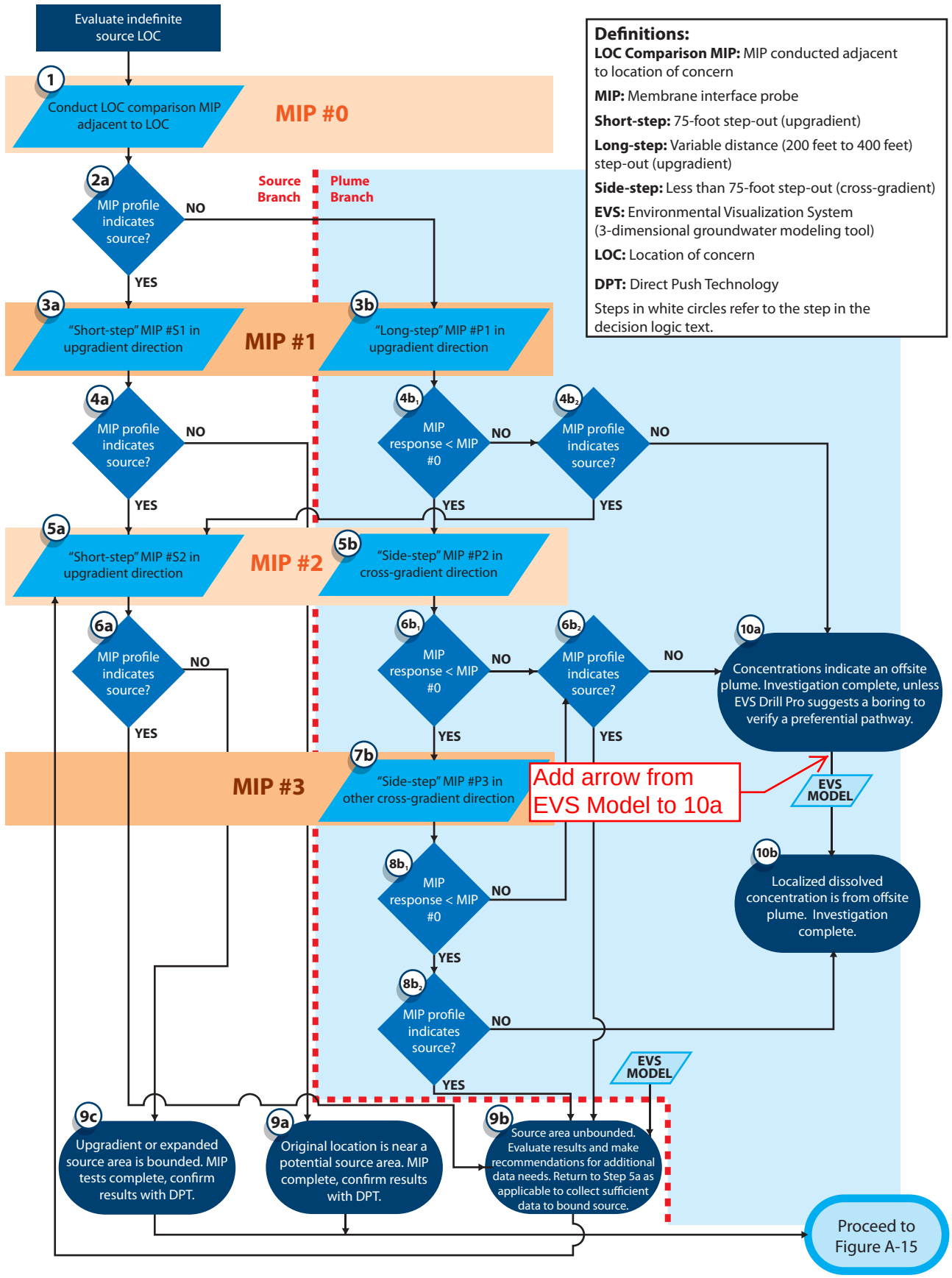

Definitions:

LOC Comparison MIP: MIP conducted adjacent to location of concern

MIP: Membrane interface probe

Short-step: 75-foot step-out (upgradient)

Long-step: Variable distance (200 feet to 400 feet) step-out (upgradient)

Side-step: Less than 75-foot step-out (cross-gradient)

EVS: Environmental Visualization System (3-dimensional groundwater modeling tool)

LOC: Location of concern

DPT: Direct Push Technology

Steps in white circles refer to the step in the decision logic text.

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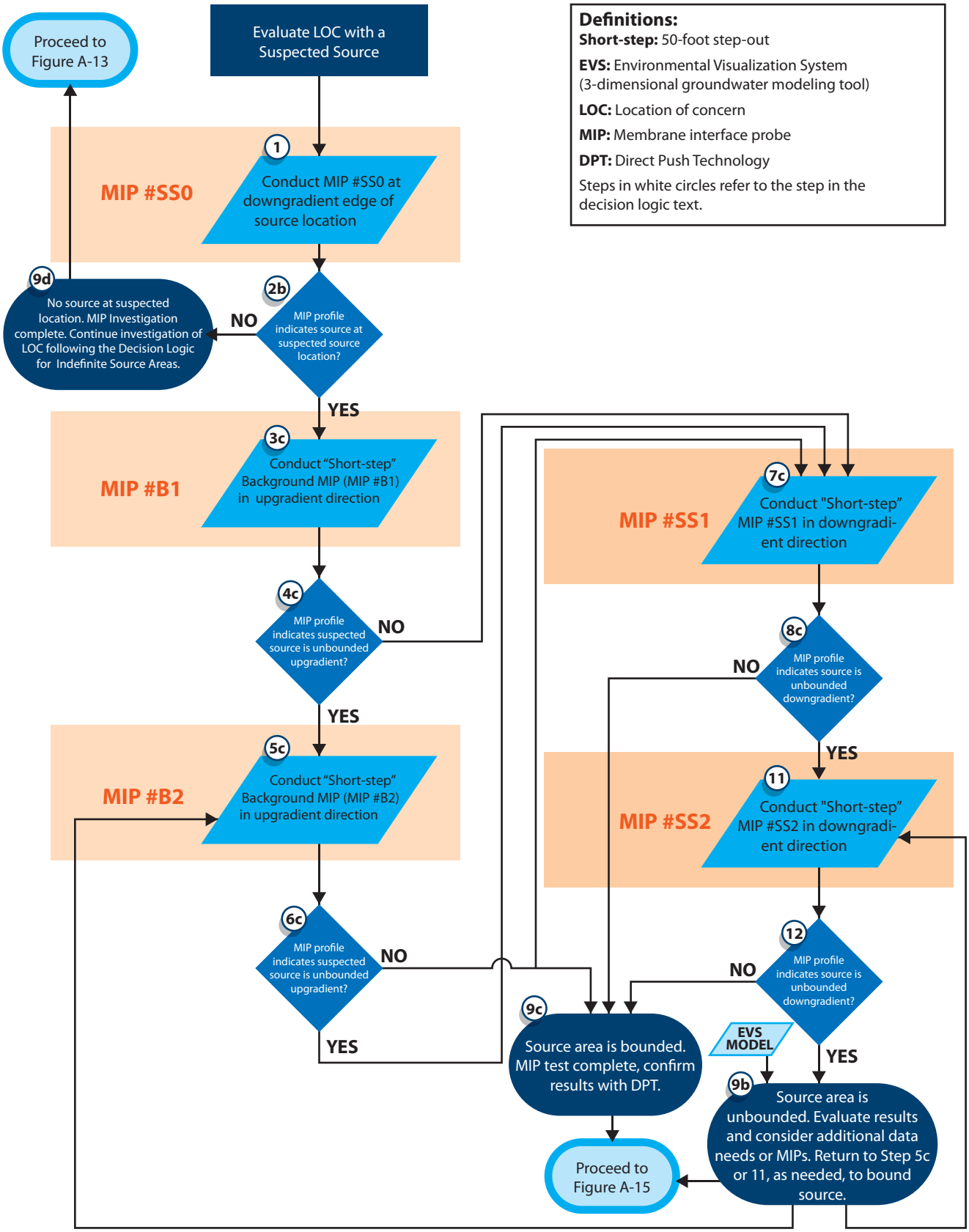
Former Orion Park Housing Area
Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE A-13
DECISION LOGIC FOR INDEFINITE SOURCE AREAS

Sampling and Analysis Plan for the Supplemental Site Investigation



Former Orion Park Housing Area
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FIGURE A-14
DECISION LOGIC FOR FOR THE PAINT LOCKER (SUSPECTED SOURCE)
Sampling and Analysis Plan for the Supplemental Site Investigation

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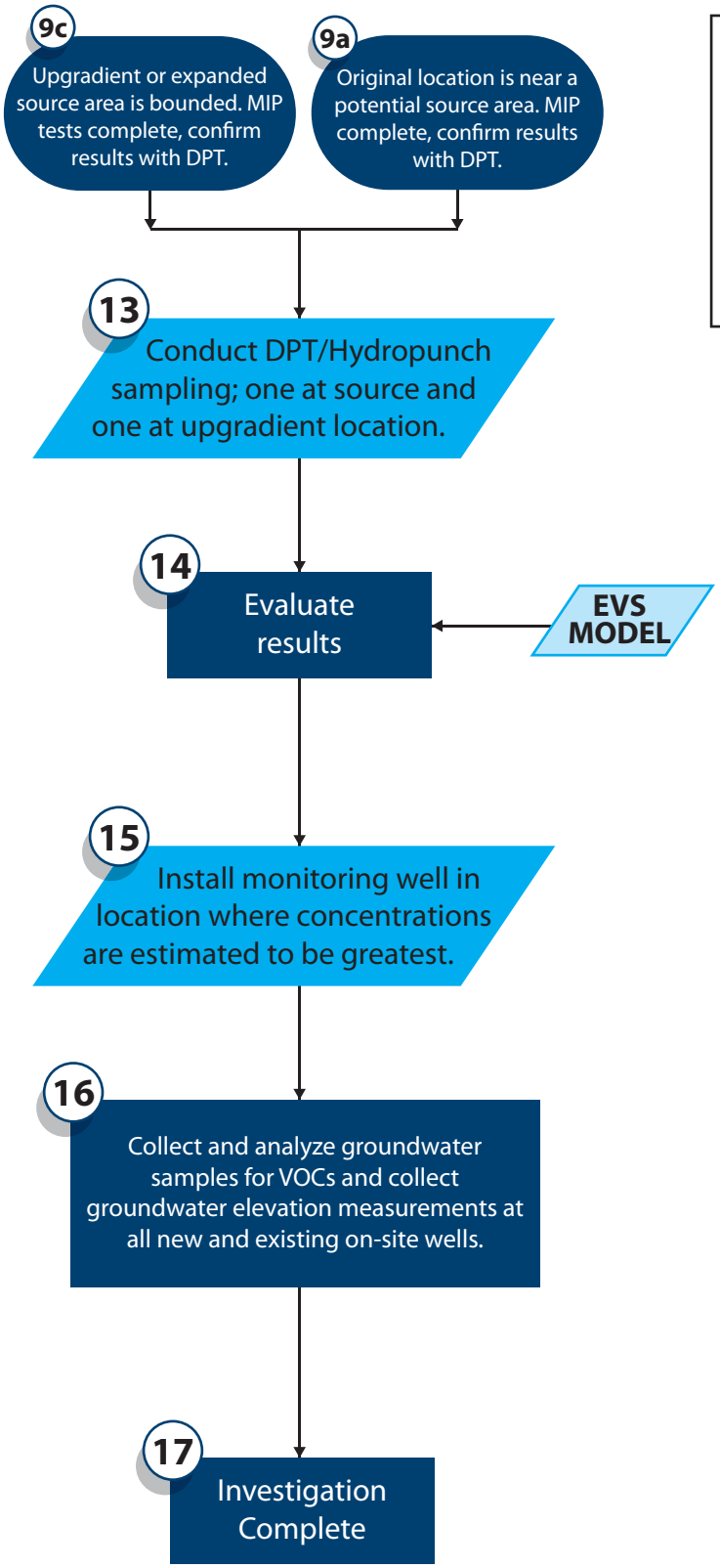

Definitions:

EVS: Environmental Visualization Software - (3-dimensional groundwater modeling tool)

DPT: Direct Push Technology

MIP: Membrane interface probe

VOCs: Volatile organic compounds

Steps in white circles refer to the step in the decision logic text.

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FIGURE A-15
DECISION LOGIC FOR DPT/HYDROPUNCH SAMPLES AND MONITORING WELL INSTALLATION
Sampling and Analysis Plan for the Supplemental Site Investigation

TABLE

Table A-1. Conceptual Site Model for On-Site Sources
Sampling and Analysis Plan for the Supplemental Site Investigation, Former Orion Park Housing Area

Source	Time Period	Source Loading	Initial Release Point	Secondary Release Point
[A] Agricultural: Farmer / worker	Up to 1965	Low volume, infrequent (septic tank), low volume periodic	Degreasing septic tank, agricultural equipment cleaning	Discharge to leach field (c), discharge to ground surface
[B] Residential: Backyard Mechanic	Early 1960s through 2001	Low volume, infrequent	(a) Ground surface (b) Drain	Leak from pipes or sewers (d)
[C] Construction Worker	1-2 years during 1960s	Low to moderate volume, irregular	Ground surface	Subsurface soil through leaching
[D] Commercial Worker	Early 1960 through 2001	Low to moderate volume, irregular	(a) Ground surface (b) Drain	Leak from pipes or sewers (d)

Note:
Letters (A , B, C, D) and (a, b, c, d, f, g, h) relate to objects presented in Figure A-7 (Conceptual Site Model for Potential On-Site Residential and Agricultural Sources) and Figure A-8 (Conceptual Site Model for Potential On-Site Construction and Commercial/Agricultural Sources).

ATTACHMENT A1
DECISION LOGIC FOR MIP TEST LOCATIONS AT THE FORMER OPHA

ATTACHMENT A1

Decision Logic for MIP Test Locations at OPHA

This investigation will evaluate locations of concern (LOC) identified in comments provided by the U.S. Environmental Protection Agency (EPA) at the former Orion Park Housing Area (Site) on the 2006 Draft Groundwater Monitoring and Well Installation and Sampling Report (Tetra Tech EC Inc. 2007). LOCs are identified below and are organized to directly associate with the comments. The following LOCs have been identified for investigation during the Supplemental Site Investigation.

LOC #	Starting Point of Investigation	LOC Identified in EPA or NASA Comments	Aquifer	Indefinite Source or Suspected Source
1	MCH-9UA/FW35A	Area in the vicinity of MCH-9UA/FW35A	A1	Indefinite
2a	MCH-7UA	Central area in the vicinity of MCH-7UA, MCH-11UA	A1	Indefinite
2b	MCH-11UA			Indefinite
3	Paint Locker for Suspected Source Evaluation and FW15B for Alternative Indefinite Source Evaluation	Central area in the vicinity of MCH-5UA/FW15B	A1	Suspected (Paint Locker) (but will evaluate FW15B as an indefinite source if no source identified in Paint Locker evaluation)
4	MCH-1UA/FW41A	Southwestern area in the vicinity of MCH-1UA, FW41A, GW-4, FW12B	A1	Evaluate indefinite source in vicinity of MCH-1UA; evaluate suspected source at FW41A by collecting a soil sample with direct push technology (DPT) at the capillary fringe where the elevated photo-ionization detector (PID) readings were collected.
5a	MCH-6LA	Central area in the vicinity of MCH-6LA, FW17B, FW20B, and connection to MCH-10-LA	A2	Indefinite
5b	FW17B			Indefinite
5c	FW20B			Indefinite
6b	MCH-10LA	Area in the vicinity of MCH-11-UA, MCH-10LA and Former Farmhouse Buildings	A2	Indefinite

The investigation is divided into an initial phase that will use two to four membrane interface probe (MIP) tests and cone penetrometer tests (CPT) to categorize and prioritize the LOC, followed by a second phase that will use direct push technology (DPT) and Hydropunch groundwater sampling to refine the characterization of LOCs that appear to be potential source areas and result in installation of a new monitoring well.

The following terms and definitions are essential to this discussion:

Locations of Concern: A LOC is an area with anomalously high concentrations of trichloroethene (TCE) and where there are no upgradient samples with similar concentrations to indicate an off-site source. Each LOC is associated with either an indefinite or a suspected source. LOCs are existing monitoring wells or DPT-based groundwater sample locations. The starting point of each investigation will be the well or DPT-based groundwater sample location indicated in the EPA or National Aeronautics and Space Administration (NASA) comment.

Membrane Interface Probe (MIP) Technology: The MIP test run with a CPT produces a vertical profile of total volatile organic chemicals (VOC) response at a given location. At the Site, the VOC response is anticipated to include concentrations of both TCE and cis-1,2-dichloroethene (DCE). The MIP profile is almost continuous (response at approximately 1-inch intervals) and provides an integrated vertical profile of geology and VOC concentrations when a CPT is run concurrently. The MIP provides a precise response compared with results from groundwater samples extracted from monitoring wells. Groundwater samples from a monitoring well provide an average concentration of VOCs in water across the entire vertical distance of the monitoring well screen. All monitoring wells at the Site were constructed with 10-feet long screens.

Conceptual Site Model (CSM): According to the CSM proposed during the August 10, 2010, scoping meeting, release points for potential historical on-site sources were above the water table or first saturated zone (A aquifer). As a result, the VOC profile at and near a release point should exhibit the highest VOC response at or near the surface of the water table. The A-aquifer at OHPA does not have a significant vertical flow component between the first-saturated A1 zone and underlying A2 zone. As a result, VOCs should migrate to deeper zones within the aquifer by following discrete, higher-velocity flow paths along higher-permeability pathways and through transverse dispersive flow. Therefore, CPT/MIP profiles near a source should show the highest response near the top of the saturated zone (in the capillary fringe), and CPT/MIP profiles away from a source should show the highest response in the most permeable pathway that is hydraulically connected to the source area.

Indefinite Source: Indefinite source areas are not associated with any known source or location of chlorinated solvent disposal or release.

Paint Locker: One location at the Site, the Navy Paint Locker, has been identified as a potential suspected source area. As a result, the investigation approach and decision logic for the Navy Paint Locker site will be different than the approach for the other LOCs.

The decision flow charts show distinct decision trees for an indefinite source area (Figure A-13 in the main sampling and analysis plan) and for the Paint Locker (Figure A-14). A decision flow chart guiding DPT/Hydropunch sampling and groundwater monitoring well installation is provided in Figure A-15.

Environmental Visualization System (EVS): EVS is a modeling software program that creates 3-dimensional (3D) visualizations from subsurface geologic, hydrologeologic, water table surface, and chemical concentration contour data. EVS combines data to create geologic cross-sections and 3D models that can be used to refine the CSM in an iterative manner.

SEQUENCE 1. DECISION LOGIC FOR INDEFINITE SOURCE AREAS

The Army proposes to implement the following sample selection sequence for indefinite source areas at LOCs:

1. MIP #0: Identify the hydrostratigraphic unit and permeable interval from which the past groundwater sample was collected at the LOC. In some cases, the permeable interval will be in the A1 zone; in others, it will be in the A2 zone. In a few cases, LOCs have been identified that include both the A1 and A2 zones. This investigation will focus on the A1 zone if TCE concentrations in both zones at a LOC appear to be elevated, since the purpose of the investigation is to locate on-site hot spots that indicate an on-site source.

   Clear the area around the LOC for utilities, and complete a CPT/MIP test (MIP #0) adjacent to the well or DPT at the LOC to compare the MIP response to historical concentrations at that location. The CPT/MIP test should extend down through A1 or A2 zones of the aquifer, as appropriate.

2a. Decision Step: Determine if MIP response indicates a source:

   Review the CPT/MIP response to identify the lithologic zones in which VOCs were detected at the highest concentrations in the MIP test. In addition, review the CPT/MIP response to assess whether the anomalously high MIP responses correlate with the coarsest sediments in the saturated zone (typically not a potential source area) or the capillary fringe material (an indication of a potential source area). Figures A1-1 and A1-2 present examples of an MIP response coupled with the CPT log in a source area and in a plume area. In general:

   - MIP response that is greatest in the capillary fringe indicates a source area:
   - MIP response $\geq 7e^6$ µV indicates residual or liquid NAPL source;
   - MIP response $\geq 4e^6$ µV indicates proximity to residual or liquid NAPL source.
   - MIP profile that decreases sharply within the first saturated zone may indicate a source area
   - MIP profile that is highest in finer-grained materials in the first saturated zone may indicate proximity to a source

If the MIP profile indicates a source, follow the Source Branch of Figure A-13 and continue to Step 3a. Otherwise, follow the Plume Branch of Figure A-13 and continue to Step 3b.

The decision logic used in this Step 2a is also used in Steps 4a, 6a, $4b_2$, $6b_2$, and $8b_2$.

Source Branch: Figure A-13 shows the steps associated with potential suspected sources (Source Branch). The Source Branch steps on Figure A-13 described below end with a completed MIP investigation and direct the field geologist to Figure A-15 to confirm MIP/CPT results with DPT/Hydropunch samples.

3a. Short-Step, MIP #S1: Step directly upgradient 75 feet (short-step) from MIP #0, clear utilities and push MIP #S1 through zones of interest indicated by MIP #0.

4a. Decision Step: Does the MIP profile indicate a source?

- If YES, then go to Step 5a
- If NO, then go to Step 9a.

5a. Short-Step, MIP #S2: Step directly upgradient 75 feet (short-step) from MIP #S1, clear utilities, and push MIP #S2 through zones of interest indicated by MIP #S1. Proceed to decision logic Step 6a.

6a. Decision Step: Does the MIP profile indicate a source?

- If YES, then go to Step 9b.
- If NO, then go to Step 9c.

9a. Original Location (MIP #0) is near a potential source area. MIP investigation is complete. Confirm results with DPT. Proceed to Step 13 on Figure A-15.

9b. Source area is unbounded (MIP responses indicate potential source area). Evaluate using EVS to make recommendations for additional data needs. Return to Step 5a (for Source Branch) or Steps 5c or 11 (for Paint Locker [Suspected Source] Branch), as needed, to conduct one or more additional MIP borings at appropriate distance as indicates by the EVS model.

9c. Source area is bounded in direction investigated (MIP responses indicate potential source area). MIP investigation is complete. Confirm results with DPT. Proceed to Step 13 on Figure A-15.

Plume Branch: Figure A-13 shows the steps associated with a potential plume migrating on site from elsewhere (Plume Branch). The Plume Branch steps on Figure A-13 described below terminate on Figure A-13 with the investigation completed.

3b. Long-Step, MIP #P1: Step directly upgradient 200 to 400 feet (Long-Step) (depending on evaluation of each LOC; see Figures A-11 and A-12) from MIP #0, clear utilities, and push MIP #P1 through zones of interest indicated by MIP #0. Step distance varies between LOCs; check Figures A-11 or A-12 for each LOC.

$4b_1$. Decision Step: Is the maximum response at MIP #P1 less than the maximum response at MIP #0 by at least one-half order-of-magnitude on the electron volt (eV) scale?

- If YES, then go to Step 5b.
- If NO, then go to Step $4b_2$.

$4b_2$. Decision Step: Does the MIP profile indicate a source?

- If YES, then go to Step 5a on the Source Branch.
- If NO, then go to Step 10a.

5b. Side-Step, MIP #P2: Step cross-gradient less than 75 feet (side-step) in either direction (depending on evaluation of each LOC; see Figures A-11 and A-12) from MIP #P1, clear utilities, and push MIP #P2 through zones of interest indicated by MIP #P1. Proceed to decision logic Step $6b_1$.

$6b_1$ Decision Step: Is the maximum response at MIP #P2 less than the maximum response at MIP #0 by at least one-half order-of-magnitude on the eV scale?

- If YES, then go to Step 7b
- If NO, then go to Step $6b_2$.

$6b_2$. Decision Step: Does the MIP profile indicate a source?

- If YES, then go to Step 9b on the Source Branch.
- If NO, then go to Step 10a.

7b. Side Step, MIP#P3: Step cross-gradient less than 75 feet (side-step) from MIP #P1 in the other direction (depending on evaluation of each LOC; see Figures A-11 and A-12), clear utilities, and push MIP #P3 through zones of interest indicated by MIP #P1. Proceed to decision logic Step $8b_1$.

$8b_1$ Decision Step: Is the maximum response at MIP #P3 less than the maximum response at MIP #0 by at least one-half order-of-magnitude on the eV scale?

- If YES, then go to Step $8b_2$.
- If NO, then go to Step $6b_2$.

$8b_2$. Decision Step: Does the MIP profile indicate a source?

- If YES, then go to Step 9b on the Source Branch.
- If NO, then go to Step 10b.

10a. Concentrations indicate an offsite plume. **Investigation complete, unless EVS Drill Pro suggests a boring to verify a preferential pathway.** Use EVS Drill Pro to determine if a MIP is required to show continuity along a preferential pathway between this MIP location and an already-identified offsite plume. The MIP would target a location to verify a preferential pathway.

10b. Localized dissolved concentration is from an offsite plume. **Investigation complete.** Investigation is inconclusive with respect to the elevated concentrations at the LOC. MIP profiles do not exhibit source characteristics and plume could not be traced upgradient. Use EVS to demonstrate that the high concentrations are from an offsite plume, but that they are the result of site-specific hydrogeologic/lithologic characteristics (soil variability, other) that is causing a localized variation in concentrations.

SEQUENCE 2. DECISION LOGIC FOR THE PAINT LOCKER (SUSPECTED SOURCE)

The Army proposes to implement the following sample selection sequence to investigate the suspected source at the Paint Locker. Figure A-14 shows the steps for evaluating the Paint Locker. At the end of this evaluation, the Paint Locker is either identified and bounded as a source and the investigation proceeds to Step 13 on Figure A-15, or it is not identified as a source and the investigation proceeds to Step 2a on Figure A-13.

1. MIP #SSO: Follow step 1 as in the Decision Logic for Indefinite Source Areas, but place CPT/MIP (MIP #SS0) on the downgradient edge of the known source area (instead of adjacent to an existing well or DPT).

2b. Decision Step: Does the MIP profile at MIP #SS0 indicate a source? Follow the description of source and plume characteristics presented in Step 2a of the Decision Logic for Indefinite Source Areas to answer this question.

- If YES, then go to Step 3c.
- If NO, then proceed to 9d. Evaluate LOC as an indefinite source, and proceed to Step 1 on Figure A-13.

3c. Short-Step, MIP #B1: Step directly upgradient 50 feet (short-step) from MIP #SS0, clear utilities, and push background MIP #B1 through zones of interest indicated by MIP #SS0. Proceed to decision logic Step 4c.

4c. Decision Step: Does the MIP profile indicate the suspected source is unbounded in the upgradient direction?

- If YES, then go to Step 5c.
- If NO, then go to Step 7c.

5c. Short-Step, Background MIP #B2: Step directly upgradient 50 feet (short-step) from MIP #B1, clear utilities, and push background MIP #B2 through zones of interest indicated by MIP #B1. Proceed to decision logic Step 6c.

6c. Decision Step: Does the MIP profile indicate the suspected source is unbounded in the upgradient direction?

- If YES, then the source area is unbounded in the upgradient direction. Confirm results with DPT and make recommendations for additional data needs as in Step 9b to characterize in upgradient direction (see Source Branch logic). Then, proceed to Step 7c to determine if source area is bounded in the downgradient direction.
- If NO, go to Step 9c (see Source Branch logic). Proceed to Step 7c to determine if source area is bounded in the downgradient direction.

7c. Short-Step, MIP #SS1: Step directly downgradient 50 feet (short-step) from MIP #SS0, clear utilities, and push MIP #SS1 through zones of interest indicated by MIP #SS0. Proceed to decision logic Step 8c.

8c. Decision Step: Does the MIP profile indicate the suspected source is unbounded in the downgradient direction?

- If YES, then go to Step 11.
- If NO, then go to Step 9c (see Source Branch logic).

9d. No source area at suspected location. The MIP investigation of the Paint Locker (suspected source) area is complete. Proceed to Step 1 in the Decision Logic for Indefinite Source Areas (Figure A-13) and evaluate MIP response at MIP #0. Continue to evaluate an indefinite source according to the logic presented. If the logic for the Plume Branch is followed, use MIP #SS0 as location MIP #P1. Evaluate results of MIP #SS0 as MIP #P1 in Decision Step $4b_1$.

11. Short-Step, MIP #SS2: Step directly downgradient 50 feet (short-step) from MIP #SS1, clear utilities, and push MIP #SS2 through zones of interest indicated by previous MIPs. Proceed to decision logic Step 12.

12. Decision Step: Does the MIP profile indicate the suspected source is unbounded in the downgradient direction?

- If YES, then the source area is unbounded in the downgradient direction. Confirm results with DPT and make recommendations for additional data needs as in Step 9b (see Source Branch logic).
- If NO, go to Step 9c (see Source Branch logic).

DECISION LOGIC FOR DPT AND HYDROPUNCH SAMPLES AND INSTALLATION OF GROUNDWATER MONITORING WELLS

The source area for each LOC that has source characteristics will be bounded using DPT/Hydropunch groundwater sample locations.

All CPT MIP work will be completed before any DPT/Hydropunch groundwater samples are collected so that all LOCs can be prioritized. Groundwater samples then will be collected from the locations that exhibited the highest apparent concentration or greatest anomalously high concentration.

13. DPT/Hydropunch Sampling: This step will consist of source confirmation through DPT/Hydropunch sampling if a potential source is indicated by CPT/MIP results (Steps 9a and 9c). A DPT/Hydropunch will be pushed at the source location (either the strongest MIP response in the capillary fringe, or the strongest MIP in the saturated zone if there are no responses in the capillary fringe) and the upgradient MIP location that bounds the source. One to two groundwater samples will be collected at each of the two locations.

14. EVS Model: The groundwater and lithology data from previous investigations and this investigation will be combined and incorporated into EVS to assess the most likely locations of sources and locations of elevated TCE concentrations in groundwater that are related to these sources.

15. Monitoring Well: One monitoring well will be installed where TCE concentrations are likely to be highest.

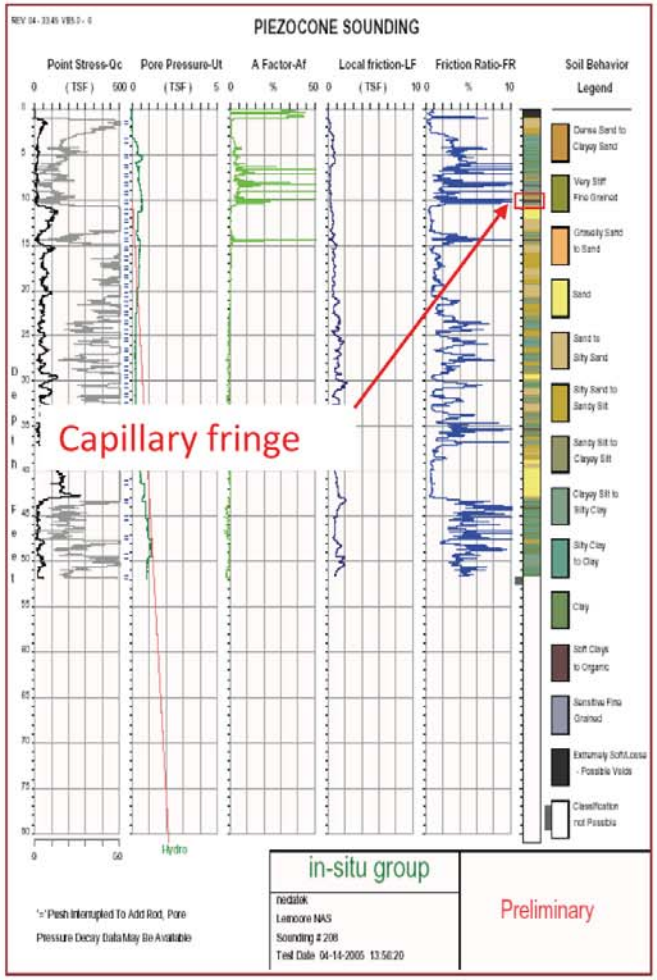
16. Groundwater Monitoring: After all MIPs, CPTs, DPTs, and monitoring wells have been installed, a round of groundwater samples will be collected and analyzed for VOCs. Groundwater levels will also be measured at all existing and new on-site wells.

17. Investigation is complete.

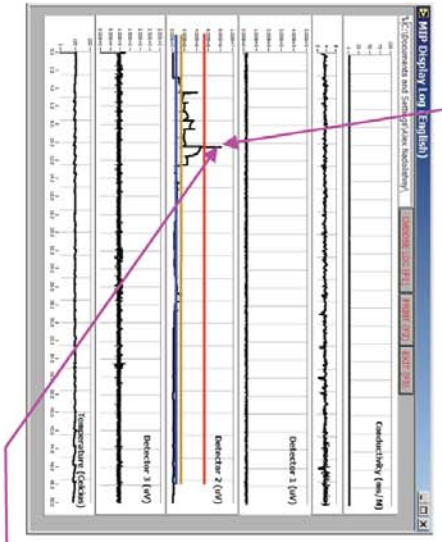
Soil Behavior Legend

- Dense Sand to Clayey Sand
- Very Stiff Fine Grained
- Gravelly Sand to Sand
- Sand
- Sand to Silty Sand
- Silty Sand to Sandy Silt
- Sandy Silt to Clayey Silt
- Clayey Silt to Silty Clay
- Silty Clay to Clay
- Clay
- Soft Clays to Organic
- Sensitive Fine Grained
- Extremely Soft/Loos · Possible Voids
- Classification not Possible

CPT Logs



MIP Logs



MIP log legend

- Baseline (variable)
- 5.0 e +5
- 1.0 e +6
- 5.0 e +6

1. Maximum MIP response at 10.45 feet (capillary fringe)

Discrete Sample Results

TCE	1,1-DCE	Depth
5	5	1.25
62	5	11.25
5	6.4	27.25
9.9	7.7	36.75
13	21	41.25
21	9.4	45.75
5	5	58.25
8.5	5	65.75
8.1	5	73.25
31	5	97.75

Notes:

The sample depths in the discrete sample results table are from a co-located DPT advanced 5 feet from the MIP. They are soil samples collected from the DPT core and analyzed in a mobile lab for TCE using 8260B lab methods. The depth reported in note 1 refers to the depth of a specific peak, or feature, on the MIP output log.

CPT – Cone penetrometer technology
DPT – Direct push technology
MIP – Membrane interface probe
TCE – Trichloroethene

American Integrated Services, Inc.

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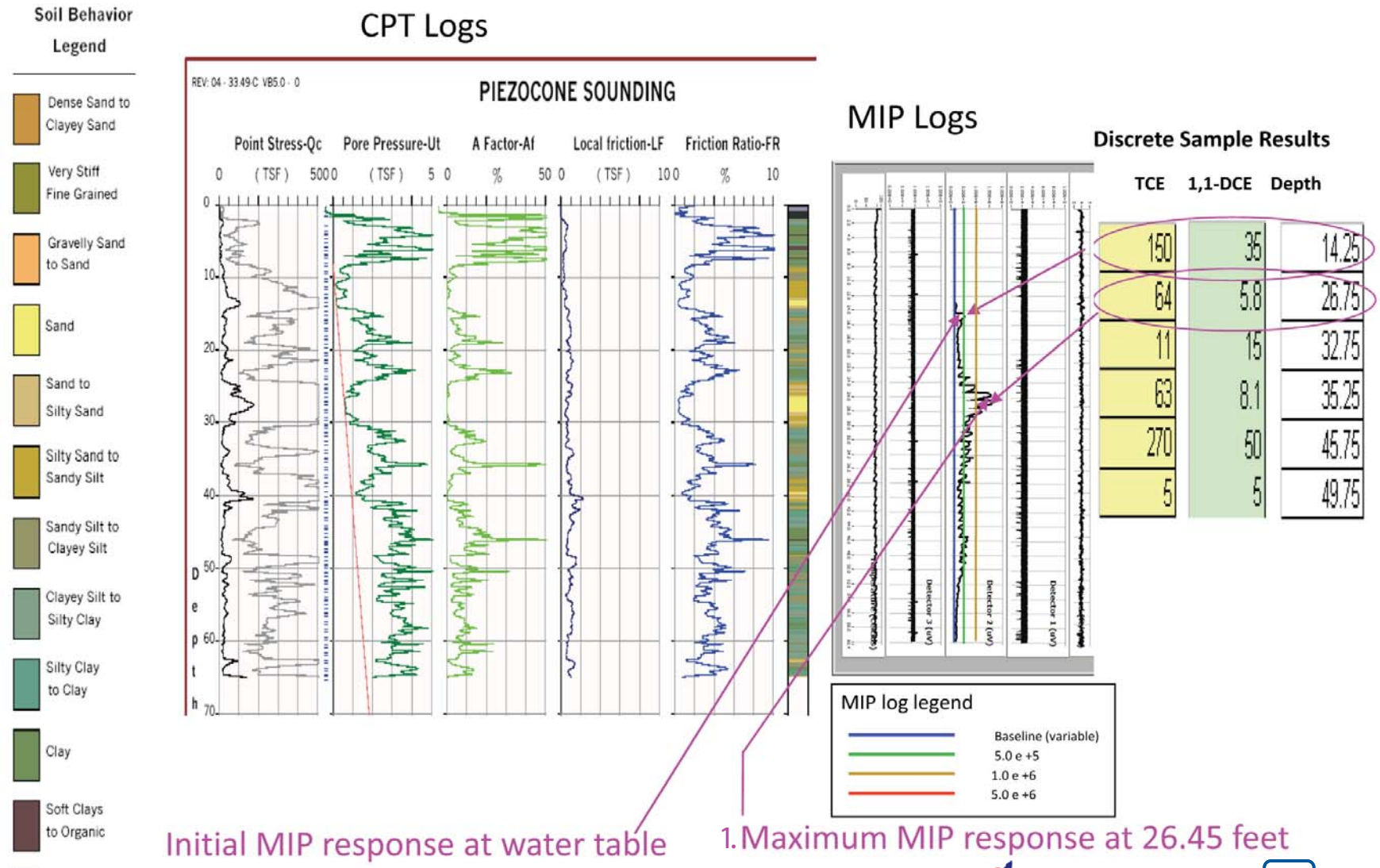
Orion Park Housing Area
Moffett Field

FIGURE A1-1
EXAMPLE OF CPT AND MIP DATA FROM A SOURCE AREA

Sampling and Analysis Plan for the Supplemental Site Investigation



Notes:

The sample depths in the discrete sample results table are from a co-located DPT advanced 5 feet from the MIP. They are soil samples collected from the DPT core and analyzed in a mobile lab for TCE using 8260B lab methods. The depth reported in note 1 refers to the depth of a specific peak, or feature, on the MIP output log.

CPT – Cone penetrometer technology
DPT – Direct push technology
MIP – Membrane interface probe
TCE – Trichloroethene

American Integrated Services, Inc.

TETRA TECH

Orion Park Housing Area
Moffett Field

FIGURE A1-2
EXAMPLE OF CPT AND MIP DATA FROM A PLUME AREA

Sampling and Analysis Plan for the Supplemental Site Investigation

ATTACHMENT A2
FIELD FORMS

Figure 2 - LOC # : **Site:** Former OPHA **Final Determination (source or plume):** **Comments:**

Decison Logic Summary Table **Contractor:** AIS/Tetra Tech **Field Personnel:** **Date:**

Steps and Data Input			Decision Criteria		Results					
Decision Logic Step #	**Order of Steps Taken in Field**	**Data Input**	**Decision Criteria** [k]	**Decision Criteria Details**	**Peak MIP Response (µV)**[a]	**Result**[b]	**Total Score** [c]	**MIP Boring Type** [l]	**MIP Boring Number** [m]	**Notes**
1		Historical DPT sample results, MIP response	MIP #0 response reflects historical VOC detection?	Does MIP Profile [d] indicate detection of VOCs within depth interval of historical VOC detection? If yes, proceed with investigation, if no, recalibrate MIP	NA	Yes/No	NA	MIP #0		
2a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #0		
2b		MIP Profile[d]	MIP profile indicates source at suspected source location?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS0		
3a		No input, MIP drilled			NA					
3b										
3c										
4a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #S1		
4b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P1		
4b2		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P1		
4c		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #B1		
5a		No Input, MIP drilled	Step 75 feet upgradient (or as determined by EVS for iteration)		NA					
5b		Boring Logs	Direction for next MIP?	Qualitative review of historical boring logs			NA			
5c		No Input, MIP drilled	Step 50 feet upgradient		NA					
6a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #S2		
6b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P2		
6b2		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P3		
6c		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #B2		
7a		No step 7a	NA			left or right	NA			
7b		No Input, MIP drilled			NA					
7c		No Input, MIP drilled	Step 50 feet downgradient		NA					

h. Response Profile Detail

	Score
A) Is MIP response greatest in the capillary fringe?	2
B) Does MIP response indicate a peak ≥ 7.0×10^6 microvolts?	2
C) Does MIP response indicate a peak ≥ 4.0×10^6 microvolts (but < 7.0×10^6 microvolts) ?	1
D) Does MIP response have a decreasing trend with depth in the uppermost saturated zone?	1
E) Is MIP response greatest in low-permeability (clayey silt or clay) formations?	1
Maximum Possible Score =	**6**

Total Score ≥ 2 Adequate indication of a nearby source, select "source" branch

Total Score 0-1 Inadequate indication of a nearby source, select "plume" branch

Figure 2 - LOC # : **Site:** Former OPHA **Final Determination (source or plume):** **Comments:**

Decison Logic Summary Table **Contractor:** AIS/Tetra Tech **Field Personnel:** **Date:**

Steps and Data Input			Decision Criteria		Results					
Decision Logic Step #	**Order of Steps Taken in Field**	**Data Input**	**Decision Criteria** [k]	**Decision Criteria Details**	**Peak MIP Response (µV)**[a]	**Result**[b]	**Total Score** [c]	**MIP Boring Type** [l]	**MIP Boring Number** [m]	**Notes**
8b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P3		
8b2		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P3		
8c		MIP Profile[d]	MIP profile indicates source is unbounded downgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS1		
9a		Terminal Point	MIP complete. Confirm results with DPT.	NA						
9b		MIP responses & CPT readings[g]	Determine appropriate distance.	EVS modelling	upgadient or downgradient			MIP #S2		
9c		Terminal Point	MIP complete. Confirm results with DPT.	NA						
9d		Terminal Point for Source Investigation	Continue Investigation as indefinite source	Proceed to Step 1	NA					
10a		MIP responses & CPT readings[g]	Evaluate preferential pathway	EVS: Concentrations indicate an off-site plume. Investigation complete, unless EVS drill guide indicates need for additional MIP.[i]	NA					
10b		MIP responses & CPT readings[g]	Investigation complete.	EVS: Localized dissolved concentration from offsite plume. Investigation complete.[i]	NA					
11		No Input, MIP drilled	Step 50 feet downgradient	NA						
12		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS2		

Notes:

(a) MIP Response = multiphase interface probe (MIP) quantitative reading in millivolts (µV) at specific depths below ground surface; readings correlated to VOC concentration

(b) Applicable result for each step circled: yes/no, left/right, upgradient/downgradient, or A, B, C, D, or E

(c) Total Score = Sum of A, B, C, D, and E

(d) MIP Profile = VOC concentrations recorded at 0.05? foot depth intervals from ground surface to bottom of boring

(e) Monitoring Well Boring Log = lithologic description of geology from ground surface to bottom of boring

(f) Monitoring Well VOC chemical analytical results

(g) CPT readings = cone pentrometer technology (CPT) pressure readings recorded continuously from ground surface to bottom of borin

(h) Decision Criteria Details for "MIP Profile = source?"

Response Profile Detail	**Score**
A) Is MIP response greatest in the capillary fringe?	2
B) Does MIP response indicate a peak ≥ 7.0×10^6 microvolts?	2
C) Does MIP response indicate a peak ≥ 4.0×10^6 microvolts (but < 7.0×10^6 microvolts) ?	1
D) Does MIP response have a decreasing trend with depth in the uppermost saturated zone?	1
E) Is MIP response greatest in low-permeability (clayey silt or clay) formations?	1
Maximum Possible Score =	**6**

Total Score ≥ 2 Adequate indication of a nearby source, select "source" branch

Total Score 0-1 Inadequate indication of a nearby source, select "plume" branch

(i) EVS: Use EVS Drill Pro to determine if an MIP is required to show continuity along a preferential pathway between this MIP location and an already-identified offsite plume. The MIP would target a location to verify a preferntial pathway.

(j) EVS: Use EVS to demonstrate that the concentrations are from an offsite plume, but the result of site-specific hydrogeologic/lithologic characteristics (soil variability, other) that is causing a localized variation in concentrations. A preferntial pathway to assess off-site movement has been identified.

(k) Decision criteria corresponds to Figures A-13 and A-14 of the SAP.

(l) MIP Boring number corresponds to boring ID in Worksheet #27 of the SAP

(m) MIP Boring type corresponds to Figures A-13 and A-14 of the SAP

FIELD INSTRUMENT CALIBRATION RECORD

Calibration Code:		Sheet of
Employee Performing Calibration:		Date:
Instrument:	**Standards:**	**Lot Number and Expiration Date:**
(1) pH meter	pH = 7.00	
(2) pH meter	pH = 4.00	
(3) pH meter		
(4) Specific conductance meter	Oakton Standard (1,413 μS/cm)	
(5) Specific conductance meter	Oakton Standard (8,974 μS/cm)	
(6) Dissolved oxygen meter	Saturation Method (100%)	
(7) Oxidation reduction potential meter		
(8) Multi-gas meter – H_2S		
(9) Multi-gas meter – Hg vapor		
(10) Particulate meter		
(11)		
(12)		
(13)		

Instrument Calibration Data

Inst. No.	Time	Response As Found	Response As Left	Solution Temp (C)	Zero	Battery Check	Alarm Point	Notes
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

Review		*Action*
On-Site Health and Safety Officer	Date	
Site Manager/Project Manager	Date	
Health and Safety Review	Date	

Tetra Tech EM Inc.
Oakland Office

1999 Harrison Street, Suite 500
Oakland, CA 94612
510.302.6300 Phone
510.433.0830 Fax

Chain of Custody Record No. _____

	Lab PO#:	**Lab:**
Project name:	**TtEMI technical contact:**	**Field samplers:**
Project (CTO) number:	**TtEMI project manager:**	**Field samplers' signatures:**

Sample ID	Sample Location (Pt. ID)	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sleeve	Glass Jar				VOA	SVOA	Pest/PCBs	Metals	TPH Purgeables	TPH Extractables										

No./Container Types — **Analysis Required** — **Preservative Added**

	Name (print)	Company Name	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks:

Fed Ex #:

TETRA TECH EM INC.
GROUNDWATER LEVEL MEASUREMENTS LOG

Type of organic vapor meter used (circle): PID FID

Well Identification Number	Organic Vapor Information		Water Level Information							Depth to Well Bottom from Top of PVC Casing[2] (feet)	Comments
					Depth to Groundwater Information						
	PID/FID Reading (ppm)	Date	Well previously equilibrated? (Yes/No)	If not previously equilibrated, **pressure detected** when cap removed? (NA/Yes/No)	Time	Date	Depth to Groundwater[1] from Pump Platform or Riser, if present (feet)	Thickness of Pump Platform or Riser, if present (feet)	Depth to Groundwater[1] from Top of PVC Casing (feet)		

Notes: 1 Where bladder pump sampling platform or riser is present, depth to water must be corrected to depth from top of PVC casing.
2 Note if access to well bottom is limited by presence of dedicated bladder pump.

Field Staff: _____ **Field Staff Signature:** _____

Page No.: _____ **Date:** _____

Tetra Tech EM Inc.

MONITORING WELL SAMPLING FORM

Date/Time of Sample Collection: _____/_____ Project Site/Subsite: _____

Sample ID: _____

Field ID:_____ Point Name:_____

Depth to Well Bottom: _____ ft. below top of casing (PVC cap)

Depth to Water Level: _____ ft. below PVC cap

Depth to Water Level: _____ ft below PVC cap prior to sampling

Method of Purging: Bladder Pump Submersible Pump
Bailer

Minimum Purge Volume: Two-inch well _____ Liters

Four-inch well _____ Liters

Purge Calcs

Control Box Settings: Box # _____Refill=_____Discharge=_____ Throttle=_____psi

Total Purged _____Liters Purge Rate goal = 0.5 Liters/Min. Actual purge rate_____Liters/Min

PHYSIO-CHEMICAL PARAMETERS DURING PURGING

Measure in order listed	Initial reading									Stabilization Criteria	Final
Time											
PH										+/- 0.2	
Temperature (°C)										+/- 2.0 °C	
Specific Conductance (µmhos/cm)										+/- 3%	
Turbidity (NTU)										+/- 10%	
Dissolved Oxygen (mg/L)										+/- 0.2	
ORP (mV)										+/- 10	
Each Volume Purged (L)											
Total Liters Purged											

Duplicate Sample Collected? No Yes (Sample ID of Duplicate) _____

MS/MSD Sample Collected? No Yes _____

Sample Remarks (odors, colors, sediment): _____

Comments_____

Sample(s) Collected By: _____

Well Volume purge Calc: Length of tubing X 9.6 (ml/ft) + 130 (bladder volume) = Total required purge (liters) before collection of parameters.

TETRA TECH EM INC.

SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

DO:

Bldg./Site:

Project Name:

Boring Number:	Date Started:
Drilling Method: (*Circle one*) HSA Continuous Core/Direct Push/Hand Auger	Date Completed:
Air Rotary/Mud Rotary/Dual Tube Percussion/Sonic/Vacuum	Logged By:
Outer Diameter of Boring:	Drilling Subcontractor:
Inner Diameter of Well Casing:	Driller:
Depth to Water (ft./bgs.)	Location Sketch:

Time	Depth (ft) bgs	Drive Interval	Recovered Interval	Sample ID	V.B. utility type, dia. / Blow count (per 6 inches)	Description	USCS soil symbol	Well construction	OVM (ppm)

TETRA TECH EM INC.

SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

DO:

Bldg./Site:

Project Name:

Time	Depth (ft) bgs	Drive Interval	Recovered Interval	Sample ID	Blow count (per 6 inches) / V.B. utility type, dia.	Description	USCS soil symbol	Well construction	OVM (ppm)

TETRA TECH EM INC.

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. _____ WELL NO. _____

Project _____
Project No. _____
Date(s) of Installation _____
Date(s) of Development _____
Personnel/Company _____
_____
Type of Rig Used _____

Casing Diameter/Type _____
Borehole Diameter _____
Screened Interval(s) _____
Total Length of Well Casing_____
Measured Total Depth (TOC) Initial _____
Final _____
Initial Depth to Water
(TOC) _____ Date _____ Time _____
Stabilized Depth to Water
(TOC) _____ Date _____ Time _____

DEVELOPMENT

TECHNIQUE(S)	EQUIPMENT TYPE/CAPACITY
____ Jetting (Airlift)	_____
____ Surge Block	_____
____ Bailing	_____
____ Pumping	_____
____ Other	_____

FLUIDS ADDED

Lost Drilling Fluid:_____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation:_____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Ground Water Quality Parameters of
Added Water Measured: Y N
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: _____ Ft. of water
x _____ Gallons/Foot
= _____ Gallons per Single Casing Volume
Sand Pack Volume: _____ Ft. of Saturated Sand Pack
x _____Gallons/Foot (borehole diameter)
= _____ Gallons (in borehole)
- _____ Gallons of Casing Volume
= _____ x 0.3 (Assuming porosity = 30%)
= _____ Gallons Within Sand Pack
Single Purge Volume: _____ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: _____ Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour,Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

INSTRUMENT CALIBRATION

pH Meter: _____ Spec. Conductance Meter:_____
pH 4.0 = _____ @ _____ °C Standard _____ µmhos/cm@ 25°C
pH 7.0 = _____ @ _____ °C Reading _____ µmhos/cm @ _____ °C
pH 10.0 = _____ @ _____ °C Turbidity Meter: _____
Dissolved Oxygen Meter: _____ Other: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity or D.O.	Clarity, Odor, PID Readings, Other:

Development Completed at _____ Gallons Discharged. Date: _____ Time: _____
Criteria: _____ Personnel: _____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

Corrective Action Request Form

TETRA TECH EM INC.

Project Name: _____ **Date:** _____

Project No.: _____ **Project Manager:** _____

Location: _____

To (Project Manager): _____

From (Audit Team Members): _____

Description Problem:

_____

_____

_____

_____

Corrective Action Required:

_____

_____

_____

_____

The above corrective action must be completed by (Date): _____

Acknowledgement of Receipt

_____

(Signature and Date)

Corrective Action Request Form

TETRA TECH EM INC.

Corrective Action Taken:

_____

_____

_____

_____

Project Manager: _____

(Signature and Date)

Audit Team Members:

Corrective Action *is* / *is not* satisfactory

_____

(Date and Initial)

Remarks: _____

_____

_____

_____

_____

QC Coordinators:

Corrective Action *is* / *is not* satisfactory

_____

(Date and Initial)

Remarks: _____

_____

_____

_____

_____

cc: **Program QA Manager**

ATTACHMENT A3
STANDARD OPERATING PROCEDURES

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL SAMPLING

SOP NO. 005

REVISION NO. 2

Last Reviewed: June 2009

Quality Assurance Approved	6-19-09 Date

1.0 BACKGROUND

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

1.1 PURPOSE

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

1.2 SCOPE

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

1.3 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

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

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

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

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

2.0 SOIL SAMPLING PROCEDURES

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

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

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

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

2.1 SOIL SAMPLE COLLECTION PROCEDURES

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

2.1.1 Procedure for Preserving and Collecting Soil Samples for VOC analysis

Samples collected for VOC analysis using traditional methods, such as collection in a jar with no preservation, are shown to yield nonrepresentative samples due to loss of VOCs. To prevent such losses,

preservation with methanol or sodium bisulfite may be used to minimize volatilization and biodegradation. This preservation may be performed in the laboratory or in the field, depending on the sample collection methodology used. The specific sampling methodology will be specified in the project-specific QAPP or work plan.

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

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

2.1.1.1 Soil Samples to be Preserved at the Laboratory

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

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

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

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

2.1.1.2 Soil Samples to be Preserved in the Field

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

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

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

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

2.1.2 Procedure for Collecting Soil Samples for Non-VOC Analyses

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

2.2 TEST PIT AND TRENCH SOIL SAMPLING

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

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

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

Soil samples can also be obtained directly from the backhoe bucket or from the excavated material after it has been removed and deposited on plastic sheeting. The sampling personnel shall direct the backhoe excavator to obtain material from the selected depth and location within the excavation. The backhoe

operator shall set the backhoe bucket on the ground in a designated location, at a sufficient distance from the excavation to allow the sampler safe access to the bucket. The backhoe operator shall disengage the controls and signal to the sampler that it is safe to approach the bucket. The soil sample shall then be collected from the center of the backhoe bucket to reduce the potential for cross-contamination of the sample.

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

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

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

2.3 SURFACE SOIL SAMPLING

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

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

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

2.3.1 Hand Auger

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

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

2.3.2 Bucket Auger

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

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

2.3.3 Core Sampler

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

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

2.3.4 Shovel

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

2.3.5 Trier

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

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

2.3.6 Trowel

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

2.4 SUBSURFACE SOIL SAMPLING

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

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

unconsolidated soils. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.4.1 Split-Spoon Sampler

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

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

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

2.4.2 Thin-Wall Tube Sampler

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

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

2.4.3 Direct-Push Technology Sampler

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

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

FIGURE 1

HAND-OPERATED CORE SAMPLER

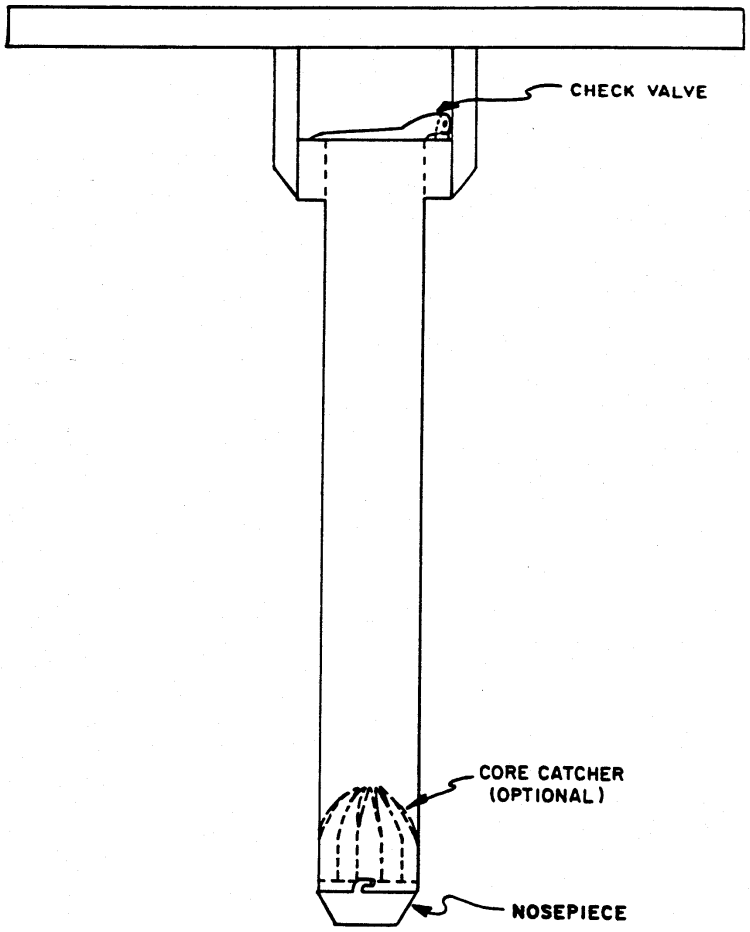


FIGURE 2

TRIER

TRIER

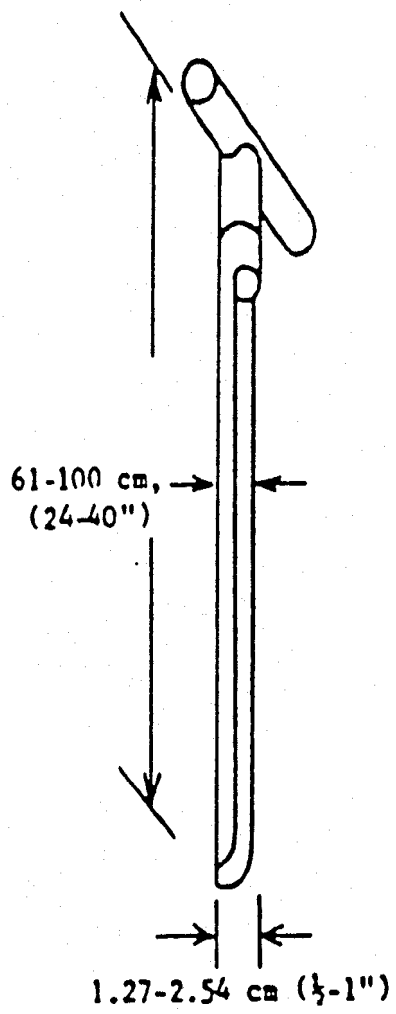


FIGURE 3

GENERIC SPLIT-SPOON SAMPLER

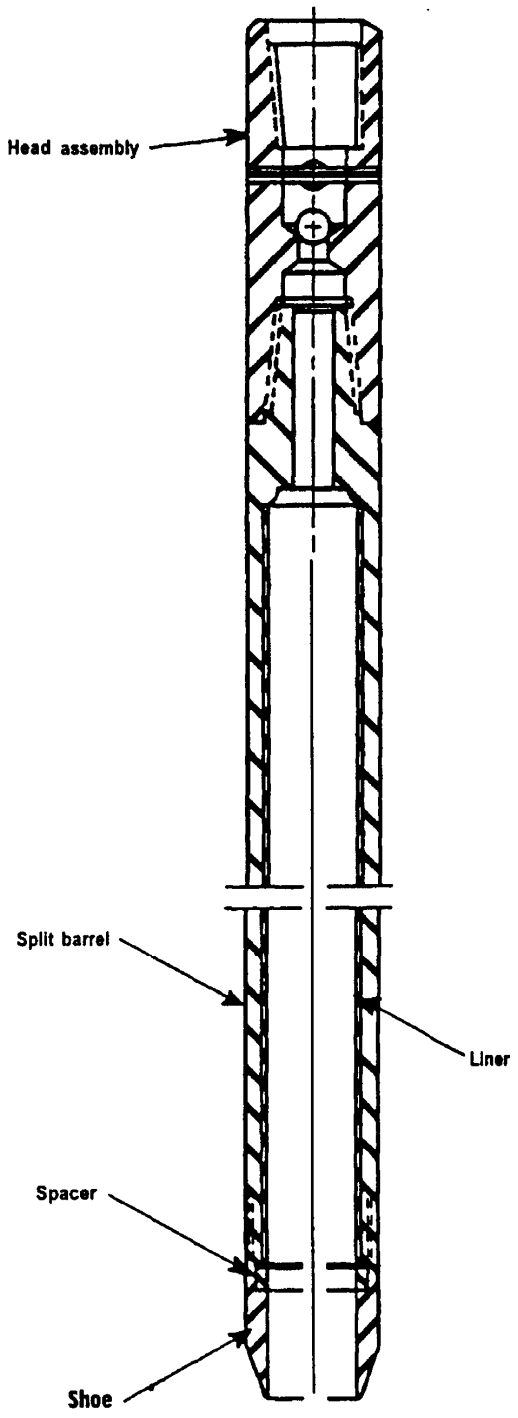
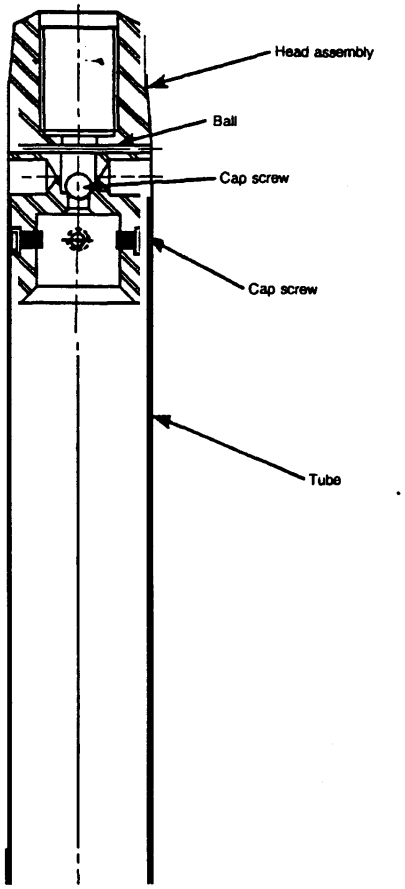


FIGURE 4

THIN-WALL TUBE SAMPLER



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

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

SOP NO. 014

REVISION NO. 1

Last Reviewed: July 2009

July 2009	
Quality Assurance Approved	Date

1.0 BACKGROUND

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

1.1 PURPOSE

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

1.2 SCOPE

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

1.3 DEFINITIONS

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

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

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

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

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

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

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

1.4 REFERENCES

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

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1.5 REQUIREMENTS AND RESOURCES

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

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

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

2.0 PROCEDURES

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

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

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

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

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

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

2.1 STATIC WATER LEVEL MEASUREMENT

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

2.2 TOTAL WELL DEPTH MEASUREMENT

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

the distance between the bottom of the well and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth from ground surface to the bottom of the well. The well number, measurement date and time, and individual readings should be recorded in a field logbook.

2.3 IMMISCIBLE LAYER DETECTION AND MEASUREMENT

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

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

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLE COLLECTION
USING LOW-FLOW SAMPLING METHODOLOGY

SOP NO. 015

REVISION NO. 1

Last Reviewed: April 2010

RMiesing	July 28, 2009
Quality Assurance Approved	Date

1.0 BACKGROUND

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

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

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

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

discharge. Therefore, the sample collected by this method is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

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

1.2 SCOPE

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

1.3 DEFINITIONS

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

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

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

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

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

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

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

1.4 REFERENCES

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

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

1.5 REQUIREMENTS AND RESOURCES

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

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

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

2.0 PROCEDURE

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

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

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

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturers' directions (see SOP No. 061 for more details regarding measurement of groundwater indicator parameters). Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration

should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen).

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

2.2 WELL PURGING

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

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

to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

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

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

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

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

Purging will continue until these stabilization criteria have been met, excluding temperature, or three well casing volumes have been purged. If three casing volumes of water have been purged and the

stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began after three well casing volumes were purged.

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

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

where

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

r = inside radius of the well (feet)

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

7.48 = conversion factor (cubic feet to gallons)

Common well diameter sizes and corresponding volumes are listed below.

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

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

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

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

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

2.3 SAMPLE COLLECTION

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

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

12. Nitrate and ammonia

13. Radionuclides

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

FIGURE 1 - LOW-FLOW GROUNDWATER SAMPLING DATA SHEET

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

Purge Calculations

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

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

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

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL INSTALLATION

SOP NO. 020

REVISION NO. 4

Last Reviewed: April 2009

Quality Assurance Approved	May 21, 2009 Date

1.0 BACKGROUND

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

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

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

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

Monitoring well materials

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

- Concrete surface pad and bumper posts
- Uncontaminated water

Monitoring well installation procedures

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

Record-keeping procedures

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

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

1.1 PURPOSE

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

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

1.2 SCOPE

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

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

1.3 DEFINITIONS

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

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

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

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

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

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

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

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

1.4 REFERENCES

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

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

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

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

1.5 REQUIREMENTS AND RESOURCES

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

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

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

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

2.0 MONITORING WELL INSTALLATION PROCEDURES

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

2.1 MONITORING WELL CONSTRUCTION MATERIALS

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

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

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

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

2.1.1 Casing Materials

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

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

2.1.2 Well Screen Materials

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

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

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

2.1.3 Filter Pack Materials

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

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

2.1.4 Annular Sealant (Bentonite Pellets or Chips)

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

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

2.1.5 Grouting Materials

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

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

2.1.6 Tremie Pipe

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

2.1.7 Surface Completion and Protective Casing Materials

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

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

2.1.8 Concrete Surface Pad and Bumper Posts

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

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

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

2.1.9 Uncontaminated Water

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

2.2 MONITORING WELL INSTALLATION PROCEDURES

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

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

2.2.1 Well Screen and Riser Placement

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

1. Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.

2. Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.

3. Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.

4. Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.

5. Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.

6. The screened interval should not extend across an aquiclude or aquitard.

7. If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.

8. If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.

9. If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen slot size and well pack material are determined based

on the specifications described in the work plan. The well-screen slot size can only be selected after the filter pack grain size is specified. In monitoring wells, the well screen should retain 90 to 100 percent of the filter pack sands. Cumulative weight percent vs. grain size in thousandths of an inch (standard size for screen slots) of the selected filter sand is used to select the appropriate screen size.

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

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

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

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

2.2.2 Filter Pack Placement

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

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

4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.

5. Check the depth of sand in the hole using a weighted tape.

6. Pull the drill casing up ahead of the sand to keep the sand from bridging.

7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

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

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

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

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

2.2.3 Temporary Casing Retrieval

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

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

2.2.4 Annular Seal Placement

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

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

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

2.2.5 Grouting

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

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

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

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

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

2.2.6 Surface Completion and Protective Casing

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

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

2.2.7 Permanent and Multiple Casing Well Installation

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

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

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

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

2.3 RECORD -KEEPING PROCEDURES

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

2.3.1 Surveying

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

2.3.2 Permits and Well Construction Records

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

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

2.3.3 Monitoring Well Identification

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

FIGURE 1
MONITORING WELL COMPLETION RECORD

DRILLING INFORMATION

RIG TYPE _____

DRILLING BEGAN:

DATE _____ TIME _____

BORING DIAMETER (in) _____

BORING DEPTH (ft) _____

WELL INSTALLATION BEGAN:

DATE _____TIME _____

WELL DEPTH (ft) _____

SURFACE COMPLETION

ABOVE GROUND W/ CRASH POSTS

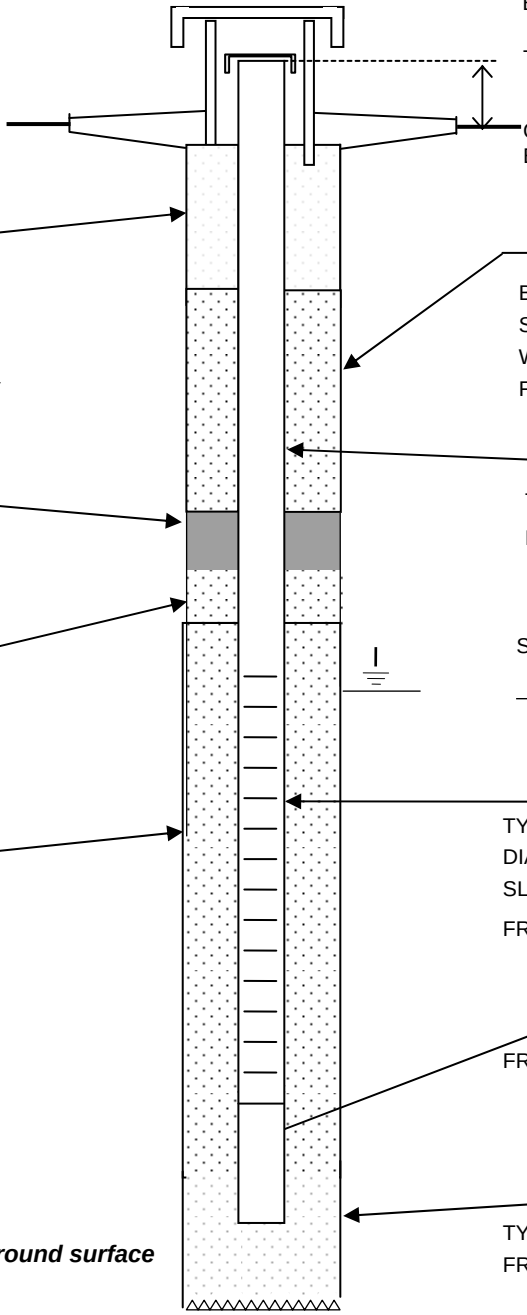
MONITORING WELL

MONITORING WELL ID _____

PROJECT _____

SITE _____

BOREHOLE ID _____



TOP OF CASING (ft)

GROUND SURFACE ELEVATION (ft)

ANNULAR SEAL

PORTLAND CEMENT (lbs) _____

BENTONITE (lbs) _____

WATER (gal) _____

FROM (ft) _____TO (ft) _____

BENTONITE/SAND SLURRY

BENTONITE (lbs) _____

SAND (lbs) _____

WATER (gal) _____

FROM (ft) _____TO (ft) _____

CASING

TYPE _____

DIAMETER (in) _____

BENTONITE SEAL

TYPE _____

BENTONITE (lbs) _____

WATER (gal) _____

FROM (ft) _____TO (ft) _____

STATIC WATER LEVEL (ft)

_____

FINE SAND

SAND SIZE _____

SAND (lbs) _____

FROM (ft) _____TO (ft) _____

WELL SCREEN

TYPE _____

DIAMETER (in) _____

SLOT SIZE (in) _____

FROM (ft) _____TO (ft) _____

FILTER PACK

SAND SIZE _____

SAND (lbs) _____

FROM (ft) _____TO (ft) _____

SUMP

FROM (ft) _____TO (ft) _____

CENTRALIZERS

INTERVALS _____

_____

BOREHOLE BACKFILL

TYPE _____

FROM (ft) _____TO (ft) _____

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

Notes_____

_____

_____

FIGURE 2A

MONITORING WELL TYPICAL CONSTRUCTION DETAILS – ABOVE GRADE COMPLETION

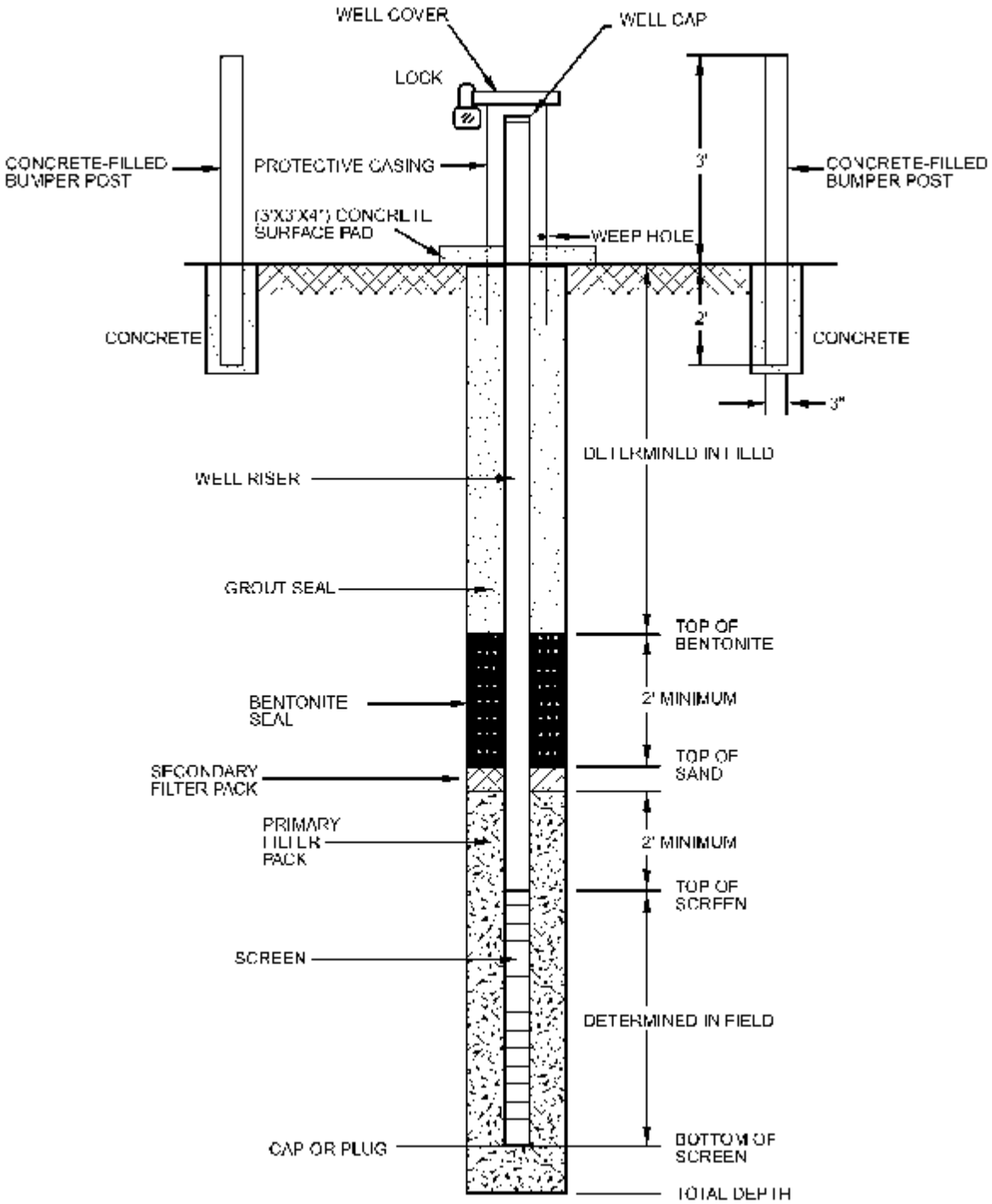


FIGURE 2B

MONITORING WELL TYPICAL CONSTRUCTION DETAILS – FLUSH MOUNTED COMPLETION

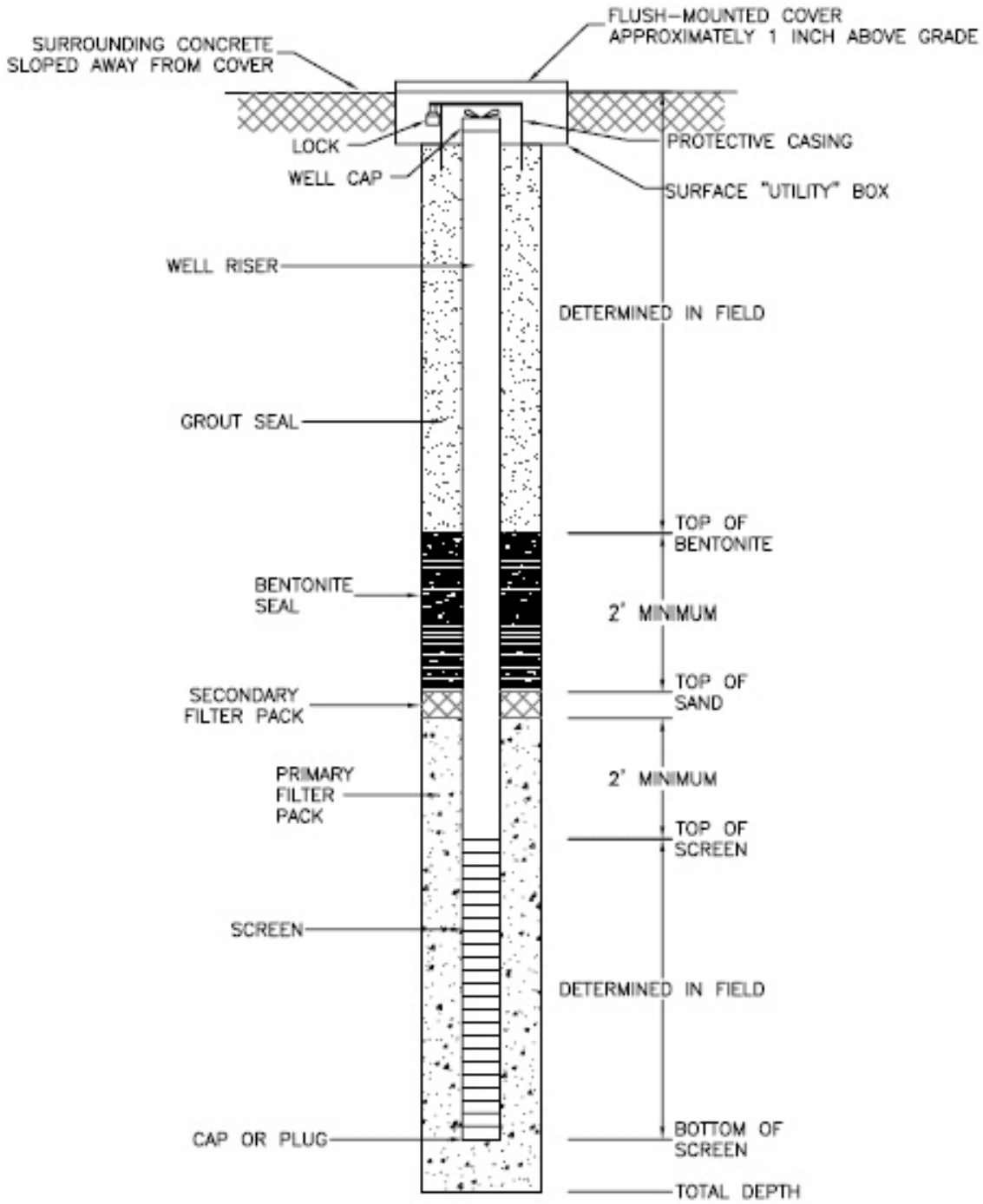
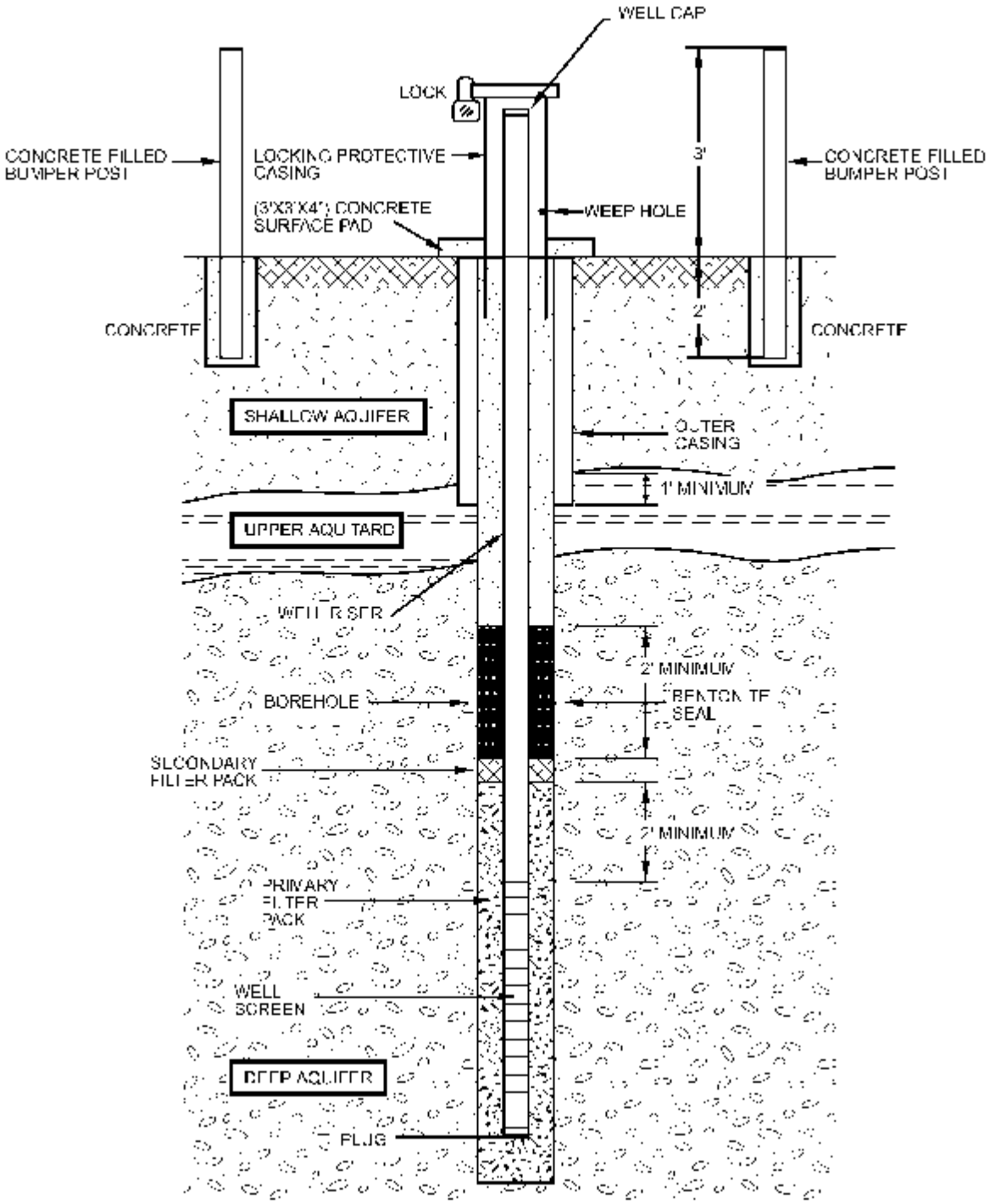


FIGURE 3

MULTIPLE CASING WELL CONSTRUCTION DIAGRAM



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 021

REVISION NO. 4

Last Reviewed: June 2009

Quality Assurance Approved	06-19-09 Date

1.0 BACKGROUND

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

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

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

1.1 PURPOSE

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

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

1.2 SCOPE

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

1.3 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

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

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

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

2.0 WELL DEVELOPMENT PROCEDURES

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

2.1 WELL DEVELOPMENT METHODS

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

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

2.1.1 Mechanical Surging

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

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

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

The accumulation of material developed from a specific screen interval can be measured by sounding the total depth of the well before and after surging. Continue surging until little or no sand accumulates.

2.1.2 Overpumping

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations and is usually conducted in conjunction with mechanical surging or backwashing. Overpumping is commonly implemented using a downhole submersible pump lowered to the bottom of the well. In cases were the water table is less than 25 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump at the ground surface. The intake pipe is lowered into the water column at a depth sufficient to ensure that the water in the well is not drawn down to the pump intake level. The inflow of water at the well screen is not dependent on the location of the pump intake as long as it remains submerged.

Overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well, opening clogged screen slots, and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen because of the flow rate and direction created by overpumping may be overcome by using mechanical surging or backwashing in conjunction with this method.

2.1.3 Air Lift Pumping

Air lift pumping uses a two-pipe system consisting of an air injection pipe and a discharge pipe. In this well development method, an air lift pump is operated by cycling the air pressure on and off for short periods of time. This operation provides a surging action that can dislodge fine-grained particles in the vicinity of the well screen. Subsequently applying a steady, low pressure removes the fines drawn into the well by the surging action.

The bottom of the air lift should be at least 10 feet above the top of the well screen. Air is injected through an inner pipe at sufficient pressure to bubble out directly into the surrounding discharge pipe. The bubbles formed by the injected air cause the column of water in the discharge pipe to be lifted upward and allow water from the aquifer to flow into the well. This arrangement prevents injected air from entering the well screen. Pumping air through the well screen and into the filter pack and adjacent hydrologic unit should be avoided because it can cause air entrainment, inhibiting future sampling efforts and possibly altering groundwater chemistry.

The air injected into the well should be filtered using an oil-air filter and oil trap to remove any compressor lubricant entrained in the air. Air pressures required for this well development method are relatively low; an air pressure of 14.8 pounds per square inch should move a 30-foot column of water. For small-diameter, shallow wells where the amount of development water is likely to be limited, tanks of inert gas (such as nitrogen) can be used as an alternative to compressed air.

2.1.4 Backwashing

Effective development procedures should cause flow reversals through the screen openings that will agitate the sediment, remove the finer fraction, and then rearrange the remaining formation particles. Backwashing overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the submersible pump and out through the well screen. The backflow portion of the backwashing cycle breaks down bridging, and the inflow then moves the fine material toward the screen and into the well.

Some wells respond satisfactorily to backwashing techniques, but the surging effect is not vigorous enough to obtain maximum results in many cases.

A variation of backwashing may be effective in low-permeability formations. After the filter pack is installed around the monitoring well screen, clean water is circulated down the well casing, out through the well screen and filter pack, and up through the open borehole before the grout or bentonite seal is placed in the annulus. Flow rates should be controlled to prevent floating the filter pack. Because of the low hydraulic conductivity of the formation, negligible amounts of water will infiltrate into the formation. Immediately after this procedure, the bentonite seal should be installed, and the nonformation water should be pumped out of the well and filter pack.

2.1.5 Surge Bailing

Surge bailing can be an effective well development method in relatively clean, permeable formations where water flows freely into the borehole. A bailer made of stainless steel or polyvinyl chloride and slightly smaller than the well casing diameter is allowed to fall freely through the borehole until it strikes the groundwater surface. The contact of the bailer produces a downward force and causes water to flow outward through the well screen, breaking up bridging that has developed around the screen. As the bailer fills and is rapidly withdrawn from the well, the drawdown created causes fine particles to flow through the well screen and into the well. Subsequent bailing can remove these particles from the well. Lowering the bailer to the bottom of the well and using rapid short strokes to agitate and suspend solids that have settled to the well bottom can enhance removal of sand and fine particles. Bailing should continue until the water is free of suspended particles.

2.1.6 Well Jetting

Well jetting can be used to develop monitoring wells in both unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in a very small increments to be sure that all portions of the screen are exposed to the jetting action.

Jetting is relatively ineffective on the fine screens typically used in monitoring wells (slot sizes from 0.01 to 0.02 inch). In addition, jetting requires the introduction of external water into the well and surrounding formation. This water should be obtained from a source of known chemistry. Water introduced for development should be completely removed from the aquifer immediately after development.

The use of compressed air as a jetting agent should not be employed for development of monitoring wells. Compressed air could entrain air in the formation, introduce oil into the formation, and damage the well screen.

2.2 FACTORS TO CONSIDER WHEN SELECTING A WELL DEVELOPMENT METHOD

It is important to check federal, state, and local regulatory requirements for monitoring well development requirements. This SOP may be changed to accommodate applicable regulations, site conditions, or equipment limitations where applicable.

The type of geologic material, the design, completion of the well, and the type of drilling method used are all factors to be considered during the development of a monitoring well.

Monitoring well development should usually be started slowly and gently and then performed with increasing vigor as the well is developed. Most well development methods require the application of sufficient energy to disturb the filter pack, thereby freeing fine particles and allowing them to be drawn into the well. The coarser particles then settle around and stabilize the screen.

Development of wells completed in fine sand and silt strata should involve methods that are relatively gentle so that strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the formation. In addition, development methods should be carefully selected based upon the potential contaminants present, the quantity of wastewater generated, and requirements for containerization or treatment of wastewater.

For small diameter and small volume wells, a development bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small diameter wells.

Any time an air compressor is used for well development, it should be equipped with an oil-air filter or oil trap to minimize the introduction of oil into the screened area. The presence of oil could affect the organic constituent concentrations of the water samples collected from the well.

The presence of light nonaqueous-phase liquids (LNAPL) can impact monitoring well development. Water jetting or vacuum-enhanced well development may assist in breaking down the smear zone in the LNAPL. Normal development procedures are conducted in the water-saturated zone and do not affect the LNAPL zone.

2.3 INITIATING WELL DEVELOPMENT

Newly completed monitoring wells should be developed as soon as practical, but no sooner than 24 to 48 hours after grouting is completed if rigorous well development methods are used. Development may be initiated shortly after well installation if the development method does not interfere with the grout seal. State and local regulations should be checked for guidance. The following general well development steps can be used with any of the methods described in Section 2.1.

1. Assemble the necessary equipment on a plastic sheet around the well. This may include a water level meter (or oil-water interface probe if LNAPL or dense nonaqueous-phase liquids [DNAPL] are present); personal protective equipment; pH, conductivity, temperature, and turbidity meters; air monitoring equipment; Well Development Data Sheets (see Figure 2); a watch; and a field logbook.

2. Open the well and take air monitoring readings at the top of the well casing and in the breathing zone. See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

3. Measure the depth to water and the total depth of the monitoring well. See SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) for additional guidance.

4. Measure the initial pH, temperature, turbidity, and specific conductance of the groundwater from the first groundwater that comes out of the well. Note the time, initial color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. See SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), 013 (Field Measurement of Specific Conductance), and 088 (Field Measurement of Water Turbidity) for additional guidance.

5. Develop the well using one or more of the methods described in Section 2.1 until the well is free of sediments and the groundwater turbidity has reached acceptable levels. Record the development method and other pertinent information on a Well Development Data Sheet (see Figure 2) or in a field logbook.

6. Containerize any groundwater produced during well development if groundwater contamination is suspected. The containerized water should be sampled and analyzed to determine an appropriate disposal method.

7. Do not add water to assist in well development unless the water is from a source of known chemical quality and the addition has been approved by the project manager. If water is added, five times the amount of water introduced should be removed during development.

8. Continue to develop the well, repeating the water quality measurements for each borehole volume. Development should remove a minimum of 3 well volumes and continue if necessary until water quality parameters are stable to within 10 percent. Development should also continue until all the water added during development (if any) is removed or the water has a turbidity of less than 50 nephelometric turbidity units. This level may only be attainable after allowing the well to settle and testing at low flow sampling rates.

9. At the completion of well development, measure the final pH, temperature, turbidity, and specific conductance of the groundwater. Note the color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. In addition to the final water quality parameters, the following data should be noted on the Well Development Data Sheet: well identification, date(s) of well installation, date(s) and time of well development, static water level before and after development, quantity of water removed and time of removal, type and capacity of pump or bailer used, and well development technique.

All contaminated water produced during development should be containerized in drums or storage vessels properly labeled with the date collected, generating address, well identification, and consultant contact number.

2.4 DURATION OF WELL DEVELOPMENT

Well development should continue until representative water is free of drilling fluids, cuttings, or other materials introduced during well construction. When pH, temperature, turbidity, and specific conductance readings stabilize and the water is visually clear of suspended solids, the water is representative of formation water. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment-free sample in a matter of minutes, whereas bailing the well may require several hours of continuous effort to obtain a clear sample.

An on-site project geoscientist should make the final decision as to whether well development is complete. This decision should be documented on a Well Development Data Sheet (see Figure 2) or in a field logbook. Upon completion of the well development, the data sheet must be checked for completeness and technical accuracy by another qualified person as soon as practical.

2.5 CALCULATIONS

It is necessary to calculate the volume of water in the well. Monitoring well diameters are typically 2, 3, 4, or 6 inches. The height of the water column (in feet) in the well can be multiplied by the following conversion factors to calculate the volume of water in the well casing.

Well Diameter (inches)	Volume (gal/foot)
2	0.1631

3	0.3670
4	0.6524
6	1.4680

3.0 POTENTIAL PROBLEMS

The following potential problems can occur during development of monitoring wells:

- In some wells the pH, temperature, and specific conductance may stabilize, but the water remains turbid. When this occurs, the well may still contain construction materials (such as drilling mud in the form of a mud cake) and formation soils that have not been washed out of the borehole. Excessive or thick drilling mud cannot be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete well development. If the well is completed in a silty zone, it may be necessary to sample with low flow methods or filtering. If, after several attempts, all parameters have stabilized except turbidity, the well may be considered developed with the exception noted in the field log and/or Well Completion Report.

- Mechanical surging and well jetting disturb the formation and filter pack more than other well development methods. In formations with high clay and silt contents, surging and jetting can cause the well screen to become clogged with fines. If an excessive amount of fines is produced, sand locking of the surge block may result. Well development with these methods should be initiated gently to minimize disturbance of the filter pack and to prevent damage to the well screen.

- Effective overpumping may involve the discharge of large amounts of groundwater. This method is not recommended when groundwater extracted during well development is contaminated with hazardous constituents. If the hazardous constituents are organic compounds, this problem can be partially overcome by passing the groundwater through an activated carbon filter.

- When a well is developed by mechanical surging or bailing, rapid withdrawal of the surge block or bailer can result in a large external pressure outside of the well. If the withdrawal is too rapid and this pressure is too great, the well casing or screen can collapse.

- A major disadvantage of well jetting is that an external supply of water is needed. The water added during well jetting may alter the hydrochemistry of the aquifer; therefore, the water added in this development procedure should be obtained from a source of known chemistry. In addition, the amount of water added during well development and the amount lost to the formation should be recorded.

- The use of air in well development can chemically alter the groundwater, either directly through chemical reaction or indirectly as a result of impurities introduced through the air stream. In addition, air entrainment within the formation can interfere with the flow of groundwater into the monitoring well. Consequently, air should not be injected in the immediate vicinity of the well screen.

FIGURE 1

SCHEMATIC DRAWING OF A SURGE BLOCK

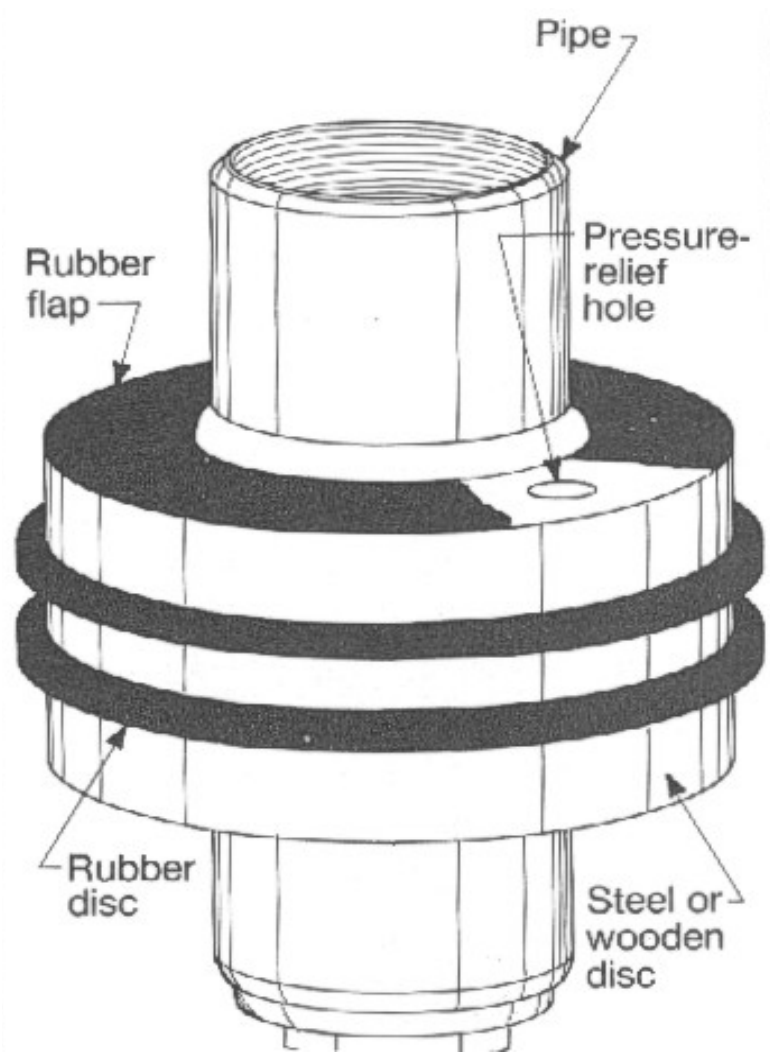

FIGURE 2
WELL DEVELOPMENT DATA SHEET

BORING NO. _____WELL NO. _____ Sheet ___ of ___

Project _____
Project No. _____
Date(s) of Installation _____
Date(s) of Development _____
Personnel/Company _____
_____
Type of Rig Used _____

Casing Diameter/Type _____
Borehole Diameter _____
Screened Interval(s) _____
Total Length of Well Casing_____
Measured Total Depth (TOC) Initial _____
Final _____
Initial Depth to Water
(TOC) _____ Date ____ Time _____
Stabilized Depth to Water
(TOC) _____ Date ____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

____ Jetting (Airlift) _____
____ Surge Block _____
____ Bailing _____
____ Pumping _____
____ Other _____

FLUIDS ADDED

Lost Drilling Fluid:_____ Gallons
Lost Purge Water: _____ Gallons
+
Water During Installation:_____ Gallons
Fluids Added)
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Ground Water Quality Parameters of
Added Water Measured: Y N
Sample Collected of Added Water: Y N
Grade.)
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: _____ Ft. of water
x _____ Gallons/Foot
= _____ Gallons / Single Casing Volume
Sand Pack Volume: _____ Ft. of Saturated Sand Pack
x _____Gallons/Foot (borehole
diameter)
= _____ Gallons (in borehole)
- _____ Gallons of Casing Volume
= _____ x 0.3 (Assume porosity = 30%)
= _____ Gallons Within Sand Pack
Single Purge Volume: _____ Gallons (Casing Vol.
Sand Pack Vol. +
Fluids Added)
Minimum Purge Volume: _____ Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour,Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below
Grade.)
Immiscible Phases Present: Y N Thickness _____

INSTRUMENT CALIBRATION

pH Meter: _____ Spec. Conductance Meter:_____
pH 4.0 = _____ @ _____ °C Standard _____ µmhos/cm@ 25°C
pH 7.0 = _____ @ _____ °C Reading _____ µmhos/cm @ _____ °C
pH 10.0 = _____ @ _____ °C Turbidity Meter: _____
Dissolved Oxygen Meter: _____ Other: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity or D.O.	Clarity, Odor, PID Readings, Other:

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF GROUNDWATER INDICATOR PARAMETERS

SOP NO. 061

REVISION NO. 2

Last Reviewed: July 2009

	July 2009
Quality Assurance Approved	Date

1.0 BACKGROUND

Various water quality monitoring systems can be used for determining groundwater indicator parameters in the field. Commonly measured field indicator parameters include pH, specific conductance, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity. Groundwater field measurements are typically collected in conjunction with groundwater sampling or monitoring well development (see SOPs 010, 015, and 021).

Various types of water quality systems exist including down-hole systems and flow through cells. Tetra Tech used several common water quality meters including various types of In-Situ, YSI, Hydac, and Horiba meters (see Figure 1 at the end of this SOP). The sampling team should select the type of meter or monitoring system based on site-specific conditions including data collection needs, the types of wells being sampled, and the sampling procedures used. Multiple parameter systems should be used when multiple field parameters are to be measured.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the general requirements and procedures for using various water quality monitoring systems for determining groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field.

1.2 SCOPE

This SOP applies to general procedures for calibrating and operating water quality monitoring systems in the field. The project work plan or field sampling plan should identify the types of systems to be used and the actual project-specific field parameters to be measured. For each type of water quality system, the manufacturer's manual should be consulted for specific operating instructions.

1.3 DEFINITIONS

Single Parameter System: A meter or monitoring system consisting of a single probe designed to measure a single indicator parameter.

Multiple Parameter System: A meter or monitoring system consisting of multiple probes capable of measuring multiple indicator parameters.

Open Container Measurements: Field measurements performed in an open container such as a cup, a jar, or a bucket where an air/water interface exists.

Flow-Through Chamber or Cell: A plastic cell or chamber connected to the sample pump discharge tubing so that a continuous flow of water passes across the probes. Additional tubing is used to route water from the flow-through cell to a waste container or final discharge point.

Down-Hole Monitoring System: A meter or monitoring system where probes are submerged by inserting them into the well. The probes are attached to the meter (located at the well head or ground surface) by one or more cables.

pH: A measure of the acidity or alkalinity of a solution. The pH scale ranges from 0 to 14 with strongly acidic solutions at the low end, strongly basic solutions at the high end, and "pure" or neutral water at 7. Field measurements of pH are recorded in standard units.

Specific Conductance: The ability of a solution to conduct electricity; a measure of the solution's ionic activity and content. The higher the concentration of ionic (dissolved) constituents, the higher the conductivity. Conductivity of the same water changes substantially with temperature. Specific conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity. Conductivity is measured by placing two electrodes (with opposite electrical charge) in the water. For a known electrical current, the voltage drop across the electrodes reveals the solution's resistance. Since the resistance of aqueous solution changes with temperature (resistance drops with increasing temperature), the resistance is corrected to the resistance of the solution at 25 ºC. Field measurements are recorded in units of microsiemens per centimeters (µS/cm).

Temperature: The degree of hotness or coldness of the solution being measured. Field measurements are typically recorded in degrees Celsius (°C).

ORP: ORP, or redox potential, is the tendency of a chemical species to acquire electrons and be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or lose electrons when new chemical species are introduced. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (to be reduced by oxidizing the new species) and a solution with a lower (more negative) reduction potential will have a tendency to lose electrons to the new species (to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the pH of an aqueous solution, the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor. It does not characterize the capacity of the system for oxidation or reduction, in much the same way that pH does not characterize the buffering capacity. Field measurements are typically recorded in millivolts (mV).

DO: Dissolved oxygen (or oxygen saturation) is a relative measure of the amount of oxygen dissolved or carried in a given medium. In aquatic environments, dissolved oxygen is a relative measure of the amount of oxygen (O_2) dissolved in the water. Field measurements are typically recorded in milligrams per liter (mg/L).

Turbidity: Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids). Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand, very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid. Field measurements are typically recorded in Nephelometric Turbidity Units (NTU).

1.4 REFERENCE

Essential Handbook of Ground-Water Sampling by Gillian Nielsen, 2007.

Tetra Tech EM Inc. July 2009. SOPs 010, 015, and 021

1.5 REQUIREMENTS AND RESOURCES

The following items are typically required to measure groundwater pH, specific conductance, temperature, ORP, DO, and turbidity using this SOP:

- Single or multiple parameter water quality measuring system
- Specific conductance calibration solutions
- Buffer solutions of pH 4, 7, and 10 for pH calibration
- Distilled or deionized water
- Rinse bottle
- 50-milliliter (mL) sample cups or beakers
- Sample tubing and connectors (specific to each type of system)
- Waste container to collect purge water
- Logbook or field data sheets

2.0 PROCEDURES

The procedures outlined in this SOP are general and may apply to various types of water quality monitoring systems to measure groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field. General procedures for testing and calibrating the monitoring systems are presented first, followed by procedures for using the instruments and making field measurements. Each particular monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

2.1 TESTING AND CALIBRATION PROCEDURES

Each field meter or monitoring system should be calibrated according to manufacturer's specifications. In general, equipment should be thoroughly cleaned then calibrated and tested before the start-up of sampling at each site. Equipment should be calibrated and tested using manufacturer provided solutions and standards. Care should be taken to rinse the probes between testing and calibration to prevent cross contaminating solutions. Solutions should be poured from the manufacturer's container into another container to prevent compromising the entire solution provided by the manufacturer. Calibration and testing of field equipment should be documented each time it is performed in field logbooks (or field data sheets, if applicable). If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.

2.2 FIELD MEASUREMENT PROCEDURES

Each field meter or monitoring system should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring system being used (open container systems, flow-through cell systems, or down-hole systems) and the types of field parameters being measured. In addition, most systems include a data logging option. A description of open container, flow-through cell, and down-hole measurement processes are discussed below, followed by a general procedural summary and a summary of common errors associated with field measurements of indicator parameters.

2.2.1 Open Container Measurements

Open container measurements consist of collecting groundwater and placing it in a cup or container for field measurements using a hand held system. This method of field measurements is commonly used when bailing wells, but can also be used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan. To make open container field measurements, samplers collect groundwater from the well and place in a cup or container large enough to adequately submerge the probe or probes, as specified in the manufacturer's operations manual. For open containers, measurements should be taken in the following order: temperature, specific conductance, pH, and turbidity. Open container systems are not recommended for low-flow sampling as flow-through systems are more appropriate. The probes and

cup or container should be thoroughly rinsed after each field measurement and between sampling locations.

2.2.2 Flow-Through Cell Measurements

Flow-through cell systems consist of measuring groundwater parameters as a continuous flow of water passes across the probes through a cell or chamber, and is primarily used when pumping wells and using low-flow sampling procedures. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The flow-through cell or chamber is placed "in line" between the discharge tubing of the pump and the container used to collect purged water. The outlet from the pump must be connected to the sample chamber input. The sample chamber outlet must then be connected or routed to a waste container (or to another designated discharge point). Tubing, fittings, and adaptors are generally required and may be provided by the manufacturer. Pump discharge tubing and chamber inlets and outlets are typically 1/2 or 3/8 inch diameter.

After the cell or chamber is connected to the pump discharge tubing and waste collection container, the sensors should be inserted into the sensor mounting plate in their respective ports. Any unused sensor ports must have plugs installed to close off the sample chamber. The probe cables are then connected to the meter following manufacturer's specifications.

With the system connected, the sampler should turn on the pump according to the manufacturer's instructions and then turn on the water quality monitor. Before recording any values, the sample chamber should be full, all air should be voided, and all of the displayed values should be stable. The probes and sample chamber should be thoroughly rinsed between sampling locations.

2.2.3 Down-Hole Measurements

Down-hole measurement systems consist of inserting the probes (or a multi-parameter sensor housing) inside a well to obtain field measurements, and is primarily used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications.

Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The probes or sensor are attached to a hand held meter or control unit by a cable and lowered inside the well to be sampled. Limiting factors when using down-hole systems include probe or sensor diameters and available cable lengths. The probes should be thoroughly decontaminated between sampling locations...

2.2.4 General Procedures for Field Measurements of Indicator Parameters

The following section discusses general procedures that typically apply to making field measurements of indicator parameters using various types of field instruments. Each particular type of meter or monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

1. Inspect the instrument and batteries prior to the field effort.
2. Check the integrity of the buffer solutions used for field calibration since frequent replacement is necessary as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at proper levels and no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended) following manufacturer's instructions and record data in field logbook or on field data sheets.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to several minutes. If the parameter values continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be occurring in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize should be clearly noted in the logbook or field data sheet. For DO, provide for sufficient flow past the membrane by gently stirring the sample. Probes without stirrers placed in wells (down-hole measurements) may be gently moved up and down to achieve the required mixing.
6. Read and record the value of each parameter being measured making sure units of measure are clearly recorded.
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in accordance with manufacturer's instructions

2.2.5 Common Errors or Problems Associated With Field Measurements

The project work plan or field sampling plan should clearly identify the types of parameters to be measured, the measurement frequency, and "stabilization" requirements. It is essential to ensure that the type of monitoring system selected is compatible with the monitoring well sampling or development methods to be utilized. Some common errors to avoid are identified below:

- No, or incorrect equipment calibration
- Incorrect or expired calibration standards
- Poor equipment maintenance
- Inadequate training or unfamiliarity with equipment
- No record of units of measure and "+" or "-" values for ORP
- Too much time taken to measure temperature sensitive parameters
- DO and ORP measured in closed systems (flow-through cell or down-hole) instead of closed cell systems

FIGURE 1

THE HORIBA U-10 WATER QUALITY MONITORING SYSTEM
THE IN-SITU TROLL 9500 LOW-FLOW SYSTEM
THE YSI HAND HELD 556 METER

Horiba U-10

In-Situ Troll

YSI 556

APPENDIX B
ACCIDENT PREVENTION PLAN/ SITE SAFETY AND HEALTH PLAN

FINAL

Appendix B

Accident Prevention Plan Supplemental Site Inspection at Former Orion Park Housing Area

Former Naval Air Station Moffett Field, California

October 2010

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... B-iii

B1.0 SIGNATURE SHEET B-1

B2.0 BACKGROUND INFORMATION B-2

B2.1 PROJECT DESCRIPTION B-2
B2.2 PROJECT LOCATIONS AND DESCRIPTIONS B-3
B2.3 PHASES OF WORK ANTICIPATED B-4

B3.0 STATEMENTS OF SAFETY AND HEALTH POLICY B-9

B4.0 RESPONSIBILITIES AND LINES OF AUTHORITIES B-12

B4.1 STATEMENT OF THE RESPONSIBILITY B-12
B4.2 PERSONNEL RESPONSIBLE FOR SAFETY B-12
B4.3 COMPETENT/QUALIFIED PERSON(S) B-13
B4.4 COMPETENT PERSON REQUIRED AT JOB SITE B-13
B4.5 PRE-WORK SAFETY AND HEALTH ANALYSIS B-13
B4.6 LINES OF AUTHORITY B-14
B4.7 NONCOMPLIANCE POLICIES AND PROCEDURES B-16
B4.8 PROCEDURES FOR ACCOUNTABLE FOR SAFETY B-16

B5.0 SUBCONTRACTORS aND SUPPLIERS B-16

B5.1 IDENTIFICATION OF SUBCONTRACTORS AND SUPPLIERS B-16
B5.2 SAFETY RESPONSIBILITIES OF SUBCONTRACTORS AND SUPPLIERS B-17

B6.0 TRAINING B-18

B6.1 NEW HIRE TRAINING REQUIREMENTS B-18
B6.2 PROJECT-SPECIFIC TRAINING REQUIREMENTS B-18
B6.3 PROCEDURES FOR PERIODIC TRAINING FOR SUPERVISORS AND EMPLOYEES B-18
B6.4 REQUIREMENTS FOR EMERGENCY RESPONSE TRAINING B-19

B7.0 SAFETY AND HEALTH INSPECTIONS B-19

B7.1 RESPONSIBILITIES FOR INSPECTION B-19
B7.2 EXTERNAL INSPECTIONS/CERTIFICATIONS B-20

TABLE OF CONTENTS (Continued)

B8.0 ACCIDENT REPORTING B-20
B8.1 EXPOSURE DATA B-20
B8.2 ACCIDENT INVESTIGATIONS, REPORTS, AND LOGS B-20
B9.0 PLANS REQUIRED BY THE SAFETY MANUAL B-21
B10.0 RISK MANAGEMENT PROCESS B-21
B11.0 REFERENCES B-23

FIGURES

B-1 Site Location
B-2 Monitoring Wells In and Around OPHA
B-3 Proposed MIP/CPT Locations, Upper Aquifer (A1 Zone)
B-4 Proposed MIP/CPT Locations, Lower Aquifer (A2 Zone)

ATTACHMENTS

B1 Site Safety and Health Plan
B2 AIS/Tetra Tech Forms
B3 Site-Specific Plans
B4 Employee Training/Qualifications

ACRONYMS AND ABBREVIATIONS

F	Degree Fahrenheit
§	Section
AHA	Activity hazard analysis
AIS	American Integrated Services, Inc.
APP	Accident prevention plan
bgs	Below ground surface
CFR	Code of Federal Regulations
cm	Centimeter
COR	Contracting Officer Representative
CPR	Cardiopulmonary resuscitation
CPT	Cone Penetrometer Test
CRZ	Contamination reduction zone
DPT	Direct Push Technology
EM	Engineer Manual
EPA	U.S. Environmental Protection Agency
FPM	Field Project Manager
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSA	Hollow stem auger
HSR	Health and safety representative
IDLH	Immediately dangerous to life or health
IDW	Investigation derived waste
mg/kg	Milligram per kilogram
mg/m^3	Milligram per cubic meter
MIP	Multiphase Interface Probe
MSDS	Material safety data sheet
NAS	Naval Air Station
NIOSH	National Institute of Occupational Safety and Health
OPHA	Former Orion Park Housing Area
OSHA	Occupational Safety and Health Administration

PEL	Permissible exposure limit
PID	Photoionization device
POC	Point of contact
PPE	Personal protective equipment
ppm	Part per million
REL	Recommended exposure limit
RPM	Remedial project manager
SSC	Site safety coordinator
SSHP	Site safety and health plan
SSI	Supplemental Site Inspection
ST	Short-term limit
SWP	Safe work practice
TCE	Trichloroethene
Tetra Tech	Tetra Tech EM, Inc.
TLV	Threshold limit value
TOM	Task order manager
TWA	Time weighted average
USACE	U.S. Army Corps of Engineers
VOC	Volatile organic compound

B1.0 SIGNATURE SHEET

CLIENT NAME: US ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
CONTRACT NO.: W91238-06-D-0018 DO 0004
ACCIDENT PREVENTION PLAN
SUPPLEMENTAL SITE INSPECTION AT
FORMER ORION PARK HOUSING AREA
FORMER NAVAL AIR STATION, MOFFETT FIELD, CALIFORNIA

We the undersigned have read and approve of the Accident Prevention Plan (APP), and the applicable health and safety guidelines presented in this APP for on-site work activities at Former Naval Air Station (NAS) Moffett Field, California.

Name	Signature and Date	Phone
Prepared by: Dave Brown AIS/Tt Environmental Scientist		(619) 525-7188
Approved By: David Herrera AIS/Tt Health and Safety Representative		(310) 522-1168
Concurrence By: Kelly Stater AIS/Tt Company/Corporate Officer		(805) 639-0884

This certifies that American Integrated Services (AIS) and Tetra Tech EM, Inc (Tetra Tech), a subcontractor to AIS, working together as the AIS/Tetra Tech team have assessed the type, risk level, and severity of hazards for the project and has selected appropriate personal protective equipment (PPE) for site personnel in accordance with Occupational Safety and Health Administration (OSHA) Title 29 of the Code of Federal Regulations (CFR), Section (§) 1910.132, and the U.S. Army Corps of Engineers (USACE) Safety Manual, Publication Number Engineer Manual (EM) 385-1-1 (USACE 2008). A Site Safety and Health Plan (SSHP) has also been generated to accompany this APP, which is located in Attachment B1.

B2.0 BACKGROUND INFORMATION

Contractor: AIS/Tetra Tech

Contract Number: W91238-06-D-0018 DO 0004

Project Name: Supplemental Site Inspection at Former Orion Park Housing Area, Former NAS Moffett Field, Mountain View, California

B2.1 PROJECT DESCRIPTION

The site-specific health and safety provisions in this document have been developed for use during field activities at the Former Orion Park Housing Area (OPHA) in Mountain View, California. The supplemental site inspection (SSI) will include a hydrogeologic study, soil and groundwater sampling, and subsequent identification of preferential pathways to assess movement of contamination from off-site through OPHA. The investigation is being conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act, and the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan, with regulatory coordination of U.S. Environmental Protection Agency (EPA) Region 9.

Under contract to USACE, American Integrated Services (AIS) and Tetra Tech EM Inc. (Tetra Tech), a subcontractor to AIS, will work as the AIS/Tetra Tech team to perform the following field activities as part of the SSI for OPHA:

- Collect groundwater samples and groundwater elevation measurements to verify current volatile organic compound (VOC) concentrations in groundwater and the potentiometric surface at OPHA.
- Advance between 28 and 50 cone penetrometer test (CPT) borings equipped with a multiphase interface probe (MIP) to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through OPHA.
- Advance up to 18 direct-push technology (DPT) borings, if warranted, to define on-site sources of contamination
- Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at OPHA at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells.
- Oversight of surveying of soil borings and groundwater monitoring wells
- Oversight of IDW disposal off-site

The SSI work plan documents the AIS/Tetra Tech team's approach for implementing the field activities of the SSI at OPHA. The work plan describes the project management approach for

investigation. The work plan will be used in conjunction with the sampling and analysis plan (SAP), which is Attachment B1 of this work plan.

The SAP describes the investigation and sampling activities associated with the CPTs, DPTs, and monitoring wells during the SSI. The SAP provides the project quality objectives (PQO), field sampling procedures, quality assurance/quality control (QA/QC) requirements, and data gathering methods (Appendix A of this work plan). The SAP addresses all elements of a quality assurance project plan (QAPP) required by the following EPA guidance documents: "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5" (EPA 2001), and the "Uniform Federal Policy for Quality Assurance Project Plans" (EPA 2005). One soil sample, up to 33 groundwater samples from wells, and up to 18 grab groundwater samples will be collected at OHPA. Soil and groundwater samples collected will be analyzed by an off-site laboratory.

B2.2 PROJECT LOCATIONS AND DESCRIPTIONS

OPHA is part of the USACE's recently demolished Moffett Community Housing and was part of the former Naval Air Station Moffett Field (Moffett), Mountain View, California (Figure B-1). The Department of the Navy (Navy) transferred the Community Housing to the Air Force in 1994. The Community Housing was subsequently transferred to the USACE in July 2000. The OPHA site covers approximately 77 acres. Pursuant to the Base Realignment and Closure 2005 recommendations, the U.S. USACE Reserves have demolished the existing housing units and associated structures over a 30-acre area in the northern part of the OPHA site, so a new Armed Forces Reserve Center and associated support facilities could be constructed.

Prior to demolishment, OPHA consisted of housing units and support facilities along with associated streets, parking areas, and green space. Multi-family residences occupied most of OPHA. The area is relatively flat, ranging from 15 feet to 36 feet above mean sea level (msl). There are no wetlands or surface water located in OPHA. Stevens Creek is located due west of OPHA.

OPHA was vacant or used for agriculture prior to the construction of military housing. Housing was constructed between the years 1941 through 1982. The housing units included Moffett Homes built in 1941, Orion Park built in 1968, and Macon Terrace II and Macon Terrace III built in 1982 (Foster Wheeler Environmental Corporation [FWENC] 2002a). The northern and southern rows of Moffett Homes were demolished in 1981 or 1982 to make room for Macon Terrace II and III construction. The remaining Moffett Homes units were demolished in 2001. The area that had been Moffett Homes is now open green space.

A portion of OPHA was used for agriculture until sometime after 1965 (FWENC 2002a). The approximate location of former farm buildings is shown on Figure B-2. The former farm apparently had at least one potable supply well. Santa Clara Valley Water District (SCVWD) well records indicate that well 06S02W15G01, approximately 160 feet deep, was decommissioned on March 24, 1993. The well was located immediately north of Housing Unit 842. The farmhouse likely had a septic tank and drain lines. Usage by normal household activities would not suggest VOC contamination (Air Force Base Conversion Agency 2000); however, EPA information indicates solvents such as TCE may have been discharged to septic

systems as a degreaser. The area around the septic tank was investigated in 2009 by the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM) (USACHPPM 2009b). No VOC contamination was detected in the area around the abandoned septic tank, and the report concluded that the septic tank system was not a source of TCE contamination in the aquifer.

The purpose of the SSI field investigation will be to assess whether sources on-site cause elevated concentrations of TCE in groundwater. Locations of concern (LOC) have been identified through review of historical groundwater sampling data and historical aerial photographs and contractor's reports. This field investigation will evaluate whether an on-site source of TCE is present. If it is determined that no on-site source of TCE is present, the results will support site closure.

The field investigation will be implemented in five phases:

- **Phase 1 – Non-intrusive activities:** Obtain permits, notify the proper personnel, mobilize to the site, prepare the site; clear utilities; collect groundwater samples from the 11 existing wells for analysis of VOCs; collect groundwater elevation measurements from on- and off-site wells (see Appendix A of this work plan)
- **Phase 2 – Intrusive activities:** Advance between 28 and 50 CPT borings equipped with a MIP to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through OPHA.
- **Phase 3 - Intrusive activities:** Advance up to 18 DPT borings, if warranted, to define on-site sources of contamination. Collect one soil sample associated with FW41A.
- **Phase 4 - Intrusive activities:** Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at OPHA at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells.
- **Phase 5 – Non-intrusive activities:** Dispose of investigation-derived waste (IDW) off-site.

B2.3 PHASES OF WORK ANTICIPATED

Fieldwork on this project will be implemented in phases. The detailed scope of work for the field activities to be performed at OPHA will include the following tasks:

- Mobilization (see activity hazard analysis [AHA] No. 1 in Attachment B1)
- Monitoring Well Elevation Measurements (If weather permits, November 18, 2010) (see AHA No. 3 in Attachment B1)

- The AIS/Tetra Tech team will collect water level measurements at all on-site monitoring wells before they are sampled. Additionally, water level measurements will be collected at the off-site wells northeast of OPHA owned and operated by NASA, the off-site wells east of OPHA owned and operated by the Navy, and the off-site wells south of OPHA owned and operated by the Santa Clara County vector control yard, pending permission from the owners. Groundwater elevation measurements will be used to verify or modify the groundwater contours at OPHA. The proposed CPT and MIP boring locations will be adjusted based on the resulting groundwater contours. The field team will record all water level measurements to the nearest 0.1 inch in field logbooks and groundwater sampling sheets. All water level measurements will be measured with a water level indicator.

- Monitoring Well Groundwater Sampling (If weather permits, November 18 through 22, 2011) (see AHA No. 3 in Attachment B1)

  The AIS/Tetra Tech team will collect groundwater samples from the 11 existing on-site wells (Figure B-2) with peristaltic or non-dedicated submersible bladder pumps (as appropriate for the depth) following low-flow micropurge methodology detailed in standard operating procedure (SOP) 015 developed by Tetra Tech and included as part of the SAP (Appendix A of this work plan). Before each well is purged, organic vapor will be measured at the top of the well using a PID. Respiratory protection equipment will be available to each team and will be worn if organic vapors exceed the action levels detailed in the site safety and health plan (Attachment B1 of this APP). Groundwater will be slowly purged using an adjustable flow rate peristaltic or bladder pump system and run through a "flow-through" cell where groundwater parameters will be monitored and recorded every 3 to 5 minutes.

- Utility Clearance & Soil Boring Location Mark-outs (If weather permits, on or about November 29 through December 1, 2010) (see AHA No. 2 in Attachment B1)

  The AIS/Tetra Tech Team will notify Underground Service Alert at least 2 working days before any intrusive activities to verify the absence or presence of utilities. In addition, a utility clearance subcontractor will survey the ground surface around each of the proposed subsurface borings for the presence of subsurface utilities using non-intrusive geophysical techniques. The FPM or another AIS/Tetra Tech Team field staff will accompany the utility locator and will locate the CPT/MIP sampling locations (see Appendix A of this work plan) in the field using a hand-held global positioning system (GPS) device. An area with a 5-foot radius will be cleared around each location. Each cleared location will be staked or marked. A member of the AIS/Tetra Tech team will be present to adjust locations in the field, as needed. Any utilities identified by the utility locator will be marked on the ground with paint. If additional borings are required, a utility locator will return to the site to clear the ground surface around each of the additional borings before the subsurface investigation.

AIS/Tetra Tech will coordinate with the USACE to verify all proposed soil boring locations are clear of underground and overhead utilities. AIS/Tetra Tech personnel will perform oversight for all utility clearance activities.

- Cone Penetrometer Borings with Membrane Interface Probe Oversight (If weather permits, November 29 through December 10, 2010) (see AHA No. 4 in Attachment B1)

  After the utility clearance is complete, AIS/Tetra Tech personnel will perform oversight of the CPT drilling subcontractor (RSI Drilling) who will advance between 20 and 40 CPT borings to either 35 feet bgs or 65 feet bgs to support lithological investigations. The driller will use a MIP to obtain a profile of VOC contamination. The MIP will be equipped with a photoionization detector (PID), flame ionization detector (FID) and an electron capture detector (ECD) and will produce continuous logs of the output of each detector. The proposed CPT/MIP sampling locations are provided in Figures B-3 and B-4.

- Direct Push Technology Oversight (If weather permits, January 3 through 7, 2011) (see AHA No. 5 in Attachment B1)

  Once CPT/MIP borings are completed, the direct push technology driller (RSI Drilling) will advance up to 18 DPTs associated with the 9 LOCs to allow collection of up to two discrete-depth grab groundwater samples in each boring using a HydroPunch.

- Discrete Soil Sampling (If weather permits, one day during the period January 3 through January 7, 2011) (see AHA No. 5 in Attachment B1)

  One subsurface soil sample will be collected to investigate a possible source of contamination at FW41A. The subsurface soil samples will be collected using DPT methods. The lithologic (CPT) and VOC-concentration (MIP) profiles will be obtained in real time as the DPT rod is driven into the subsurface. After the real-time data are reviewed, an additional DPT boring will be installed adjacent (approximately 5 feet away) to selected profiles to obtain either a discrete soil or groundwater sample, or a subsurface soil sample for risk assessment. Soil samples will be obtained from an acetate sleeve placed inside the core barrel. Select samples will be sent to a California-certified, off-site laboratory. Additional details are provided in the SAP (Tetra Tech 2010). An EnCore sampler will be used to collect soil samples for analysis of VOCs immediately after the acetate sleeve is opened.

- Discrete Groundwater Sampling (If weather permits, January 10 through January 14, 2011) (see AHA No. 3 in Attachment B1)

  Using CPT/MIP data collected in a nearby boring to select the depth, discrete groundwater samples will be collected at selected intervals from a DPT boring adjacent to the initial boring. After the Hydropunch tool is installed to the desired depth, the drive pipe will be lifted slightly to open the inlet ports and allow groundwater to enter the sample chamber. The samples will then be collected using a bailer. All samples will be placed in bottles or vials, labeled, and kept in an ice-filled cooler, which will be sent to a California-certified, off-site laboratory.

A temporary well may be installed in the boring if a saturated zone is encountered, but the recharge is insufficient to collect a groundwater sample using the Hydropunch. The temporary well will consist of a polyvinyl chloride (PVC) screen and casing left in the borehole overnight. Groundwater will then be bailed from the temporary well using a disposable Teflon bailer after a sufficient amount of water has entered the screened interval. The well casing and screen will be removed after the sample has been collected.

The DPT core barrel will be decontaminated between holes and just before sample collection so that potential compounds in the upper soil column do not contaminate the sample interval.

Soil generated from borings will be placed in drums at the drill site and labeled with the contents, dates of generation, and responsible party. The containers will then be transferred to a designated storage area and characterized for disposal.

After all samples have been collected, AIS/Tetra Tech Team will instruct the subcontractor to seal all soil borings in accordance with State of California regulations. Destruction of the boring will include completely sealing the borehole with a bentonite and cement grout. The grout will be emplaced starting from the bottom of the hole and brought to the surface. All borings will then be staked for location surveying by GPS.

- Groundwater Well Installation Oversight (If weather permits, January 24 through January 28, 2011) (see AHA No. 6 in Attachment B1)

  After the chemical analytical laboratory results from DPT and HydroPunch groundwater and soil sampling have been analyzed and evaluated, monitoring wells will be installed. The driller will install and develop groundwater monitoring wells using a hollow-stem auger (HSA) drill rig. If utilities are anticipated, the driller may hand auger the top 5 feet before drilling. The HSA auger will be outfitted with a cage to prevent workers from contacting rotating or spinning equipment.

  Wells will be constructed of 4-inch-diameter, schedule 40 PVC. Well screens will be 5-feet long, 4-inch-diameter, schedule 40 PVC with 0.010-inch slot-size. Borings around the well screen will be filled with Number 2 sand from the bottom of the screened interval up to a minimum of 2 feet above the top of the screening interval. A 2-foot-thick seal of bentonite chips will be placed directly above the sand, and a Portland cement and bentonite grout seal will be placed from the top of bentonite chips to the ground surface. Each well will be completed with a flush-mounted cover secured in a concrete cap. Well covers will be closed with a lockable casing plug.

- Monitoring Well Development Oversight (If weather permits, January 31 through February 4, 2011) (see AHA No. 7 in Attachment B1)

  After the wells have been installed and completed, the drillers will develop the wells. AIS/Tetra Tech personnel will perform oversight of the well development activities.

The subcontractor will develop each well by surging and pumping water from the well. A volume equal to three times the volume of well casing and filter pack, plus a volume equal to three volumes of all water added to the augers during well installation, will be pumped from the well.

- Groundwater Sampling for Newly Installed Wells (If weather permits, January 31 through February 4, 2011) (see AHA No. 3 in Attachment B1)

  After the wells have been developed, each newly installed monitoring well will be allowed to recover for a minimum of 48 hours before groundwater sampling begins. AIS/Tetra Tech personnel will collect groundwater samples using the low-flow micropurge method described above and in the SAP (Appendix A of this work plan).

- Well Surveying (If weather permits, January 31 through February 1, 2011) (see Monitoring Well Surveying AHA in Attachment B1)

  Concurrently with well development and groundwater sampling, a licensed land surveyor will survey the horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of the newly installed groundwater monitoring wells. Horizontal coordinates (easting and northing) of the surveyed locations will be supplied in U.S. survey feet in California State Plane Coordinates, Zone III, using the North American Datum of 1984. Vertical elevations shall be supplied in U.S. survey feet relative to mean sea level, based on the North American Vertical Datum of 1988. All elevations will be supplied to the nearest 0.01 foot.

- IDW Management (If weather permits, February 1 through May 1, 2011) (see AHA No. 9 in Attachment B1)

  Three types of IDW will be generated during the field work:

  - Soil from soil borings
  - Well development groundwater
  - Disposable sampling equipment and personal protective equipment (PPE)

  As waste is generated, it will be classified, labeled, managed, and disposed of in accordance with EPA guidance and applicable state and federal regulations. The soil is anticipated to be shipped as Resource Conservation and Recovery Act (RCRA) hazardous waste or non-RCRA hazardous waste, or nonhazardous waste. The waste will be tracked using hazardous waste and nonhazardous waste manifests, as appropriate. This waste classification will be made after the soil has been characterized by the AIS/Tetra Tech Team and profiled by the disposal facility. The IDW will be transported by the AIS/Tetra Tech Team to the disposal facility within 90 days after the first IDW is produced.

- Demobilization (If weather permits, February 4) (See AHA No. 10 in Attachment B1)

B3.0 STATEMENTS OF SAFETY AND HEALTH POLICY

AIS/Tetra Tech is committed to providing our employees with a safe and healthful workplace. The principal elements of our program are founded on the requirements presented in the Health and Safety Policies presented on the next three pages.

American Integrated Services, Inc.

Corporate Health and Safety Philosophy

AIS's work force is dedicated to the belief that all accidents are preventable and a zero-incidents goal is attainable. When it comes to achieving world-class health and safety performance, there's no room for compromise at AIS. It's not about statistics; it's about people not getting hurt. We are committed to having a health and safety record that makes us proud.

Our vision and values statement calls on every employee and contractor working for the company to strive for incident-free operations, and to manage risks to prevent injuries, illnesses and accidents. Safety and health responsibilities come first, last and always.

Our position on health and safety is clear, emphatic and fixed at American Integrated Services: It applies to everyone everywhere - whether walking down a hallway in an office or excavating hazardous wastes from a congested downtown environment. Zero incidents is no accident.

AIS has a systematic approach to health and safety management designed to ensure compliance with the law and to achieve continuous performance improvement. Our approach:

- Engages employees and service providers to manage health and safety performance as a line responsibility with clear authorities and accountabilities
- Sets targets for improvement and measures, appraises and reports performance
- Requires subcontractors to manage health and safety in line with this policy
- includes health and safety performance in the appraisal of all staff and rewards accordingly
- Ensures that all employees and subcontractors understand that working safely is a condition of employment, and that they are each responsible for their own safety and the safety of those around them.
- Provides employees with the capabilities, knowledge and resources necessary to instill personal ownership and motivation to achieve health and safety excellence
- Provides relevant safety and health information to subcontractors and requires them to provide proper training for the safe, environmentally sound performance of their work

With the help of everyone employed by or working for AIS, we can attain our vision of Zero Incidents and more importantly, maintain it throughout the years as we grow.

President
American Integrated Services, Inc.

2010
Tetra Tech EM Inc. Health and Safety Policy

Tetra Tech EMI Belief	Tetra Tech EMI Action
Tetra Tech EM Inc. believes that our employees are our most valuable resource, and that their health and safety takes precedence over all other goals of our company.	We will provide our employees with a safe and healthful workplace.
Tetra Tech EM Inc. believes that all occupational illnesses and injuries can be prevented and are convinced that a strong Health and Safety program is essential to achieve this goal.	We will provide the necessary resources to implement an effective health and safety program that complies with applicable regulations, industry standards, consensus standards, and Tetra Tech, Inc. and our clients' safety policies and procedures. We will provide training necessary for our employees to do their jobs safely.
Tetra Tech EM Inc. believes that strong management of the health and safety program is essential to success.	We are committed to provide professional safety resources and to the EMI Safety Council and Management Review Committee.
Tetra Tech EM Inc. believes that employee involvement in the health and safety program at all levels is essential to its success.	All employees must recognize a personal responsibility for their own health and safety while performing their work, line management must take personal responsibility for effectively implementing the health and safety program for employees under their watch, and upper management must demonstrate their personal commitment to keeping employees safe. We will encourage all employees to provide input and constructive criticism to the health and safety program.
Tetra Tech EM Inc. believes that clearly-communicated safety expectations are critical to achieving our safety goals.	We review and update our health and safety goals annually and communicate them to every EMI employee.

Ron Chu
President

Matthew M. Soltis, CIH, CSP
Director, Health and Safety

TETRA TECH

Safety Excellence

TETRA TECH EMI 2010

Health & Safety Goals

Maintain a **100% completion rate of Health & Safety orientation training for all new-hire and transfer employees**

Maintain our total **OSHA recordable incident rate below 1.1 incidents per 100 employees**

Maintain our **DART rate below 0.5 incidents per 100 employees**

Establish and maintain a **new company-wide corrective actions database**

Perform 15 project field safety audits by Health & Safety Department **annually**

TETRA TECH *Safety Excellence*

B4.0 RESPONSIBILITIES AND LINES OF AUTHORITIES

B4.1 STATEMENT OF THE RESPONSIBILITY

The AIS/Tetra Tech USACE program health and safety managers (HASMs), Dave Brown and David Herrera, are responsible for verifying that the health and safety program is implemented during all on-site activities. The AIS/Tetra Tech Site Safety Coordinators (SSCs), O. Kelly Murphy (for Phases 2, 3, and 4) and Dayna Yocum (for Phases 1 and 5), have been appointed by the task order managers (TOM) and are responsible for field implementation of tasks and procedures contained in the APP. The AIS/Tetra Tech SSCs have primary responsibility for responding to and correcting emergency situations and for taking appropriate measures to ensure the safety of site personnel and the public—for example, evacuation of personnel from the site area. The SSCs are also responsible for ensuring that corrective measures have been implemented, appropriate internal and USACE authorities have been notified, and follow-up reports have been completed. The SSCs will be responsible for contacting local authorities prior to commencing on-site work.

B4.2 PERSONNEL RESPONSIBLE FOR SAFETY

Management at AIS/Tetra Tech has the authority and responsibility for implementing and maintaining this APP. Specifically, responsibilities are as follows:

- AIS/Tetra Tech HASMs (Dave Brown and David Herrera) and subsidiary health and safety representatives (SHSR)
  - Coordinate the APP within the subsidiary or region
  - Maintain all APP files
  - Investigate all accidents to determine their root cause(s) and identify corrective actions
- AIS/Tetra Tech Field Project Manager (FPM) (O. Kelly Murphy)
  - Provide leadership for the APP
  - Allocate adequate resources
  - Ensure that employees identify and eliminate unsafe conditions and practices
  - Ensure that employees understand and perform tasks safely
  - Ensure that all employees and visitors are advised of potential hazards and wear the required PPE
  - Ensure that all subcontractors under their immediate and direct control are familiar with the site-specific hazards and comply with established safety rules
  - Correct unsafe conditions in a timely manner

- AIS/Tetra Tech SSCs (O. Kelly Murphy and Dayna Yocum)
  - Ensure that the appropriate emergency procedures are followed
  - Develop APP policies and procedures in accordance with regulations
  - Implement the APP
  - Evaluate the effectiveness of the APP
- AIS/Tetra Tech TOMs (Dayna Yocum and Kevin Bricknell)
  - Ensure development and implementation of the site-specific APP
  - Communicate specific training needs to the HASM and SHSR
- AIS/Tetra Tech Field Personnel (O. Kelly Murphy, Dayna Yocum, and Rebecca Johnson)
  - Immediately report all on-site emergencies, injuries, illnesses, spills, fires, and property damage to the SSC.
  - Comply with established health and safety programs, site-specific APP, policies, and safe work practices (SWP).
  - Report unsafe acts or conditions and situations beyond his/her ability to correct to the SHSR, HASMs, or TOM immediately.

B4.3 COMPETENT/QUALIFIED PERSON(S)

All work under this contract, including this field effort, is subject to a comprehensive health and safety program implemented by David Herrera, CIH, Director of Health and Safety for AIS.

B4.4 COMPETENT PERSON REQUIRED AT JOB SITE

The AIS/Tetra Tech SSC has primary responsibility for responding to and correcting emergency situations and for taking appropriate measures to ensure the safety of site personnel and the public—for example, evacuation of personnel from the site area. Therefore, no work shall be performed while the SSC, or equivalent, is not present.

B4.5 PRE-WORK SAFETY AND HEALTH ANALYSIS

All personnel and visitors entering the site will be required to review the APP and sign the Compliance Agreement form (HSP-4), and site workers will be required to sign the Daily Tailgate Safety Meeting form (HST-2) (see Attachment B2).

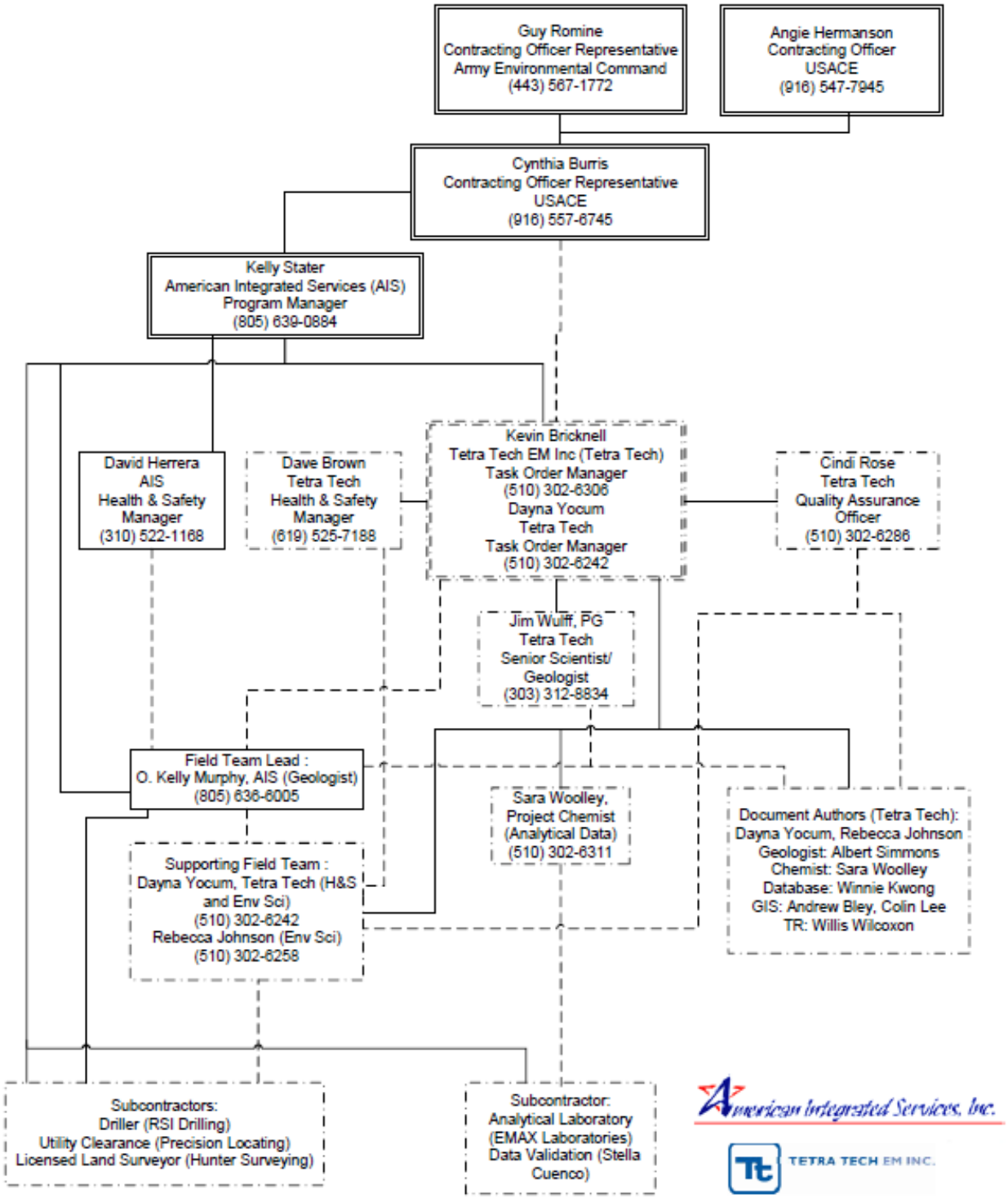
Minor changes in APP procedures will be discussed at the beginning of each work day by the SSC at the daily tailgate safety meeting (Attachment B2). Significant plan revisions must be discussed with the AIS/Tetra Tech HASM and TOM, and approved via the APP amendment form found in Attachment B2. Before on-site activities begin, the AIS/Tetra Tech SSC will present a briefing for all personnel who will participate in on-site activities. The following topics will be addressed during the pre-work briefing:

- Names of the SSC and the designated alternate
- Site history
- Work tasks
- Hazardous chemicals that may be encountered on site
- Physical hazards that may be encountered on site
- PPE, including type or types of respiratory protection to be used for work tasks
- Mandatory Training and Certification Requirements (Hazardous Waste Operations and Emergency Response [HAZWOPER]; HAZWOPER 8-Hr Refresher; Vehicle Operation, and so forth)
- Environmental surveillance (air monitoring) equipment use and maintenance
- Action levels and situations requiring upgrade or downgrade of level of protection
- Site control measures, including site communications, control zones, and SWPs
- Decontamination procedures
- Emergency communication signals and codes, including incident reporting procedures
- Environmental accident emergency procedures (in case contamination spreads outside the exclusion zone)
- Personnel exposure and accident emergency procedures (in case of falls, exposure to hazardous substances, and other hazardous situations)
- Fire and explosion emergency procedures
- Emergency telephone numbers
- Emergency routes

Any other health and safety-related issues that may arise before on-site activities begin, as well as during implementation of on-site activities, will also be conducted and discussed during the pre-work briefing by the SSC and will be documented in the Daily Tailgate Safety Meeting form (Form HST-2 in Attachment B2). The tailgate safety meetings will be attended by all site workers, subcontractors and visitors, and conducted by the TOM and/or SSC. Any changes in procedures or site-specific health and safety-related matters will be addressed during these meetings.

B4.6 LINES OF AUTHORITY

An organizational chart presenting the lines of authority for this project is shown below: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Utility Clearance (Precision Locating)
Licensed Land Surveyor (Hunter Surveying)
Subcontractor:
Analytical Laboratory
(EMAX Laboratories)
Data Validation (Stella
Cuenco)
American Integrated Services, Inc.
TETRA TECH EM INC.

B4.7 NONCOMPLIANCE POLICIES AND PROCEDURES

APP enforcement shall be rigorous during this field effort. Violators of the APP will be verbally notified upon first violation, and the violation will be noted by the AIS/Tetra Tech SSC in a field logbook. Upon second violation, the violator will be notified in writing, and the AIS/Tetra Tech TOM and the violator's supervisor will be notified. A third violation will result in a written notification and violator's eviction from the site. The written notification will be sent to the human resources department and the AIS/Tetra Tech HASM.

B4.8 PROCEDURES FOR ACCOUNTABLE FOR SAFETY

The AIS/Tetra Tech managers and supervisors are held responsible for the safety on job sites. AIS/Tetra Tech personnel are expected to comply with all applicable health and safety standards and company policies. Clear and willful violations and disregard of established health and safety policies may result in the use of disciplinary action up to and including employment termination in accordance with company policy. Each employee found in noncompliance shall have the infraction documented and placed in his or her personnel file. The AIS/Tetra Tech NHASM is responsible for and authorized to cite employees for health and safety infractions. However, violations may be reported to the Office Manager by other employees provided that documentation or substantiation of the violation is available. All infractions will be discussed with the employee, at which time he or she may provide evidence indicating lack of wrongdoing.

B5.0 SUBCONTRACTORS AND SUPPLIERS

Individual subcontractors are required to cooperate with the SSC within the parameters of their scopes of work. Health and safety hazards resulting from the actions of subcontractors will be brought to their immediate attention for correction and also be noted in the field notebook. Violations by AIS/Tetra Tech staff will brought to the attention of the TOM. TOMs are expected to visit sites on a periodic basis, especially at complex or long-term project sites, to evaluate site conditions and compliance with programs and SWPs.

B5.1 IDENTIFICATION OF SUBCONTRACTORS AND SUPPLIERS

The following companies will provide AIS/Tetra Tech subcontracted services for this field effort:

> **Utility Locator (Precision Locating) –** Before any intrusive investigation begins, the ground surface around each of the proposed subsurface boring locations will be examined for the presence of subsurface utilities using geophysical techniques. An approximate area with a 5-foot radius will be cleared and staked at each location. Any utilities identified will be marked on the ground with paint. Locations will be adjusted in the field to avoid underground utilities.

Driller (RSI Drilling) – The drilling subcontractor will provide one CPT rig equipped with a MIP, a DPT rig equipped with HydroPunch technology to collect groundwater samples, and a hollow-stem auger rig for installation of 4-inch groundwater monitoring wells. The driller will also provide all equipment and materials necessary to complete and develop the groundwater monitoring wells.

Surveyor (Hunter Surveying) – A licensed land surveyor will survey the top of casings of the monitoring wells, once completed.

IDW Management – AIS will provide removal and disposal of all IDW created during supplemental SI field activities at Former NAS Moffett Field.

AIS/Tt-hired subcontractor personnel participating in work defined as "high hazard" by AIS/Tetra Tech have been pre-approved by AIS/Tetra Tech to conduct the aforementioned tasks based on a thorough review of the subcontractor's safety metrics. The review includes the subcontractor's experience modification rate (EMR), total recordable incident rate, and lost workday case rate, as well as other pertinent subcontractor safety program elements.

B5.2 SAFETY RESPONSIBILITIES OF SUBCONTRACTORS AND SUPPLIERS

AIS/Tetra Tech-hired subcontractor personnel participating in sampling activities are required to read and comply with all sections of the APP. Moreover, each AIS/Tetra Tech-hired subcontractor shall develop and deliver AHA for each task he or she will perform in relation to this scope of work, which in turn will be reviewed by AIS/Tetra Tech corporate safety personnel. Subcontractor safety documents, such as AHAs, are included in Attachment B1 of this APP.

All field personnel entering the site must sign the Compliance Agreement form included in Attachment B2 of this APP. Subcontractor personnel must comply with all applicable 29 CFR §1910.120 training, fit-testing, and medical surveillance requirements. Subcontractors are responsible for providing PPE required by this plan for their personnel and are directly responsible for the health and safety of their employees. Subcontractors who have not met OSHA training, medical surveillance, and PPE requirements are not permitted to enter areas where exposure to hazardous materials is possible.

Personnel will be encouraged to report to the SSC any conditions or practices that they consider detrimental to their health or safety, or those they believe violate applicable health and safety standards. Such reports may be made orally or in writing. Personnel who believe that an imminent danger threatens human health or the environment will be encouraged to bring the matter to the immediate attention of the SSC for resolution. Job site activities presenting danger to life or limb should be stopped immediately, and reported to the SSC for resolution.

B6.0 TRAINING

B6.1 NEW HIRE TRAINING REQUIREMENTS

AIS/Tetra Tech new hires, who will participate in on-site activities, will be required to meet training requirements outlined in 29 CFR §1910.120, "Hazardous Waste Operations and Emergency Response." All AIS/Tetra Tech personnel qualification and training certification documentation is included in Attachment B4. Training requirements for this project, at a minimum, include the following:

- 40-hour HAZWOPER Course
- 8-hour HAZWOPER Refresher Course, if applicable
- First Aid and cardiopulmonary resuscitation (CPR) training, including training in blood-borne pathogens

B6.2 PROJECT-SPECIFIC TRAINING REQUIREMENTS

All on-site personnel must satisfy any specialized training requirements that are presented in the AHA for tasks to be completed under this contract task order. No project-specific training is required for field activities to be conducted at OPHA, Former NAS Moffett Field.

B6.3 PROCEDURES FOR PERIODIC TRAINING FOR SUPERVISORS AND EMPLOYEES

All on-site personnel who may be exposed to hazardous conditions, including AIS/Tetra Tech and subcontractor personnel and site visitors who will participate in on-site activities, will be required to meet training requirements outlined in 29 CFR §1910.120, "Hazardous Waste Operations and Emergency Response." AIS/Tetra Tech personnel are required to update training, if necessary, via classes held at individual office locations or on-line training. All on-line classes shall be OSHA-approved. All AIS/Tetra Tech personnel qualification and training certification documentation is included in Attachment B4. A list of training requirements is detailed below:

- 40-hour HAZWOPER Course
- 8-hour HAZWOPER Refresher Course
- 30-hour Construction Safety Training Course (SSC only)
- First Aid and CPR training, including training in blood-borne pathogens (at least two personnel on-site will be certified at all times.)
- AHA training

B6.4 REQUIREMENTS FOR EMERGENCY RESPONSE TRAINING

As required by the USACE EM 385-1-1 (USACE 2008), AIS/Tetra Tech will ensure that a minimum of two personnel on-site at all times have current certifications in CPR and First Aid; in addition, these two individuals will have been trained in the hazards of blood-borne pathogens. Though all project personnel have this current training, at least two of the following personnel will be on-site at all times during the project: O. Kelly Murphy, Dayna Yocum and Rebecca Johnson. Other than rendering basic CPR and First Aid with respect for blood-borne pathogens, the two employees are not expected to perform emergency medical duties.

All emergency medical assistance will be gained from a non-Army source. The closest hospital to the site is Kaiser Permanente Medical Center located at 555 Castro Street in Mountain View, California. Directions to this hospital, as well as contact numbers for both the hospital and ambulance services, are included in Attachments B1 and B3. AIS/Tetra Tech personnel are instructed to perform a drive-by of the nearest hospital to ensure it is in operation and the route is well-mapped.

As a follow-up to an injury requiring care beyond basic first aid or to possible exposure above established exposure limits, all employees are entitled to and encouraged to seek medical attention and physical testing. Such injuries and exposures must be reported to the AIS/Tetra Tech HASMs. Depending on the type of injury or exposure, follow-up testing, if required, must be performed within 24 to 48 hours of the incident. The employer's medical consultant has responsibility to advise the type of tests required to accurately monitor for exposure effects.

B7.0 SAFETY AND HEALTH INSPECTIONS

B7.1 RESPONSIBILITIES FOR INSPECTION

The SSC is responsible for conducting an informal field audit during the field activities. The Field Audit Checklist is provided in Attachment B2. These informal field audits will assist the SSC, FPM, and TOM in knowing where deficiencies, if any, exist.

It is AIS/Tetra Tech's internal policy that all jobsites involving work for the USACE are subject to both announced and unannounced audits by corporate safety staff. The dates audits are scheduled are based on a variety of factors, including the amount of time AIS/Tetra Tech employees are on the jobsite, and the complexity of the work being performed or overseen.

For this project, the following audit schedule will be adhered to:

- Daily, informal site safety inspections shall be conducted by the AIS/Tetra Tech SSC during this field effort to ensure safe work areas and compliance with the APP. Results of these inspections will be recorded on a Field Audit Checklist (Form AF 1 in Attachment B2).

All items noted during formal and informal field audits will be communicated to the AIS/Tetra Tech Director of Health and Safety, who maintains a corrective/preventive action database. Responsibility for resolving each item noted during these audits is assigned from the Director of Health and Safety. Items are tracked through resolution and permanently maintained in this database. Results from formal field audits are also regularly communicated throughout AIS/Tetra Tech through training and electronic means as a method of incident and illness reduction.

B7.2 EXTERNAL INSPECTIONS/CERTIFICATIONS

No external inspections are required for Sites OPHA, Former NAS Moffett Field.

B8.0 ACCIDENT REPORTING

On a quarterly basis, AIS/Tetra Tech compiles safety statistics specific to work we do for the USACE. These statistics are communicated through our TOMs to appropriate USACE personnel.

B8.1 EXPOSURE DATA

Hazardous work conditions or unsafe work practices will be corrected in a timely manner, both in the field and in the office. Upon discovery of an unsafe condition at a field site, the degree of hazard must be assessed and action may range from complete shutdown of the operation to phased correction. Employees shall follow specific information for emergency evacuation and PPE usage as described in the site-specific APP. Once the investigation of the incident is completed, the USACE COR must be contacted regarding the details and any corrective actions of the incident.

B8.2 ACCIDENT INVESTIGATIONS, REPORTS, AND LOGS

All accidents involving near misses, injuries, or illnesses must be immediately reported to the TOM and the HASM, and documented on Form IR in Attachment B2. The Incident Report Form must be signed by the on-site FPM, on-site SSC, and Office Manager, and submitted to the AIS/Tetra Tech HASM within 24 hours of an emergency situation. Both forms must be reviewed by the TOM. The USACE COR must be contacted within 24 hours of the incident.

If any of the following occur, the AIS/Tetra Tech TOM or SSC will contact the USACE COR immediately:

- Fatality
- Total or partial disability
- Hospitalization of three or more personnel from one incident
- Property damage exceeding $200,000

AIS/Tetra Tech will shut down a project during which life threatening, severe environmental impact, or significant equipment or property damage conditions exist.

All emergency situations require follow-up and reporting. The Incident Report must include proposed actions to prevent similar incidents from occurring. The HASM must be fully informed of the corrective action process so that he/she may implement applicable elements of the process at other sites.

Emergency situations must also be reported to the USACE COR. Contact information for these individuals is listed in Section B9.0 of this APP.

B9.0 PLANS REQUIRED BY THE SAFETY MANUAL

Listed below are the required site-specific plans and procedures that are applicable to this USACE field effort. The Site Safety and Health Plan (SSHP) is included in Attachment B1. These plans are included in Attachment B3.

- Layout plans (04.A.01)
- Emergency response plans
- Plan for prevention of alcohol and drug abuse (01.C.02)
- Site sanitation plan (Section 02)
- Hazard communication program (06.B.01)
- Heat/Cold Stress Monitoring Plan (06.I.02)
- Fire Prevention Plan (09.A)

B10.0 RISK MANAGEMENT PROCESS

Detailed site-specific hazards and controls are provided for each activity of the operation in the form of AHAs. The AHAs comply with EM 385-1-1 (USACE 2008). These AHAs cover activities identified in Section B2.3 to be performed by AIS/Tetra Tech during sampling at OPHA, Former NAS Moffett Field. In addition, subcontractors have submitted their task-specific AHAs for the projects tasks that AIS/Tetra Tech will oversee. The subcontractor AHAs are presented immediately following AIS/Tetra Tech's AHAs found is the SSHP located in Attachment B1, and described in the following bulleted list:

AIS/Tetra Tech AHAs

- Mobilization and Demobilization
- Utility Clearance Oversight
- Groundwater Sampling and Elevation Measurement
- Cone Penetrometer Technology, Direct Push Technology, and Hollow Stem Auger Drilling Oversight

- Soil Sampling
- Groundwater Monitoring Well Installation Oversight
- Groundwater Monitoring Well Development Oversight
- Investigation Derived Waste Management Oversight
- Decontamination Procedures

Subcontractor AHAs

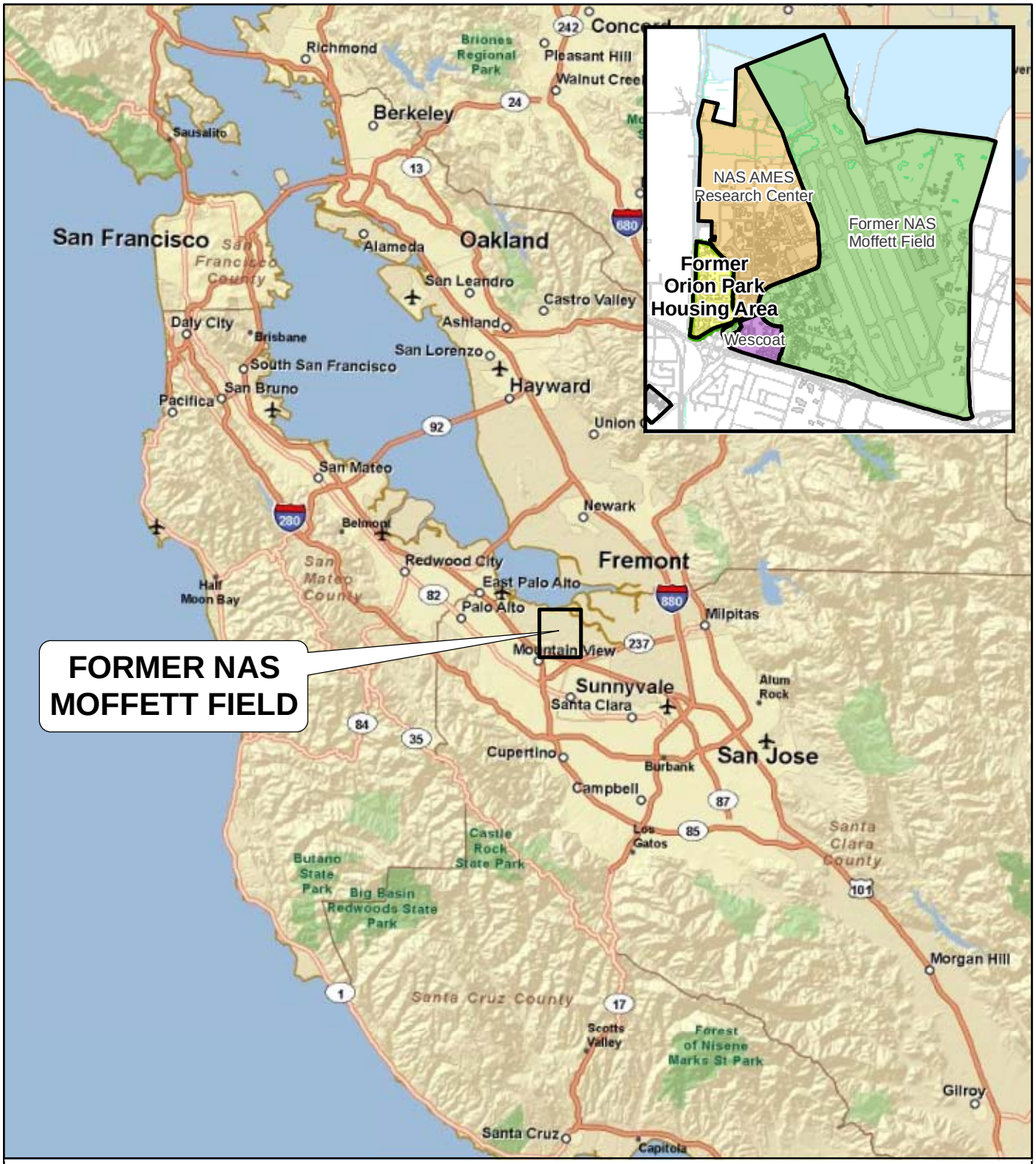
- Site Walk and Set-Up (Driller)
- Hand Augering/Hand Tools (Driller)
- Drilling Rig Mobilization (Driller)
- Direct Push Operations (Driller)
- Drilling Rig Demobilizations (Driller)
- Decontamination Operation (Direct Push Rods) (Driller)
- Monitoring Well Surveying (Surveyor)

B11.0 REFERENCES

Tetra Tech, Inc. 1999. "Health and Safety Manual."

U.S. Army Corps of Engineers (USACE). 2008. Engineer Manual (EM) 385-1-1, Safety and Health Requirements Manual. Available Online at http://usace.army.mil/CESO/Documents/EM385-1-1FINAL.pdf

FIGURES



American Integrated Services, Inc.

TETRA TECH

N

0 4 8 16

Miles

NAS Naval Air Station

Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE B-1

SITE LOCATION

Accident Prevention Plan
Supplemental Site Investigation

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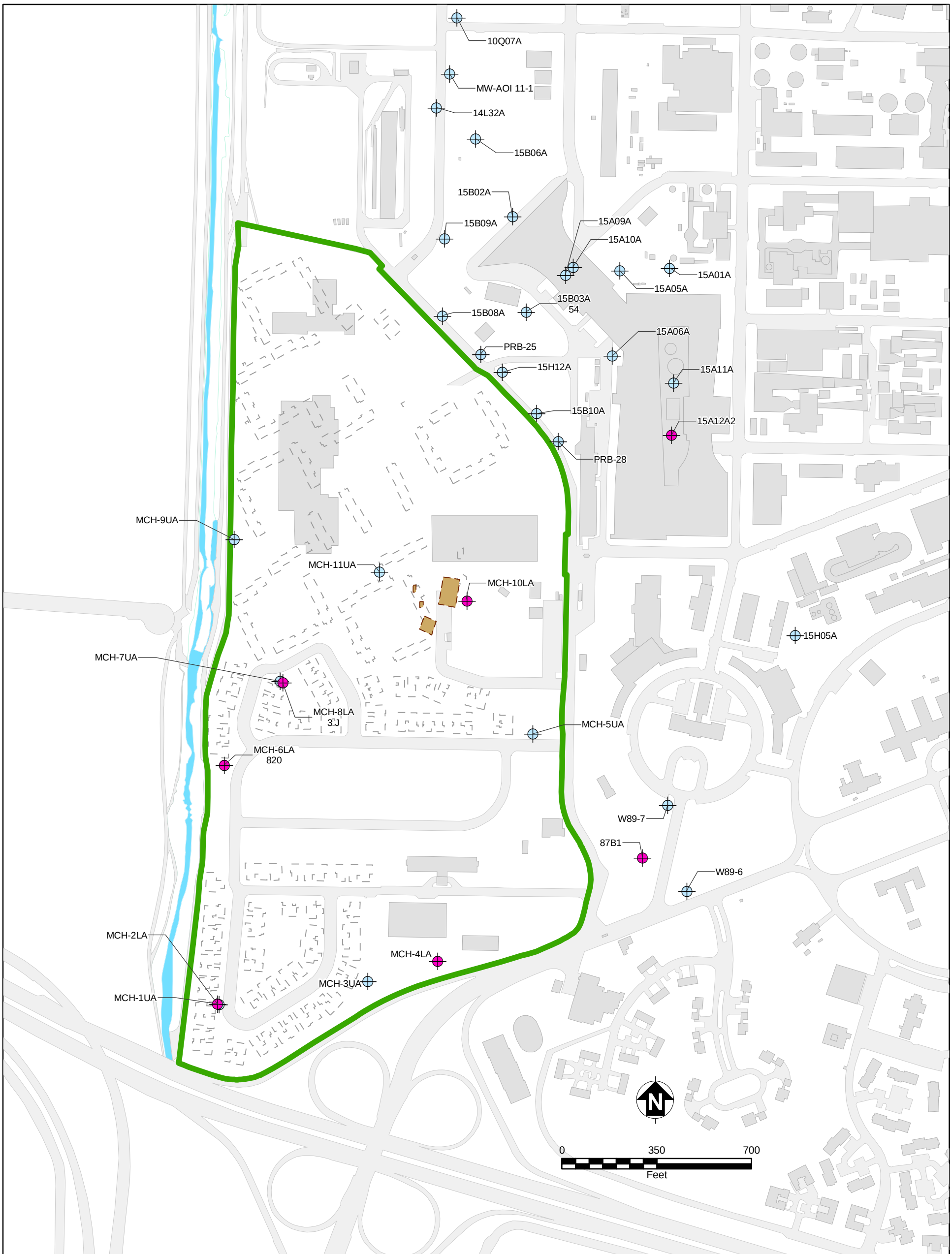

Lower A Aquifer Well Location

Upper A Aquifer Well Location

Former Farm Building

Former Orion Park Housing Area Boundary

Demolished Building Footprint

Building/Structure

Road

Water

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Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE B-2

MONITORING WELLS IN AND AROUND OPHA

Accident Prevention Plan

Supplemental Site Investigation

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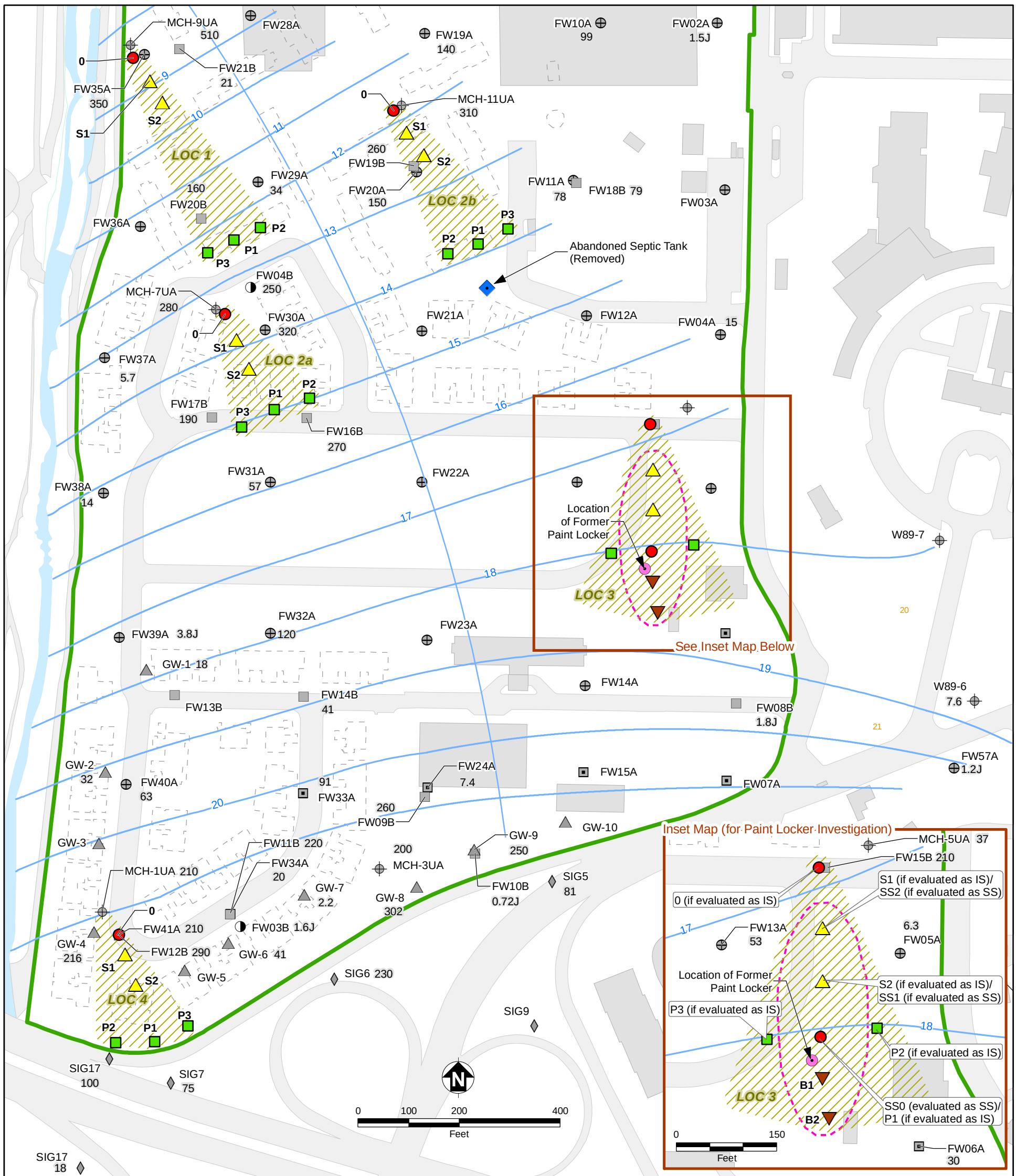

MIP #0 (or MIP #SS0) - Proposed LOC Comparison MIP/CPT

MIP #S1-S2 - Proposed Step-out MIP/CPT for Source Branch

MIP #P1-P3 - Proposed Step-out MIP/CPT for Plume Branch

MIP # B1-B2 - Proposed Background Step-out MIP/CPT for Paint Locker (Suspected Source) Branch

Army CPT and DPT/Hydropunch Sample Location, 2003

Phase 1 DPT/Temporary Well, CPT, and DPT/Hydropunch

Phase 1 DPT/Temporary Well Sample Location, 2002

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Phase 2 DPT/Temporary Well Sample Location, 2002

EPA CPT and DPT/Hydropunch

IT Corp DPT/Hydropunch Sample Location, 2000

Upper A Aquifer (A1 Zone) Well Location

SAIC DPT/Hydropunch Sample Location, 1999

Abandoned Septic Tank (Removed)

Location of Former Paint Locker

15 Groundwater Elevation Contour in Feet, Upper A Aquifer (A1 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

General Flow Direction Upper A Aquifer (A1 Zone)

Location of Concern

Paint Locker (Suspected Source) Evaluation Area

Former Orion Park Housing Area Boundary

Demolished Building Footprint

Building/Structure

Road

Water

B	Background
CPT	Cone Penetrometer Test
DPT	Direct Push Technology
EPA	U.S. Environmental Protection Agency
IS	Indefinite Source
IT	International Technology Corporation
LOC	Location of Concern
MIP	Membrane Interface Probe
MSL	Mean Sea Level
SAIC	Science Applications International Corporation
SS	Suspected Source
TCE	Trichloroethene
µg/L	Micrograms per liter

Note: The highest concentration detected during the 3rd quarter of 2002 (FW DPT borings), 2003 (SIG borings), or 2005 (HP boring and MCH wells) within the A2 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

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Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE B-3
PROPOSED MIP/CPT LOCATIONS, UPPER A AQUIFER (A1 ZONE)

Accident Prevention Plan
Supplemental Site Investigation

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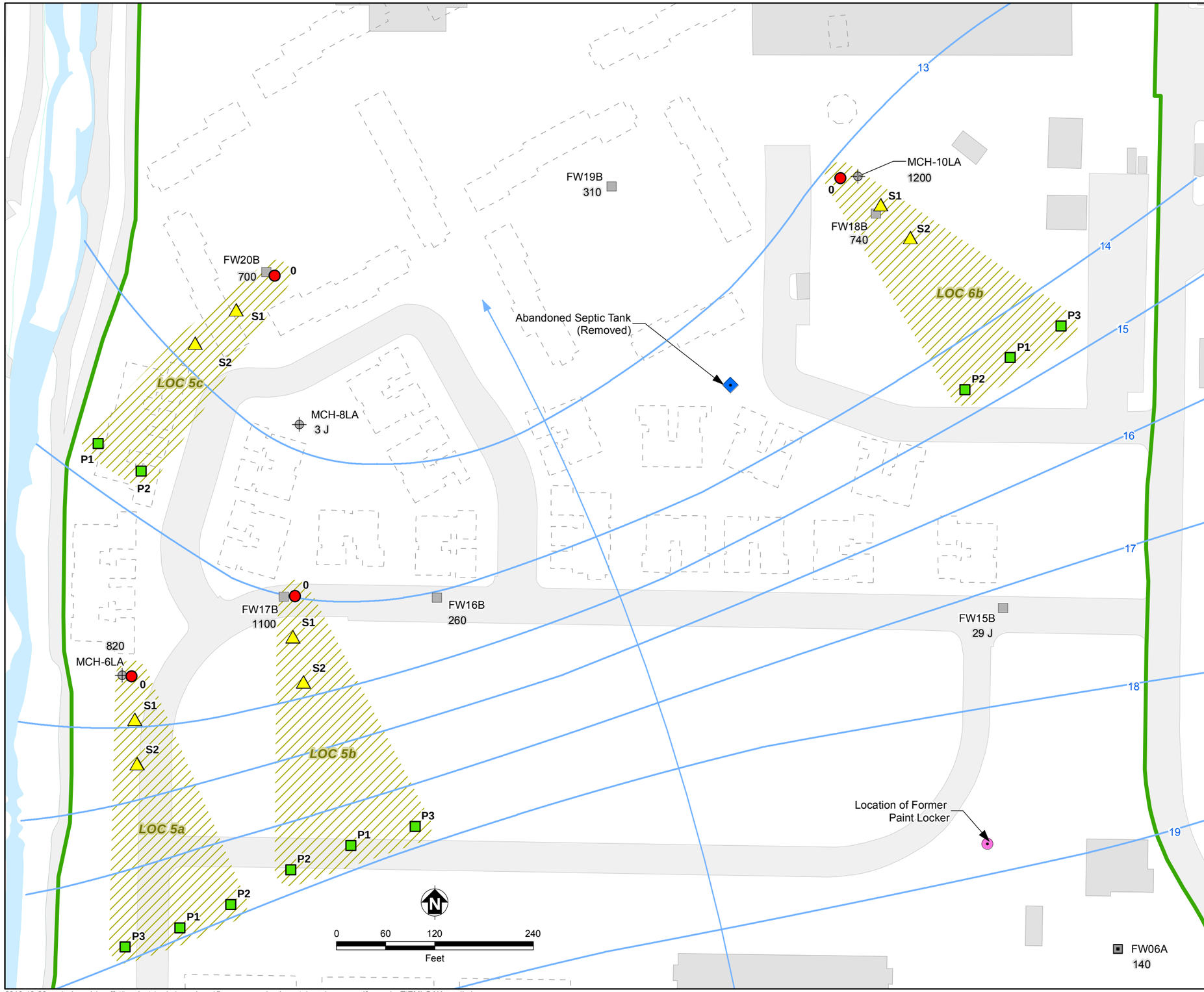

MIP #0 - Proposed LOC Comparison MIP/CPT

MIP #1-2 - Proposed Step-out MIP/CPT for Source Branch

MIP #1-3 - Proposed Step-out MIP/CPT for Plume Branch

Army CPT and DPT/Hydropunch Sample Location, 2003

Phase 1 DPT/Temporary Well, CPT, and DPT/Hydropunch

Phase 2 CPT and DPT/Hydropunch Sample Location, 2002

Lower A Aquifer (A2 Zone) Well Location

Abandoned Septic Tank (Removed)

Location of Former Paint Locker

15 Groundwater Elevation Contour in Feet, Lower A Aquifer (A2 Zone) (MSL) (Collected August 2005 by Tetra Tech EC)

General Flow Direction Lower A Aquifer (A2 Zone)

Location of Concern

Former Orion Park Housing Area Boundary

Demolished Building Footprint

Building/Structure

Road

Water

CPT	Cone Penetrometer Test
DPT	Direct Push Technology
LOC	Location of Concern
MSL	Mean Sea Level
MIP	Membrane Interface Probe
µg/L	Micrograms per liter
TCE	Trichloroethene

Note: The highest concentration detected during the 3rd quarter of 2002 (FW DPT borings), 2003 (SIG borings), or 2005 (HP boring and MCH wells) within the A2 aquifer at each well or boring is presented. Locations without concentrations indicate the result is below laboratory reporting limits.

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Former Orion Park Housing Area

Former Naval Air Station Moffett Field, Moffett Field, CA

FIGURE B-4

PROPOSED MIP/CPT LOCATIONS, LOWER A AQUIFER (A2 ZONE)

Accident Prevention Plan
Supplemental Site Investigation

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ATTACHMENT B1
SITE SAFETY AND HEALTH PLAN

FINAL

Attachment B1

Site Safety and Health Plan Supplemental Site Investigation at Former Orion Park Housing Area

Former Naval Air Station Moffett Field, California

October 2010

Prepared for:
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Prepared under:
U.S. Army Corps of Engineers
Contract Number W91238-060D-0018 DO 0004
Task Order Option 1

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... B-v

EMERGENCY INFORMATION B-1

B1.1.0 INTRODUCTION B-3

B1.1.1 BRIEF SITE HISTORY B-4

B1.1.2 PROJECT DESCRIPTIONS B-5

B1.2.0 PLANNED PROJECT ACTIVITIES B-5

B1.3.0 SITE SAFETY HEALTH PLAN PERSONNEL AND PLAN ENFORCEMENT B-10

B1.3.1 PROJECT PERSONNEL B-10

B1.3.1.1 Task Order Manager and Field Project Manager B-11

B1.3.1.2 Site Safety Coordinator B-11

B1.3.1.3 Health and Safety Representative B-11

B1.3.1.4 AIS/Tetra Tech Employees B-11

B1.3.1.5 Visitors B-12

B1.3.2 HEALTH AND SAFETY PLAN ENFORCEMENT B-12

B1.4.0 TRAINING REQUIREMENTS B-12

B1.5.0 PERSONAL PROTECTION REQUIREMENTS B-14

B1.5.1 PROTECTIVE EQUIPMENT AND CLOTHING B-14

B1.5.2 REASSESSMENT OF PROTECTION LEVELS B-15

B1.5.3 LIMITATIONS OF PROTECTIVE CLOTHING B-15

B1.6.0 MEDICAL SURVEILLANCE B-16

B1.6.1 HEALTH MONITORING REQUIREMENTS B-16

B1.6.2 SITE-SPECIFIC MEDICAL MONITORING B-16

B1.6.3 MEDICAL SUPPORT AND FOLLOW-UP REQUIREMENTS B-17

B1.7.0 SITE-SPECIFIC HAZARD EVALUATION B-17

B1.7.1 CHEMICAL HAZARDS B-17

B1.7.2 EXPOSURE HAZARDS B-17

B1.7.3 PHYSICAL HAZARDS B-18

B1.7.4 BIOLOGICAL HAZARDS B-18

B1.7.4.1 Snakes B-18

B1.7.4.2 Insects and Spiders B-31

B1.7.4.3 Vermin B-35

B1.7.4.4 Wild (Feral) Dogs B-36

B1.8.0 PERSONAL MONITORING B-36
B1.8.1 USE AND MAINTENANCE OF SURVEY EQUIPMENT B-36
B1.8.2 THERMAL STRESS MONITORING B-37
B1.9.0 SITE SAFETY PROCEDURES B-37
B1.10.0 SITE CONTROL B-37
B1.10.1 ON-SITE COMMUNICATIONS B-37
B1.10.2 SITE CONTROL ZONES B-38
B1.10.2.1 Zone 1: Exclusion Zone B-38
B1.10.2.2 Zone 2: Contamination Reduction Zone B-39
B1.10.2.3 Zone 3: Support Zone B-39
B1.10.3 SITE ACCESS CONTROL B-39
B1.11.0 DECONTAMINATION B-39
B1.11.1 PERSONNEL DECONTAMINATION B-39
B1.11.2 EQUIPMENT DECONTAMINATION B-39
B1.11.3 SAMPLING EQUIPMENT B-40
B1.12.0 EMERGENCY RESPONSE PLANNING B-40
B1.12.1 PRE-EMERGENCY PLANNING B-40
B1.12.2 PERSONNEL ROLES AND LINES OF AUTHORITY B-41
B1.12.3 EMERGENCY RECOGNITION AND PREVENTION B-41
B1.12.4 EVACUATION ROUTES AND PROCEDURES B-41
B1.12.5 EMERGENCY CONTACTS AND NOTIFICATIONS B-42
B1.12.6 HOSPITAL ROUTE DIRECTIONS B-42
B1.12.7 EMERGENCY MEDICAL TREATMENT PROCEDURES B-42
B1.12.8 PROTECTIVE EQUIPMENT FAILURE B-42
B1.12.9 FIRE OR EXPLOSION B-43
B1.12.10 WEATHER-RELATED EMERGENCIES B-43
B1.12.11 EMERGENCY EQUIPMENT AND FACILITIES B-43
B1.12.12 REPORTING B-43
B1.13.0 REFERENCES B-44

AIS/Tetra Tech Activity Hazard Analysis

1 Mobilization and Demobilization

2 Utility Clearance Oversight

3 Groundwater Sampling and Elevation Measurement

4 Cone Penetrometer Technology, Direct Push Technology, and Hollow Stem Auger Drilling Oversight

5 Soil Sampling

6 Groundwater Monitoring Well Installation Oversight

7 Groundwater Monitoring Well Development Oversight

8 Investigation Derived Waste Management Oversight

9 Decontamination

Subcontractor Activity Hazard Analysis

Site Walk and Set-Up (Driller)

Hand Augering/Hand Tools (Driller)

Drilling Rig Mobilization (Driller)

Direct Push Operations (Driller)

Drilling Rig Demobilizations (Driller)

Decontamination Operation (Direct Push Rods) (Driller)

Monitoring Well Surveying (Surveyor)

Tables

B1-1 Potential Chemical Hazards

B1-2 Site Specific Air Monitoring Requirements and Action Levels

B1-3 Heat and Cold Stress Conditions

Attachments

B1-1 Material Safety Data Sheets

B1-2 Safe Work Practices

ACRONYMS AND ABBREVIATIONS

F	Degree Fahrenheit
§	Section
AHA	Activity hazard analysis
AIS	American Integrated Services, Inc.
APP	Accident prevention plan
bgs	Below ground surface
CFR	Code of Federal Regulations
cm	Centimeter
CPR	Cardiopulmonary resuscitation
CRZ	Contamination reduction zone
EM	Engineer Manual
EPA	U.S. Environmental Protection Agency
FPM	Field project manager
HASM	Health and Safety Manager
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSA	Hollow stem auger
IDLH	Immediately dangerous to life or health
IDW	Investigation derived waste
mg/kg	Milligram per kilogram
mg/m^3	Milligram per cubic meter
MSDS	Material safety data sheet
NAS	Naval Air Station
NIOSH	National Institute of Occupational Safety and Health
OPHA	Former Orion Park Housing Area
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
PID	Photoionization device
POC	Point of contact
PPE	Personal protective equipment
ppm	Part per million
REL	Recommended exposure limit

SSC	Site safety coordinator
SSHP	Site safety and health plan
ST	Short-term limit
Tetra Tech	Tetra Tech EM, Inc.
TDS	Total dissolved solids
TLV	Threshold limit value
TOM	Task order manager
TWA	Time weighted average
USACE	U.S. Army Corps of Engineers
VOC	Volatile organic compound

EMERGENCY INFORMATION

POST THIS PAGE ON-SITE

EMERGENCY CONTACTS AND ROUTE TO HOSPITAL

Emergency Contact	**Telephone No.**
California Poison Control System	(800) 222-1222
WorkCare	(800) 455-6155
Fire Department (Mountain View Fire Department)	911 or (650) 903-6365
Police Department (Mountain View Police Department)	911 or (650) 903-6364
AIS/Tetra Tech Personnel:	
Human Resource Development: Amy Clark	(626) 470-2516
AIS Health and Safety Manager: David Herrera	(310) 522-1168
Tetra Tech Health and Safety Manager: Dave Brown	(619) 525-7188
AIS/Tetra Tech Program Manager: Kelly Stater	(805) 639-0884
AIS/Tetra Tech Task Order Manager: Kevin Bricknell	(510) 302-6306,
AIS/Tetra Tech Deputy Task Order Manager: Dayna Yocum	(510) 302-6242
Field Team Lead: O. Kelly Murphy	(805) 636-6005
Site Safety Coordinator (Phases 2, 3, and 4): O. Kelly Murphy	(805) 636-6005
Site Safety Coordinator (Phases 1 and 5): Dayna Yocum	(510) 302-6242
Chemist: Sara Woolley	(510) 302-6311
Environmental Scientist: Rebecca Johnson	(510)302-6258
Professional Geologist: Jim Wulff	(303) 312-8834
IDW Management: AIS, Jennifer Sherman,	(310) 522-1168
Subcontractors:	
Utility Locator: Precision Locating, Julie	(925) 516-2860
Surveying: Hunter Surveying, James White	(916) 988-5600
Driller: RSI Drilling, David Boggs	(510) 532-2424
USACE Client Contact:	
Army Remedial Project Manager : Guy Romine	(443) 567-1772
Contracting Officer: Angie Hermenson	(916) 547-7945
Contracting Officer Representative: Cynthia Burris	(916) 557-6745

**** In case of emergency, always dial 911.***

Emergency Evacuation Meeting Location:	**Safe Meeting Place:**
Upwind of the location where work is being performed.	Safe distance from the sites – see the following page for evacuation route from the site

Medical Emergency

Hospital Name:	Kaiser Permanente Mountain View Medical Center
Hospital Address:	**555 Castro Street** Mountain View, California
Hospital Telephone No.:	General (650) 903-3022
Ambulance Telephone No.:	911

EMERGENCY INFORMATION (Continued)

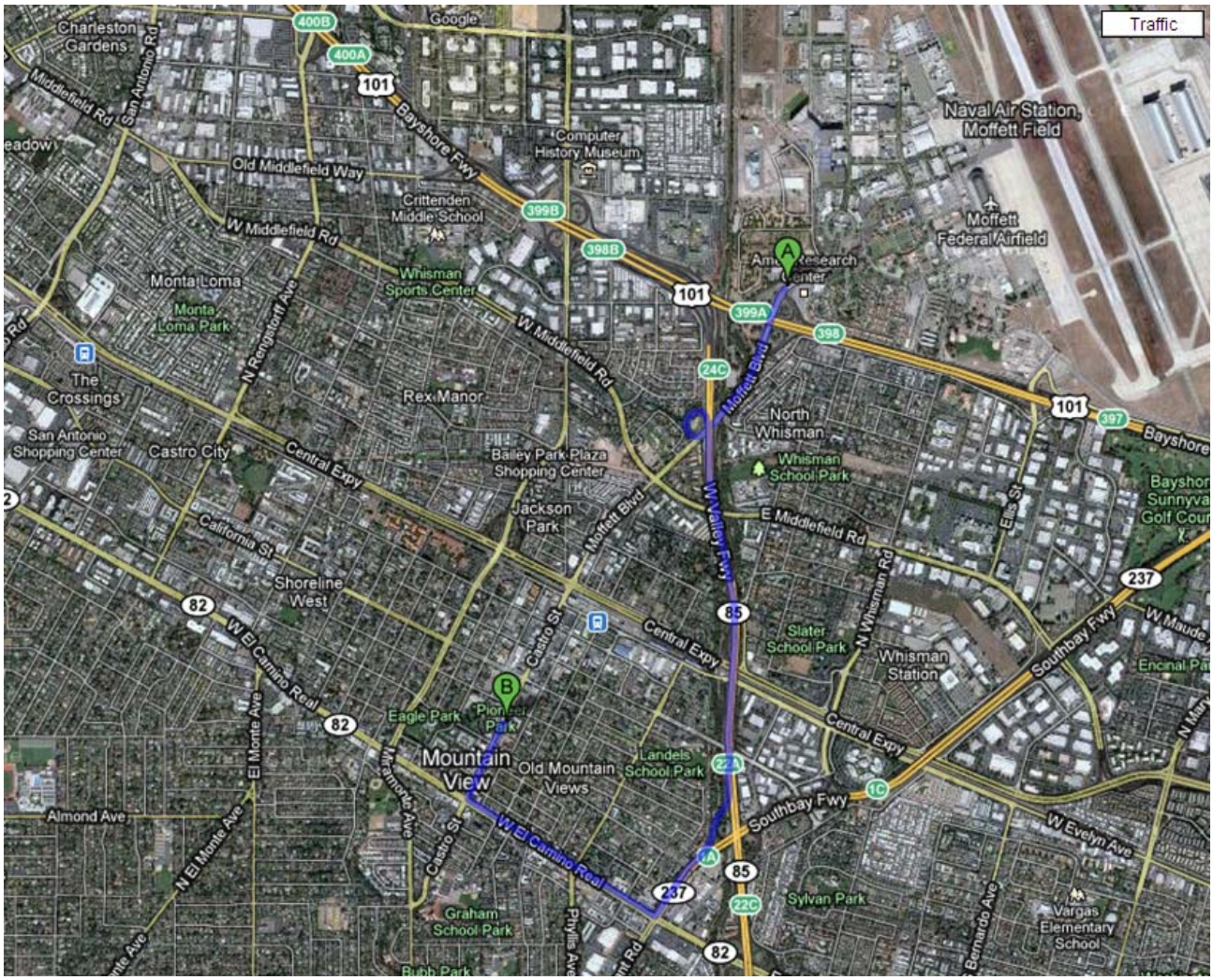
POST THIS PAGE ON SITE

ROUTE TO HOSPITAL FROM OPHA

Route to Hospital:

1.	**(A)** Head southwest on Moffett Boulevard	1.2 mile
2.	Continue onto Castro St	0.4 mile
3.	Turn right at Mercy St	0.1 mile
4.	Take the 1st left onto Franklin Street	0.1 mile
5.	Take the 1st left onto Church Street	0.1 mile
6.	Take the 1st left onto Castro Street	423 feet
7.	**(B)** Destination on RIGHT:	

End at **Kaiser Permanente Mountain View Medical Center: 555 Castro Street**, **Mountain View, CA** (Total Distance = 2.1 miles; Total Time = about 7 minutes)



B1.1.0 INTRODUCTION

This site safety and health plan (SSHP), which is included as an attachment to the Accident Prevention Plan (APP), describes the purpose and scope of the project, explains the responsibilities of project personnel, describes the hazards of that will be conducted at the Former Orion Park Housing Area (OPHA) located at Former Naval Air Station (NAS) Moffett Field, California. Field activities will include oversight of utility clearance, oversight of direct push technology (DPT) soil drilling, oversight of temporary and permanent groundwater monitoring wells, oversight of groundwater monitoring well development, soil and groundwater sampling, oversight of surveying and oversight of investigation derived waste (IDW) removal.

Under contract to USACE, American Integrated Services (AIS) and Tetra Tech EM Inc. (Tetra Tech), a subcontractor to AIS, will work as the AIS/Tetra Tech team to perform the following field activities as part of the SSI for OPHA:

- Collect groundwater samples and groundwater elevation measurements to verify current volatile organic compound (VOC) concentrations in groundwater and the potentiometric surface at OPHA.
- Advance between 28 and 50 cone penetrometer test (CPT) borings equipped with a multiphase interface probe (MIP) to identify potential on-site sources of contamination and identify the preferential pathways of off-site sources of contamination moving through OPHA.
- Advance up to 18 direct-push technology (DPT) borings, if warranted, to define on-site sources of contamination
- Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at OPHA at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells.
- Oversight of surveying of soil borings and groundwater monitoring wells
- Oversight of IDW disposal off-site

The SSI work plan documents the AIS/Tetra Tech team's approach for implementing the field activities of the SSI at OPHA. The work plan describes the project management approach for field activities and the planned work activities at OPHA before, during and after the investigation. The work plan will be used in conjunction with the sampling and analysis plan (SAP) (Appendix A of this work plan).

The SAP describes the investigation and sampling activities associated with the CPTs, DPTs, and monitoring wells during the SSI. The SAP provides the project quality objectives (PQO), field sampling procedures, quality assurance/quality control (QA/QC) requirements, and data gathering methods (AIS/Tetra Tech 2010). The SAP addresses all elements of a quality assurance project plan (QAPP) required by the following EPA guidance documents: "EPA requirements for Quality Assurance Project Plans, EPA QA/R-5" (EPA 2001), and

sample and up to 33 groundwater samples will be collected at OHPA. Soil and groundwater samples collected will be analyzed by an off-site laboratory.

This SSHP summarizes requirements for AIS/Tetra Tech personnel and any visitors who want to enter the site during the field activities at OPHA at Former NAS Moffett Field. A facility location map is included as Figure B-1 of the APP. This SSHP has been prepared in compliance with U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 385-1-1 (USACE 2008). Activities to be performed at OPHA are currently proposed to begin on January 3, 2011. Any changes or modifications made to the SSHP shall be made in writing and concurrence of the health and safety manager (HASM) and accepted by the USACE Contracting Officer (COR).

B1.1.1 BRIEF SITE HISTORY

OPHA is part of the USACE's recently demolished Moffett Community Housing and was part of the former Naval Air Station Moffett Field (Moffett), Mountain View, California (Figure B-1 of the APP). The Department of the Navy (Navy) transferred the Community Housing to the Air Force in 1994. The Community Housing was subsequently transferred to the USACE in July 2000. The OPHA site covers approximately 77 acres. Pursuant to the Base Realignment and Closure 2005 recommendations, the U.S. USACE Reserves have demolished the existing housing units and associated structures over a 30-acre area in the northern part of the OPHA site, so a new Armed Forces Reserve Center and associated support facilities could be constructed.

Prior to demolishment, OPHA consisted of housing units and support facilities along with associated streets, parking areas, and green space. Multi-family residences occupied most of OPHA. The area is relatively flat, ranging from 15 feet to 36 feet above mean sea level (msl). There are no wetlands or surface water located in OPHA. Stevens Creek is located due west of PHA.

OPHA was vacant or used for agriculture prior to the construction of military housing. Housing was constructed between the years 1941 through 1982. The housing units included Moffett Homes built in 1941, Orion Park built in 1968, and Macon Terrace II and Macon Terrace III built in 1982 (Foster Wheeler Environmental Corporation [FWENC] 2002a). The northern and southern rows of Moffett Homes were demolished in 1981 or 1982 to make room for Macon Terrace II and III construction. The remaining Moffett Homes units were demolished in 2001. The area that had been Moffett Homes is now open green space.

A portion of OPHA was used for agriculture until some time after 1965 (FWENC 2002a). The approximate location of former farm buildings is shown on Figure B-2 of the APP. The former farm apparently had at least one potable supply well. Santa Clara Valley Water District (SCVWD) well records indicate that well 06S02W15G01, approximately 160 feet deep, was decommissioned on March 24, 1993. The well was located immediately north of Housing Unit 842. The farmhouse likely had a septic tank and drain lines. Usage by normal household activities would not suggest VOC contamination (Air Force Base Conversion Agency 2000). The area around the septic tank was investigated in 2009 by the U.S. Army Center for Health Promotion and Preventative Medicine (U.S. Army CHPPM) (USACHPPM 2009). It was determined that no VOC contamination was present in the area around the abandoned septic tank.

B1.1.2 PROJECT DESCRIPTIONS

The purpose of the SSI field investigation will be to assess whether sources on site cause elevated concentrations of TCE in groundwater. Locations of concern (LOC) have been identified through review of historical groundwater sampling data and historical aerial photographs and contractor's reports. This field investigation will evaluate whether an on-site source of TCE is present. If it is determined that no on-site source of TCE is present, the results will support site closure, and the site will exit the CERCLA process.

The field investigation will be implemented in five phases:

- **Phase 1 – Non-intrusive activities:** Obtain permits, notify the proper personnel, mobilize to the site, prepare the site; clear utilities; collect groundwater samples from the 11 existing wells for analysis of VOCs; collect groundwater elevation measurements from on- and off-site wells (see Appendix A of this work plan)
- **Phase 2 – Intrusive activities:** Advance between 28 and 50 CPT borings equipped with a MIP to identify potential on-site sources of contamination and identify the preferential pathways of contamination moving through OPHA.
- **Phase 3 - Intrusive activities:** Advance up to 18 DPT borings, if warranted, to define on-site sources of contamination. Collect one soil sample associated with FW41A.
- **Phase 4 - Intrusive activities:** Install, develop, sample, and survey up to nine groundwater monitoring wells, if warranted, to monitor concentrations of TCE at OPHA at specific depth intervals in any identified on-site contamination source area. Collect groundwater samples for VOC analysis at 11 existing on-site wells.
- **Phase 5 – Non-intrusive activities:** Dispose of investigation-derived waste (IDW) off-site.

B1.2.0 PLANNED PROJECT ACTIVITIES

Fieldwork on this project will be implemented in phases. The detailed scope of work for the field activities to be performed at OPHA will include the following tasks:

- Mobilization (see activity hazard analysis [AHA] No. 1 in Attachment B1)
- Monitoring Well Elevation Measurements (If weather permits, November 18, 2010) (see AHA No. 3 in Attachment B1)

- The AIS/Tetra Tech team will collect water level measurements at all on-site monitoring wells before they are sampled. Additionally, water level measurements will be collected at the off-site wells northeast of OPHA owned and operated by NASA, the off-site wells east of OPHA owned and operated by the Navy, and the off-site wells south of OPHA owned and operated by the Santa Clara County vector control yard, pending permission from the owners. Groundwater elevation measurements will be used to verify or modify the groundwater contours at OPHA. The proposed CPT and MIP boring locations will be adjusted based on the resulting groundwater contours. The field team will record all water level measurements to the nearest 0.1 inch in field logbooks and groundwater sampling sheets. All water level measurements will be measured with a water level indicator.

- Monitoring Well Groundwater Sampling (If weather permits, November 18 through 22, 2011) (see AHA No. 3 in Attachment B1)

  The AIS/Tetra Tech team will collect groundwater samples from the 11 existing on-site wells (Figure B-2) with peristaltic or non-dedicated submersible bladder pumps (as appropriate for the depth) following low-flow micropurge methodology detailed in standard operating procedure (SOP) 015 developed by Tetra Tech and included as part of the SAP (Appendix A of this work plan). Before each well is purged, organic vapor will be measured at the top of the well using a PID. Respiratory protection equipment will be available to each team and will be worn if organic vapors exceed the action levels detailed in the site safety and health plan (Attachment B1 of this APP). Groundwater will be slowly purged using an adjustable flow rate peristaltic or bladder pump system and run through a "flow-through" cell where groundwater parameters will be monitored and recorded every 3 to 5 minutes.

- Utility Clearance & Soil Boring Location Mark-outs (If weather permits, on or about November 29 through December 1, 2010) (see AHA No. 2 in Attachment B1)

  The AIS/Tetra Tech Team will notify Underground Service Alert at least 2 working days before any intrusive activities to verify the absence or presence of utilities. In addition, a utility clearance subcontractor will survey the ground surface around each of the proposed subsurface borings for the presence of subsurface utilities using non-intrusive geophysical techniques. The FPM or another AIS/Tetra Tech Team field staff will accompany the utility locator and will locate the CPT/MIP sampling locations (see Appendix A of this work plan) in the field using a hand-held global positioning system (GPS) device. An area with a 5-foot radius will be cleared around each location. Each cleared location will be staked or marked. A member of the AIS/Tetra Tech team will be present to adjust locations in the field, as needed. Any utilities identified by the utility locator will be marked on the ground with paint. If additional borings are required, a utility locator will return to the site to clear the ground surface around each of the additional borings before the subsurface investigation.

AIS/Tetra Tech will coordinate with the USACE to verify all proposed soil boring locations are clear of underground and overhead utilities. AIS/Tetra Tech personnel will perform oversight for all utility clearance activities.

- Cone Penetrometer Borings with Membrane Interface Probe Oversight (If weather permits, November 29 through December 10, 2010) (see AHA No. 4 in Attachment B1)

  After the utility clearance is complete, AIS/Tetra Tech personnel will perform oversight of the CPT drilling subcontractor (RSI Drilling) who will advance between 20 and 40 CPT borings to either 35 feet bgs or 65 feet bgs to support lithological investigations. The driller will use a MIP to obtain a profile of VOC contamination. The MIP will be equipped with a photoionization detector (PID), flame ionization detector (FID) and an electron capture detector (ECD) and will produce continuous logs of the output of each detector. The proposed CPT/MIP sampling locations are provided in Figures B-3 and B-4.

- Direct Push Technology Oversight (If weather permits, January 3 through 7, 2011) (see AHA No. 5 in Attachment B1)

  Once CPT/MIP borings are completed, the direct push technology driller (RSI Drilling) will advance up to 18 DPTs associated with the 9 LOCs to allow collection of up to two discrete-depth grab groundwater samples in each boring using a HydroPunch.

- Discrete Soil Sampling (If weather permits, one day during the period January 3 through January 7, 2011) (see AHA No. 5 in Attachment B1)

  One subsurface soil sample will be collected to investigate a possible source of contamination at FW41A. The subsurface soil samples will be collected using DPT methods. The lithologic (CPT) and VOC-concentration (MIP) profiles will be obtained in real time as the DPT rod is driven into the subsurface. After the real-time data are reviewed, an additional DPT boring will be installed adjacent (approximately 5 feet away) to selected profiles to obtain either a discrete soil or groundwater sample, or a subsurface soil sample for risk assessment. Soil samples will be obtained from an acetate sleeve placed inside the core barrel. Select samples will be sent to a California-certified, off-site laboratory. Additional details are provided in the SAP (Tetra Tech 2010). An EnCore sampler will be used to collect soil samples for analysis of VOCs immediately after the acetate sleeve is opened.

- Discrete Groundwater Sampling (If weather permits, January 10 through January 14, 2011) (see AHA No. 3 in Attachment B1)

  Using CPT/MIP data collected in a nearby boring to select the depth, discrete groundwater samples will be collected at selected intervals from a DPT boring adjacent to the initial boring. After the Hydropunch tool is installed to the desired depth, the drive pipe will be lifted slightly to open the inlet ports and allow groundwater to enter the sample chamber. The samples will then be collected using a bailer. All samples will be placed in bottles or vials, labeled, and kept in an ice-filled cooler, which will be sent to a California-certified, off-site laboratory.

A temporary well may be installed in the boring if a saturated zone is encountered, but the recharge is insufficient to collect a groundwater sample using the Hydropunch. The temporary well will consist of a polyvinyl chloride (PVC) screen and casing left in the borehole overnight. Groundwater will then be bailed from the temporary well using a disposable Teflon bailer after a sufficient amount of water has entered the screened interval. The well casing and screen will be removed after the sample has been collected.

The DPT core barrel will be decontaminated between holes and just before sample collection so that potential compounds in the upper soil column do not contaminate the sample interval.

Soil generated from borings will be placed in drums at the drill site and labeled with the contents, dates of generation, and responsible party. The containers will then be transferred to a designated storage area and characterized for disposal.

After all samples have been collected, AIS/Tetra Tech Team will instruct the subcontractor to seal all soil borings in accordance with State of California regulations. Destruction of the boring will include completely sealing the borehole with a bentonite and cement grout. The grout will be emplaced starting from the bottom of the hole and brought to the surface. All borings will then be staked for location surveying by GPS.

- Groundwater Well Installation Oversight (If weather permits, January 24 through January 28, 2011) (see AHA No. 6 in Attachment B1)

  After the chemical analytical laboratory results from DPT and HydroPunch groundwater and soil sampling have been analyzed and evaluated, monitoring wells will be installed. The driller will install and develop groundwater monitoring wells using a hollow-stem auger (HSA) drill rig. If utilities are anticipated, the driller may hand auger the top 5 feet before drilling. The HSA auger will be outfitted with a cage to prevent workers from contacting rotating or spinning equipment.

  Wells will be constructed of 4-inch-diameter, schedule 40 PVC. Well screens will be 5-feet long, 4-inch-diameter, schedule 40 PVC with 0.010-inch slot-size. Borings around the well screen will be filled with Number 2 sand from the bottom of the screened interval up to a minimum of 2 feet above the top of the screening interval. A 2-foot-thick seal of bentonite chips will be placed directly above the sand, and a Portland cement and bentonite grout seal will be placed from the top of bentonite chips to the ground surface. Each well will be completed with a flush-mounted cover secured in a concrete cap. Well covers will be closed with a lockable casing plug.

- Monitoring Well Development Oversight (If weather permits, January 31 through February 4, 2011) (see AHA No. 7 in Attachment B1)

  After the wells have been installed and completed, the drillers will develop the wells. AIS/Tetra Tech personnel will perform oversight of the well development activities.

The subcontractor will develop each well by surging and pumping water from the well. A volume equal to three times the volume of well casing and filter pack, plus a volume equal to three volumes of all water added to the augers during well installation, will be pumped from the well.

- Groundwater Sampling for Newly Installed Wells (If weather permits, January 31 through February 4, 2011) (see AHA No. 3 in Attachment B1)

  After the wells have been developed, each newly installed monitoring well will be allowed to recover for a minimum of 48 hours before groundwater sampling begins. AIS/Tetra Tech personnel will collect groundwater samples using the low-flow micropurge method described above and in the SAP (Appendix A of this work plan).

- Well Surveying (If weather permits, January 31 through February 1, 2011) (see Monitoring Well Surveying AHA in Attachment B1)

  Concurrently with well development and groundwater sampling, a licensed land surveyor will survey the horizontal (northing and easting) and vertical elevation (top of well cover) coordinates of the newly installed groundwater monitoring wells. Horizontal coordinates (easting and northing) of the surveyed locations will be supplied in U.S. survey feet in California State Plane Coordinates, Zone III, using the North American Datum of 1984. Vertical elevations shall be supplied in U.S. survey feet relative to mean sea level, based on the North American Vertical Datum of 1988. All elevations will be supplied to the nearest 0.01 foot.

- IDW Management (If weather permits, February 1 through May 1, 2011) (see AHA No. 9 in Attachment B1)

  Three types of IDW will be generated during the field work:

  - Soil from soil borings
  - Well development groundwater
  - Disposable sampling equipment and personal protective equipment (PPE)

  As waste is generated, it will be classified, labeled, managed, and disposed of in accordance with EPA guidance and applicable state and federal regulations. The soil is anticipated to be shipped as Resource Conservation and Recovery Act (RCRA) hazardous waste or non-RCRA hazardous waste, or nonhazardous waste. The waste will be tracked using hazardous waste and nonhazardous waste manifests, as appropriate. This waste classification will be made after the soil has been characterized by the AIS/Tetra Tech Team and profiled by the disposal facility. The IDW will be transported by the AIS/Tetra Tech Team to the disposal facility within 90 days after the first IDW is produced.

- Demobilization (If weather permits, February 4) (See AHA No. 10 in Attachment B1)

B1.3.0 SITE SAFETY HEALTH PLAN PERSONNEL AND PLAN ENFORCEMENT

This section describes responsibilities of project personnel and summarizes requirements for visitors at OPHA during field activities. Accordingly, this SSHP also addresses health and safety protocols and requirements associated with all field tasks. This section of the SSHP further discusses the enforcement of health and safety requirements associated with these activities.

B1.3.1 PROJECT PERSONNEL

The following personnel and organizations are associated with planned activities at the site. The organizational structure will be reviewed and updated as necessary during the course of the project.

Name / Title	Responsibility	Telephone No.
Client Representative:		
Cynthia Burris	USACE COR	(916) 557-6745
AIS/Tetra Tech Personnel:		
Kelly Stater	Program Manager	(805) 639-0884
Kevin Bricknell	Project Manager	(510) 302-6306
David Herrera	AIS Health and Safety Manager	Office (310) 522-1168
Dave Brown	Tt Health and Safety Officer	Office (619) 525-7188
Dayna Yocum	Site Safety Coordinator	(510) 302-6242
O. Kelly Murphy	Field Team Leader	(805) 636-6005
Sara Woolley	Chemist	(510) 302-6311
Rebecca Johnson	Environmental Scientist	(510) 302-6258
Jim Wulff	Professional Geologist	(303) 312-8834
AIS	IDW Transporter	(310) 522-1168
Subcontractors:		
RSI Driling	Driller	(510) 532-2424
Precision Locating	Utility Locator	(925) 516-2860
Hunter Land Surveying	Surveyor	(916) 988-5600

The AIS/Tetra Tech task order manager (TOM), field project manager (FPM), site safety coordinator (SSC), and AIS/Tetra Tech health and safety manager (HASM) will be responsible for implementation and enforcement of the provisions of this SSHP. Their duties and the expectations for AIS/Tetra Tech employees are described in the following sections.

All work under this contract, including this field effort, is subject to a comprehensive health and safety program implemented by David Herrera, CIH. Mr. Herrera serves as the Director of Health and Safety for AIS.

B1.3.1.1 Task Order Manager and Field Project Manager

The AIS/Tetra Tech Program Manager (PGM), Kelly Stater, has ultimate responsibility ultimately responsible for the OPHA SSI work. Kevin Bricknell, PE, QEP, and Dayna Yocum will act as the task order managers (TOMs) and are the key individuals representing the Tetra Tech team and are responsible for ensuring implementation of the requirements set forth in this SSHP. Some of this responsibility may be achieved through delegation to site-dedicated personnel that report directly to the TOM. The TOM shall regularly confer with site personnel regarding safety and health compliance.

The AIS/Tetra Tech FPM, O. Kelly Murphy, will oversee and direct field activities and has day-to-day responsibility for ensuring implementation of the SSHP. Subcontractor compliance with the SSHP shall be monitored by the FPM. The FPM will report directly to the TOM any health and safety-related issues.

B1.3.1.2 Site Safety Coordinator

The AIS/Tetra Tech SSCs (also known as the Site Safety and Health Officer), O. Kelly Murphy (during Phases 2, 3, and 4) and Dayna Yocum (during Phases 1 and 5), will be responsible for field implementation of tasks and procedures contained in this SSHP, including air monitoring, establishing a decontamination protocol, and ensuring the signing of the Daily Tailgate Safety Meeting form (Form HST-2) and the Compliance Agreement (Form HSP-4) by all personnel working on site. The SSC will have advanced field work experience and be familiar with health and safety requirements specific to the project. The SSC will be responsible for contacting local authorities (such as the Mountain View Fire Department and the Mountain View Police Department) as appropriate prior to commencing on-site work. The SSC will also maintain the Daily Site Log.

B1.3.1.3 Health and Safety Representative

The AIS/Tetra Tech HASMs, Dave Brown and David Herrera, are responsible for administration of the company health and safety program. The HASM will act in an advisory capacity to project managers and site personnel for project-specific health and safety issues. The AIS/Tetra Tech TOM will establish a liaison between officers and representatives of the USACE and the HASMs on matters relating to health and safety.

The AIS/Tetra Tech HASM, David Herrera, CIH is responsible for overseeing the implementation of the SSHP. Mr. Herrera will be available if project emergencies arise during field activities.

B1.3.1.4 AIS/Tetra Tech Employees

AIS/Tetra Tech employees (Dayna Yocum and Rebecca Johnson) are expected to fully participate in implementing the site SSHP by obtaining necessary training, attending site safety meetings, always wearing designated personal protective equipment (PPE), complying with site safety and health rules, and advising the AIS/Tetra Tech SSC of health and safety concerns at the

site. The AIS/Tetra Tech SSC is the competent person required to be present during field activities and has primary responsibility for responding to and correcting emergency situations.

B1.3.1.5 Visitors

All site visitors will be required to read the SSHP and sign the Compliance Agreement form. Visitors will be expected to comply with relevant Occupational Safety and Health Administration (OSHA) requirements. Visitors will also be expected to provide their own PPE required by the SSHP. Visitors who have not met OSHA training, medical surveillance, and PPE requirements are not permitted to enter areas where exposure to hazardous materials is possible. The SSC will ensure that the visitor will remain outside of the exclusion zone to observe work being conducted. The visitor will not be permitted within the exclusion zone area until they are able to provide proper training documentation. If the visitor insists on entering the exclusion zone, work will stop. Once the visitor exits the exclusion zone, work may resume.

B1.3.2 HEALTH AND SAFETY PLAN ENFORCEMENT

SSHP enforcement during the field activities at OPHA, former NAS Moffett Field shall be rigorous. Violators of the SSHP will be verbally notified upon first violation, and the violation will be noted by the AIS/Tetra Tech SSC in a field logbook. Upon the second violation, the violator will be notified in writing, and the AIS/Tetra Tech TOM and the violator's supervisor will be notified. A third violation will result in a written notification and violator's eviction from the site. The written notification will be sent to human resources development and the HASM.

Personnel will be encouraged to report to the SSC any conditions or practices that they consider to be detrimental to their health or safety or those they believe are in violation of applicable health and safety standards. Such reports may be made orally or in writing. Personnel who believe that an imminent danger threatens human health or the environment are encouraged to stop work and bring the matter to the immediate attention of the SSC for resolution.

At least one copy of this SSHP will be available to all site personnel at all times. Additional copies of the SSHP will be included in every onsite vehicle used during field activities. Minor changes in SSHP procedures will be discussed at the beginning of each workday by the SSC at the daily tailgate safety meeting. Significant plan revisions must be reviewed and approved by the HASM, and discussed with the project manager.

B1.4.0 TRAINING REQUIREMENTS

All on-site personnel who may be exposed to hazardous conditions, including AIS/Tetra Tech and subcontractor personnel and site visitors who will participate in on-site activities, will be required to meet training requirements outlined in 29 Code of Federal Regulations (CFR) Section (§) 1910.120, "Hazardous Waste Operations and Emergency Response [HAZWOPER]." All personnel and visitors entering the site will be required to review this SSHP and sign the Compliance Agreement form (HSP-4), and site workers will be required to sign the Daily Tailgate Safety Meeting form (HST 2). A list of site-specific training requirements is detailed below:

- 40-hour HAZWOPER course
- 8-hour HAZWOPER refresher course
- 30-hour Construction Safety Training course (SSC only)
- First Aid and cardiopulmonary resuscitation (CPR) training, including training in bloodborne pathogens. (At least two people on-site must be certified at all times. All AIS/Tetra Tech field personnel, including the field manager and SSC listed in Section B1.3.1, have been certified.)
- AHA Training

Before on-site activities begin, the AIS/Tetra Tech SSC will present a briefing for all personnel who will participate in on-site activities. The following topics will be addressed during the pre-work briefing:

- Names of the SSC and the designated alternate
- Site history
- Work tasks
- Hazardous chemicals that may be encountered on site
- Physical hazards that may be encountered on site
- PPE, including type or types of respiratory protection to be used for work tasks
- Training requirements
- Environmental surveillance (air monitoring) equipment use and maintenance
- Action levels and situations requiring upgrade or downgrade of level of protection
- Site control measures, including site communications, control zones, and safe work practices (Attachment B1-2)
- Decontamination procedures
- Emergency communication signals and codes
- Environmental accident emergency procedures (in case contamination spreads outside the exclusion zone)
- Personnel exposure and accident emergency procedures (in case of falls, exposure to hazardous substances, and other hazardous situations)
- Fire and explosion emergency procedures
- Emergency telephone numbers
- Emergency routes

Any other health and safety-related issues that may arise before on-site activities begin will also be discussed during the pre-work briefing.

Issues that arise during implementation of on-site activities will be addressed during tailgate safety meetings to be held daily before the workday or shift begins and will be documented in the Daily Tailgate Safety Meeting form. Any changes in procedures or site-specific health and safety-related matters will be addressed during these meetings.

B1.5.0 PERSONAL PROTECTION REQUIREMENTS

The levels of personal protection to be used for work tasks at OPHA, NAS Moffett Field have been selected based on known or anticipated physical hazards; types and concentrations of contaminants that may be encountered on site; and contaminant properties, toxicity, exposure routes, and matrixes. The SSC will maintain PPE in the site support zone and ensure that all field personnel have the appropriate PPE to complete project tasks. The following sections describe protective equipment and clothing; reassessment of protection levels; limitations of protective clothing; and respirator selection, use, and maintenance.

B1.5.1 PROTECTIVE EQUIPMENT AND CLOTHING

Personnel will wear protective equipment when (1) site activities involve known or suspected atmospheric contamination; (2) site activities may generate vapors, gases, or particulates; or (3) direct contact with hazardous materials may occur. Based on the anticipated hazard level, personnel will initially perform field tasks in Level D protection. Field personnel are responsible to decide which PPE are necessary to complete the project-specific tasks. If site conditions or the results of air monitoring performed during on-site activities warrant a higher level of protection, all field personnel will withdraw from the site, immediately notify the AIS/Tetra Tech SSC, and wait for further instructions. Descriptions of equipment and clothing required for Level D protection are provided below.

- Coveralls or work clothes (reusable), for all field activities
- Hard hats, when working around drill activities or other overhead hazards
- Hearing protection, with a minimum noise reduction rating of 29 decibels, when working around a rotary drill rig or other loud noise
- Chemical-resistant clothing (such as Tyvek® or Saranex® coveralls) (optional)
- Outer gloves (neoprene, nitrile, or other), during all sampling activities
- Disposable inner gloves (such as latex or vinyl) (optional)
- Boots with steel-toe protection, for all field activities (steel shanks optional)
- Disposable boot covers or chemical-resistant outer boots (optional)
- Safety glasses with side shields or goggles, chemical and impact resistant, for all field activities

B1.5.2 REASSESSMENT OF PROTECTION LEVELS

PPE levels shall be upgraded or may be downgraded based on a change in site conditions or investigation findings. When a significant change in site conditions occurs, hazards will be reassessed. Some indicators of the need for reassessment are as follows:

- Commencement of a new work phase, such as the start of a significantly different sampling activity or work that begins on a different portion of the site
- A change in job tasks during a work phase
- A change of season or weather
- Temperature extremes or individual medical considerations limiting the effectiveness of PPE
- Discovery of contaminants other than those previously identified
- A change in ambient levels of airborne contaminants (see the action levels listed in Table B1-2)
- A change in work scope that affects the degree of contact with contaminated media

B1.5.3 LIMITATIONS OF PROTECTIVE CLOTHING

PPE clothing ensembles designated for use during site activities have been selected to provide protection against contaminants at known or anticipated on-site concentrations and physical states. However, no protective garment, glove, or boot is entirely chemical-resistant, nor does any protective clothing provide protection against all types of chemicals. Permeation of a given chemical through PPE depends on the contaminant concentration, environmental conditions, physical condition of the protective garment, and resistance of the garment to the specific contaminant. Chemical permeation may continue even after the source of contamination has been removed from the garment.

Field personnel will be required to perform PPE inspections prior to, during, and after its use. All site personnel will use the procedures presented below to obtain optimum performance from PPE.

When chemical-protective coveralls become contaminated, don a new, clean garment after each rest break or at the beginning of each shift. Inspect all clothing, gloves, and boots both before and during use for the following:

- Imperfect seams
- Non-uniform coatings
- Tears
- Poorly functioning closures

Inspect reusable garments, boots, and gloves both before and during use for visible signs of chemical permeation, such as the following:

- Swelling
- Discoloration
- Stiffness
- Brittleness
- Cracks
- Any sign of puncture
- Any sign of abrasion

Reusable gloves, boots, or coveralls exhibiting any of the characteristics listed above must be discarded. Reusable PPE will be decontaminated in accordance with the decontamination AHA.

B1.6.0 MEDICAL SURVEILLANCE

The following sections describe AIS/Tetra Tech's medical surveillance program, including health monitoring requirements, site-specific medical monitoring, and medical support and follow-up requirements. Procedures documented in these sections will be followed for all activities at the OPHA, NAS Moffett Field. Additional requirements are defined in the Tetra Tech, Inc., "Health and Safety Manual" (Tetra Tech 1999).

B1.6.1 HEALTH MONITORING REQUIREMENTS

All AIS/Tetra Tech and subcontractor personnel involved in on-site activities during the field activities at OPHA, NAS Moffett Field must participate in a health monitoring program as required by 29 CFR §1910.120(f). AIS/Tetra Tech has established a health monitoring program with Western Medical and WorkCare, Inc., of Orange, California. The program is overseen directly by a board-certified, occupational medicine physician. Under this program, AIS/Tetra Tech personnel receive baseline and annual or biennial physical examinations.

For each employee, AIS/Tetra Tech receives a copy of the examining physician's written opinion after post-examination laboratory tests have been completed; the AIS/Tetra Tech employee also receives a copy of the written opinion in accordance with 29 CFR §1910.120[f][7].

All subcontractors must have health monitoring programs conducted by their own clinics in compliance with 29 CFR §1910.120(f). Any visitor or observer at the site will be required to provide records in compliance with 29 CFR §1910.120(f) before entering the site.

B1.6.2 SITE-SPECIFIC MEDICAL MONITORING

There are no site-specific medical monitoring requirements for field activities at OPHA, NAS Moffett Field.

B1.6.3 MEDICAL SUPPORT AND FOLLOW-UP REQUIREMENTS

As a follow-up to an injury requiring care beyond basic first aid or to possible exposure above established exposure limits, all employees are entitled to and encouraged to seek medical attention and physical testing. Such injuries and exposures must be reported to the SSC and HASM. Depending on the type of injury or exposure, follow-up testing, if required, must be performed within 24 to 48 hours of the incident. It will be the responsibility of the employer's medical consultant to advise the type of test required to accurately monitor for exposure effects. The AIS/Tetra Tech Incident Report must be completed by the AIS/Tetra Tech TOM in the event of an accident, illness, or injury. A copy of this form must be forwarded to the HASM for use in determining the recordability of the incident and for inclusion in AIS/Tetra Tech's medical surveillance records.

B1.7.0 SITE-SPECIFIC HAZARD EVALUATION

Field activities and physical features of the site may expose field personnel to a variety of hazards. This section provides information on potential hazards related to site activities and the nature of hazardous material impacts. Potential chemical and physical hazards related to site activities are discussed below.

B1.7.1 CHEMICAL HAZARDS

In addition to the site chemicals, which are listed in Table B1-1, other potentially harmful chemicals that will be present on site during field activities include the following:

- Vehicle fuels (gasoline and diesel)
- Decontamination substance (Alconox® or Liquinox)
- Sample preservatives (hydrochloric acid, nitric acid)

The material safety data sheets (MSDS) included in Attachment B1-1 of this SSHP summarize health and safety information for hazardous materials that will be encountered at the site.

B1.7.2 EXPOSURE HAZARDS

Site-specific environmental surveillance (air monitoring) will be conducted at OPHA, NAS Moffett Field using a photoionization detector (PID) to monitor organic vapors during drilling activities and soil sampling. In addition, noise monitoring will be conducted using a sound level meter, if necessary. Nuisance dust could result from backfilling the soil borings with bentonite pellets; however, it is unlikely that the nuisance dust will cause an exposure hazard. Air monitoring requirements and action levels of the chemicals are listed in Table B1-2.

If site conditions or the results of air monitoring performed during on-site activities warrant a higher level of personal protection, all field personnel will withdraw from the site, immediately notify the AIS/Tetra Tech SSC, and wait for further instructions.

B1.7.3 PHYSICAL HAZARDS

Physical hazards associated with site activities present a potential threat to on-site personnel. Dangers are posed by, but not limited to, utility and power lines, slippery surfaces, unseen obstacles, noise, heat, cold, and poor illumination.

Injuries resulting from physical hazards can be avoided by using safe work practices and employing caution when working with machinery (Attachment B1-2). In addition, potential hazards associated with project tasks are discussed in each task-specific AHA. To ensure a safe workplace, the SSC will conduct and document regular safety inspections and will make sure that all AIS/Tetra Tech workers and visitors are informed of any potential physical hazards related to the site. Physical hazards that have been identified at this site include the following:

- Accidents caused by slipping, tripping, or falling
- Noise hazards, such as heavy equipment, Rotary Drilling, or truck traffic
- Underground utility clearance will be conducted by a third-party subcontractor or Dig Alert
- Overhead hazards, such as electrical lines
- Safe Drilling Practices
- Heavy equipment
- Heat/Cold stress

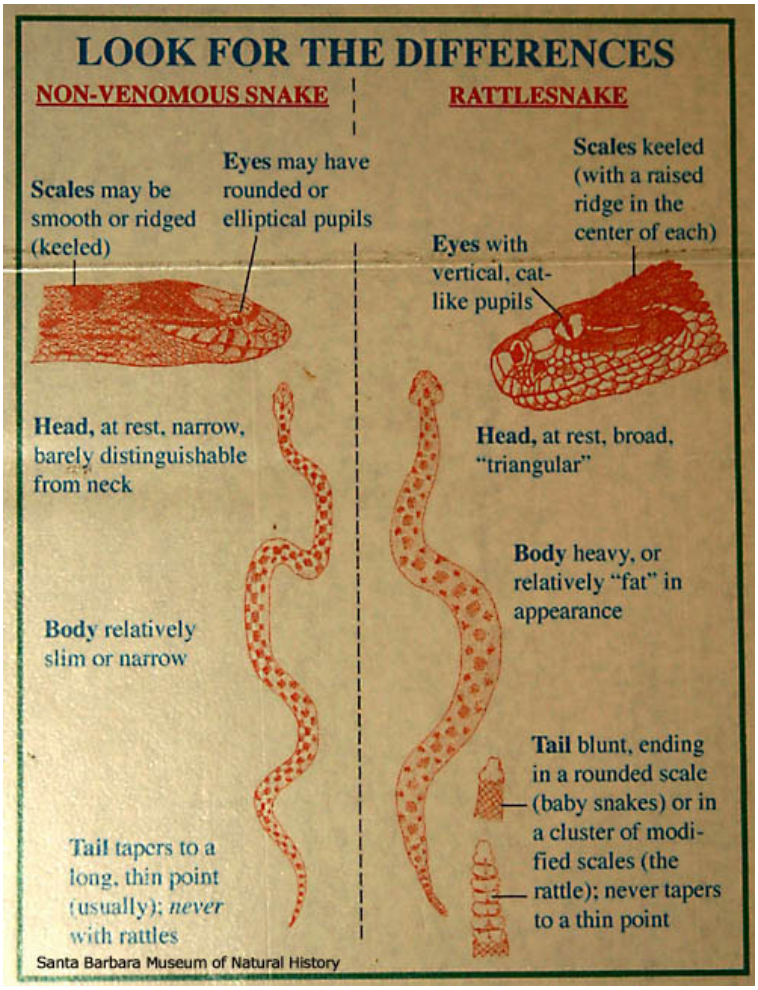
B1.7.4 BIOLOGICAL HAZARDS

Many of the planned site activities will occur outside in areas that are not improved or maintained. As a result, the potential for encountering natural hazards exists. Insect/animal bites and stings, poisonous plants, and inclement weather are natural hazards that may be present given the location of activities to be conducted. In general, avoidance of areas of known infestation or growth will be the preferred exposure control for insects/animals and poisonous plants. The following information is provided as a precaution to help recognize and avoid these types of hazards.

The on-site SSC shall screen the area for biological hazards during the initial site visit and shall discuss any problems with USACE personnel. Multiple biological hazards are present at Moffett Field. The most common hazards anticipated are discussed below.

B1.7.4.1 Snakes

Several types of poisonous snakes are indigenous to this region. One measure to prevent snake bites is for the field team to have a basic understanding of these reptiles as summarized below. The following chart describes how to distinguish between poisonous and non-poisonous snakes.



If a rattlesnake is encountered, personnel should slowly and quietly back away from the snake and should then inform all personnel at the site of its location. Personnel shall not attempt to move or kill a snake because certain species of rattlesnake are protected under state and federal laws. The following snakes may be encountered at OPHA, NAS Moffett Field.

Northern Rubber BOA Snake - Nonvenomous

Considered harmless to humans.

Size: Adults 15 - 33 inches (35 - 84 cm.) Typical size of adults is 15 - 25 inches. Newborns 7.5-9 inches. Small or dwarf populations have been found in the Tehachapi, Greenhorn and Paiute Mountains, on Breckenridge Mountain, and on Mt. Pinos.

Appearance: A small constrictor with a stout body and smooth shiny small-scaled loose and wrinkled skin which gives the snake a rubbery look and feel. Light brown, dark brown, pink, tan, or olive-green above, and yellow, orange, or cream colored below. Usually uniform in color on the back, but sometimes dark spots or mottling occur, especially in northern populations, possibly due to scarring. Usually no pattern below, but sometimes there is dark mottling. Young snakes are pink or tan, and can be brightly-colored. Eyes are small with vertically elliptical pupils.

The tail is short and blunt and looks like a head. When threatened, the snake hides its head in its coiled body, and elevates the tail to fool an attacker into attacking the tail. Snakes with scarred tails are common.

Behavior: Nocturnal and crepuscular, sometimes active in daylight. Sometimes active in weather that would be too cold for most reptiles, with surface temperatures in the 50s. A good burrower, climber and swimmer. Often found under logs, boards and other debris, sometimes on roads at dusk. Known to live as long as 40 - 50 years in the wild.

Range: In California, from south of Monterey north along the coast and from the Tehachapi mountains north through the Sierras. Possibly present farther south along the coast. Absent from the Great Valley and deserts. Ranges east through northern Nevada and Utah into western Wyoming and Montana, and north into Canada.

Habitat: Grassland, mountain meadows, chaparral, woodland, along streamsides, deciduous and coniferous forest. From sea level to over 10,000 feet. elevation.

Desert Rosy BOA Snake - Nonvenomous

Considered harmless to humans.

Size: Adults 17 - 44 inches long (43 - 112 cm) but generally under 36 inches. Hatchlings are 10 - 14 inches long.

Appearance: A heavy-b odied snake with smooth shiny scales and a blunt, but tapered tail. The head is only a little wider than the neck. Pupils are vertical.

There are three well-defined dark stripes, tan, brick red, rose, or reddish-brown in color, running lengthwise on the back and sides with a gray, cream, tan, yellowish or whitish ground color inbetween. Flecks of the stripe color are rarely present in the ground color, unlike the Coastal Rosy Boa. Snakes with more contrasting even-edged stripes are associated with drier habitats. The belly is cream to grayish with dark flecks.

Males have small spurs on each side of the vent which are vestigial hind limbs.

Rosy boas of all subspecies have been common pet snakes for many years. Breeders have produced new color morphs and, in order to promote regional variations in appearance, they have also designated sometimes confusing locality-specific names such as Verbenia, Corn Springs, Whitewater, Pioneertown, Long Canyon, Mojave, San Gabriel, Lake Elsinore, Hemet, Unicolor, Anza-Borrego, Harquahala, Bagdad, Baja Cape, San Felipe, Catavina, and Bay of LA, among others.

Behavior: Primarily active at dawn, dusk, and at night, rarely in daylight, but may be active in the morning, especially in cool weather. In the hottest and coldest months of the year, remains inactive in burrows or under surface debris. A good climber.

Sometimes rolls the body into a ball and hides the head when alarmed.

Range: Occurs in southeastern California, from the Death Valley region south through the Mojave Desert east of the Transverse Ranges, but not to the Nevada border, then east to the Colorado River, and farther into western Arizona. Absent from the Coachella valley area and south in the extreme low desert. Distribution is spotty in the lower desert parts of the range. Snakes in the eastern San Gorgonio pass and Palm Springs area are considered integrades.

Habitat: Inhabits arid scrublands, semi-arid shrublands, rocky deserts, desert oases, canyons, and rocky areas. Appears to be common in riparian areas, but does not require permanent water.

Mohave Glossy Snake - Nonvenomous

Considered harmless to humans.

Size: Adults 26-70 in. (66-178 cm) Average length is 3 - 4 feet.

Appearance: Smooth, glossy scales with a faded or bleached-out appearance - a light brown, gray, cream, or pink ground color with tan brown or gray blotches on back and sides with black edges and a pale, unmarked underside. An average of 63 narrow blotches on body.

Behavior: Nocturnal. Burrows, hiding underground in daytime.

Diet: Preys mostly on sleeping diurnal lizards, but also eats small snakes, terrestrial birds, and mammals. Kills prey by direct swallowing or constriction.

Reproduction: Lays eggs in June and July.

Range: Occurs from Inyo County south through most of the Mojave Desert, and east barely into Nevada.

Habitat: Inhabits barren open sandy desert, desert scrub, rocky washes, grasslands.

Mohave Shovel-Nose Snake - Nonvenomous

Considered harmless to humans.

Size: Adults are 11 - 17 inches long (25 - 43 cm)

Appearance: Smooth, shiny scales, not keeled. The ground color is cream or yellowish and the body is circled with 40 or more black bands, usually with no red crossbands between them. Most black bands do not completely encircle the body. The head is narrow with a large spade-like scale on the tip of a flat shovel-like snout, a countersunk lower jaw, and nasal valves.

Behavior: Nocturnal. Burrows underground in daytime, but occasionally found by day in shaded areas. Smooth scales, flat shout, concave abdomen, and nasal valves are adaptations that allow for a quick swimming movement through loose sand, with an s-shaped, side-to-side movement. Often seen crossing desert roads at night.

Range: Found in the central southern California deserts to the base of the mountains - south and east of the Sierras and Tehachapis, and north and west of the Transverse and Peninsular ranges. Ranges north to around the Panamint Valley, south to near the Salton Sea, and east to the state line. Ranges farther east into southern Nevada and west central Arizona.

Habitat: Inhabits dry desert habitats with loose sand and often with little vegetation - washes, dunes, sandy flats, rocky hillsides.

Northern Desert Night Snake - Mildly Venomous

Not considered dangerous to humans.

Size: Adults can be 12 - 26 inches long (30-66 cm.). Most seen are 8 - 12 inches long, rarely over 16 inches. Hatchlings are about 7 inches in length.

Appearance: A small slender snake with a narrow flat head, smooth scales in 21 rows, and vertical pupils. Color varies, often matching the substrate, from light gray, light brown, beige, to tan or cream, with dark brown or gray blotches on the back and sides. Usually a pair of large dark markings on the neck and a dark bar through or behind the eyes. Whitish or yellowish and unmarked underneath.

Behavior: Nocturnal, and also active at dusk and dawn. Can be found under rocks, boards, dead Joshua tree branches, and other surface objects. Often seen crossing desert roads on warm nights.

Range: Found throughout southern California, north to San Luis Obispo County, east and north along the western Sierra Nevada mountains, and into the Great Basin desert in the far northeast part of California, including Lava Beds National Monument. There is also a record for Siskiyou county north of Yreka near the Oregon Border, and an old record from Santa Cruz Island. Ranges south into Baja California, east throughout the southwest, and north into Washington.

Habitat: Found in a variety of habitats, often arid areas, from chaparral, Sagebrush flats, deserts, suburban lots and gardens, mountain meadows, grassland. Most commonly found in areas with abundant surface cover. Sea level to 8,700 feet (2,650 meters).

California Kings Snake - Nonvenomous

Considered harmless to humans.

Size: Adult *Lampropeltis getula* are 30 - 85 inches (76 - 216 cm). California Kingsnakes do not reach that size, seldom exceeding 48 inches. Most commonly found at 2.5 - 3.5 feet in length. Hatchlings are about 12 inches long.

Appearance: Smooth, shiny, unkeeled scales. The head is barely wider than the neck. Highly variable in appearance. Most commonly seen with alternating bands of black or brown and white or light yellow, including the underside, where the light bands become wider. A striped phase with a white or light yellow stripe on the back occurs in coastal southern California. An unbanded phase with a dark belly and lateral striping occurs in the northern San Joaquin Valley and southern Sacramento Valley. A dark banded phase with a dark underside occurs in coastal Los Angeles County, some with a high number of bands. A

desert phase occurs with dark black bands and narrow bright white bands. Some variants have much dark speckling in the light bands, others with much light speckling in the dark bands.

Behavior: Active during daylight in cooler weather and at night, dawn, and dusk when temperatures are high. When disturbed, generally not aggressive, but sometimes vibrates the tail quickly, hisses, and rolls into a ball, hiding the head and showing the vent with it's lining exposed. A powerful constrictor, coiling tightly around its prey. Immune to rattlesnake venom. A popular pet snake. Many unusual color phases have been bred, including albinos.

Range: Found throughout California, except the damp redwood zone of the extreme northwest coast, and the northeast corner. Absent from high elevations in the Sierras, the Trinity Alps, and the Cascades. Rages north into southwestern Oregon, east into southern Nevada, southern Utah, southwestern Colorado and northwestern New Mexico, and south through much of Arizona into Sonora, Mexico, and south throughout the Baja California peninsula.

Habitat: Found in a wide variety of habitats - forest, woodland, chaparral, grassland, marshes, farmland, ranches, deserts, and even brushy suburban areas.

Red Coachwhip - Nonvenomous

Considered harmless to humans.

Size: Adults of this species are 36 - 102 inches long (91 - 260 cm.) Hatchlings are about 13 inches long.

Appearance: A slender fast-moving snake with smooth scales, a large head and eyes, and a thin neck. Large scales above eyes. 17 scale rows at mid body. Coloration is variable; light brown, pink or reddish above with pink, brown, or black bands across the neck. Black and yellow phases of this subspecies are found outside of California. The dark coloring is interspersed with light coloring creating a banded or saddled appearance, with dark coloring surrounding the light scales. Color typically changes to a solid tan or reddish coloring along the length of the long thin tail. The braided appearance of scales on the tail (like a whip) gives this snake its common name.

Behavior: Active in the daytime. Hunts crawling with head the held high above the ground, occasionally moving it from side to side. The prey is overcome and crushed with the jaws or beneath loops of the body and eaten without constriction. Often strikes agressively when threatened or handled. Good climbers, able to climb bushes and trees. Seen moving quickly even on hot sunny days, but often seen basking on roads in early morning or resting underneath boards or other surface objects. Frequently run over by vehicles and found dead on the road, partly due to the tendency of this snake to stop and eat road-killed small animals.

Range: Ranges throughout southern California from Ventura county to the Baja California border and north around the eastern side of the Sierra Nevada Mountains though the Great Basin desert into norhwestern Nevada, and south through nevada and much of Arizona to part of Sonora and Baja California. Apparently intergrades with *M. f. rudocki* in eastern Kem County.

Habitat: Inhabits open areas of desert, grassland, scrub, and sagebrush, including rocky, sandy, flat, and hilly ground. Avoids dense vegetation. Takes refuge in rodent burrows, under shaded vegetation, and under surface objects.

Spotted Leaf Nose Snake - Nonvenomous

Considered harmless to humans.

Size: 12 - 20 inches long (30 - 51 cm.)

Appearance: A small pale snake with dark blotches, smooth scales and a blunt snout. The rostral scale over the nose is enlarged and raised above the level of the other scales, giving this snake its name, as the scale looks like part of a leaf folded over the nose. The ground color is pale tan, pink, or greyish with brown blotches on the back from the back of the head to the tail. The underside is white and unmarked. Pupils are vertical. Some males may have weekly keeled scales.

Behavior: Active at night. The enlarged rostral scale may help this snake burrow through sand in search of prey. When threatened, may draw back and strike. Secretive - at one time thought to be very rare, until Laurence Klauber discovered that they were common after finding them on paved desert roads at night in 1922.

Range: Occurs from Inyo County south through the Mojave and Colorado deserts up to the desert base of the mountain ranges. Ranges east into Nevada and the southwest edge of Utah, south to the Baja California cape region, and through western Arizona south along the western coast of Mexico.

Habitat: Sandy or gravelly deserts - open flats, washes, alluvial fans, foothills. Creosote bush is typically present. F rom below sea level in the Imperial Valley to about 4,000 feet (1,200 m.)

Great Basin Gopher Snake - Nonvenomous

Considered harmless to humans.

Size: Adults of this species can be 2.5 - 7 feet long (76 - 213 cm.) Great Basin Gophersnakes have been recorded up to 6 feet (183 cm) and are most commonly under 5 ft. long (152 cm.). Hatchlings of *P. catenifer* are fairly long, generally around 15 inches in length (38 cm.)

Appearance: A large snake with heavily keeled scales, a narrow head that is slightly wider than the neck, and a protruding rostral scale on the tip of the snout. Ground color is cream to yellowish, with large brown, blackish, and reddish brown blotches along the back and smaller markings on the sides. Often the blotches form a dark band on the sides of the neck. The back of the neck is pale in the southern part of the range, but mottled with dark coloring in the northern part of the range. The underside is pale with some dark markings.

Behavior: Active in the daytime, and at night in hot weather, and especially at dusk and dawn. One of the most commonly seen snakes on roads and trails, especially in the spring when males are actively seeking a mate, and in the fall when hatchlings emerge. A good burrower, climber,

and swimmer. A powerful constrictor; kills prey by suffocating them in body coils or by pressing the animal against the walls of their underground burrows.

When threatened, a gophersnake willl elevate and inflate its body, flatten its head into a triangular shape, hiss loudly, and quickly shake its tail back and forth to make a buzzing sound which may be a mimic of a rattlesnake rattle.

You can listen to a recording of a gophersnake hissing here, and watch short movies of a gopher snake hissing and striking here, and shaking its tail here.

Range: Occurs in southeastern California north of approximately the Riverside county line through the Mojave Desert and east of the Sierra Nevada mountains. Ranges north through nevada, eastern Oregon and Washington into British Columbia. Also found in parts of Idaho, Utah, Wyoming, Colorado, Arizona, and new Mexico. There is a wide range of integration with *P. c. catenifer* in northeastern California and eastern Oregon. Also intergrades with *P. c. annectans* in the south.

Habitat: Found in a variety of habitats - grassland, coastal sage scrub, agricultural lands, riparian areas, woodlands, and desert, from sea level to the mountains. Especially common in coastal areas.

Long Nosed Snake - Nonvenomous

Considered harmless to humans.

Size: 16 - 60 inches long (40 - 152 cm). Most snakes seen are 16- 30 inches long (40 - 76 cm). Hatchlings from 7 - 11 inches (18 - 28 cm).

Appearance: A slender snake with smooth scales and a head barely wider than the body which has a long pointed snout with a countersunk lower jaw. Most snakes are tricolored, with a saddled pattern. The ground color is white which is usually heavily speckled with black and red from the alternating red and black saddles. The saddles do not ring the body. The underside is cream or yellow with no pattern. Some snakes have no red. These are considered the "clarus" phase, and at one time were regarded as a distinct subspecies, *Rhinocheilus lecontei clarus*.

Behavior: Crepuscular and nocturnal. Occasionallly found out at mid day. Relatively cold-tolerant, especially in the northernmost part of its range. Good burrowers, spending much time underground, often in lizard and mammal burrows. Commonly found on roads at night.

When threatened, may vibrate the tail, writhe the body, and evert the vent, excreting blood and cloacal contents.

Range: In California, occurs throughout the south coast and deserts, north through the central valley and Coast range, excluding the coast, north to the Sutter Buttes, Sutter County. Not recorded from the coast north of Santa Barbara County, but possibly present. Also ranges north in the deserts east of the Sierra Nevada Mountains as far as the Honey Lake Basin in Lassen County. Ranges south of California in northern Baja California, east into Nevada, Utah, Arizona, barely into New Mexico, and south into Mexico. An isolated population occurs in Idaho.

Habitat: Arid and semi-arid deserts, grasslands, shrublands, and prairies. Sea level to 6,200 feet. (1,900 m).

Mohave Patched Nose Snake - Nonvenomous

Considered harmless to humans.

Size: *Salvadora hexalepis* ranges in size from 10 - 46 inches long (25 - 117 cm). Most snakes seen will be around 26 - 36 inches (66 - 91 cm).

Appearance: A fast, moderately-sized slender striped snake with smooth scales, large eyes, and a large scale over the tip of the snout. Well-camouflaged, this snake is pale gray with a broad yellow or tan stripe down the middle of the back, and dark stripes on the sides. These dark stripes is often vague or broken up, and occasionally corssbars obscure the stripes. The top of the head is gray or brownish. The underside is cream, sometimes shading to pale orange at the tail end.

Behavior: Little is known about the natural history of this species. Active during daylight, even in times of extreme heat. Terrestrial, but may climb shrubs in pursuit of prey. Burrows into loose soil. Able to move very quickly. Their acute vision allows them to escape quickly when they feel threatened, making this snake sometimes difficult to capture during the heat of the day. When cornered, they will inflate the body and strike.

Range: This subspecies occurs in California from roughly Riverside County, west along the desert side of the mountains, north east of the Sierra Nevada Mountains into Nevada and northeast California in Lassen County, and east into extreme southeast Utah and Arizona.

Habitat: Inhabits open arid and semi-arid areas - deserts, brushland, grassland, scrub, sagebrush, in canyons, rocky hillsides, sandy plains. *Salvadora hexalepis* occurs at elevations from below sea level to around 7,000 feet (2,130 m.)

Baja Lyresnake - Mildly Venomous

One of the larger rear-fanged snakes, but considered harmless to humans, but handle with caution, as some people have had unpleasant reactions to this snake's bite.

Size: *Trimorphodon biscutatus* have been recorded from 18 - 47 3/4 inches in length (46 - 121 cm). Most snakes encountered are 24 - 36 inches long (61 - 91 cm).

Appearance: A slender snake with a broad head well-differentiated from the slim neck. Coloring closely matches a snake's rocky habitat, from gray to light brown. There are usually about 35 dorsal blotches with light edges and a pale crossbar in the center, and smaller irregular blotches on the lower sides. A lyre-shaped marking is present on top of the head. The pupils are vertical, like those of a cat. The underside is off-white or yellowish with dark spots. The anal plate is usually undivided.

According to Stebbins there is a dark form of this snake with a light brown middorsal stripe found at the Pisgah lava flow.

Behavior: Nocturnal, active in very dry conditions as well as during rains. Terrestrial, and good climbers. This snake often searches rock crevices for prey. It can be found during the day inside crevices in large rock outcrops, as well as crossing desert roads at night.

Range: In California, this snake occurs from around Santa Barbara County northeast into Inyo County, and south along the coast into Baja California, in two strips through the peninsular ranges, and along the Colorado River, splitting around the Imperial Valley. It is also absent from a large area of the Mojave Desert except for isolated localities including the Pisgah lava flow area. This may be due to the secretive nature of this snake. It may be more widespread in this area.

Habitat: Associated primarily with rocky locations in desert scrub and grassland, chaparral, oak woodland, coniferous forest, but found in rockless areas, also.

Mohave Desert Sidewinder Snake - Venomous

The venom of this snake is potentially dangerous to humans.

Size: Adults are 17 - 33 inches. (43 - 84 cm). Snakes encountered will generally be 12 - 18 inches. Juveniles are about 7 inches at birth.

Appearance: A heavy-bodied, venomous pit viper, with a thin neck and a large triangular head. Pupils are elliptical. Scales are keeled. A dark eye stripe and a pointed and upturened horn-like scale above each eye. These horns may fold down over the eyes to protect them when the snakes is crawling in burrows. Pale cream, tan, brown, pink, or grayish back color usually closely matches the soil surface allowing the snake to blend in with the background. Around 40 darker blotches on the back.

A thick tail with a rattle, consisting of loose interlocking segments, at the end. A new rattle segment is added each time the skin is shed. Newborn snakes do not have a rattle - just a single button which does not make a sound. The segment of the rattle closest to the body on an adult snake is brown. The Colorado Desert Sidewinder has a black segment. Heat sensing pits on the sides of the head help the snake to locate prey by their warmth.

Long, hollow, movable fangs connected to venom glands inject a toxic venom which quickly immobilize the prey. The snake can control the amount of venom injected and the fangs are replaced if broken. Though the amount of venom a sidewinder injects is relatively small and rarely deadly, bites on humans are potentially dangerous. Even a dead snake can bite and inject venom if the jaws open reflexively when they are touched.

Behavior: Primarily nocturnal and crepuscular during periods of excessive daytime heat, but also active during daylight when the temperature is more moderate. Not active during cooler periods in Winter.

An ambush hunter, it sits buried beneath the surface of loose sand with just the top of the head showing, near kangaroo rat warrens, and lizard or rodent trails, then strikes at and releases the prey. The snake then follows the trail of the envenomated animal and swallows it whole.

When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing a buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Moves with a sidewinding locomotion, throwing raised loops of the body to the side to push itself forward in an s-sheped curve. A sidewinders trail looks like a series of parallel j-shaped lines pointing roughly 45 degrees from the direction of movement.

Range: Found in south-central California south and east of the Sierras south to roughly the San Bernardino county line. Ranges east through Nevada to extreme southwestern Utah and south to extreme west-central Arizona.

Habitat: Inhabits primarily areas of wind-blown sands, especially where sand hummocks are topped with vegetation. Also found in hardpan, open flats, rocky hillsides, and other desert areas, especially those grown with creosote bush, where the terrain is open, not obstructed by rocks or vegetation, allowing the broad sidewinding locomotion.

Panamint Rattlesnake - Venomous

The venom of this snake is potentially dangerous to humans.

Size: Adults are 23-52 inches in length (58-132 cm) averaging 2 - 3 feet. Young 10 inches.

Appearance: A heavy-bodied, venomous pit viper, with a thin neck and a large triangular head. Pupils are elliptical. Scales are keeled.

Shows a great variety of body coloration which usually allows the snake to blend into its environment - tan, yellowish, orangish, gray, off-white, brown. The body is marked with a pattern consisting of dark speckled banded markings, which can be vague or distinct. A dark band or bands on the tail, but not usually alternating with light bands . The tail has a rattle on the end, consisting of loose interlocking segment s. A new rattle segment is added each time the skin is shed. Newborn snakes do not have a rattle - just a single button which does not make a sound.

Heat sensing pits on the sides of the head help the snake to locate prey by their warmth. Long, hollow, movable fangs connected to venom glands inject a very toxic venom which quickly immobilize prey. The snake can control the amount of venom injected and the fangs are replaced if broken. Bites on humans are potentially dangerous without immediate medical treatment. Even a dead snake can bite and inject venom if the jaws reflexively open when they are touched.

Behavior: Primarily nocturnal and crepuscular during periods of excessive daytime heat, but also active during daylight when the temperature is more moderate. Not active during cooler periods in Winter.

An ambush hunter, it may wait near lizard or rodent trails, striking at and releasing passing prey. The snake then follows the trail of the envenomated animal and swallows it whole. Prey is also found while the snake is actively moving.

When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing a buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Range: Found in central eastern California, from approximately the Mojave River north along the east side of the Sierras into Nevada. Sea level to 8,000 feet (2,440 m).

Habitat: Associated mostly with habitats composed of rocky outcrops and boulders, but also found in creosote bush and cactus deserts and open coniferous woodlands.

Northern Mohave Rattlesnake - Venomous

The venom of this snake is potentially dangerous to humans.

Size: Adults 24 - 51 inches long (61 - 129 cm). Most snakes encountered are from 18 - 40 inches in length. Newborns are about 10.5 inches.

Appearance: A heavy-bodied, dangeously venomous pit viper, with a thin neck and a large triangular head. Pupils are elliptical. Scales are keeled. Usually there are 2 or 3 large scales on the top of the head between the supraoculars. (The Western Diamond-backed Rattlesnake usually has 4 or more small scales between the supraoculars.) A light stripe runs from behind the eye diagonally to the upper lip beyond the corner of the mouth, but does not cross over the lip. (The posterior light stripe of the Western Diamond-backed Rattlesnake extends to the upper lip in front of the corner of the mouth, crossing over the lip.)

Ground color varies from greenish gray, yellow, tan, olive green, to brown. Irregular, dark, well-defined, diamond or near diamond-shaped dorsal markings.

Black and white rings surround a thick tail. The black rings are narrower than the light rings, and often offset. A rattle on the end of the tail, consisting of loose interlocking segments. A new rattle segment is added each time the skin is shed. Newborn snakes do not have a rattle - just a single button which does not make a sound.

Similar to and easily confused with the Western Diamond-backed Rattlesnake, though there is little range overlap in California.

Heat sensing pits on the sides of the head help the snake to locate prey by their warmth. Long, hollow, movable fangs connected to venom glands inject a very toxic venom which quickly immobilize prey. The snake can control the amount of venom injected and the fangs are replaced if broken. Bites on humans are potentially dangerous without immediate medical treatment. Even a dead snake can bite and inject venom if the jaws reflexively open when they are touched.

Behavior: Primarily nocturnal and crepuscular during periods of excessive daytime heat, but also active during daylight when the temperature is more moderate. Not active during cooler periods in Winter.

Prey is found while the snake is actively moving, or by ambush, where the snake waits near lizard or rodent trails, striking at and releasing passing prey. The snake then follows the trail of the envenomated animal and swallows it whole.

When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing a buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Range: Found in southeastern California from the Colorado river roughly near the San Bernardino County line, west through the Mojave desert, north, east of the Sierras into Inyo County. Absent from the southeastern Colorado deserts, but there are unconfirmed reports of sightings west of the Colorado River in Imperial County. Ranges north into Nevada, east into west Texas, and far south into Mexico.

Habitat: Inhabits grassland, desert scrub, rocky slopes, creosote bush flats, open juniper woodland, and light chaparral.

Southwestern Threadsnake - Nonvenomous

Considered harmless to humans.

Size: Adults 7 - 16 inches long (18-41 cm). Hatchlings are around 4 - 5 inches long.

Appearance: A very thin snake with a blunt head and tail. The tail is tipped with a small spine. Eyes are nonfunctional dark spots visible under translucent plates. The scales are shiny and cycloid. Belly plates are not enlarged. The lower jaw is countersunk.

Coloring is brown, purple, or pink. This snake can be mistaken for a large worm.

Behavior and Natural History: When hunting for food, burrows under roots, rocks, and into ants nests. Often found under rocks, boards, or other surface debris where the soil is slightly moist. Sometimes found crawling on roads at night.

When threatened, this snake often writhes around, forming a tight coil while releasing pungent fluids from the cloaca. These fluids serve to repel defensive attacks by the ants and termites on which it feeds.

Range: Occurs along the Southern California coast, the east, north of the range of *L.h.cahuilae*, into southern Nevada and western Arizona, and south along the west coast of Baja California.

Habitat: Inhabits areas where the soil is suitable for burrowing: brushy mountain slopes, deserts, rocky hillsides, washes near streams, beach sand.

Snake Avoidance Measures

Avoidance is the first line of defense. If you see them, do not harass them, attempt to capture, move or otherwise disturb them. Leave them alone and respect the wild!

- Do not pick up ground cover as this is a potential nesting area.
- Stick to well-used trails and wear over-the-ankle boots and loose-fitting long pants. Avoid tall grass, weeds and heavy underbrush which snakes commonly frequent. If these areas cannot be avoided, wear snake chaps.

- Be observant in open, sunny areas, as snakes are cold-blooded and need to "sun themselves" to regulate their body temperature.
- Do not put your hands where you cannot see.
- Step on logs and rocks, never over them, and be especially careful when climbing rocks. Snakes will also crawl along buildings and doorways as the building or logs offer protection on one side. Examine the area carefully before entering buildings (stepping over doorway threshold plates) not regularly used and maintained.

Snakebite Control Measures

Initial efforts will be directed to avoid, where possible, nesting and territorial areas. However, should field personnel come in contact with these animals and receive a bite, the following actions are necessary:

- Obtain a detailed description of the snake. This and the bite mark will enable medical personnel administering medical aid to provide prompt and correct antidotes.
- Immobilize the bite victim to the extent possible. Physical exertion can mobilize the toxins (if poisonous varieties) from the bite point systemically through the body.
- The venom should be wiped off the skin because it will affect the skin.
- Apply a pressure wrap (for extremities), just above and over the bite area using whatever is available (an article of clothing)— with a couple wraps of the pressure wrap in place over the bite area to limit movement and restrict toxins from leaving the site of the bite.
- Seek medical attention immediately, and notify the SSC and TOM.

B1.7.4.2 Insects and Spiders

The avoidance measures listed above for snakes (Section B1.7.4.1) will also be employed for other natural hazards such as bees, wasps, hornets, mosquitoes, fire ants, ticks and spiders, etc. Before initial assignment on the project, personnel with known allergic responses to insect stings shall make their field team leader and SSC aware of this condition. These personnel shall also carry an antidote kit if so advised by their physician. The SSC shall confirm that the antidote kit is accessible and shall notify the emergency medical service providers in the event of any incident.

The principle hazards of concern associated with these biological hazards are as follows:

Insect Bites and Stings

Insect bites and stings may be difficult to control. However, in an effort to minimize this hazard, the following control measures will be implemented where possible:

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Products such as n,n-diethyl-m-toluamide (DEET) should not be applied directly to the skin due to potential irritation. This product, when permitted for use, should be applied over clothing articles.
- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and will aid in visual recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks.
- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. AIS/Tetra Tech personnel, visitors, and subcontractors should perform a more detailed check of their bodies when showering in the evening. Ticks prefer moist areas of the body and will migrate to those locations.

Bees, Wasps and Hornets

Bees, hornets, yellow jackets, wasps and mosquitoes can sting or bite. Though irritating and uncomfortable, in most cases insect bites or stings are harmless. However, insect bites can cause allergic reactions in some people.

- If stung, remove the stinger by scraping a card across the wound (do not squeeze).
- Wash the area with warm, soapy water.
- Apply a cold compress to control swelling.
- Take aspirin for pain and an antihistamine, as needed, for minor itching and swelling.
- If you experience a body-wide reaction, severe local swelling, especially around the face or neck, or have difficulty breathing, call 911 immediately.
- The specialists at the Poison Center are available to help if a bite or sting occurs.

Scorpions

Fifty-nine species and subspecies of scorpions are known from California. Many of the species are natives of tropical and desert regions of the earth. The scorpions vary in color (there are red, yellow, green and black color scorpions) and in length. Scorpions are nocturnal animals. They usually spend all the day sheltered from light under a stone, a bark, in a burrow, and they only leave their hiding places during the night to eat.

A scorpion is an ancient venomous arthropod, belonging to the class of animals known as arachnid. They are closely related to the spiders. The sting of a scorpion is sometimes fatal because certain species are dangerously poisonous. The body structure of a scorpion resembles a crayfish. A scorpion has a pair of appendages extending from the sides of the mouth and also has a diabolic tail with a pair of powerful pincers. A scorpion attacks its predators and its prey with its tail.

Depending on the toxicity of their venom, the scorpions are classified into two types. There are a few species of scorpions whose sting is not harmful. The sting causes sharp pain followed by swelling; however, the effect of the sting is lost after a couple of hours. The toxicity of the venom of the other type of scorpions, is similar to that of the venomous snakes such as cobra and coral snakes. That is, the venom of these arthropods is neuro-toxic. The venomous species of scorpions are mostly found in many parts of Mexico.

Fire Ants

Fire ants present a unique situation when working outdoor in many states including California. Their aggressive behavior and their ability to sting repeatedly can pose a unique health threat. The bite injects venom that causes an extreme burning sensation. Pustules form, and can become infected if scratched. Allergic reactions of people sensitive to the venom include dizziness, swelling, shock, and in extreme cases, unconsciousness and death.

Tick and Mosquito Transmitted Illnesses and Diseases

Ticks are normally found in wooded and bushy areas. When walking through tall brush areas, personnel should periodically check themselves and their coworkers for ticks. Warm months (spring through early fall) are the most predominant time for this hazard. Ticks burrow into the skin. It is essential to remove the entire tick as soon as it is found. Perform periodic buddy checks to look for signs of tick bites. Tick bites are common but can be avoided by using insect repellants such as DEET and wearing light colored clothing.

Tick bites may occasionally result in Lyme disease or Rocky Mountain spotted fever. Lyme disease is a spirochete-type bacterial infection that is transmitted to humans and some animals by two species of ticks. The deer tick is probably the more prevalent. The female is approximately 0.25-inch long and is black and red in color. Symptoms of Lyme disease include chills, fever, headache, fatigue, stiff neck, and aching bones. Lyme disease presents itself as a rash with a small welt in the center. Symptoms of Rocky Mountain Spotted Fever include chills, fever, headache, fatigue, stiff neck, and aching bones. Spotted fever presents itself as red spots under the skin.

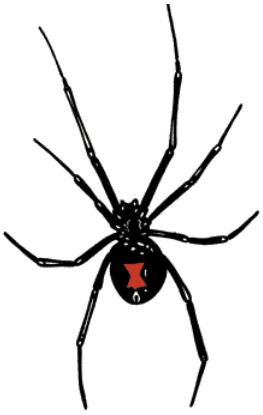
- It usually takes about 24 hours of tick attachment to a "host" for disease to be transmitted.
- The symptoms can begin as early as a few days after a bite or take as long as two weeks before appearing.
- Symptoms include headache, chills, fever and rash—much like the flu.
- If bitten, carefully remove the tick using blunt tweezers. Grasp the tick close to the skin and pull straight out with a steady pressure. Check to see that the entire tick has been removed.
- Clean with warm, soapy water; then apply an antiseptic.
- Be observant of and if any of the above symptoms develop, contact your doctor immediately.

Mosquitoes have also been identified in the transmission of Lyme's disease. In addition, mosquitoes have been identified in the transmission of West Nile Virus (WNV). WNV is a potentially serious illness. Experts believe WNV is established as a seasonal epidemic in North America that flares up in the summer and continues into the fall. The easiest and best way to avoid WNV is to prevent mosquito bites. When you are outdoors, use insect repellent containing an U.S. Environmental Protection Agency (EPA) registered active ingredient (DEET, picaridin [KBR 3023], or oil of lemon eucalyptus). Many mosquitoes are most active at dusk and dawn. Be sure to use insect repellent and wear long sleeves and pants at these times or consider staying indoors during these hours. Get rid of mosquito breeding sites by emptying standing water from buckets and barrels. People typically develop symptoms between 3 and 14 days after they are bitten by the infected mosquito.

- Approximately 80 percent of people (about 4 out of 5) who are infected with WNV will not show any symptoms at all.
- Up to 20 percent of the people who become infected have symptoms such as fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks.
- About one in 150 people infected with WNV will develop severe illness. The severe symptoms can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may be permanent.

There is no specific treatment for WNV infection. In cases with milder symptoms, people experience symptoms such as fever and aches that pass on their own, although even healthy people have become sick for several weeks. In more severe cases, people usually need to go to the hospital where they can receive supportive treatment including intravenous fluids, help with breathing and nursing care. Milder WNV illness improves on its own, and people do not necessarily need to seek medical attention for this infection though they may choose to do so. If you develop symptoms of severe WNV illness, such as unusually severe headaches or confusion, seek medical attention immediately.

Black Widow



Black widow spiders generally live in trash, closets, attics, woodpiles, garages and other dark places. They are found throughout California. Only the female spider is dangerous to humans.

The female black widow spider has a round, glossy black abdomen one-half inch in diameter with an orange-red hourglass marking her belly.

Her painful bite results in redness and warmth at the site as well as muscle cramps, twitching, rigid abdomen, difficulty breathing, weakness, headache, nausea and vomiting.

The male black widow spider is solid in color, and his bite is not venomous. If bitten, wash the area with warm, soapy water and call the Poison Center immediately

Wolf Spider

Wolf spiders are commonly found in California. They are large hairy spiders, up to 3 to 4 inches across. They are a mottled gray-brown color, which helps them hide in sand, gravel, leaves and other debris. Female wolf spiders carry their young on their backs. Except for one group, wolf spiders do not spin webs. They tend to burrow into the earth and hide. They are aggressive, come after their prey, and are fast runners. Because of their impressive size and aggressiveness, wolf spiders can easily incite panic.

- Bites from a wolf spider can cause pain, redness, and swelling.
- The large jaws/fangs can cause a tear in the skin as they bite.
- Swollen lymph glands may develop.
- The skin area at the bite may turn black.
- Swelling and pain can last up to 10 days.

B1.7.4.3 Vermin

Rats, mice, squirrels, and rabbits are carriers of disease. The most serious diseases associated with these species include rabies, plague, and Hantavirus. Where vermin are identified in work areas, the SSC shall be immediately notified. Vermin bites shall be immediately reported, and medical care shall be obtained.

Currently, cases of Hantavirus have been reported in 26 states, including all regions of the United States, as well as parts of Canada. Cases of Hantavirus have been associated with activities that bring humans into contact with rodent excreta (droppings or urine) and saliva. Activities that may bring humans into contact with the etiologic agents causing infection include the following situations:

- Working in areas of field crops
- Occupying previously vacant cabins, buildings, or outhouses
- Cleaning outbuildings
- Disturbing rodent-infested areas
- Visiting areas where rodent populations have increased
- Entering into crawlspaces or other potentially rodent-infested areas

This disease may be transmitted through broken skin, contact with conjunctivae, ingestion of contaminated food or water, or inhalation of aerosols. Humans may be infected when infective saliva or excreta are inhaled as aerosols produced directly from rodents. The disease may also be transmitted when fresh or dried materials contaminated by rodent excreta are disturbed.

Personnel should not perform work in abandoned buildings or enclosed areas contaminated with rodent droppings, debris, or nesting sites. The HASM should be contacted for further guidance.

Workers shall be advised that if a fever or respiratory illness develops within 45 days of the potential exposure, they should seek medical attention and inform the physician of potential B1.Hantavirus exposure.

B1.7.4.4 Wild (Feral) Dogs

Wild dogs may attack and may also carry rabies. Their presence shall be promptly reported to the SSC. Use of dog repellent is authorized for personnel who receive training in its safe use.

B1.8.0 PERSONAL MONITORING

The employees working closest to a source of contamination have the highest likelihood of exposure to airborne contaminant concentrations that may exceed established exposure limits. Air monitoring will be conducted at OPHA, NAS Moffett Field using a PID to monitor organic vapors during drilling activities and soil sampling. In addition, noise monitoring will be conducted using either a sound level meter or the general rule of "employees should be able to speak to someone at arm's length distance without having to raise voice". Nuisance dust is not expected during field activities; however, if it does become a hazard, field activities will be temporarily shut-down until the zone is clear.

If site conditions or the results of air monitoring performed during on-site activities warrant a higher level of protection, all field personnel will withdraw from the site, immediately notify the AIS/Tetra Tech SSC, and wait for further instructions. Selective monitoring of the workers who are closest to a source of contaminant generation would be conducted during site activities, if the SSC deems it necessary. However, no personal monitoring efforts are anticipated for this phase in fieldwork. Air monitoring requirements and action levels of the chemicals are listed in Table B1-2.

B1.8.1 USE AND MAINTENANCE OF SURVEY EQUIPMENT

All personnel using field survey equipment must have training in its operation, limitations, and maintenance. Maintenance and internal or electronic calibration will be performed in accordance with manufacturer recommendations by individuals familiar with the devices before and after their use on site in accordance with manufacturers' instructions. Repairs, maintenance, and internal or electronic calibration of these devices will be recorded in an equipment maintenance logbook. The equipment maintenance logbook for each instrument will be kept in that instrument's case. For rented monitoring equipment, repairs and maintenance will be conducted by the rental company. Results of routine calibration will be recorded in the field logbook.

B1.8.2 THERMAL STRESS MONITORING

Heat stress and cold stress are common and serious threats at hazardous waste sites. Table B1-3 discuss heat and cold stress and includes monitoring methods appropriate for the season and location of work. The SSC shall communicate directly with AIS/Tetra Tech HASM regarding heat intervals for the use of PPE during days where excessive temperatures are encountered, but the following table should be used as guidance (National Institute for Occupational Safety and Health 1985).

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Temperatures at NAS Moffett Field range from a low of 15 degrees Fahrenheit (°F) to a maximum of 107 °F, with an average temperature of 61 °F. The mean daily minimum temperature is 50 °F and the mean daily maximum is 77 °F. Prevailing winds in the valley are from the southwest, and the yearly average wind speed is 6.6 miles per hour. However, wind speeds in excess of 25 miles per hour have been recorded throughout the year, and winds in excess of 50 miles per hour are common between October and June.

B1.9.0 SITE SAFETY PROCEDURES

Periodic site safety inspections shall be conducted by the AIS/Tetra Tech SSC to ensure safe work areas and compliance with this SSHP. Results of the site safety inspections will be recorded in the field logbook or on a Field Audit Checklist.

B1.10.0 SITE CONTROL

Site control is an essential component in SSHP implementation. The following sections discuss measures and procedures for site control, such as on-site communications, site control zones, site access control, site safety inspections, and safe work practices (Attachment B1-2).

B1.10.1 ON-SITE COMMUNICATIONS

Successful communication between field teams and personnel in the support zone is essential. The following communication systems will be available during site activities:

- Cellular telephones

The hand signals listed below will be used by site personnel in emergency situations, in combustible atmospheres, or when verbal communication is difficult.

Signal	Definition
Hands clutching throat	Out of air or cannot breathe
Hands on top of head	Need assistance
Thumbs up	Okay, I am all right, or I understand
Thumbs down	No or negative
Arms waving upright	Send backup support
Gripping partner's wrist	Exit area immediately

B1.10.2 SITE CONTROL ZONES

To control the spread of contamination and employee exposures to chemical and physical hazards, on-site work areas may be divided into an exclusion zone, a contamination reduction zone (CRZ), and a support zone.

Access to the exclusion zone and CRZ will be restricted to authorized personnel. Any visitors to these areas must present proper identification and be authorized to be on site. The AIS/Tetra Tech SSC will identify work areas that visitors or personnel are authorized to enter and will enforce site control measures.

The following sections describe the exclusion zone, the CRZ, and the support zone as well as procedures to be followed in each.

B1.10.2.1 Zone 1: Exclusion Zone

An exclusion zone includes areas where contamination is either known or likely to be present or, because of work activity, has the potential to cause harm to personnel. Unless specified in Section B1.10.2, the perimeter of the exclusion zone and an appropriate radius around work task areas will be demarcated by a physical barrier, such as barricade tape or traffic cones, to restrict access. A daily roster with the date of each person's entrance into the exclusion zone; the person's name, signature, and organization; and the time of entry and exit will be kept for all personnel working in the zone. Visitors will not be permitted to enter the exclusion zone without proper qualifications, equipment, and AIS/Tetra Tech SSC authorization.

Work tasks that may require establishment of an exclusion zone include the following:

- CPT/MIP and DPT drilling of soil borings, and monitoring well installation at OPHA.

B1.10.2.2 Zone 2: Contamination Reduction Zone

A formally designated CRZ is not required for the tasks to be performed during the field activities at OPHA, NAS Moffett Field. Equipment decontamination procedures are described in Section B1.11.0. Visitors will not be permitted to enter the decontamination zone without proper qualifications and AIS/Tetra Tech SSC authorization.

B1.10.2.3 Zone 3: Support Zone

A support zone may consist of any uncontaminated and non-hazardous part of the site. The support zone should be situated in an area generally upwind of any exclusion zone whenever possible. Site visitors not meeting training, medical surveillance, and PPE requirements must stay in the support zone.

B1.10.3 SITE ACCESS CONTROL

Access to NAS Moffett Field is open – there are no gates around OPHA.

B1.11.0 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants on personnel or equipment. When properly conducted, decontamination procedures protect workers from contaminants that may have accumulated on PPE, tools, and other equipment. Proper decontamination also prevents transport of potentially harmful materials to uncontaminated areas. Personnel and equipment decontamination procedures are described in the following sections.

B1.11.1 PERSONNEL DECONTAMINATION

When appropriate to the chemical hazards present at OPHA, NAS Moffett Field, personnel decontamination will be limited by using disposable PPE.

Used, disposable PPE will be collected in sealable containers and will be disposed of properly. Personnel decontamination procedures may be modified as necessary while on site. In addition all personnel exiting the exclusion zone shall thoroughly wash their face, hands, and forearms prior to eating, drinking, smoking, or performing any other hand to mouth activities. In the event of an emergency, personnel decontamination may be postponed but not bypassed.

B1.11.2 EQUIPMENT DECONTAMINATION

Decontamination of all sampling and field monitoring equipment used during site activities will be required. Equipment decontamination procedures described in the following sections are based on guidelines appropriate for low-level contamination. Additional procedures may be found in EPA Standard Operating Procedure No. 2006, titled "Sampling Equipment Decontamination" dated August 11, 1994.

B1.11.3 SAMPLING EQUIPMENT

Sampling equipment/tools used for during field activities will be decontaminated using a three-tiered wash station. This station typically includes three buckets, each dedicated to its specific role. Bucket one shall be used for a pre-wash with water. Bucket two shall contain a soap/Alconox wash for scrubbing field tools with a brush. Bucket three shall contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use nitrile gloves when handling field tools during decontamination. Before and after each use, sampling equipment will be decontaminated with the following:

- Alconox (or Liquinox) wash followed by distilled water rinse (3-Stage).

Certain groundwater sample containers include sample preservatives, which are toxic and corrosive. Caution should be taken when filling sample containers that include preservatives as the standard operating procedure for preservation of project specific chemicals of concern. Attachment B1-1 contains an MSDS for each sample preservative presented below. The following sample preservatives will be required for groundwater samples at the seven sites at NAS Moffett Field:

- Hydrochloric acid (preservation for aqueous quality control samples)
- Nitric Acid (preservation for aqueous quality control samples)

B1.12.0 EMERGENCY RESPONSE PLANNING

This section describes emergency response planning procedures to be implemented during the field activities at NAS Moffett Field. It is consistent with local, state, and federal disaster and emergency management plans and is designed to comply with applicable provisions of 29 CFR §1910.38. The following sections discuss pre-emergency planning, personnel roles and lines of authority, emergency recognition and prevention, evacuation routes and procedures, emergency contacts and notifications, hospital route directions, emergency medical treatment procedures, protective equipment failure, fire or explosion, weather-related emergencies, spills or leaks, emergency equipment and facilities, and reporting. AIS/Tetra Tech personnel will conduct a practice exercise for the elements of the emergency action plan prior to beginning the site field activities; the field team will critique the lessons learned from this practice exercise.

B1.12.1 PRE-EMERGENCY PLANNING

During the pre-work briefing and daily tailgate safety meetings, all on-site employees will be trained in and reminded of the provisions of personal protection requirements, site communication systems, and site evacuation routes. The emergency response provisions will be reviewed on a regular basis by the AIS/Tetra Tech SSC and will be revised, if necessary, to ensure that they are adequate and consistent with prevailing site conditions.

B1.12.2 PERSONNEL ROLES AND LINES OF AUTHORITY

The AIS/Tetra Tech SSC has primary responsibility for responding to and correcting emergency situations and for taking appropriate measures to ensure the safety of site personnel and the public. Possible actions may include evacuation of personnel from the site area. The SSC is also responsible for ensuring that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed. The SSC will be responsible for contacting local authorities prior to commencing on-site work. As a courtesy to the local fire or emergency response department, and prior to site work, the SSC will contact the agencies to brief them on the type and duration of the activities that will be conducted during the field activities at OPHA, NAS Moffett Field. The SSC will explain that the SSHP is available for review at a site location to be determined and copies will also be present in each of the on-site vehicles used to conduct work at the site.

For work during the field activities at OPHA, NAS Moffett Field it has been determined that the AIS/Tetra Tech SSC will communicate directly with Cynthia Burris (916) 557-6745 after on-site and off-site emergency assistance has been obtained.

Individual subcontractors are required to cooperate with the SSC, within the parameters of their scopes of work.

Personnel are required to report all injuries, illnesses, spills, fires, and property damage to the SSC. The SSC must be notified of any on-site emergencies and is responsible for ensuring that the appropriate emergency procedures described in this section are followed.

B1.12.3 EMERGENCY RECOGNITION AND PREVENTION

Attachment B1-1 outlines potential on-site chemical hazards through an MSDS and project AHAs provide information on the hazards associated with the different tasks planned for the site. On-site personnel will be made familiar with this information and with techniques of hazard recognition through pre-work training and site-specific briefings.

B1.12.4 EVACUATION ROUTES AND PROCEDURES

In the event of an emergency that necessitates evacuation of a work task area or the site, the AIS/Tetra Tech SSC shall contact all nearby personnel using the on-site communications discussed in Section B1.10.1 to advise the personnel of the emergency. The personnel will proceed along site roads to a safe distance upwind from the hazard source. The personnel will remain in that area until the SSC or an authorized individual provides further instructions. Since this survey involves different sites, the evacuation safe meeting area will be located a safe distance upwind from the immediate source of hazard or contamination. The AIS/Tetra Tech SSC shall contact the USACE COR, Cynthia Burris (916) 557-6745 to inform her of the emergency and that personnel are leaving the site.

B1.12.5 EMERGENCY CONTACTS AND NOTIFICATIONS

The emergency information at the front of this SSHP provides names and telephone numbers of emergency contact personnel. **THIS PAGE MUST BE POSTED ON SITE OR MUST BE READILY AVAILABLE AT ALL TIMES**. In the event of a medical emergency, personnel will notify the appropriate emergency organization and will take direction from the AIS/Tetra Tech SSC. In the event of a fire, explosion, or spill at the site, the SSC will notify the appropriate local, state, and federal agencies. Once the SSC has notified appropriate emergency and/or local, state, and federal agencies and the situation has been controlled, the AIS/Tetra Tech SSC will then contact the USACE COR, Cynthia Burris (916) 557-6745 to inform her of the emergency.

B1.12.6 HOSPITAL ROUTE DIRECTIONS

Before performing any site activities, AIS/Tetra Tech personnel will conduct a pre-emergency hospital run to familiarize themselves with the route to the local hospital. A map showing the hospital route is provided in the emergency information at the front of this SSHP.

B1.12.7 EMERGENCY MEDICAL TREATMENT PROCEDURES

A person who becomes ill or injured during work tasks may require decontamination. If the illness or injury is minor, any decontamination necessary will be completed and first aid should be administered prior to patient transport. If the patient's condition is serious, partial decontamination will be completed (such as complete disrobing of the person and redressing in the person in clean coveralls or wrapping in a blanket). In the event of an emergency, personnel decontamination may be postponed but not bypassed. First aid should be administered until an ambulance or paramedics arrive. All injuries and illnesses must be reported immediately to the AIS/Tetra Tech TOM and HASM. As required by USACE Safety Manual, Publication Number EM 385-1-1 (USACE 2008), AIS/Tetra Tech will ensure that a minimum of two personnel (including subcontractors) on-site at all times have current certifications in First Aid, CPR, and bloodborne pathogen training as required by 29 CFR 1910.1030.

Any person transported to a clinic or hospital for chemical exposure treatment will be accompanied by information on the chemical he or she has been exposed to at the site, if possible. Attachment B1-1 contains this information.

B1.12.8 PROTECTIVE EQUIPMENT FAILURE

If any worker in the exclusion zone experiences a failure of protective equipment (either engineering controls or PPE) that affects his or her personal protection, the worker and all coworkers will immediately leave the exclusion zone. Re-entry to the exclusion zone will not be permitted until (1) the protective equipment has been repaired or replaced, (2) the cause of the equipment failure has been determined, and (3) the equipment failure is no longer considered to be a threat.

B1.12.9 FIRE OR EXPLOSION

In the event of a fire or explosion on-site, the local fire department will be immediately summoned. The AIS/Tetra Tech SSC or a site representative will advise the fire department of the location and nature of any hazardous materials involved. Appropriate personal protection requirements will be implemented by site personnel.

B1.12.10 WEATHER-RELATED EMERGENCIES

Site work shall not be conducted during severe weather conditions, including high-speed winds or lightning. In the event of severe weather, field personnel will stop work, secure and lower all equipment (for example, drilling masts), and leave the site.

Thermal stress caused by excessive heat or cold may occur as a result of extreme temperatures, workload, or the PPE used. Heat and cold stress treatment will be administered as described in Table B1-3.

B1.12.11 EMERGENCY EQUIPMENT AND FACILITIES

The following emergency equipment will be available on site:

- First aid kit
- Fire extinguisher
- Eye wash (portable) (ANSI-Z358.1-2004 compliant)
- Mobile telephone

B1.12.12 REPORTING

All emergency situations require follow-up and reporting. An employee involved in an incident shall immediately report the incident to the local AIS/Tetra Tech Office Health and Safety Representative, Regional Safety Officer, or HASM via phone. The AIS/Tetra Tech Incident Report (Form IR) must be completed by the AIS/Tetra Tech TOM and submitted to the AIS/Tetra Tech HASM within 24 hours of an emergency situation. The report must include proposed actions to prevent similar incidents from occurring. The HASM must be fully informed of the corrective action process so that she may implement applicable elements of the process at other sites.

B1.13.0 REFERENCES

California Herps: Reptiles and Amphibians Online Address: http://www.californiaherps.com/snakes/snakesmaps.html

AIS/Tetra Tech. 2010. Draft Work Plan for Supplemental Site Investigation at Former NAS Moffett Field, California. September.

National Institute for Occupational Safety and Health. 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

Tetra Tech, Inc. 1999. "Health and Safety Manual."

U.S. Army Corps of Engineers (USACE). 2008. Engineer Manual (EM) 385-1-1, Safety and Health Requirements Manual. Available Online at http://usace.army.mil/CESO/Documents/EM385-1-1FINAL.pdf

AIS/TETRA TECH ACTIVITY HAZARD ANALYSIS

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	1 Mobilization and Demobilization		
Competent Persons:	Dayna Yocum, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code): **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

1 *MOBILIZATION AND DEMOBILIZATION*

This AHA applies to mobilization and demobilization. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Drive to/from job site	VEHICLE ACCIDENT	• Ensure driver is "authorized" per the Tetra Tech Vehicle Safety Program • Practice defensive driving whenever traveling in a vehicle • Do not use cell phones while driving unless a hands-free device is used	**L (4)**
Set up field base/support zone	TRAFFIC HAZARD	• Wear high-visibility safety vests when in traffic areas or areas with heavy equipment • Set up field base in non-traffic areas if possible • Watch for oncoming traffic, using a spotter if traffic is heavy	**L (4)**
	BACK STRAIN/SPRAIN	• Practice proper lifting techniques (lift with the legs) • Wear leather gloves, if needed, when handling field base components • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Set up necessary work zones	EMPLOYEE EXPOSURE	• Plan and demarcate zones appropriate for the site and the type of work/contaminants on-site • If specified in the site-specific APP/SSHP, use caution tape, cones, or other barriers to differentiate work zones	**L (4)**
Fill out necessary paperwork	STRESS AND MISTAKES	• Before conducting work, ensure all proper paperwork and access issues have been dealt with accordingly	**L (4)**

1 MOBILIZATION AND DEMOBILIZATION		
This AHA applies to mobilization and demobilization. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.		
Equipment to be Used • Hands-free device for cell phone • Leather gloves if needed during site set-up • Hand truck or other lifting aid • Reflective safety vest when around vehicle traffic	**Inspection Requirements** • Inspection of vehicles to ensure road worthiness	**Training Requirements** • Tetra Tech Vehicle Safety Program • Safe Lifting Procedures • Valid state driver's license

Approved By/Date: _____/_____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	2 Utility Clearance Oversight		
Competent Persons:	Dayna Yocum, O. Kelly Murphy, Rebecca Johnson		

Overall Risk Assessment Code (RAC) (Use highest code **M (3)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

2 *UTILITY CLEARANCE OVERSIGHT*

This AHA applies to the oversight of the clearing of utilities before drilling and soil sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Clear and mark utilities at each intrusive area	MARK INCORRECT UTILITY LOCATION	• Obtain and review all pertinent utility drawings • Contact Underground Surface Alert for utility clearance • Obtain all intrusive permits and make required contacts • Inspect locating equipment for calibration and proper working order • Use industry standard color code for utilities marking &/or flagging	**L (4)**
	VEHICULAR TRAFFIC MAY PUT WORKERS IN PERIL	• Workers shall wear clearly visible safety vests • Safety cones shall be used to alert oncoming traffic • Spotters shall be used if traffic is nearby	**L (4)**
	UTILITY MARKING PAINTS MAY EXPOSE WORKERS TO HARMFUL SOLVENTS	• The manufacturer's use and safety instructions shall be followed • Ensure the area is well ventilated • Follow material safety data sheet for the paint being used • Never point spray nozzles at people • Always use down spray nozzle spray cans	**M (3)**
Investigation of utility routes, size, type, etc.	ASPHYXIATION	• Never enter or open space which is a permit-required space or otherwise labeled area • Obtain proper permits and clearance requirements appropriate for entering	**L (4)**
	HEAVY LIFTING AND POTENTIAL FOR PINCHING OR CRUSHING BODY PARTS	• Wear gloves and steel toed shoes • Use proper lifting techniques when lifting heavy items • Use crowbar to assist in lifting heavy parts	**L (4)**
	BIOLOGICAL HAZARDS, SUCH AS INSECTS OR SPIDERS	• Wear proper personal protective equipment, including gloves • Visually inspect all vaults and dark places for insects or spiders • Use flashlight in dark areas	**L (4)**

2 UTILITY CLEARANCE OVERSIGHT		
This AHA applies to the oversight of the clearing of utilities before drilling and soil sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.		
Equipment to be Used • Personal protection equipment – Hard hat – Long pants and shirts with sleeves – Safety vest • Safety cones • Flashlight	**Inspection Requirements** • Driver Vehicle Inspection Report	**Training Requirements** • 40 Hour Hazardous Waste Operations and Emergency Response

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	3 Groundwater Sampling		
Competent Persons:	Dayna Yocum, Rebecca Johnson		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

3 *GROUNDWATER SAMPLING AND GROUNDWATER ELEVATION MEASUREMENT*

This AHA applies to the collection of groundwater samples. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Set up sampling equipment	SLIPS, TRIPS, AND FALLS	• Visually inspect both sampling area and path to drill area for obstructions • Ensure all debris has been removed	**L (4)**
	BACK SPRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Measure depth to water	VAPORS INHALATION	• Use PID to monitor borehole opening and breathing zone	**L (4)**
	SPLASH BACK FROM WATER	• Wear Nitrile gloves and safety glasses	**L (4)**
Measure and insert tubing into well	SLICE OR STAB WOUNDS FROM CUTTING TUBING	• Steady EnCore sampler and apply firm pressure to T-handle when collecting soil sample from drill cuttings. • Wear Nitrile gloves and safety glasses	**L (4)**
Hook-up pump and start extracting water	VAPORS INHALATION	• Use PID to monitor borehole opening and breathing zone	**L (4)**
	SPLASH BACK FROM WATER	• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
Fill sample jars or containers with groundwater	SPLASH BACK FROM WATER	• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
	BROKEN GLASS WOUNDS FROM VIALS OR BOTTLES	• Dispose of all broken shards immediately	**L (4)**

3	GROUNDWATER SAMPLING AND GROUNDWATER ELEVATION MEASUREMENT		
This AHA applies to the collection of groundwater samples. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training			
PRINCIPLE STEPS	**POTENTIAL HAZARDS**	**PREVENTATIVE ACTIONS**	**RAC**
Store samples in coolers and load coolers into vehicle	SLIPS, TRIPS, AND FALLS	• Ensure all debris has been removed	**L (4)**
	BACK STRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Close lid on drum or container and lock	IMPROPERLY CLOSED CONTAINERS	• Ensure container is closed by visual and hand inspection	**L (4)**
Equipment to be Used • Personal protection equipment – Steel toed boots – Nitrile gloves – Safety glasses • Safety/utility knife • Wrench suited for sealing drum • PID	**Inspection Requirements** • None	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour Construction Training (SSC only)	

Approved By/Date: _____/
AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	4 Direct Push Technology Drilling Oversight		
Competent Persons:	Dayna Yocum, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code **M (3)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

4 *CONE PENETROMETER TECHNOLOGY, DIRECT PUSH TECHNOLOGY, AND HOLLOW STEM AUGER DRILLING OVERSIGHT*

This AHA applies to the oversight of Cone Penetrometer Technology (CPT), Direct Push Technology (DPT), and Hollow Stem Auger (HSA) drilling operations, which will be conducted by subcontractors. CPT and DPT drilling will be conducted to determine soil lithology and collect soil and groundwater samples. HSA drilling will be conducted to install monitoring wells. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Identify requirements prior to beginning of work	LOSS OF LIVES, HEALTH, AND PROPERTY	• Obtain and review all pertinent utility drawings, included site layout plan (*included in Attachment B1-2 of the Accident and Prevention Plan*) • Ensure that utility clearances have been conducted by independent utility clearance subcontractor • Obtain all intrusive permits and make required contacts • Inspect equipment per proper equipment checklist. Inspection shall be performed by a competent person. • Machinery and Mechanized Equipment Certification Form shall be completed and certified	**M (3)**
	LACK OF TRACTOR / TRAILER INSPECTIONS, CITATIONS, TICKETS	• Ensure driver has current license and training certificates or an affidavit from the company indicating such certifications	**L (4)**
Moving equipment into place between ground intrusion points	POTENTIAL FOR INJURY:	• Ensure driver is trained and current in certification. Ensure equipment is inspected as required by EM 385-1-1, 16A.2. and Cal-OSHA regulations. Operation Rules must be posted and followed (required by Cal-OSHA regulations). • Ensure equipment is operated properly; refer to the operator's manual, which must be onsite	**M (3)**
	EQUIPMENT COULD HIT SOMEONE OR SOMETHING	• Use spotters when positioning equipment. Ensure spotters know how to communicate with operator.	**M (3)**
	MOVING EQUIPMENT / CRUSHING DAMAGE	• Travel at slow speeds when people are walking near equipment • Wear safety vests when around moving equipment • Maintain a safe distance from moving equipment	**M (3)**
Set up of rig	ACCIDENTS RESULTING IN DEATHS, INJURIES, AND PROPERTY DAMAGE	• Don't restrict fire lanes or traffic lanes without approval • Don't set up equipment that would impede or block access to emergency equipment or devices, such as fire hydrants, valves, etc • Don't place heavy equipment over manholes, vaults, valve boxes, and similar underground structures	**L (4)**

4	CONE PENETROMETER TECHNOLOGY, DIRECT PUSH TECHNOLOGY, AND HOLLOW STEM AUGER DRILLING OVERSIGHT		
This AHA applies to the oversight of Cone Penetrometer Technology (CPT), Direct Push Technology (DPT), and Hollow Stem Auger (HSA) drilling operations, which will be conducted by subcontractors. CPT and DPT drilling will be conducted to determine soil lithology and collect soil and groundwater samples. HSA drilling will be conducted to install monitoring wells. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.			
PRINCIPLE STEPS	**POTENTIAL HAZARDS**	**PREVENTATIVE ACTIONS**	**RAC**
Towering up	LOSS OF LIVES, HEALTH, AND PROPERTY	• Ensure that utility clearances have been conducted by independent utility clearance subcontractor	**L (4)**
	PINCH POINTS / CRUSHING DAMAGE	• Use caution around moving equipment • Wear leather work gloves	**M (3)**
	POWER LINES / ELECTROCUTION	• Survey shall be conducted to identify overhead electrical hazards and potential ground hazards, such as underground utilities • Look up for clearance before towering up • Remain 100 feet from power lines	**L (4)**
	TREES / FALLING BRANCHES	• Keep out from under trees where possible • Trim tree branches when necessary • Wear hard hats and steel toed boots	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LOSS OF HEARING	• Wear adequate hearing protection (ear muffs [preferred] or ear plugs) • Consider rule of thumb for implementing ear protection; if you cannot talk to someone one arm's length away without raising your voice, you should wear ear protection.	**L (4)**
	UNDERGROUND UTILITIES / GAS LEAK-ELECTROCUTION-DAMAGE	• Hand auger to avoid breaking utility lines	**L (4)**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with knees and in pairs • Wear hard hats and steel toed boots • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person	**M (3)**
Soil boring and Hydro-punch	POTENTIAL FOR INJURY	• Drilling equipment shall be operated only by qualified (by training and experience) personnel who are authorized. • Drilling equipment shall be operated, inspected, and maintained as specified in the manufacturer's operating manual.	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LOSS OF HEARING	• Wear adequate hearing protection (ear muffs [preferred] or ear plugs) • Consider rule of thumb for implementing ear protection; if you cannot talk to someone one arm's length away without raising your voice, you should wear ear protection.	**L (4)**
	VAPORS INHALATION	• Use PID or FID to monitor borehole opening, core, and breathing zone	**L (4)**
	UNDERGROUND UTILITIES / GAS LEAK-ELECTROCUTION DAMAGE	• Ensure that utility clearances have been conducted by independent utility clearance subcontractor l • Proceed drilling with caution • Look for markings and flags of utilities on pavement and grass	**M (3)**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots	**M (3)**

4 *CONE PENETROMETER TECHNOLOGY, DIRECT PUSH TECHNOLOGY, AND HOLLOW STEM AUGER DRILLING OVERSIGHT*

This AHA applies to the oversight of Cone Penetrometer Technology (CPT), Direct Push Technology (DPT), and Hollow Stem Auger (HSA) drilling operations, which will be conducted by subcontractors. CPT and DPT drilling will be conducted to determine soil lithology and collect soil and groundwater samples. HSA drilling will be conducted to install monitoring wells. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Removal and cleaning of rod sections	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**M (3)**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Backfilling of borehole	GROUT MIX / INHALATION	• Remain upwind when mixing grout	**L (4)**
	SPLASHING GROUT / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LIFTING GROUT BAGS / CRUSHING AND BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**

Equipment to be Used

- Personal protection equipment
  - Steel toe boots
  - Hard hat
  - Safety vest
  - Safety glasses
  - Nitrile gloves/leather work gloves
- CPT, DPT, or HSA drill rig
- PID

Inspection Requirements

- Safety inspection checklist for construction equipment
- Additional requirements may be provided by the subcontractor

Training Requirements

- 40-Hour Hazardous Waste Operations and Emergency Response
- 8-Hour Refresher
- 30-Hour Construction Training (SSC only)

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/72010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	5 Soil Sampling		
Competent Persons:	Dayna Yocum, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

5 *SOIL SAMPLING*

This AHA applies to the collection of soil samples. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Set up sampling equipment	INJURY FROM DRILL RIG MOVING PARTS	• Set up away from drill rig • Stay clear of all moving parts of drill rig • Remove or bind all loose clothing • Wear proper PPE: Steel-toe boots, hard hat, safety glasses and Nitrile gloves	**L (4)**
	SLIPS, TRIPS, AND FALLS	• Visually inspect both sampling area and path to drill area for obstructions • Ensure all debris has been removed	**L (4)**
	BACK SPRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Sample collection and analysis	VAPORS INHALATION	• Use PID to monitor borehole opening and breathing zone	**L (4)**
	SLICE WOUNDS FROM CUTTING CORE TUBES	• Use a safe blade saw and sample-core splitter • Saw down onto firm surface • Have one person hold core firmly while second person saws	**L (4)**
	DEBRIS IN EYES	• Wear Nitrile gloves and safety glasses	**L (4)**
Collect soil sample via EnCore sampling apparatus	PINCH FINGERS	• Steady EnCore sampler and apply firm pressure to T-handle when collecting soil sample from drill cuttings. • Wear Nitrile gloves and safety glasses	**L (4)**
Clean work area between core arrivals	SLIPS, TRIPS, AND FALLS	• Dispose of all broken plastic shards • Keep footing area free of field equipment that might trip someone	**L (4)**
		• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**

5 *SOIL SAMPLING*

This AHA applies to the collection of soil samples. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Fill sample jars or containers with soil	BROKEN GLASS WOUNDS FROM VIALS OR BOTTLES	• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
		• Dispose of all broken shards immediately	**L (4)**
Store samples in coolers and load coolers into vehicle	SLIPS, TRIPS, AND FALLS	• Ensure all debris has been removed	**L (4)**
	BACK STRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Close lid on drum or container and lock	IMPROPERLY CLOSED CONTAINERS	• Ensure container is closed by visual and hand inspection	**L (4)**

Equipment to be Used

- Personal protection equipment
  - Steel toed boots
  - Nitrile gloves
  - Safety glasses
- Safety/utility knife
- Wrench suited for sealing drum
- PID

Inspection Requirements

- None

Training Requirements

- 40-Hour Hazardous Waste Operations and Emergency Response
- 8-Hour Refresher
- 30-Hour Construction Training (SSC only)

Approved By/Date: _____/

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	6 Groundwater Monitoring Well Installation Oversight		
Competent Persons:	Dayna Yocum, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code **M (3)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

6 *GROUNDWATER MONITORING WELL INSTALLATION OVERSIGHT*

This AHA applies to groundwater monitoring well installation oversight operations, which will be conducted by subcontractors. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Oversight of the set up of the installation area	INJURY FROM DRILL RIG MOVING PARTS	• Set up away from drill rig • Stay clear of all moving parts of drill rig • Place a drilling cage around all exposed rotating equipment (including augers) • Remove or bind all loose clothing • Wear proper PPE: Steel-toe boots, hard hat, safety glasses and Nitrile gloves	**M (3)**
	SLIPS, TRIPS, AND FALLS	• Visually inspect both sampling area and path to drill area for obstructions • Ensure all debris has been removed	**L (4)**
Oversight of the Assembling of the well casing and lowering into existing hole	PINCH POINTS/CRUSHING DAMAGE	• Wear leather work gloves • Remain alert while assembling casing • Remain upwind when pouring sand and bentonite • Lift with the knees and with assistance if needed	**M (3)**
Oversight of the pouring of sand and bentonite chips for pack and seal	BENTONITE OR DUST/INHALATION	• Remain upwind when pouring sand and bentonite	**L (4)**
Oversight of the grout overseal	LIFTING GROUT BAGS/ CRUSHING AND BACK STRAIN	• Lift with the knees and with assistance if needed	**M (3)**
	GROUT MIX/INHALATION	• Remain upwind when mixing grout	**L (4)**
	SPLASHING GROUT/EYE DAMAGE	• Wear Safety glasses	**L (4)**
	LIFTING GROUT BAGS/ CRUSHING AND BACK STRAIN	• Lift with knees and with assistance if needed and wear steel toed boots	**M (3)**

6 *GROUNDWATER MONITORING WELL INSTALLATION OVERSIGHT*

This AHA applies to groundwater monitoring well installation oversight operations, which will be conducted by subcontractors. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Oversight of the installing the monument or vault and cap well	PINCH POINTS/CRUSHING DAMAGE	• Remain alert while installing monument or vault –wear leather gloves	**M (3)**
	LIFTING MONUMENT OR VAULT/ CRUSHING AND BACK STRAIN	• Lift with knees and use proper lifting technique—weather leather gloves and steel-toe boots	**M (3)**
Decontaminate equipment using potable water and alconox solution	FAILURE TO CONTAIN WATER COULD CAUSE EXPOSURE TO THE ENVIRONMENT	• Use PID or FID to monitor borehole opening, core, and breathing zone	**L (4)**
	WATER SPRAY INTO EYE/ CONCENTRATED SOAP MY BE IRRITATING TO THE SKIN	• Wear Nitrile gloves and safety glasses • Follow manufacturers use instructions	**L4**
	SPILLS AND SPLASHES	• Wear safety glasses and use a splash guard if necessary	**L4**
Demobilization	VEHICULAR ACCIDENT	• Ensure driver is "authorized" per the Tetra Tech Vehicle Safety Program • Practice defensive driving whenever traveling in a vehicle • Do not use cell phones while driving unless a hands-free device is used also • Valid state issued driver's license	**L (4)**

Equipment to be Used

- Personal protection equipment
  - Steel toe boots
  - Hard hat
  - Safety vest
  - Safety glasses
  - Nitrile gloves/leather work gloves
- Utility Knife
- Tape Measure
- PID

Inspection Requirements

- Safety inspection checklist for construction equipment
- Additional requirements may be provided by the subcontractor

Training Requirements

- 40-Hour Hazardous Waste Operations and Emergency Response
- 8-Hour Refresher
- 30-Hour Construction Training (SSC only)

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/72010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	7 Groundwater Monitoring Well Development Oversight		
Competent Persons:	Dayna Yocum, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code **M (3)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

7 *GROUNDWATER MONITORING WELL DEVELOPMENT OVERSIGHT*

This AHA applies to groundwater monitoring well development oversight operations, which will be conducted by subcontractor or manually by Tetra Tech staff. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Oversight of the set up of the well development area	INJURY FROM WELL DEVELOPMENT RIG MOVING PARTS	• Set up away from well development rig • Stay clear of all moving parts of well development rig • Remove or bind all loose clothing • Wear proper PPE: Steel-toe boots, hard hat, safety glasses and Nitrile gloves	**M (3)**
	SLIPS, TRIPS, AND FALLS	• Visually inspect both sampling area and path to drill area for obstructions • Ensure all debris has been removed	**L (4)**
Oversight of handling of the surge block	LIFTING SURGE BLOCK/PINCH POINTS AND BACK STRAIN VAPORS INHALATION WATER IN EYES	• Wear leather work gloves & steel-toe boots • Remain upwind when well cap is removed and monitor potential vapors with PID or FID • Lift with the knees and with assistance if needed • Wear safety glasses and Nitrile gloves	**L4**
Manual surging of well	SPLASH BACK FROM WATER	• Wear safety glasses and Nitrile gloves	**L (4)**
	LIFTING SURGE BLOCK/BAILER IN WELL CASING/PINCH POINTS AND BACK STRAIN	• Lift with the knees and with assistance if needed • Remain upwind when surging/bailing is being conducted	**M (3)**
Manual bailing of groundwater	SPLASH BACK FROM WATER	• Wear safety glasses and Nitrile gloves	**L (4)**
	LIFTING SURGE BLOCK/BAILER IN WELL CASING/PINCH POINTS AND BACK STRAIN	• Lift with the knees and with assistance if needed • Remain upwind when bailing is being conducted • Wear steel toe boots and leather work gloves over Nitrile gloves	**M (3)**

7 GROUNDWATER MONITORING WELL DEVELOPMENT OVERSIGHT

This AHA applies to groundwater monitoring well development oversight operations, which will be conducted by subcontractor or manually by Tetra Tech staff. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Decontaminate equipment using potable water and alconox solution	FAILURE TO CONTAIN WATER COULD CAUSE EXPOSURE TO THE ENVIRONMENT	• Contain all water and collect into 55-gallon drums as required by the SAP	**L (4)**
	WATER SPRAY INTO EYE/ CONCENTRATED SOAP MY BE IRRITATING TO THE SKIN	• Wear Nitrile gloves and safety glasses • Follow manufacturers use instructions	**L (4)**
	SPILLS AND SPLASHES	• Wear safety glasses, use a splash guard if necessary	**L (4)**
Demobilization	VEHICULAR ACCIDENT	• Ensure driver is "authorized" per the Tetra Tech Vehicle Safety Program • Practice defensive driving whenever traveling in a vehicle • Do not use cell phones while driving unless a hands-free device is used also • Valid state issued driver's license	**L (4)**

Equipment to be Used

- Personal protection equipment
  - Steel toe boots
  - Hard hat
  - Safety vest
  - Safety glasses
  - Nitrile gloves/leather work gloves
- Well Development Rig
- Surge Block/Bailer
- Containers for bailed groundwater (manual well development)
- PID or FID

Inspection Requirements

- Safety inspection checklist for construction equipment
- Additional requirements may be provided by the subcontractor

Training Requirements

- 40-Hour Hazardous Waste Operations and Emergency Response
- 8-Hour Refresher
- 30-Hour Construction Training (SSC only)

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/7/2010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	8 Investigation-Derived Waste Management		
Competent Persons:	Dayna Yocum, Rebecca Johnson		

Overall Risk Assessment Code (RAC)
(Use highest code)
L (4)

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

8 *INVESTIGATION-DERIVED WASTE MANAGEMENT*

This AHA applies to the handling of IDW and management of IDW. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

The following information was derived from the Safe Work Practices "Drum and Container Handling Practices". Please refer to SWP 6-11 for more information, found in Attachment B1-2 of the Site Safety and Health Plan (SSHP).

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Ensure all lids are secured on all waste receptacles before sending to IDW area	SPILLS FROM UNSECURED LIDS	• Ensure lids are completely closed by visual and hand inspection	**L (4)**
Lift IDW receptacles into truck or vehicle that will transport it to the IDW area.	EQUIPMENT SAFETY	• Maintain a safe distance from moving equipment • Use hand trucks and other lifting aids	**L (4)**
Place IDW receptacles in secured area in vehicle.	IDW RECEPTACLES MAY SLIDE DURING TRANSPORT	• Ensure receptacles are placed in flat, secured area of vehicle • Use rope or bungee cords	**L (4)**
Drive slowly and cautiously to IDW area.	IDW MAY SPILL WHILE DRIVING	• Drive with caution and always within posted speed limits or slower	**L (4)**
Survey IDW containers (55 gallon steel drums)	PLACING IDW INTO THE IMPROPER DRUM	• Read all labels thoroughly • Ensure the drum being used is the correct one • Inform field team leader if improper drum was used	**L (4)**
Opening the drum	USING SPARKING TOOLS MAY IGNITE VAPORS CAUSING A FIRE	• Combustible compounds are not anticipated in this field event • Only open containers that are confirmed for this field activity • Use only non-sparking tools	**L (4)**
	DRUMS CONTAINING UNKNOWN MATERIAL OR EXHIBIT PRESSURE BUILDUP	• Do not open drums containing unknown material or exhibit pressure buildup • Only open containers that are confirmed for this field activity	**L (4)**

8 *INVESTIGATION-DERIVED WASTE MANAGEMENT*

This AHA applies to the handling of IDW and management of IDW. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

The following information was derived from the Safe Work Practices "Drum and Container Handling Practices". Please refer to SWP 6-11 for more information, found in Attachment B1-2 of the Site Safety and Health Plan (SSHP).

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Empty IDW receptacles into the appropriate 55-gallon drum	SPLASHING MAY CAUSE EXPOSURE AND CONTAMINATION	• Wear proper PPE: gloves and eye protection • Pour liquid IDW slowly to avoid splashing	**L (4)**
	BACK SPRAINS MAY OCCUR FROM IMPROPER LIFTING	• Lift with knees and use proper lifting techniques • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Close lid on drum or container and lock	IMPROPERLY CLOSED CONTAINERS	• Ensure container is closed by visual and hand inspection	**L (4)**
	IMPROPER USE OF DRUM SEALERS AND WRENCH	• Provide proper tools and training in opening and sealing steel drums	**L (4)**
Equipment to be Used • Personal protection equipment – Steel toed boots – Safety vest – Nitrile gloves – Safety glasses • Wrench suited for sealing drums	**Inspection Requirements** • None	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • Proper opening and closing of 55-gallon drums	

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

ACTIVITY HAZARD ANALYSIS

Date:	9/72010	**Project:**	OPHA
Prepared By:	Dave Brown	**Project Location:**	Former NAS Moffett Field
Activity:	9 Decontamination Procedures		
Competent Persons:	Dayna Yocum, Rebecca Johnson, O. Kelly Murphy		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

9 *DECONTAMINATION PROCEDURES*

This AHA applies to the decontamination of sampling equipment. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

Upon decontaminating field tools used for sampling, a three-tiered wash station should be prepared. This station typically includes three buckets, each dedicated to its specific role. Bucket one shall be used for a pre-wash with water. Bucket two shall contain a soap/Alcohol wash for scrubbing field tools with a brush. Bucket three shall contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use Nitrile gloves when handling field tools during decontamination.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Mixing soap solution	CONCENTRATED SOAP MY BE IRRITATING TO THE SKIN	• Wear Nitrile gloves • Follow manufacturers' use instructions	**L (4)**
Set up the three-tiered wash station, using buckets or a container large enough so water does not spill out during the washing of the field tools.	SPILLS AND SPLASHES	• Wear Nitrile gloves • Use splash guard if necessary • Wear eye protection	**L (4)**
Using gloves take each field tool out and begin with the first tier of the wash station, prewash. Place the tool inside the prewash water and ensure large particles and/or dirt are generally removed.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
After prewash, place field tool into soapy/Alconox wash container. Use brush to clean field tool if necessary.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
After soapy wash, place field tool in final rinse container. May use spray bottle to spray the field tool. If using spray bottle, aim inside final rinse container.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
Replace lid on wash containers and return to transporting vehicles.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
	BUCKETS ARE HEAVY AND MAY POSE LIFTING INJURIES	• Use proper lifting techniques (lift with legs) • Get help with heavy or awkwardly-shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids when possible	**L (4)**

9 *DECONTAMINATION PROCEDURES*

This AHA applies to the decontamination of sampling equipment. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

Upon decontaminating field tools used for sampling, a three-tiered wash station should be prepared. This station typically includes three buckets, each dedicated to its specific role. Bucket one shall be used for a pre-wash with water. Bucket two shall contain a soap/Alcohol wash for scrubbing field tools with a brush. Bucket three shall contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use Nitrile gloves when handling field tools during decontamination.

PRINCIPLE STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Equipment to be Used • Personal protection equipment – Steel toed boots – Nitrile gloves – Safety glasses • Buckets with lids • Scrubber • Spray bottles	**Inspection Requirements** • None	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour Construction Training (SSC only)	

Approved By/Date: _____ / _____

AIS/Tetra Tech Health and Safety Representative

RSI Drilling Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☐ New ☒ Revised	Date: 7-17-09
RSI Drilling Client: General Loc: Various		
Work Type: Environmental	Work Activity: **Site Walk and Set-Up**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Manager	Vice-President		
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Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1. Site Walk and Set-up	Vehicle traffic (These hazards will be present in all phases of the job and all precautions will apply for the entire job.)	• Wear proper PPE to include hard hat, safety glasses, traffic vest, steel toed shoes at all times while on site • Make sure the primary contractor has notified the station attendant • Wear gloves and hearing protection when necessary • Conduct tailgate safety meeting and review this AHA • Confirm that vehicle pre-trip inspections (DVIR's) have been conducted. If they have not, conduct the inspection and note any deficiencies. • Watch for vehicles when out of the exclusion zone • Set up exclusion using snow fence or delineator posts, cones & caution tape. • Set up large enough exclusion zone for the type of work being done
	Slips, Trips & Falls	• Survey area for uneven surfaces and other tripping hazards • Remove all trip hazards by keeping materials/objects organized and out of walkways • Keep work surfaces dry when possible • Lay sand, plywood or other rough work surface where possible • Stay aware of footing and do not run • Store drum lids and rings in a safe manner that will not create a tripping hazard
	Underground utilities	• If available, review utility maps and as-builts • Visual survey for trenches and cuts in asphalt, electrical boxes, water and gas meter locations, and manhole covers • Manhole covers – Open to investigate size, depth, and direction (watch finger placement) • Check utility ground markings(USA, Dig Alert) If not there, do not break ground!
	Struck by vehicles while opening manhole cover	• Set up exclusion zone using cones or delineator post and caution tape • Make sure you are wearing all PPE to include hard hat and high visibility vest
	Pinched fingers from lifting	• Wear work gloves • Use the proper tool such as a pry bar to lift manhole cover • Keep hands away from pinch points

	Back Injury	• Use proper tools and lifting techniques
	Overhead utilities and obstructions	• Check all overhead locations for cables, wires, canopies and any other overhead obstructions • Check with client if there is a protocols for drilling distance to canopy • Keep mast a **minimum** of 15 feet from overhead power lines (20 ft. if 230, 285 kv / 25 ft. if 345 kv / 35 ft if 500 kv) Check with utility company if in doubt • Do not move rig with must up • Use a spotter if any visual obstruction exist
	Interfering with Handicap Parking/ Access (ADA)	• Make sure client has made accommodations for Handicap Parking/Access • If possible, do not block Handicap Parking/ Access with drill rig, trucks, or work area
	Noise	• Wear hearing protection during use of drill rig
	• Fire/Explosions • Fuel spills	• As site conditions/activities warrant or if required by the property owner/operator, establish Hot Work Permit including air monitoring using direct-reading, real-time instruments such as LEL/O2 meter. (Primary contractor supplies fire permit, fire watch, PID, and LEL meter, and monitoring.) • Ensure type ABC, 20-lb, fully charged fire extinguisher is within 25' of rig • Post No Smoking signs around work area if not already posted • Establish designated smoking area off-site • Identify emergency shut-off switch on rig and at active locations • Stop all activities during any emergency or abnormal condition • Call 911, notify client, and CDI management if spill is over 1 gallon
	Insect bites, animals, snakes & vegetation	• Inspect work areas when arriving at site to identify bio-hazards • Use insect repellant as necessary • Stay alert and safe distance away from biological hazards • Wear appropriate PPE including leather gloves, long pants, and shirts with at least short sleeves. Snake chaps should be used only **if probability of encountering.**
	Truck Movement or Rollover	• Chock wheels • Do not move vehicle with mast up • Level rig with hydraulic jacks • Approach hills at a 90 degrees angle (right angle) • Where unstable soil exists, the soil should be assessed by a qualified professional engineer to ensure safe conditions with implementation of design control measures prior to start of work (If you don't know, don't go.)
Vehicle backing	Striking people or fixed objects	• Drill rigs and support trucks should be equipped with back up alarms or use horn while backing • Avoid backing if possible. Plan your departure on arrival. • Inspect area to be backed into – check low and high • Use a spotter – backing objective location, signal to be used, where the spotter will stand, and to agree on hand signals to be used before proceeding. • Spotter should stop the vehicle if anyone enters or approaches the backing area • Driver must STOP the vehicle if he looses site of the spotter • If no spotter is available - inspect area, vehicles larger than a pick-up truck must use cones, delineator post, or snow fencing to mark the area to be backed into
Equipment Set-up	Equipment breaking during set-up and/or operations & striking people	• Qualified Driller must inspect drill rig, cables, hydraulic hoses, controls, rod racks, slings, drive heads, pull heads and accessories. Do not use if faulty. • Use Daily Drill Rig Safety Inspection form. • Inspect emergency shut of switches and test. Do not use if faulty. • Inspect all tools and equipment to ensure good working order. • Drill rig safety inspection completed to include inspection of wire ropes and clips attached per manufacturer's specifications

RSI Drilling Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐Office ☐ Construction	☐ New ☒ Revised	Date: 7/23/09
RSI Drilling Client: General Loc: Various		
Work Type: Environmental	Work Activity: **Hand Augering/Hand Tools**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Director	Vice President			
David Boggs	Don Winglewich			
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E-mail: David@RSIdrilling.com	Don@RSIdrilling.com			

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1. Site Walk and Set-up	Vehicle traffic (These hazards will be present in all phases of the job and all precautions will apply for the entire job.)	• Follow all critical action established on the AHA for "**Site Walk and Set-up"** including wearing all PPE upon arrival
	Weather	Equipment/Tools not to be operated in severe inclement weather such a lightning storms, high winds, severe rain, or where visibility is reduce
	Fire	• No smoking in work area • Fire extinguishers on all heavy equipment/site vehicles
	Uneven surfaces	• Level truck using hydraulic jacks and jack pads if needed
2. Remove asphalt or concrete surface	Flying debris	• Communicate with co-workers and make sure nobody is in the way
	Sharp objects such as concrete reinforcement materials	• Be careful and wear gloves • Visual inspection
3. Hand clear soil borings	Hand Augering	• Location of underground utilities and installations identified. • Make sure work area is clear • Keep auger sharp – a dull auger requires more work to advance through soil • Avoid excessive twisting or wrenching motions when using auger. • Check threads and look for cracks at all connections
	Back strain	• Use proper lifting techniques – stand close to object, bend knees, position one foot to the side of the object if possible, lift head to straighten and arch your back.

		• Stretch before lifting • Get assistance with heavy (>50 lbs.) or awkward objects • Use appropriate tools such as hand trucks, booms, lift trucks, etc.
	High Noise levels	• Hearing protection must be worn (plugs or muffs or both)
	Underground Utilities	Make sure the location of underground utilities and installations are identified. • Stop and re-evaluate if obstruction is encountered.
	Chemical or Hydrocarbon exposure	• Wear nitrile rubber gloves if there is a skin exposure potential • Upgrade to OSHA Level C if necessary (organic vapor respirator) • Steam clean augers between boreholes • Wash hands before you eat or drink
	Cuts from sharp sampling tools	• Wear heavy work gloves
	Wire rope clips releasing	• Drill rig safety inspection completed to include inspection of wire ropes and clips attached per manufacturer's specifications
	Tools or equipment falling off of stowage	• Proper PPE to include hard hat, steel toed shoes, and safety glasses • Do not stow tools or equipment in unsecured locations • Stow hack saw and other tools on hooks
4. Backfill & resurface	Creating a tripping hazard by Inadequate sealing of hole	• Make sure exclusion zone is still secure Pour granular bentonite and hydrate • When mixing grout, mix to specification and completely fill the hole
	Cement dust exposure	• Avoid skin contact with cement. If skin contact is made, wash it off asap • Avoid breathing cement dust – position yourself upwind or use mechanical ventilation or if you choose, a paper dust mask can be worn. • Wear proper PPE to include work gloves, safety glasses, and other PPE as required
	Moving parts	• Keep hands clear of moving parts
	Back Strain from removing Whirlybird mixer	• Do not lift and twist at the same time. Lift the mixer all the way out. Point your toes in the direction you are turning. • If you are not tall enough to lift it all the way out before twisting, use the buddy system.
5. Decon tooling	High pressure water or steam	• Follow all Critical Actions as Described on the **AHA for Decontamination Operations** • **Keep two hands on wand during operation**
	Pinch points	• Secure rod in decon unit • Be aware of hand placement. Avoid pinch points • Be aware of all moving parts
6.Site cleanup	Back strain	• Continue to use correct lifting techniques • Use the buddy system for awkward or heavy objects over 50 lbs.
	Slips, trips & falls	• Make careful visual sweep of site • Check for tools, debris, or dirt left on-site • Watch your step
7. Preparation for return to office	Materials falling off truck	• Perform a pre-trip walk around to make sure everything is secure • Make sure all safety pins and other securing devices are in place • Put all tools away where they will not fall off of truck **See AHA for Drill Rig Demobilization**

RSI Drilling Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☐ New ☒ Revised	Date: **7/17/09**
Client: General Loc: Various		
Work Type: Environmental	Work Activity: **Drilling Rig Mobilization**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Officer	Vice President			Date
David Boggs	Don Winglewich			
Ph: 407-394-7837	Ph: 415-235-6951			
david@RSIdrilling.com	Don@RSIdrilling.com			

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1.Material Loading	Back strain	• Continue to use correct lifting techniques • Use the buddy system for awkward or heavy objects over 50 lbs.
	Slips, trips & falls	• Make careful visual sweep of site • Check for tools, debris, or dirt left on-site • Watch your step
2. Prepare rig and trailer to mobilize	Equipment falling off rig and/or trailer and creating road hazards	• Down-hole hammer must be stowed on deck, not in the spindle. • Secure all samplers, bolt bucket, air gun & hoses, hammers & wrenches, and hoist plug in side tool boxes • Secure spindle extensions with bungee cords on deck • Check conditions of straps to make sure they are in good condition • Secure misc. tools or any other equipment in side boxes • Check ground under and around truck for trash, tools, and equipment • Secure augers in auger racks, use safety pins on vertical bars if there is a pin hole for it • Perform walk around and check tires and lug nuts
3. Mobilize to Jobsite	Materials falling off truck	• Perform a pre-trip walk around to make sure everything is secure • Make sure all safety pins and other securing devices are in place
	Vehicle accident	• Check tail lights during walk around during pre-trip walk around • Drive safely and defensively using the Smith System • Maximum speed limit of 55 mph • Do not talk on cell phone while driving

RSI Drilling Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☐ New ☒ Revised	Date: 7/16/09
Client: General Loc: Various		
Work Type: Environmental	Work Activity: **Direct Push Operations**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the SSHASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Manager	Vice President			
David Boggs	Don Winglewich			
Ph: 407-394-7837	Ph: 415-235-6951			
E-mail: David@RSIdrilling.com	Don@RSIdrilling.com			

Personnel and Training

All onsite personnel from RSI Drilling with have the proper training required for safely and properly completing the proposed scope of work. All Staff members are 40-Hour Hazwoper trained with 8-Hour review certificates and medically cleared to perform field work. Additional trainings can be obtained or provided as necessary. Each field employee will have proper equipment and project training prior to beginning work. Project and experience and references can be provided upon request.

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1. Site Walk and Set-up	Vehicle traffic (These hazards will be present in all phases of the job and all precautions will apply for the entire job.)	• Follow all critical action established on the AHA for "**Site Walk and Set-up"** including wearing all PPE upon arrival
	Weather	Equipment not to be operated in severe inclement weather such as light storms, high winds, severe rain, or where visibility is reduced.
	Fire	• No smoking in work area • Fire extinguishers on all heavy equipment/site vehicles
2.Mast-up drill rig	Overhead obstructions/ Power lines	• Double check area for obstructions beforehand • Have a lookout watch while driller moves vehicle or raises mast • Do not move drill rig with mast raised • Keep mast a **minimum** of 15 feet from overhead power lines (20 ft. if 230, 285 kv / 25 ft. if 345 kv / 35 ft if 500 kv) Check with utility company if in doubt
	Uneven surfaces	• Level truck using hydraulic jacks and jack pads if needed
3. Remove asphalt or concrete surface	Flying debris Moving objects Generating Sparks	• Communicate with co-workers and make sure nobody is in the way • Wear full PPE as designated in SSHSP. • Be aware of surroundings and site variables prior to using any power equipment. • Set up proper exclusion zone prior to beginning work.
	Sharp objects such as concrete	• Be careful and wear gloves • Visual inspection

	reinforcement materials	
4. Hand clear soil to 5 ft if required by client	Back Strain Equipment Failure Damaging subsurface utilities Proper backfill or covering of borehole following clearing Properly containing cuttings	• Location of underground utilities and installations identified. • Make sure work area is clear • Keep auger sharp – a dull auger requires more work to advance through soil. Double check all threads and handles to ensure safe working order prior to starting work. • Avoid excessive twisting or wrenching motions when using auger. • Be aware of obstructions underground. Do no force hand tools through obstructions, verify with site manager prior to proceeding to prevent damaging potential utilities. • Properly backfill or cover all locations after clearing to prevent tripping and other hazards associated with open borings. • Properly contain all cuttings for borings as specified in SSHSP.
5. Equipment Checklist	Injuries caused by worn or faulty equipment.	• Check all kill switches. Review with client at the beginning of each working shit and again as requested by client throughout the day. • Check all switches and controls on rigs to verify proper working order • Check all threads on all pipes to ensure good working order. • Check all fluid levels on rig and other power equipment onsite. • Review locations of all fire extinguishers and first aid equipment in case of emergency • Review scope of work and verify all tools for the project are present and in good working order.
6. Push Rod, collect samples	Pinch points	• Be aware of hand placement. Avoid pinch points • Stay away from moving parts
	High Noise levels	• Hearing protection must be worn (plugs or muffs or both)
	Underground Utilities	• Location of underground utilities and installations identified.
	Chemical or Hydrocarbon exposure	• Wear nitrile rubber gloves if there is a skin exposure potential • Upgrade to OSHA Level C if necessary (organic vapor respirator) • Steam clean augers between boreholes • Wash hands before you eat or drink • Provide air monitoring equipment as needed. Coordinate air monitoring equipment with client and site safety manager prior to mobilizing to site.
	Cuts from sharp sampling tools	• Wear work gloves • Use correct tools for opening sleeves (Hooked safety blade) • When opening sleeves, cut away from body • Place soil core on sturdy surface prior to cutting
	Wire rope clips releasing	• Drill rig safety inspection completed to include inspection of wire ropes and clips attached per manufacturer's specifications
	Tools or equipment falling off of stowage	• Proper PPE to include hard hat, steel toed shoes, and safety glasses • Do not stow tools or equipment in unsecured locations • Stow hack saw and other tools on hooks
6.	Creating a tripping	• Pour granular bentonite and hydrate

Backfill & resurface	hazard by Inadequate sealing of hole	• When mixing grout, mix to specification and completely fill the hole
	Cement dust exposure	• Avoid skin contact with cement. If skin contact is made, wash it off asap • Avoid breathing cement dust – position yourself upwind or use mechanical ventilation or if you choose, a paper dust mask can be worn. • Wear proper PPE to include work gloves, safety glasses, and other PPE as required
	Moving parts	• Keep hands clear of moving parts
	Back Strain from removing Whirlybird mixer	• Do not lift and twist at the same time. Lift the mixer all the way out. Point your toes in the direction you are turning. • If you are not tall enough to lift it all the way out before twisting, use the buddy system.
7. Decon tooling	High pressure water or steam	• Follow all Critical Actions as Described on the **AHA for Decontamination Operations** • **Keep two hands on wand during operation**
	Pinch points	• Secure rod in decon unit • Be aware of hand placement. Avoid pinch points • Be aware of all moving parts
8.Site cleanup	Back strain	• Continue to use correct lifting techniques • Use the buddy system for awkward or heavy objects over 50 lbs.
	Slips, trips & falls	• Make careful visual sweep of site • Check for tools, debris, or dirt left on-site • Watch your step
9. Preparation for return to office	Materials falling off truck	• Perform a pre-trip walk around to make sure everything is secure • Make sure all safety pins and other securing devices are in place • Put all tools away where they will not fall off of truck **See AHA for Drill Rig Demobilization**

RSI Drilling

Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐Office ☐ Construction	☐ New ☒ Revised	Date**: 7-16-09**
RSI Drilling Client: General Loc: Various		
Work Type: Environmental	Work Activity**:** **Drilling Rig Demobilizations**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Manager	Vice-President			
David Boggs	Don Winglewich			
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Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1.Site cleanup	Back strain	• Continue to use correct lifting techniques • Use the buddy system for awkward or heavy objects over 50 lbs.
	Slips, trips & falls	• Make careful visual sweep of site • Check for tools, debris, or dirt left on-site • Watch your step
2. Prepare rig and trailer for return to shop	Equipment falling off rig and/or trailer and creating road hazards	• Down hole hammer must be stowed on deck, not in the spindle. • Secure all samplers, bolt bucket, air gun & hoses, hammers & wrenches, and hoist plug in side tool boxes • Secure spindle extensions with bungee cords on deck • Check conditions of bungee cords to make sure they are in good condition • Secure misc. tools or any other equipment in side boxes • Discard all trash from bed of rig • Check ground under and around truck for trash, tools, and equipment • Remove all spoils from jack pads by using your foot (not your hand) • Remove all spoils from rod holder and wiggle tail area of rig by hand • Secure augers in auger racks, use safety pins on vertical bars if there is a pin hole for it • Perform walk around and check tires and lug nuts, • Perform walk around and check all doors for bins, boxes, trucks, and trailers. Make sure all doors are closed properly and secured before moving the truck or rig.
3. Return to office	Materials falling off truck	• Perform a pre-trip walk around to make sure everything is secure • Make sure all safety pins and other securing devices are in place
	Vehicle accident	• Check tail lights during walk around during pre-trip walk around • Drive safely and defensively using the Smith System • Maximum speed limit of 55 mph • Do not talk on cell phone while driving

RSI Drilling

Activity Hazard Analysis

AHA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☐ New ☒ Revised	Date: 7-20-09
RSI Drilling Client: General Loc: Various		
Work Type: Environmental	Work Activity: **Decontamination Operation (Direct Push Rods)**	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, traffic vest, steel-toed boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HASP). Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Health and Safety Manager	Vice-President			
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Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

PROJECT MANAGER: HEALTH & SAFETY DIRECTOR:

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
		• **Perform SPSA before each step**
1. Decon set-up	Exposure to site traffic	• Set up exclusion zone to include decon unit(s) (55 gallon barrels) if possible. • If necessary set up separate exclusion zone for decon but consider traffic flow.
	Pedestrian traffic	• Position decon unit(s)(55 gallon barrels) close to drill rig inside exclusion zone (if possible) • If unable to include in drill rig exclusion zone, set up large enough separate decon unit exclusion zone
	Decon unit shifting while disconnecting from drill rig	• Chock tires to prevent unit from moving
	Moving decon unit	• Never use forklift to move decon unless you have a proper hitch attachment
2. Decon operations	Noise up to 100 dB	• Hearing Protection must be worn
	High pressure water or steam (cuts and water injection) Decon Chemicals	• Proper PPE to include hard hat, full face shield with heavy duty chemical resistant gloves, safety glasses, long sleeve shirts and a chemical resistant apron • Keep water temperature below 180 degrees F • Keep two hands on wand at all times during operation • Do not aim wand at any part of your body • Do not aim wand at anybody else
	Pinch points	• Avoid setting rods down on fingers, roll rods off hand into decon unit
	falling objects	• Make sure grading is secure • Do not toss rods into decon, (they can and have bounced out)
	Slipping hazard due to wet	• Lay down plywood or sand

	surface	• Drain water periodically to avoid overflow spills
	Back Strain	• Raise tongue of decon unit to lower the back of unit and make it easier to get rods in and out • Use proper lifting techniques •
	Shoulder injury	• Restrict decon to one layer of rods at a time
	Electrical shock	• Use caution while turning on and off • Do not get on switch wet • **GFCI's are required-NO EXCEPTIONS-Test before each use!**
3. Clean-up	Slips, trips & falls	• Make careful visual sweep of site • Check for tools, debris, or dirt left on-site • Watch your step
4. Preparation for return to office	Materials falling off truck	• Perform a pre-trip walk around to make sure everything is secure • Put all tools away where they will not fall off of truck • Make sure all safety pins and other securing devices are in place • Double check safety pin that hold cart on decon unit **See AHA for Drum and Drum Dolly Handling**

TABLES

TABLE B1-1: POTENTIAL CHEMICAL HAZARDS
Site Safety and Health Plan for Additional Site Investigation at OPHA Former NAS Moffett Field, California

Chemical and Medium	Exposure Limit and IDLH Level	Exposure Route	Toxic Characteristics
Volatile Organic Compounds			
Tetrachloroethene	PEL = 100 ppm REL = TWA 100 ppm TLV = TWA 100 ppm IDLH = 150 ppm	Inhalation, ingestion, skin absorption,	Acute: Causes central nervous system effects. Dizziness, weakness, nausea, vomiting, headache; Vapors can irritate eyes; splashes may cause damage to eye tissue Chronic: Symptoms noted above may be produced by cumulative exposure
Benzene	PEL = TWA 1 ppm, ST 5 ppm REL = TWA 0.1 ppm, ST 1 ppm TLV = TWA 0.5 ppm, ST 2.5 ppm IDLH= 500 ppm	Inhalation, Skin absorption, Ingestion	Acute: Irritated eyes, skin, respiratory system; giddiness; headache; nausea; staggering gait; fatigue; anorexia; inflamed skin; bone marrow depressant; carcinogen Chronic: Blood, CNS, skin, bone marrow, eyes, respiratory system
Ethylbenzene	PEL = TWA 100ppm REL = TWA 100ppm, ST 125 ppm TLV = TWA 100ppm, ST 125 ppm IDLH = 800 ppm	Inhalation, Skin absorption, Ingestion	Acute: Irritated eyes; skin; mucous membrane; headache; stupor; coma Chronic: CNS, skin, eyes, respiratory system
Toluene	PEL = TWA 200 ppm REL = TWA 100 ppm, ST 150 ppm TLV = TWA 50 ppm IDLH = 500 ppm	Inhalation, Skin absorption, Ingestion	Acute: Irritated eyes, nose, throat; fatigue, weakness; confusion; euphoria; dizziness, incoherence, respiratory problems Chronic: CNS, liver, kidneys, skin, eyes, respiratory system
Xylene(s)	PEL = 100 ppm REL = 100 ppm TLV = TWA 100 ppm, ST 150 ppm IDLH = 900 ppm	Inhalation, Skin absorption, Ingestion	Acute: Irritated eyes, nose, throat, skin, excitement, drowsiness, uncoordinated movement, corneal vacillation, nausea, vomiting, abdominal pain, inflamed skin Chronic: Eyes, skin, respiratory, CNS, liver, kidneys, gastrointestinal tract, blood

TABLE B1-1: POTENTIAL CHEMICAL HAZARDS (CONTINUED)
Site Safety and Health Plan for additional site investigation at OPHA, Former NAS Moffett Field, California

Chemical and Medium	Exposure Limit and IDLH Level	Exposure Route	Toxic Characteristics
Polycyclic Aromatic Hydrocarbons			
2-Methylnaphthanene	PEL = NE REL = NE TLV = NE IDLH = NE	Inhalation, Skin absorption, Ingestion	Acute: Irritated eyes, skin irritation, respiratory system irritation
Naphthalene	PEL = TWA 50 mg/m^3 REL = TWA 50 mg/m^3, ST 75 ppm TLV = 10 ppm IDLH = 250 ppm	Skin absorption, Ingestion	Acute: Irritated eyes; headache; confusion; excitement; drowsiness, uncoordinated movement, corneal vacillation, nausea, vomiting, abdominal pain, inflamed skin Chronic: Eyes, skin, blood, liver, kidneys, CNS

Notes:

CNS	Central nervous system
CVS	Cardiovascular system
IDLH	Immediately dangerous to life or health
mg/m^3	Milligram per cubic meter
NA	Not available
NIOSH	National Institute for Occupational Safety and Health
PEL	Permissible exposure limit
REL	Recommended exposure limit
ST	Short-term limit
TLV	Threshold limit value
TWA	Time-weighted average

Reference:

NIOSH. 2005. "Pocket Guide to Chemical Hazards." U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

TABLE B1-2: SITE-SPECIFIC AIR MONITORING REQUIREMENTS AND ACTION LEVELS
Site Safety and Health Plan for Additional Site Investigation at OPHA, Former NAS Moffett Field, California

Contaminant or Hazard	Task	Monitoring Device	Action Level	Monitoring Frequency	Action
Organic Vapors	Drilling Collection of soil samples Handling of IDW	PID/FID	< 50 ppm	Continuous or as needed	Continue work in Level D PPE with regular monitoring
			> 50 ppm		Use Level C or B PPE, depending on concentration
Particulates	Drilling Collection of soil samples Handling of IDW	Particulate Monitor	< 5 mg/m^3	Hourly or more frequent, as determined by SSC	Use Level D PPE
			5 to 10 mg/m^3	Continuous	Use Level C PPE and implement dust suppression
			> 10 mg/m^3	NA	Stop Work and implement dust suppression activities
Noise	Drilling	Sound level meter or be able to speak to someone at arm's length distance without having to raise voice	> 85 dBA	When necessary	Use hearing protection

Notes:

dBA Decibel as measured on the A-weighted scale
FID Flame ionization detector
PID Photoionization detector
PPE Personal protective equipment
ppm Parts per million

TABLE B1-3: HEAT AND COLD STRESS CONDITIONS
Site Safety and Health Plan for Additional Site Investigation at OPHA, Former NAS Moffett Field, California

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 104 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

ATTACHMENT B1-1
MATERIAL SAFETY DATA SHEETS

- Alconox®
- Vehicle Fuels (Gasoline and Diesel)
- Isobutylene (PID Calibration)
- Nitric Acid
- Spray Paint
- Hydrochloric Acid

MSDS Number: **A2052** * * * * * *Effective Date:* ***05/14/03*** * * * * * *Supercedes:* ***02/18/03***

ALCONOX®

1. Product Identification

Synonyms: Proprietary blend of sodium linear alkylaryl sulfonate, alcohol sulfate, phosphates, and carbonates.
CAS No.: Not applicable.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: A461

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Alconox® proprietary detergent mixture	N/A	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate

Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
May cause irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

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4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. When mixed with water, material foams profusely. Small amounts of residue may be flushed to sewer with plenty of water.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moisture may cause material to cake. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White powder interspersed with cream colored flakes.

Odor:
No information found.
Solubility:
Moderate (1-10%)
Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

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11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

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--------\Cancer Lists\-------------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC Category
------------------------------------    -----    -----------    -------------
Alconox®                                 No          No            None
proprietary detergent mixture
```

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12. Ecological Information

Environmental Fate:
This product is biodegradable.
Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Not regulated.

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Alconox® proprietary detergent mixture	Yes	No	No	No

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Alconox® proprietary detergent mixture	No	No	Yes	No

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Alconox® proprietary detergent mixture	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Alconox®	No	No	No

```
  proprietary detergent mixture


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes.
Keep container closed.
Use with adequate ventilation.
Avoid breathing dust.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:
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****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MOBILE OIL CORP. -- AUTOMOTIVE GASOLINES -- 9130-00-142-9457
========== Product Identification ==========

Product ID:AUTOMOTIVE GASOLINES
MSDS Date:01/08/1987
FSC:9130
NIIN:00-142-9457
MSDS Number: BHFXX
=== Responsible Party ===
Company Name:MOBILE OIL CORP.
Address:3225 GALLOWS RD.
City:FAIRFAX
State:VA
ZIP:22037
Info Phone Num:800-662-4525 703-249-3265
Emergency Phone Num:212-883-4411
CAGE:KO244
=== Contractor Identification ===
Company Name:MOBIL OIL CORP, NORTH AMERICAS MARKETING AND REFINING
Address:3225 GALLOWS ROAD
Box:City:FAIRFAX
State:VA
ZIP:22037
Country:US
Phone:800-662-4525/ 856-224-4644
CAGE:3U728
Company Name:MOBILE OIL CORP.
Address:3225 GALLOWS RD.
Box:City:FAIRFAX
State:VA
ZIP:22037
Phone:800-662-4525 703-249-3265
CAGE:KO244

========== Composition/Information on Ingredients ==========

Ingred Name:GASOLINE
CAS:8006-61-9
RTECS #:LX3300000
Fraction by Wt: >95%
OSHA PEL:300 PPM/500 STEL
ACGIH TLV:300 PPM/500STEL;9192

Ingred Name:BENZENE (SARA III)
CAS:71-43-2
RTECS #:CY1400000
Fraction by Wt: <5%
OSHA PEL:1PPM/5STEL;1910.1028
ACGIH TLV:10 PPM; A2; 9192
EPA Rpt Qty:10 LBS
DOT Rpt Qty:10 LBS

Ingred Name:TETRAETHYL LEAD (SARA III)
CAS:78-00-2
RTECS #:TP4550000
OSHA PEL:S, 0.075MG/M3(PB)
ACGIH TLV:S, 0.1 MG/M3(PB)9192
EPA Rpt Qty:10 LBS
DOT Rpt Qty:10 LBS

========== Hazards Identification ==========

LD50 LC50 Mixture:ORAL RAT LD50 18,800 MG/KG
Routes of Entry: Inhalation:YES Skin:NO Ingestion:NO
Reports of Carcinogenicity:NTP:YES IARC:YES OSHA:YES
Health Hazards Acute and Chronic:PRODUCT IS IRRITATING TO EYES,SKIN RESPIRATORY TRACT AND DEPRESSES THE CENTRAL NERVOUS SYSTEM. CHRONIC OVER EXPOSURE MAY CAUSE LIVER,KIDNEY, OR NERVOUS SYSTEM DAMAGE.
Explanation of Carcinogenicity:VONTAINS BENZENE;LISTED BY ALL THREE. ALSO,AN API STUDY FOUND LIVER CANCER IN MICE EXPOSED TO GASOLINE VAPORS.
Effects of Overexposure:EYE/SKIN CONTACT:TRANSITORY IRRITATION. INHALED: RSSPIRATORY IRRITATION,CENTRAL NERVOUS SYSTEM DEPRESSION INCLUDING,EUPHORIA,HEADACHE,DIZZINESS,DROWINESS,FATIGUE,TREMORS,CON VULSIONS,NAUSEA,VOMITING,DI ARRHEA,LOSS OF CONSCIOUSNESS.AND FINALLYDEATH. INGESTED:G/I IRRITATION,PLUS SYMPTOMS SIMILAR TO THOSE UNDER "INHALED".
Medical Cond Aggravated by Exposure:PRE-EXISTING,SKIN CONDITIONS OR IMPAIRED LIVER,KIDNEY FUNCTION MAY BE AGGRAVATED BY THIS PRODUCT.

========== First Aid Measures ==========

First Aid:EYE:FLUSH WITH WATER 15 MIN, SKIN:WASH WITH SOAP & WATER. REMOVE CONTAMINATED CLOTHING;LAUNDER BEFORE REUSE. INHALED:REMOVE TO FRESH AIR.RESUSCITATE OR GIVE OXYGEN AS NEEDED. GET MEDICAL CARE. INGESTE D:GET IMMEDIATE MEDICAL ATTENTION. DO NOT INDUCE VOMITING. IF VOMITING OCCURS,MINIMIZE ASPIRATION HAZARD.

========== Fire Fighting Measures ==========

Flash Point Method:TCC
Flash Point:-40F
Lower Limits:1.3
Upper Limits:7.6
Extinguishing Media:DRY CHEMICAL, CARBON DIOXIDE,FOAM,WATER FOG. WATER MAY BE INEFFECTED,AS PRODUCT WILL FLOAT AND MAY SPREAD FIRE.
Fire Fighting Procedures:WEAR SELF CONTAINED BREATHING APPARATUS IN ENCLOSED AREAS. WATER SPRAY MAY BE USED TO COOL FIRE EXPOSED CONTAINERS.
Unusual Fire/Explosion Hazard:VAPORS ARE HEAVIER THAN AIR,ACCUMULATING IN LOW AREAS,TRAVELING ALONG GROUND AND MAY FLASH BACK FROM DISTANT IGNITION SOURCE.

========== Accidental Release Measures ==========

Spill Release Procedures:ELIMATE IGNITION SOURCES. ISOLATE AREA. USE PROTECTIVE EQUIPMENT AS NECESSARY. STOP LEAK AND CONTAIN SPILL. DIKE AS NEEDED TO KEEP SPILL FROM DRAINS,WATER WAYS ETC. WATER FOG MAY BE USED TO REDUCE VAP ORS & PERSONAL HAZARD. REPORT SPILL PERLAW.
Neutralizing Agent:NONE

========== Handling and Storage ==========

Handling and Storage Precautions:STORE IN A COOL,DRY,ISOLATED,WELL VENTILATED AREA. KEEP IGNITION SOURCES AWAY. GROUND CONTAINERS TO PREVENT STATIC DISCHARGE DURING TRANSFERS.
Other Precautions:FIRE AND EXPLOSION ARE THE ACUTE HAZARDS OF THIS PRODUCT. TAKE EXTRAORDINARY STEPS TO PREVENT THEM.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:IF NEEDED,USE NIOSH/MSHA RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE OR PREFERRABLY,A POSITIVE PRESSURE AIR SUPPLIED RESPIRATOR OR SELF CONTAINED BREATHING APPARATUS.
Ventilation:USE EXPLOSION PROOF VENTILATION EQUIPMENT TO MAINTAIN EXPOSURE BELOW PEL/TLV.
Protective Gloves:IMPERVIOUS RUBBER OR POLYMER.
Eye Protection:SAFETY GLASSES,OR SPLASH GOGGLES.
Other Protective Equipment:SAFETY SHOWER/EYE WASH. WORK CLOTHING AS NEEDED TO PROTECT FROM PROLONGED/REPEATED CONTACT.
Work Hygienic Practices:USE GOOD CHEMICAL HYGIENE PRACTICE. AVOID UNNECESSARY CONTACT. MINIMIZE ALL CONTACT.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

HCC:F1
Boiling Pt:=23.9C, 75.F
B.P. Text:75-430F
Vapor Density:3.5 (AIR)
Spec Gravity:0.72 - 0.76
pH:K
Solubility in Water:NEGLIGIBLE
Appearance and Odor:CLEAR RED LIQUID;GASOLINE ODOR.
Percent Volatiles by Volume:100 N/

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
STRONG OXIDIZERS
Stability Condition to Avoid:HEAT,SPARKS AND OTHER IGNITION SOURCES,VAPOR ACCUMULATIONS.
Hazardous Decomposition Products:CARBON DIOXIDE,CARBON MONOXIDE

========== Disposal Considerations ==========

Waste Disposal Methods:DISPOSE I/A/W FEDERAL,STATE,LOCAL REGULATIONS. PRODUCT QUALIFYS AS IGNITABLE WASTE AND CANNOT BE LANDFILLED. IF RECOVERY OR RECYCLE ARE UNNACCEPTABLE, INCINERATION MAY BE ACCEPTABLE DISPOSAL METHODS.

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HNU SYSTEMS INC -- ISOBUTYLENE SPAN GAS, SEE SUPP DATA -- 6665-01-214-8247
========== Product Identification ==========

Product ID:ISOBUTYLENE SPAN GAS, SEE SUPP DATA
MSDS Date:12/08/1987
FSC:6665
NIIN:01-214-8247
MSDS Number: BJDVR
=== Responsible Party ===
Company Name:HNU SYSTEMS INC
Address:160 CHARLEMONT ST
City:NEWTON HIGHLANDS
State:MA
ZIP:02161
Country:US
Info Phone Num:617/964-6690
Emergency Phone Num:800/841-4357
CAGE:57631
=== Contractor Identification ===
Company Name:HNU SYSTEMS INC
Address:160 CHARLEMONT ST
Box:City:NEWTON HIGHLANDS
State:MA
ZIP:02161
Country:US
Phone:617/964-6690
CAGE:57631

========== Composition/Information on Ingredients ==========

Ingred Name:ISOBUTYLENE
CAS:115-11-7
RTECS #:UD0890000
Fraction by Wt: 0.01%

========== Hazards Identification ==========

LD50 LC50 Mixture:NONE SPECIFIED BY MANUFACTURER.
Routes of Entry: Inhalation:YES Skin:NO Ingestion:NO
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ISOBUTYLENE IS A SIMPLE ASPHYXIANT;
MODERATE CONCENTRATION IN AIR CAUSE UNCONSCIOUSNESS. CONTACT

W/LIQUID CAUSES FROSTBITE.
Explanation of Carcinogenicity:NOT RELEVANT
Effects of Overexposure:SEE HEALTH HAZARDS.
Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

========== First Aid Measures ==========

First Aid:IF BREATHED, REMOVE INDIVIDUAL TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. KEEP PERSON WARM, QUIET; GET MEDICAL ATTENTION.

========== Fire Fighting Measures ==========

Flash Point Method:CC
Flash Point:-76 C OR -105 F
Lower Limits:1.8%
Upper Limits:9.6%
Extinguishing Media:CO2 OR DRY CHEMICAL
Fire Fighting Procedures:STOP FLOW OF ISOBUTYLENE IF POSSIBLE. USE WATER SPRAY TO COOL SURROUNDING CONTAINERS.
Unusual Fire/Explosion Hazard:ISOBUTYLENE IS HEAVIER THAN AIR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION. SHOULD FLAME BE EXTINGUISHED AND FLOW OF GAS CONTINUE SEE SUPP DATA.

========== Accidental Release Measures ==========

Spill Release Procedures:NONE SPECIFIED BY MANUFACTURER.
Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

========== Handling and Storage ==========

Handling and Storage Precautions:STORE AWAY FROM HEAT AND PROTECT CYLINDERS FROM PHYSICAL DAMAGE.
Other Precautions:DO NOT PUNCTURE CYLINDER.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:POSITIVE PRESSURE AIR LINE OR SCBA FOR EMERGENCY USE.
Ventilation:HOOD W/FORCED VENTILATION TO PREVENT ACCUMULATION ABOVE LEL.
Protective Gloves:PLASTIC OR RUBBER.

Eye Protection:SAFETY GOGGLES OR GLASSES.
Other Protective Equipment:SAFETY SHOES, SAFETY SHOWER, EYEWASH FOUNTAIN.
Work Hygienic Practices:NONE SPECIFIED BY MANUFACTURER.
Supplemental Safety and Health
MFR PART NO, TRADE NAME:CALIBRATION GAS 101- 350-N, DC102573.EXPLO HAZ:INCREASE VENTILATION TO PREVENT FORMATION OF FLAMMABLE MIXTURE IN LOW AREAS/POCKETS. NOTE:DATA GIVEN FOR PURE ISOBUTLENE. CYLINDE R OF HNU SPAN GAS/ISOBUTYLENE CALIBRATION GAS CONTAINS 100 PPM IN ZERO AIR OR 0.01% ISOBUTYLENE IN AIR.

========== Physical/Chemical Properties ==========

Boiling Pt:B.P. Text:19.6F,-6.9C
Melt/Freeze Pt:M.P/F.P Text:-221F,-140C
Vapor Pres:@20C 24SIG
Vapor Density:1.95
Spec Gravity:0.59
Solubility in Water:UNAVAILABLE
Appearance and Odor:CLEAR UNPLEASANT ODOR SIMILAR TO COAL GAS

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
OXIDIZERS.
Stability Condition to Avoid:NONE SPECIFIED BY MANUFACTURER.
Hazardous Decomposition Products:NONE

========== Disposal Considerations ==========

Waste Disposal Methods:DISPOSAL MUST BE I/A/W FED, STATE AND LOCAL REGULATIONS.

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MSDS Number: **N3659** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***10/15/99***

NITRIC ACID 1.0 N AND 2.0 N VOLUMETRIC SOLUTIONS

1. Product Identification

Synonyms: Azotic acid solution; nitric acid 6.3%; nitric acid 1.0 N volumetric solution; nitric acid 2.0 N volumetric solution; nitric acid 12.6%
CAS No.: 7697-37-2
Molecular Weight: 63.00
Chemical Formula: HNO3 in H2O
Product Codes:
J.T. Baker: 5639
Mallinckrodt: 3510

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	6 - 13%	Yes
Water	7732-18-5	> 87%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

---

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes

before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
May react explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc.
Fire Extinguishing Media:
If involved in a fire, use water spray.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect from physical damage and direct sunlight. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Nitric Acid:
OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA)
ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Breathing air quality must meet the requirements of the OSHA respiratory protection standard (29CFR1910.134). Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:
Suffocating, acrid.
Solubility:
Infinitely soluble.
Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.

Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Heat and incompatibles.

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11. Toxicological Information

For Nitric Acid: Investigated as a mutagen and reproductive effector.

```
--------\Cancer Lists\-----------------------------------------------------
                                     ---NTP Carcinogen---
Ingredient                           Known    Anticipated    IARC Category
-------------------------------------  -----    -----------    -------------
Nitric Acid (7697-37-2)                 No          No            None
Water (7732-18-5)                       No          No            None
```

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12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 20L

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 20L

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15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                        TSCA  EC   Japan  Australia
----------------------------------------------  ----  ---  -----  ---------
Nitric Acid (7697-37-2)                           Yes  Yes   Yes      Yes
Water (7732-18-5)                                 Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\---------------------------------
                                                         --Canada--
Ingredient                                        Korea  DSL   NDSL  Phil.
----------------------------------------------  -----  ---   ----  -----
Nitric Acid (7697-37-2)                           Yes   Yes   No     Yes
Water (7732-18-5)                                 Yes   Yes   No     Yes

--------\Federal, State & International Regulations - Part 1\----------------
                                            -SARA 302-    ------SARA 313------
Ingredient                                  RQ    TPQ     List  Chemical Catg.
----------------------------------------  ---   -----   ----  --------------
Nitric Acid (7697-37-2)                     1000  1000    Yes        No
Water (7732-18-5)                           No    No      No         No

--------\Federal, State & International Regulations - Part 2\----------------
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Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: Yes (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Store in a tightly closed container.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases call a physician.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:
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Prepared by: Environmental Health & Safety
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Material Safety Data Sheet

SECTION I - Material Identity
SECTION II - Manufacturer's Information
SECTION III - Physical/Chemical Characteristics
SECTION IV - Fire and Explosion Hazard Data
SECTION V - Reactivity Data
SECTION VI - Health Hazard Data
SECTION VII - Precautions for Safe Handling and Use
SECTION VIII - Control Measures
SECTION IX - Label Data
SECTION X - Transportation Data
SECTION XI - Site Specific/Reporting Information
SECTION XII - Ingredients/Identity Information

SECTION I - Material Identity

Item Name	
Part Number/Trade Name	S03700 ALERT ORANGE QUIK-MARK INVERTED <<MARKING>> <<PAINTS>>
National Stock Number	8010PS03700
CAGE Code	09800
Part Number Indicator	A
MSDS Number	188218
HAZ Code	B

SECTION II - Manufacturer's Information

Manufacturer Name	SHERWIN-WILLIAMS / KRYLON/SPRAYON INDUSTRIAL PROD

Street	31500 SOLON ROAD
City	SOLON
State	OH
Country	US
Zip Code	44139
Emergency Phone	800-424-9300 CHEMTREC
Information Phone	800-777-2966 (FFAX) 800-955-6737

MSDS Preparer's Information

Date MSDS Prepared/Revised	17AUG98
Active Indicator	Y

Alternate Vendors

SECTION III - Physical/Chemical Characteristics

Appearance/Odor	ORANGE SPRAY PAINT
Boiling Point	<0-395F
Melting Point	NA
Vapor Density	> AIR
Specific Gravity	0.8093
Evaporation Rate	> ETHER
Solubility in Water	NA
Chemical pH	NR
Container Type	R
Container Pressure Code	2
Temperature Code	4
Product State Code	L

SECTION IV - Fire and Explosion Hazard Data

Flash Point	31
Flash Point Method	UNK
Lower Explosion Limit	0.9
Upper Explosion Limit	27.0
Extinguishing Media	CARBON DIOXIDE, DRY CHEMICAL, FOAM
Special Fire Fighting Procedures	FULL PROTECTIVE EQUIPMENT INCLUDING SCBA SHOULD BE USED. WATER SPRAY MAY BE INEFFECTIVE. IF WATER IS USED, FOG NOZZLES ARE PREFERABLE. WATER MAY BE USED TO COOL CLOSED CONTAINERS TO PREVENT PRESSURE BUILD-UP AND POSSIBLE AUTOIGNITION OR EXPLOSION WHEN EXPOSED TO EXTREME HEAT
Unusual Fire/Explosion Hazards	CLOSED CONTAINERS MAY EXPLODE (DUE TO THE BUILD-UP OF PRESSURE) WHEN EXPOSED TO EXTREME HEAT. ISOLATE FROM HEAT, ELECTRICAL EQUIPMENT, SPARKS AND OPEN FLAME. APPLICATION TO HOT SURFACES REQUIRES SPECIAL PRECAUTIONS. DURING EMERGENCY

	CONDITIONS OVEREXPOSURE TO DECOMPOSITION PRODUCTS MAY CAUSE A HEALTH HAZARD. SYMPTOMS MAY NOT BE IMMEDIATELY APPARENT . OBTAIN MED ATTENTION

SECTION V - Reactivity Data

Stability	YES
Stability Conditions to Avoid	NONE KNOWN
Materials to Avoid	NONE KNOWN
Hazardous Decomposition Products	BY FIRE: CARBON DIOXIDE, CARBON MONOXIDE
Hazardous Polymerization	NO
Polymerization Conditions to Avoid	WILL NOT OCCUR

SECTION VI - Health Hazard Data

Route of Entry: Skin	YES
Route of Entry: Ingestion	YES
Route of Entry: Inhalation	YES
Health Hazards - Acute and Chronic	IRRITATION OF EYES, SKIN AND RESPIRATORY SYSTEM. MAY CAUSE NERVOUS SYSTEM DEPRESSION. EXTREME OVEREXPOSURE MAY RESULT IN UNCONSCIOUSNESS AND POSSIBLY DEATH
Carcinogenity: NTP	NO
Carcinogenity: IARC	NO
Carcinogenity: OSHA	NO
Explanation of Carcinogenity	NONE
Symptoms of Overexposure	HEADACHE, DIZZINESS, NAUSEA, AND LOSS OF COORDINATION ARE INDICATIONS OF EXCESSIVE EXPOSURE TO VAPORS OR SPRAY MISTS
Medical Cond. Aggrevated by Exposure	NONE GENERALLY RECOGNIZED
Emergency/First Aid Procedures	[INHAL] REMOVE FROM EXPOSURE. RESTORE BREATHING. KEEP WARM AND QUIET. [SKIN] WASH AFFECTED AREA THOROUGHLY WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. LAUNDER BEFORE REUSE. [EYES] FLUSH EYES WITH LARGE AMOUNTS OF WATER FOR 15 MIN. GET MED ATTENTION [INGEST] NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. DO NOT INDUCE VOMITING. GIVE SEVERAL GLASSES OF WATER. SEEK MED ATTENTION

SECTION VII - Precautions for Safe Handling and Use

Steps if Material Released/Spilled	REMOVE ALL SOURCES OF IGNITION. VENTILATE AND REMOVE WITH INERT ABSORBENT
Neutralizing Agent	NR
Waste Disposal Method	MAY BE HAZARDOUS AS DEFINED UNDER

	THE RCRA 40 CFR 261. WASTE MUST BE TESTED FOR IGNITABILITY TO DETERMINE THE APPLICABLE EPA HAZARDOUS WASTE NUMBERS. DO NOT INCINERATE. DEPRESSURIZE CONTAINER. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS REGARDING POLLUTION
Handling and Storage Precautions	CONTENTS ARE EXTREMELY FLAMMABLE. KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME. VAPORS WILL ACCUMULATE READILY AND MAY IGNITE EXPLOSIVELY. DURING USE AND UNTIL ALL VAPORS ARE GONE: KEEP AREA VENTILATED. DO NOT SMOKE. EXTINGUISH ALL FLAMES, PILOT LIGHTS, AND HEATERS. TURN OFF STOVES. ELECTRIC TOOLS
Other Precautions	INTENTIONAL MISUSE BY DELIBERATELY CONCENTRATING AND INHALING THE CONTENTS CAN BE HARMFUL OR FATAL

SECTION VIII - Control Measures

Respiratory Protection	IF PERSONAL EXPOSURE CANNOT BE CONTROLLED WEAR A PROPERLY FITTED ORGANIC VAPOR/PARTICULATE RESPIRATOR APPROVED BY NIOSH/MSHA FOR PROTECTION AGAINST MATERIALS. WHEN SANDING OR ABRADING THE DRIED FILM, WEAR A DUST/MIST RESPIRATOR APPROVED BY NIOSH/MSHA FOR DUST WHICH MAY BE GENERATED FROM THIS PRODUCT, UNDERLYING PAINT, OR THE ABRASIVE
Ventilation	LOCAL EXHAUST PREFERABLE. GENERAL EXHAUST ACCEPTABLE
Protective Gloves	WEAR GLOVES WHICH ARE RECOMMENDED BY GLOVE SUPPLIER FOR PROTECTION AGAINST MATERIALS IN SECTION II
Eye Protection	SAFETY SPECTACLES WITH UNPERFORATED SIDE SHIELDS
Other Protective Equipment	NR
Work Hygenic Practices	NR
Supplemental Health/Safety Data	NR

SECTION IX - Label Data

Protect Eye	YES
Protect Skin	YES
Protect Respiratory	YES
Chronic Indicator	YES
Contact Code	SLIGHT
Fire Code	UNKNOWN
Health Code	UNKNOWN
React Code	UNKNOWN
Specific Hazard and Precaution	TARGET ORGANS: LIVER, URINARY, BLOOD FORMING, CARDIOVASCULAR,

REPRODUCTIVE SYSTEMS

SECTION X - Transportation Data

SECTION XI - Site Specific/Reporting Information

Volatile Organic Compounds (P/G)	3.47
Volatile Organic Compounds (G/L)	415.8408

SECTION XII - Ingredients/Identity Information

Ingredient #	01
Ingredient Name	PROPANE
CAS Number	74986
Proprietary	NO
Percent	16
OSHA PEL	1000 PPM
Ingredient #	02
Ingredient Name	LT ALIPHATIC HYDROCARBON SOLVENT
CAS Number	68410979
Proprietary	NO
Percent	18
OSHA PEL	NE
ACGIH TLV	NE
Ingredient #	03
Ingredient Name	MINERAL SPIRITS
CAS Number	64742887
Proprietary	NO
Percent	6
OSHA PEL	100 PPM
ACGIH TLV	50 PPM
Ingredient #	04
Ingredient Name	ETHYLBENZENE
CAS Number	100414
Proprietary	NO
Percent	2
OSHA PEL	100 PPM
ACGIH TLV	100 PPM
Ingredient #	05
Ingredient Name	XYLENE
CAS Number	1330207
Proprietary	NO
Percent	9
OSHA PEL	100 PPM
ACGIH TLV	100 PPM

MSDS *Material Safety Data Sheet*

International Chemical Industries, Inc
Km. 32 Bo. Tuktukan, Guiguinto, Bulacan
Philippines

24 Hour Emergency Telephone: 1-800-1-888-6800

All non-emergency calls should be directed to Customer Service (1-800-1-888-6800 x501)

Hydrochloric Acid

Section 1 – Product Identification

Synonyms: Muriatic acid; hydrogen chloride, aqueous
CAS No.: 7647-01-0
Molecular Weight: 36.46
Chemical Formula: HCl

Section 2 – Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hydrogen Chloride	7647-01-0	31 – 33 %	Yes
Water	7732-18-5	67 – 69 %	No

Section 3 – Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE, MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

Health Rating: 3 – Severe (Poison)
Flammability Rating: 0 – None
Reactivity Rating: 2 – Moderate
Contact Rating: Extreme (Corrosive)

Potential Health Effects

Inhalation: Corrosive! Irritating to respiratory tract; inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.
Ingestion: Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea. Swallowing may be fatal.

Skin Contact: Corrosive! Can cause redness, pain, and severe skin burns unless the hydrochloric acid is washed off immediately. Skin may dry or crack due to astringent nature of material. Repeated skin contact may lead to development of dermatitis. Concentrated solutions cause deep ulcers and discolor skin.
Eye Contact: Corrosive! Eye contact results in severe irritation and painful burns of the eyes and eyelids. If material is not removed by copious irrigation with water at room temperature, visual Impairment or total loss of vision could result.
Chronic Exposure: Prolonged exposure to low-level concentrations of hydrochloric acid vapor may cause discoloration and erosion of teeth, bleeding of nose and gums, and ulcers of the nasal mucosa. Asthma, bronchitis, emphysema, bronchial hyperactivity, skin allergies, and eczema may all be aggravated by exposure to hydrochloric acid vapor.
Aggravation of Pre-existing Conditions: Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

The discomfort caused by hydrochloric acid vapor is usually sufficient to induce a person to leave areas of excessive concentrations; vapor can be fatal to those sprayed with acid or trapped in enclosed areas.

Section 4 – First Aid Measures

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion: DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact: In case of contact, immediately flush skin with plenty of water, avoiding hot water or hard scrubbing, for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally to ensure thorough rinsing; delay can result to permanent injury. Get medical attention immediately.

Section 5 – Fire Fighting Measures

Fire: Extreme heat or contact with metals can release flammable hydrogen gas.
Explosion: Not considered to be an explosion hazard.
Fire Extinguishing Media: If involved in fire, use water spray. Neutralize with soda ash or slaked lime.
Special Information: In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out.

Section 6 – Accidental Release Measures

Review safety precautions before proceeding with cleanup. Use appropriate personal protection equipment. Evacuate area and stay upwind. Attempts to stop or reduce leak should be made only by trained personnel, when there is at most a minimal risk of injury. Large spills should be contained with dikes and pumped into tanks suitable for acid storage. Full acid-resistant suits and self-contained breathing apparatus should be worn. Use a water fog or spray to control vapors. Neutralize spill with lime (calcium hydroxide), limestone (calcium carbonate), or soda ash (sodium carbonate). CAUTION: limestone and soda ash will evolve CO2; ventilation should be provided in closed areas. Dike area around spill to prevent spreading, and use of absorbent material to pick up spill.

Section 7 – Handling and Storage

Storage tanks and piping for HCl should be constructed of materials recommended for corrosive products. FRP, PVC, HDPE, and/or rubber are the materials of choice for piping and storage tank. Metering pumps and other equipment that comes in contact with concentrated solutions of HCl must also be constructed of acid resistant materials such as PVC, rubber, Teflon, ceramic and Hastalloy C. No wetted parts shall contain metals such as carbon steel, stainless steel, brass or aluminum.

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. When diluting, the acid should always be added to water slowly and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Observe all warnings and precautions listed for the product.

Section 8 – Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Hydrochloric acid:
OSHA Permissible Exposure Limit (PEL): 5 ppm (ceiling)
ACGIH Threshold Limit Value (TLV): 2 ppm (Ceiling), A4 not classifiable as a human carcinogen
Ventilation System: A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area.
Personal Respirators (NIOSH Approved): If the exposure limit is exceeded, a full facepiece respirator with an acid gas cartridge may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection: Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.
Eye Protection: Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

Section 9 – Physical and Chemical Properties

Appearance: Colorless, fuming liquid
Odor: Pungent odor of hydrogen chloride.
Solubility: Infinite in water with slight evolution of heat.
Density: 1.15
Boiling Point: 53C (127F) Azeotrope (20.2%) boils at 109C (228F)
Melting Point: -74C (-101F)
Vapor Density (Air=1): No information found
Vapor Pressure (mm Hg): 190 @ 25C (77F)
Evaporation Rate: No information found.

Section 10 – Stability and Reactivity

Stability: Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products: When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.
Incompatibilities: A strong mineral acid, concentrated hydrochloric acid is incompatible with many substances and highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.
Conditions to Avoid: Heat, direct sunlight.

Section 11 – Toxicological Information

Inhalation rat LC50: 3124 ppm/1H; oral rabbit LD50: 900 mg/kg (Hydrochloric acid concentrated); investigated as a tumorigen, mutagen, reproductive effector.
Carcinogenicity: None of the components of this material are listed as a carcinogen by IARC, NTP, OSHA or ACGIH.

Section 12 - Ecological Information

Environmental Fate: When released into the soil, this material is not expected to biodegrade. When released into the soil, this material may leach into groundwater.
Environmental Toxicity: This material is expected to be toxic to aquatic life.

Section 13 - Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to an approved waste facility. Processing, use or contamination of this product may change the waste management options. Dispose of waste in accordance with applicable federal, state and local requirements.

Section 14 – Transport Information

Domestic (Land, D.O.T)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
DOT Labels: Corrosive
DOT Placards: Corrosive
Packing Group: II

International (Water, I.M.O.)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
IMO Label: Corrosive
Packing Group: II
Shipping Containers: Rubber-lined steel tank cars/trucks; polyethylene drums, bottles
Storage Conditions: Keep containers closed

Section 15 – Regulatory Information

TSCA: CAS No. 7647-01-0 is listed on the TSCA Chemical Substance Inventory

Section 16 – Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.

Label First Aid

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

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ATTACHMENT B1-2
SAFE WORK PRACTICES

- General Safe Work Practices
- Drum and Container Handling Practices
- Spill and Discharge Control Practices
- Heat Stress
- Cold Stress
- Biohazards
- Use of Heavy Equipment

TETRA TECH, INC.
HEALTH AND SAFETY MANUAL
VOLUME III

SAFE WORK PRACTICES (SWP)

GENERAL SAFE WORK PRACTICES

SWP NO.: 6-1

ISSUE DATE: JULY 1998

REVISION NO.: 1

Disclaimer: This safe work practice (SWP) is the property of Tetra Tech, Inc. (Tetra Tech), and its subsidiaries. Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

GENERAL SAFE WORK PRACTICES

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards. These SWPs establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations. This list is not inclusive and may be amended as necessary.

- Do not eat, drink, chew gum or tobacco, take medication, or smoke in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.
- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. A thorough shower and washing must be conducted as soon as possible if excessive skin contamination occurs.
- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on drums, equipment, or the ground. Do not place monitoring equipment on potentially contaminated surfaces.
- Remove beards or facial hair that interfere with a satisfactory qualitative respirator fit test or routine pre-entry positive and negative pressure checks.
- Be familiar with and knowledgeable of and adhere to all instructions in the site-specific health and safety plan (HASP). At a minimum, a safety meeting will be held at the start of each project to discuss the HASP. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.
- Be aware of the location of the nearest telephone and all emergency telephone numbers.
- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.
- Plan and delineate entrance, exit, and emergency escape routes.
- Rehearse unfamiliar operations prior to implementation.
- Use the “buddy system” whenever respiratory protection equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.
- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.

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- Minimize the number of personnel and equipment in contaminated areas (such as the exclusion zone). Nonessential vehicles and equipment should remain within the support zone.

- Establish appropriate support, contamination reduction, and exclusion zones.

- Establish appropriate decontamination procedures for leaving the site.

- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).

- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech, subcontractor, and project site visitor personnel; air quality and personal exposure monitoring data; and other information related to safety matters. Form SSC-1, Daily Site Log, may be used to record names of on-site personnel.

- A portable eyewash station should be located in the support zone if chemical splashes to eyes are possible.

- Do not bring matches and lighters in the exclusion zone or contamination reduction zone.

- Observe coworkers for signs of toxic exposure and heat or cold stress.

- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

DRUM AND CONTAINER HANDLING PRACTICES

SWP NO.: 6-11

ISSUE DATE: JULY 1998

REVISION NO.: 1

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DRUM AND CONTAINER HANDLING PRACTICES

This safe work practice (SWP) establishes procedures to protect field personnel and the public from exposure to hazardous materials resulting from the handling, opening, sampling, transferring, overpacking, and shipping of drums.

Regional health and safety representatives (RHSR) and subsidiary health and safety representatives (SHSR) are responsible for providing technical guidance to project managers and site safety coordinators (SSC) on drum and container handling procedures. Project managers are responsible for ensuring implementation of this SWP, when warranted, on their projects. SSCs are responsible for enforcement of this SWP at the work site. Field personnel are required to adhere to drum and container handling guidelines and procedures.

All drum and container handling operations must adhere to all applicable federal, state, local, contractual, and company requirements. Preparation and shipping of containers of hazardous materials must comply with applicable U.S. Environmental Protection Agency (EPA) and U.S. Department of Transportation (DOT) regulations. All drums and containers used during hazardous waste operations must meet appropriate DOT regulations for the materials they contain.

Drum and container handling should be approached in a systematic, stepwise manner, especially when the contents are unknown or containers are in poor condition. Inspection, opening, sampling, overpacking, and staging requirements for drums and containers are described below.

1.0 INSPECTION

Drums or containers should be visually inspected before any work is conducted to gain as much information as possible about their contents. Field personnel should document in the field logbook the following information:

- Any labels or other markings indicating possible contents
- Drum or container condition (such as rusted, leaking, or dented)
- Signs of pressure (such as bulging or swelling)

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- Drum or container size, construction, and type
- Configuration of drum or container head (open or closed top)

After observations are documented in the field logbook, each drum or container should be labeled with an identification code for future tracking.

2.0 OPENING

For efficient and safe drum or container opening, personnel must adhere to the guidelines below.

- If available, remote-controlled drum or container opening equipment should be used.
- In order to protect the employee, a suitable shield shall be placed between the employee and the drum being opened.
- Only spark-proof tools should be used to open drums and containers.
- Drums or containers containing unknown materials should be opened using Level B personal protection, including splash protection.
- Drums or containers containing radioactive material should not be opened or handled until the appropriate personnel with expertise in this area have been consulted.
- Air monitoring equipment should be available near the drum or container being opened, such as combination oxygen and combustible gas meters, colorimetric tubes, and photoionization detectors.
- Tools used for drum or container opening should be decontaminated after each use to avoid mixing incompatible wastes.
- Drums or containers should be resealed as soon as possible to minimize vapor generation.
- If possible, drums or containers exhibiting signs of pressure should not be opened.

3.0 SAMPLING

Drum and container sampling poses a variety of potential hazards to worker health and safety, including direct contact with hazardous materials, inhalation of hazardous vapors, and the possibility of drum or container explosion or rupture. The guidelines below should be used to properly sample drums and containers.

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- Prior to sampling, a sample plan must be developed that includes the following information:
  - Background information on the waste
  - Which drums or containers will be sampled
  - Appropriate sampling devices
  - Sample containers to be used
- Sampling personnel should not stand on drums or containers or lean over other drums or containers to obtain samples.
- All phases in the vertical cross section of each drum or container should be sampled.
- Disposable glass tubing or other disposable sampling devices should be used to sample liquid.
- When sampling liquids, absorbent pads should be placed on drum tops to collect spillage that may occur while transferring samples into containers.
- Sampling personnel should document container number, any container labeling, sampling date and time, and number and color of different phases.

4.0 OVERPACKING

During an emergency, drums and containers should be handled as detailed below.

- Leaks should be plugged or patched immediately if this can be done without risk.
- Damaged drums and containers should be placed in an overpack container with absorbent pads to collect any spilled material or the contents transferred into a clean, compatible drum or container.
- Absorbent material should be used to collect any leakage that may occur during shipment.

During remedial actions, the procedures below apply to drum and container handling.

- Drums or containers should be placed in overpack containers, and any identification number assigned to the drum or container should be placed on the outside of the overpack container.

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- If drum or container contents are to be bulked with other drum or container contents, the compatibility of the contents should be verified by a field characterization study prior to bulking.

5.0 STAGING

Staging refers to moving drums or containers in an organized manner to predesignated areas. Drums or containers may be staged to facilitate characterization and remedial action and also to protect drums or containers from potentially hazardous site conditions (such as high temperatures and proximity to ignition sources or heavy equipment). To ensure that staging is conducted in a safe and efficient manner, the guidelines below should be followed.

- Staging activities should be kept to a minimum to prevent hazards associated with increased handling of drums or containers.
- The staging area should be as close as possible to the site exit.
- The staging area should be level and covered with plastic sheeting or absorbent material.
- The staging area should be diked to contain possible spills.
- Drums or containers should be secured on pallets whenever possible to aid in the safe movement of drums or containers and to isolate the drums or containers from the soil surface.
- Drums or containers should not be stacked on top of each other.
- Drums or containers should be staged according to chemical composition of the contents. Drums or containers containing incompatible materials should be kept segregated.
- Drums and containers should be staged far enough apart to allow for the movement of equipment and personnel.

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TETRA TECH, INC.
HEALTH AND SAFETY MANUAL
VOLUME III

SAFE WORK PRACTICES (SWP)

SPILL AND DISCHARGE CONTROL PRACTICES

SWP NO.: 6-14

ISSUE DATE: JULY 1998

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SPILL AND DISCHARGE CONTROL PRACTICES

This safe work practice (SWP) provides contingency measures for spills and unintentional discharges from handling and transporting hazardous materials. Spill and discharge control practices should follow specific procedures to ensure the safety of responders and bystanders and to limit environmental impacts.

1.0 GENERAL PROCEDURES

Immediate action should be taken to control and contain any spill following the general guidelines below:

- Unnecessary people should be kept away from the spill or discharge.
- The hazardous area should be isolated.
- If the spill or discharge creates a hazardous situation or results in injury or an environmental release, the emergency procedures of the HASP should be implemented. Emergency response telephone numbers, designated contacts, and special reporting procedures are presented in the HASP.
- Personnel should stay on the upwind side of the spill or discharge.
- Entry into a confined space or low area where liquids or vapors may accumulate should be avoided.
- Sources of ignition should be eliminated if the spill or discharge involves combustible materials.
- Drains, manholes, waterways, sewers, and the like should be identified and covered or protected.
- The spill should be controlled or absorbed using appropriate media or devices.
- When the spill or discharge is fully contained and under control, spill or discharge material should be collected.
- Following cleanup, the spill area should be evaluated by collecting soil samples and screening the area with air monitoring instruments.

2.0 SOLIDS

If the spill or discharge material is solid and nonreactive, the material should be scooped up and placed in a suitable and compatible container until the disposal method has been determined.

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3.0 LIQUIDS

If liquid is discharged, the following general procedures apply:

- The point of discharge should be immediately identified and measures taken to eliminate further discharges by uprighting or patching containers, transferring contents, or other appropriate methods.
- Any discharged liquids or sludge should be removed or retrieved.
- Discharged materials should be cleaned up with absorbent materials or devices.
- Spent absorbent material should be placed into storage or disposal containers.

4.0 REPORTING

In some instances, a release may require reporting to government agencies. If a reportable quantity is released (this quantity is stated on the Material Safety Data Sheet) or human health or the environment is threatened, appropriate national, state, and local administering agency personnel should be notified. The timeframe for notification may vary from agency to agency. Notification may be required immediately or within 24 hours, depending on the type, location, and amount of released material. The appropriate agency to report spills to should be determined during HASP development.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

HEAT STRESS

SWP NO.: 6-15

ISSUE DATE: JULY 1998

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HEAT STRESS

This safe work practice (SWP) describes situations where heat stress is likely to occur and provides procedures for the prevention and treatment of heat-related injuries and illnesses. Wearing personal protective equipment (PPE), especially during warm weather, puts employees at considerable risk of developing heat-related illness. Health effects from heat stress may range from transient heat fatigue or rashes to serious illness or death.

Many factors contribute to heat stress, including PPE, ambient temperature and humidity, workload, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors are elevated ambient temperatures in combination with fluid loss. Because heat stress is one of the more common health concerns that may be encountered during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat stress. Heat stroke is the most serious heat-related illness—it is a threat to life and has a 20 percent mortality rate. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age directly affect the tendency to heat stroke. Table 1 lists the most serious heat conditions, their causes, signs and symptoms, and treatment.

Training is an important component of heat stress prevention. Employees are instructed to recognize and treat heat-related illnesses during 8-hour health and safety refresher and first aid training courses. When working in hot environments, specific steps should be taken to lessen the chances of heat-related illnesses. These include the following:

- Ensuring that all employees drink plenty of fluids (Gatorade® or its equivalent)
- Ensuring that frequent breaks are scheduled so overheating does not occur
- Revising work schedules, when necessary, to take advantage of the cooler parts of the day (such as working from 5:00 a.m. to 11:00 a.m. and 6:00 p.m. to nightfall).

When PPE must be worn (especially Levels A and B), suggested guidelines relating to ambient temperature and maximum wearing time per excursion are as shown in Table 2.

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TABLE 1

HEAT STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 104 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions

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TABLE 2

SUGGESTED GUIDELINES WHEN WEARING PPE

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Source: National Institute for Occupational Safety and Health (NIOSH). 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

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To monitor the level of an employee's heat stress, the following should be measured:

- Heart Rate: Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period; if heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next period, shorten the following work cycle by one-third.

- Oral Temperature: Use a disposable oral thermometer (3 minutes under the tongue) to measure the oral temperature at the end of the work period. If oral temperature exceeds 99.6 °F (37.6 °C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6 °F at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear impermeable PPE when his or her oral temperature exceeds 100.6 °F (38.1 °C).

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HEALTH AND SAFETY MANUAL
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SAFE WORK PRACTICES (SWP)

COLD STRESS

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COLD STRESS

This safe work practices (SWP) describes situations where cold stress is likely to occur and discusses procedures for the prevention and treatment of cold-related injuries and illnesses. Cold conditions may present health risks to employees during field activities. The two primary factors that influence the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Other factors that increase susceptibility to cold stress include age (very young or old), smoking, alcohol consumption, fatigue, and wet clothing. Hypothermia can occur at temperatures above freezing if the individual has on wet or damp clothing or is immersed in cold water. The combined effect of temperature and wind can be evaluated using a wind chill index as shown in Table 1.

Bare flesh and body extremities that have high surface area-to-volume ratios such as fingers, toes, and ears are most susceptible to wind chill or extremely low ambient temperatures. Because cold stress can create the potential for serious injury or death, employees must be familiar with the signs and symptoms and various treatments for each form of cold stress. Table 2 provides information on frostbite and hypothermia, the two most common forms of cold-related injuries.

Training is an essential component of cold stress prevention. Employees are instructed to recognize and treat cold-related injuries during 8-hour health and safety refresher and first aid training courses. When working in cold environments, specific steps should be taken to lessen the chances of cold-related injuries. These include the following:

- Protecting of exposed skin surfaces with appropriate clothing (such as face masks, handwear, and footwear) that insulates, stays dry, and blocks wind
- Shielding the work area with windbreaks to reduce the cooling effects of wind
- Providing equipment for keeping workers' hands warm by including warm air jets and radiant heaters in addition to insulated gloves
- Using adequate insulating clothing to maintain a body core temperature of above 36 °C
- Providing extra insulating clothing on site

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TABLE 1

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE

Estimated Wind Speed (in miles per hour - mph)	**Actual Temperature Reading (°F)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
CALM	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* in less than 1 hour with dry skin; maximum danger from false sense of security				*INCREASING DANGER* from freezing of exposed flesh within 1 minute				*GREAT DANGER* that flesh may freeze within 30 seconds			
	Trench foot may occur at any point on this chart.											

Source: Modified from American Conference of Governmental Industrial Hygienists. 1997. "Threshold Limit Values for Chemical Substances and Physical Agents."

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TABLE 2

COLD STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

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- Reducing the duration of exposure to cold
- Changing wet or damp clothing as soon as possible

During periods of extreme cold (10 °F or less) workers should use the buddy system to ensure constant protective observation.

Specific monitoring criteria are not established for cold stress. However, employees should be thoroughly cognizant of the signs and symptoms of frostbite and hypothermia (see Table 1) in themselves as well as in coworkers. All instances of cold stress should be reported to the site safety coordinator. Work schedules may be adjusted and warm-up regimes imposed as needed to deal with temperature and wind conditions.

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TETRA TECH, INC.
HEALTH AND SAFETY MANUAL
VOLUME III

SAFE WORK PRACTICES (SWP)

BIOHAZARDS

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BIOHAZARDS

Biological hazards, or "biohazards," include plants, animals or their products, and parasitic or infectious agents that may present potential risks to worker health. This safe work practice (SWP) discusses procedures for working with biohazards, preventive guidelines, and first-aid procedures for the most common hazards field staff are likely to encounter. This SWP does not address biohazards such as those associated with medical waste. Procedures for working with this type of biohazard should be addressed in the site-specific health and safety plan (HASP) on a case-by-case basis.

During preparation of the site-specific HASP, the preparer should consider which plants, animals, and other biological agents may be encountered; assess their potential risk to project personnel; and attach this SWP to the HASP, if necessary. Office health and safety representatives should become familiar with biological hazards indigenous to the geographical area in which most of their office personnel work and assist in evaluating the risks to personnel on projects staffed from their offices. SWPs for insects, snakes, animals, plants, waterborne pathogens (giardia), and hantavirus are provided below.

1.0 INSECTS

SWPs for reducing the chance of insect bites or stings and for treating bites or stings are listed below.

- Workers should keep as much skin area covered as possible by wearing long-sleeved shirts, long pants, and a hat. Pant legs should be tucked into socks or boots and shirts into pants. In addition, workers should wear light colored clothing.
- A proven insect repellent should be used on bare skin and clothing.
- When possible, tall grasses and brush that could harbor ticks should be avoided.
- Several times during the day and at the end of the work day, each worker should perform a check for evidence of imbedded ticks or previous bites. Particular attention should be paid to the scalp, neck, ankles, back of the legs, and waist.
- When opening well covers, vaults, or other closed items, workers should watch for hornet or wasp nests and black widow or brown recluse spiders. Workers should never reach into spaces with unprotected arms.
- Workers should watch carefully for bees around open soft drinks or food.

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- If a worker is stung by a bee, the stinger should be carefully removed, if present. The wound should be washed and a cold pack applied. Allergic reaction should be watched for and is evidenced by extreme swelling, redness, pain, or difficulty breathing.

- If a worker is stung or bit by a spider or scorpion, medical attention should be obtained immediately.

2.0 SNAKES

SWPs for encounters with snakes and for treating snakebites are listed below.

- Workers should avoid walking in areas known to harbor snakes. Workers should be cautious when picking up or moving items that have been on the ground.

- Workers should wear boots made of heavy material that protect the ankles and pants. Heavy work gloves should be worn for picking up items.

- If one snake is encountered, others may be present. Workers should leave the area by retracing their steps.

- If a worker is bitten, the wound should be washed and the injured area immobilized and kept lower than the heart, if possible. Ice or a tourniquet should not be applied to a snake bite. The wound should not be cut. If medical care is more than 30 minutes away from a work site, a snakebite kit should be available on site and workers should know how to use it.

3.0 ANIMALS

SWPs for encounters with animals and for treating associated wounds are listed below.

- If workers encounter a wild animal, the animal should be observed for unusual behavior such as a nocturnal animal out during the day, drooling, an appearance of partial paralysis, irritability, meanness, or a strangely quiet demeanor.

- Workers should never touch the body of a dead animal because certain diseases could be carried by fleas still on the body.

- Workers should avoid animal droppings (including bird droppings). Pathogens, some of which can become airborne, may still be present in the droppings.

- If a worker is bitten, he or she should get away from the animal to avoid further bites. Workers should not try to stop, hold, or catch the animal.

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- If the wound is minor, it should be washed with soap and water. Any bleeding should then be controlled, and an antibiotic ointment and dressing should be applied. All animal bite wounds should be watched for signs of infection.

- If the wound is bleeding seriously, the bleeding should be controlled but the wound should not be cleaned. Medical assistance should be summoned immediately.

- If a rabid animal is suspected, immediate medical attention should be summoned. If possible, workers should try to remember what the rabid animal looked like and the area in which it was last seen. The animal should be reported by calling the local emergency number.

4.0 PLANTS

SWPs for plants are as follows:

- Workers should be aware of the types and appearances of poisonous plants in the work site area. Poison ivy, oak, and sumac are the most frequently encountered plants that can cause reaction from casual contact. If a worker is extremely sensitive to these plants, he or she should avoid the area entirely because airborne drift could be sufficient to cause a reaction. Other plants, such as fireweed, can cause painful, short-term irritation and should be avoided as well. Workers should avoid touching face and eye areas after contact with any suspicious plant.

- Workers should wear proper clothing if working in or near overgrown areas. Disposable outerwear should be used, if necessary, and workers should not touch the material with bare hands during removal if the outerwear may have contacted poisonous plants.

- If contact with a poisonous plant has occurred, the affected area should be immediately washed thoroughly with soap and water. If a rash or weeping sore has already begun to develop, a paste of baking soda and water should be applied to the area several times a day to reduce discomfort. Lotions such as Calamine or Caladryl should be applied to help soothe the area. If the condition gets worse and affects large areas of the body or the face, a doctor should be consulted.

- Bushy and wooded areas should be thoroughly checked for thorn-bearing trees, brush, and bramble. In some cases, impalement can cause severe pain or infection.

5.0 WATERBORNE PATHOGENS-GIARDIA

Giardia is a waterborne pathogen consisting of a protoplasmic parasite of the mammalian digestive tract. Giardia is present worldwide, with the highest occurrence in areas with poor sanitation. In the United

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States, most reported cases are in mountainous regions where drinking water is obtained from streams and is unfiltered or untreated.

Giardia is contracted by ingesting water contaminated with giardia cysts in the dormant state. Giardia parasites can only thrive in the digestive tracts of mammals. Dormant giardia organisms enter water through the feces of infected animals or humans. Giardia symptoms include severe diarrhea and upset stomach. Some people are asymptomatic but can transmit the disease to others. Medical treatment of giardia can be difficult and unpleasant; therefore, prevention is critical. Precautions for preventing exposure to giardia are listed below.

- Workers should assume that all fresh water streams are infected with the giardia organism and not drink any untreated water.
- Team members collecting sediment and water samples from streams should wash their hands thoroughly with soap and water after collecting the samples.
- Giardia parasites are relatively easy to destroy or filter. Water should be treated for drinking or cooking with iodine or another recommended giardia treatment before use.

6.0 HANTAVIRUS

Hantavirus pulmonary syndrome (HPS) is a potentially fatal infection caused by a rodent-borne hantavirus. HPS begins with a brief illness most commonly characterized by fever, muscle pain, headache, coughing, and nausea or vomiting. Other early symptoms include chills, diarrhea, shortness of breath, abdominal pain, and dizziness. In the first identified cases of HPS, this stage of the infection lasted 2 to 5 days before victims were hospitalized. Typically, by the time of hospitalization, victims were found to have tachycardia (a heart rate of greater than 100 beats per minute) and tachypnea (a breathing rate of greater than 20 breaths per minute). Fever was also common. In most cases, death occurred within 2 to 16 days of the onset of symptoms, and victims exhibited pulmonary edema and severe hypotension.

Currently, experts believe that HPS is spread by the deer mouse (*Peromyscus maniculatus*). Though the deer mouse has been found to be the primary host of hantavirus, several other rodent species have also tested positive for the virus. Pinon mice (*Peromyscus truei*), brush mice (*Peromyscus boylii*), and western

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chipmunks (*Tamia spp.*) are also likely to carry the virus. Also, cases of HPS have been reported in areas of the United States where these particular rodents are not indigenous.

Infected rodents shed the virus in their urine, feces, and saliva. Humans can be exposed to the virus through (1) inhalation of suspended rodent excreta or dust particles containing rodent excreta, (2) introduction of rodent excreta into the eyes or broken skin, and (3) ingestion of food or water contaminated by rodent excreta. HPS has a reported mortality rate of 55 percent. Transmission of hantavirus from infected individuals to healthy persons has not been documented.

Prevention of HPS infection is essential because no known antidote and no specific treatment exists for treating HPS. Therefore, employees should practice risk reduction and control measures. Guidelines for workers in locations that may have rodent infestations or habitats are listed below.

- The best approach for HPS control and prevention is through environmental hygiene practices that deter rodents from colonizing the work environment.
- Information about the symptoms of HPS and detailed guidance on preventive measures should be provided to all employees assigned to field activities.
- Medical attention should be sought immediately for workers who develop a febrile or respiratory illness within 45 days of the last potential exposure to rodents. Attending physicians should be advised of each worker's potential for occupational exposure to hantavirus. Physicians should contact local health authorities promptly if hantavirus-associated illness is suspected. A blood sample should be obtained from the affected worker and forwarded with the baseline serum sample through the state health department to the Centers for Disease Control and Prevention for hantavirus antibody testing.
- Respiratory protective equipment should be worn when handling rodents, when removing rodents from traps, and when working in areas with evidence of rodent droppings or hair. Respiratory protective equipment should include, at a minimum, a half-face air-purifying respirator (APR) or powered APR equipped with a high-efficiency particulate air (HEPA) filter (P100). Full-face regulators may be needed under some circumstances. Respiratory protective equipment should be used in accordance with Occupational Safety and Health Administration regulations.
- Dermal protection should be worn when handling rodents or traps containing rodents, or if contact with contaminated surfaces could occur. Dermal protection should include rubber or plastic gloves that should be washed and disinfected before removal.

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- A trap contaminated with rodent urine or feces or in which a rodent was captured should be disinfected with a commercial disinfectant or a 0.4 percent bleach solution. A dead rodent should be disposed of by placing the carcass in a plastic bag containing enough general-purpose household disinfectant to thoroughly wet the carcass. The bag should be sealed and disposed of by burning or by burying it in a 2- to 3-foot-deep hole. Local and state health departments can also provide appropriate disposal methods.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

USE OF HEAVY EQUIPMENT

SWP NO.: 6-26

ISSUE DATE: JULY 1998

REVISION: 1

Disclaimer: This safe work practice (SWP) is the property of Tetra Tech, Inc. (Tetra Tech), and its subsidiaries. Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

USE OF HEAVY EQUIPMENT

Truck-mounted heavy equipment and field trucks are among the types of equipment that may be used during field work. Heavy equipment can present a substantial hazard to workers. General requirements for motor vehicles and material-handling equipment are provided in the Occupational Safety and Health Administration (OSHA) Construction Industry Standards, 29 CFR 1926, Subpart O. The following precautions will be followed when heavy equipment (such as drill rigs, front-end loaders, and backhoes) is in use:

- Heavy equipment will be inspected by the operator before each work shift. The site safety coordinator (SSC) will ensure compliance with these precautions
- Equipment operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC
- Only qualified and licensed personnel will operate heavy equipment
- Hard hats, steel-toed boots, and safety glasses or goggles will be worn at all times around heavy equipment. Other personal protective equipment (PPE) specified in the site health and safety plan (HASP) will also be required
- Workers will not assume that the equipment operator is keeping track of their exact location. Workers will never walk directly behind or to the side of heavy equipment without the operator's knowledge
- Workers in close proximity to heavy equipment will maintain visual contact with equipment operators at all times
- When an operator must maneuver equipment in tight quarters, the presence of a second person will be required to ensure adequate clearance. If backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operators's normal field of vision to relay signals
- All heavy equipment used at a contaminated work site will be kept in the exclusion zone until the work has been completed. Such equipment will then be decontaminated within the designated decontamination area
- Hand-signal communications will be established when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators
- Equipment with an obstructed rear view must have an audible alarm that sounds when the equipment is moving in reverse (unless a spotter guides the operator)

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- Parking brakes will be kept engaged when equipment is not in use
- Blades, buckets, dump bodies, and other hydraulic systems will be kept fully lowered when equipment is not in use
- Equipment cabs will be kept free of all nonessential and loose items
- Seat belts must be present in all vehicles having a rollover protective structure (ROPS)
- With certain exceptions, all material-handling equipment must be equipped with ROPS
- Material-handling equipment that lacks a ROPS will not be operated on a grade unless the grade can safely accommodate the equipment involved
- Drilling auger sections and other equipment are extremely heavy. All precautions must be taken before moving heavy equipment. Appropriate equipment must be used to transport heavy equipment
- Only chains, hoists, straps, and other equipment that safely aids transport of heavy materials will be used
- Proper personal lifting techniques will be used. Workers will lift using their legs, not their backs
- A safety barrier will be used to protect workers when tires are inflated, removed, or installed on split rims
- An ongoing maintenance program for all tools and equipment must be in place. All tools and moving equipment will be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate according to manufacturer specifications. Defective items will be promptly repaired or replaced. Maintenance and repair logs will be kept
- Tools will be stored in clean, secure areas to prevent damage, loss, or theft
- Workers will not use equipment with which they are not familiar. This precaution applies to heavy as well as light equipment
- Loose-fitting clothing and loose, long hair will be prohibited around moving machinery
- Workers will make sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines present a hazard in the work area
- All personnel who are not essential to work activities will be kept out of the work area

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- Workers will be aware of their footing at all times
- Workers will remain alert at all times

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ATTACHMENT B2
AIS/TETRA TECH FORMS

- Compliance Agreement (Form HSP-4)
- Daily Tailgate Safety Meeting (Form HST-2)
- Daily Site Log (Form SSC-1)
- Field Audit Checklist (Form AF-1)
- Incident Report (Form IR)
- Incident Forms (Forms IR-A, IR-B, and IR-C)
- APP Amendment Form (APP-Amendment)

TETRA TECH, INC.

HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

Project Name: _____

Project Number: _____

I have read and understand the health and safety plan indicated above and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Name	Signature	Employer	Date

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM

Date: _____ Time: _____ Project No.: _____

Client: _____ Site Location: _____

Site Activities Planned for Today: _____

_____

Safety Topics Discussed
Protective clothing and equipment:
Chemical hazards:
Physical hazards:
Environmental and biohazards:
Equipment hazards:
Decontamination procedures:
Other:
Review of emergency procedures:
Employee Questions or Comments:

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Attendees	
Printed Name	**Signature**

Meeting Conducted by:

_____ _____

Name Title

_____

Signature

TETRA TECH, INC.

DAILY SITE LOG

Site Name:_____ Date: _____

Name (print)	Company	Time	
		In	Out

Comments:

_____

_____

_____

TETRA TECH, INC.

DOCUMENTATION OF FIELD EXPERIENCE

Employee Name:_____ Office: _____

Employee No.: _____ Date of Employment: _____

FIELD EXPERIENCE RECORD					
Level D	**Site**	**Activity**	**Supervisor**	**Date**	**Hours**
Level C	**Site**	**Activity**	**Supervisor**	**Date**	**Hours**
Level B	**Site**	**Activity**	**Supervisor**	**Date**	**Hours**
Level A	**Site**	**Activity**	**Supervisor**	**Date**	**Hours**

TETRA TECH, INC.

DOCUMENTATION OF FIELD EXPERIENCE (Continued)

This is to certify that _____ has completed the training and medical monitoring
(Employee Name)
requirements for hazardous waste field work in accordance with Title 29 of the *Code of Federal Regulations*, Part 1910.120, and is certified to work at hazardous waste sites in Level _____ and lower levels of protection.

_____
Printed Employee Name

_____ _____
Employee Signature Date

_____
Printed Health and Safety Representative Name

_____ _____
Health and Safety Representative Signature Date

TETRA TECH, INC.

FIELD AUDIT CHECKLIST

Project Name: _____ Project No.: _____

Field Location: _____ Completed by: _____

Project Manager: _____ Site Safety Coordinator: _____

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator present			
6	Daily tailgate safety meetings conducted and documented			
7	On-site personnel meet HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	Compliance with specified safe work practices			
9	Documentation of training, medical examinations, and fit tests available from employer			
10	Exclusion, decontamination, and support zones delineated and enforced			
11	Windsock or ribbons in place to indicate wind direction			
12	Illness and injury prevention program reports completed (California only)			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			
16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
18	Eyewash stations in place			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
23	Environmental and personnel monitoring performed as specified in HASP			

TETRA TECH, INC.

FIELD AUDIT CHECKLIST (Continued)

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
1	Splash suit			
2	Chemical protective clothing			
3	Safety glasses or goggles			
4	Gloves			
5	Overboots			
6	Hard hat			
7	Dust mask			
8	Hearing protection			
9	Respirator			
Instrumentation				
10	Combustible gas meter			
11	Oxygen meter			
12	Organic vapor analyzer			
Supplies				
13	Decontamination equipment and supplies			
14	Fire extinguishers			
15	Spill cleanup supplies			
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

Note: NA = Not applicable

_____
Auditor's Signature

_____
Site Safety Coordinator's Signature

_____
Date

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT REPORT

Report Date	Report Prepared By	Incident Report Number

INSTRUCTIONS:

All incidents (including those involving subcontractors under direct supervision of Tetra Tech personnel) must be documented on the IR Form.

Complete any additional parts to this form as indicated below for the type of incident selected.

TYPE OF INCIDENT (Check all that apply)	Additional Form(s) Required for this type of incident
Near Miss (No losses, but could have resulted in injury, illness, or damage)	☐ Complete IR Form Only
Injury or Illness	☐ Complete Form IR-A; Injury or Illness
Property or Equipment Damage, Fire, Spill or Release	☐ Complete Form IR-B; Damage, Fire, Spill or Release
Motor Vehicle	☐ Complete Form IR-C; Motor Vehicle

INFORMATION ABOUT THE INCIDENT

Description of Incident

_____

_____

_____

_____

Date of Incident	Time of Incident
	_____ AM ☐ PM ☐ *OR* Cannot be determined ☐
Weather conditions at the time of the incident	**Was there adequate lighting?**
	_____ Yes ☐ No ☐

Location of Incident

_____ Was location of incident within the employer's work environment? Yes ☐ No ☐

Street Address	City, State, Zip Code and Country
Project Name	**Client:**
Tt Supervisor or Project Manager	**Was supervisor on the scene?**
	Yes ☐ No ☐

WITNESS INFORMATION (attach additional sheets if necessary)

Name	Company
Street Address	**City, State and Zip Code**

Telephone Number(s)

CORRECTIVE ACTIONS

Corrective action(s) immediately taken by unit reporting the incident:

_____

_____

_____

_____

Corrective action(s) still to be taken (by whom and when):

_____

_____

_____

_____

ROOT CAUSE ANALYSIS LEVEL REQUIRED

Root Cause Analysis Level Required: Level - 1 ☐ Level - 2 ☐ None ☐

Root Cause Analysis Level Definitions

Level - 1	**Definition:** A Level 1 RCA is conducted by an individual(s) with experience or training in root cause analysis techniques and will conduct or direct documentation reviews, site investigation, witness and affected employee interviews, and identify corrective actions. Activating a Level 1 RCA and identifying RCA team members will be at the discretion of the Corporate Administration office. The following events may trigger a Level 1 RCA: ▪ Work related fatality ▪ Hospitalization of one or more employee where injuries result in total or partial permanent disability ▪ Property damage in excess of $75,000 ▪ When requested by senior management
Level - 2	**Definition:** A Level 2 RCA is self performed within the operating unit by supervisory personnel with assistance of the operating unit HSR. Level 2 RCA will utilize the 5 Why RCA methodology and document the findings on the tools provided. The following events will require a Level 2 RCA: ▪ OSHA recordable lost time incident ▪ Near miss incident that could have triggered a Level 1 RCA ▪ When requested by senior management

Complete the Root Cause Analysis Worksheet and Corrective Action form. Identify a corrective action(s) for each root cause identified within each area of inquiry.

NOTIFICATIONS

Title	Printed Name	Signature	Telephone Number	Date
Project Manager or Supervisor				
Site Safety Coordinator or Office H&S Representative				
Operating Unit H&S Representative				
Other: _____				

The signatures provided above indicate that appropriate personnel have been notified of the incident.

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TETRA TECH, INC.
INCIDENT FORM IR-A

INSTRUCTIONS:

Complete all sections below for incidents involving injury or illness.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

EMPLOYEE INFORMATION

Company Affiliation

Tetra Tech Employee? ☐ TetraTech subcontractor employee (directly supervised by Tt personnel)? ☐

Full Name	**Company (if not Tt employee)**

Street Address, City, State and Zip Code	**Address Type**
_____	Home address (for Tt employees) ☐
_____	Business address (for subcontractors) ☐

Telephone Numbers

Work: _____	Home: _____	Cell: _____

Occupation (regular job title)	**Department**

Was the individual performing regular job duties?	**Time individual began work**
Yes ☐ No ☐	_____ AM ☐ PM ☐ *OR* Cannot be determined ☐

Safety equipment

Provided? Yes ☐ No ☐

Used? Yes ☐ No ☐ If no, explain why

_____

_____

_____

Type(s) provided:

- ☐ Hard hat
- ☐ Protective clothing
- ☐ Gloves
- ☐ High visibility vest
- ☐ Eye protection
- ☐ Fall protection
- ☐ Safety shoes
- ☐ Machine guarding
- ☐ Respirator
- ☐ Other (list)

_____

NOTIFICATIONS

Name of Tt employee to whom the injury or illness was first reported	**Was H&S notified within one hour of injury or illness?**
	Yes ☐ No ☐
Date of report	**H&S Personnel Notified**
Time of report	**Time of Report**

If subcontractor injury, did subcontractor's firm perform their own incident investigation?

Yes ☐ No ☐ If yes, request a copy of their completed investigation form/report and attach it to this report.

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INCIDENT FORM IR-A

INJURY / ILLNESS DETAILS

What was the individual doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the individual was using. Be specific. Examples: "Climbing a ladder while carrying roofing materials"; "Spraying chlorine from a hand sprayer"; "Daily computer key-entry"

_____

_____

_____

What Happened? Describe how the injury occurred. Examples: "When ladder slipped on wet floor and worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; Worker developed soreness in wrist over time"

_____

_____

_____

_____

Describe the object or substance that directly harmed the individual: Examples: "Concrete floor"; "Chlorine"; "Radial Arm Saw". If this question does not apply to the incident, write "Not Applicable".

_____

_____

MEDICAL CARE PROVIDED

Was first aid provided at the site: Yes ☐ No ☐ If yes, describe the type of first aid administered and by whom?

_____

Was treatment provided away from the site: Yes ☐ No ☐ If yes, provide the information below.

Name of physician or health care professional	**Facility Name**
Street Address, City State and Zip Code	**Type of Care?**
_____ _____	Was individual treated in emergency room? Yes ☐ No ☐ Was individual hospitalized overnight as an in-patient? Yes ☐ No ☐ Did the individual die? Yes ☐ No ☐ If yes, date: _____ Will a worker's compensation claim be filed? Yes ☐ No ☐
Telephone Number	

NOTE: Attach any police reports or related diagrams to this report.

SIGNATURES

I have reviewed this report and agree that all the supplied information is accurate

Affected individual (print)	**Affected individual (signature)**	**Telephone Number**	**Date**

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

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INCIDENT FORM IR-B

INSTRUCTIONS:

Complete all sections below for incidents involving property/equipment damage, fire, spill or release.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

TYPE OF INCIDENT (Check all that apply)

Property Damage ☐ Equipment Damage ☐ Fire or Explosion ☐ Spill or Release ☐

INCIDENT DETAILS

Results of Incident: Fully describe damages, losses, etc.

_____

_____

_____

Response Actions Taken:

_____

_____

_____

Responding Agency(s) (i.e. police, fire department, etc.)	**Agency(s) Contact Name(s)**

DAMAGED ITEMS (List all damaged items, extent of damage and estimated repair cost)

Item:	**Extent of damage:**	**Estimated repair cost**

SPILLS / RELEASES (Provide information for spilled/released materials)

Substance	**Estimated quantity and duration**	**Specify Reportable Quantity (RQ)**
		_____ Exceeded? Yes ☐ No ☐ NA ☐

FIRES / EXPLOSIONS (Provide information related to fires/explosions)

Fire fighting equipment used? Yes ☐ No ☐ If yes, type of equipment: _____

NOTIFICATIONS

Required notifications	**Name of person notified**	**By whom**	**Date / Time**
Client: _____ Yes ☐ No ☐			
Agency: _____ Yes ☐ No ☐			
Other: _____ Yes ☐ No ☐			

Who is responsible for reporting incident to outside agency(s)? Tt ☐ Client ☐ Other ☐ Name: _____

Was an additional written report on this incident generated? Yes ☐ No ☐ If yes, place in project file.

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TETRA TECH, INC.
INCIDENT FORM IR-C

INSTRUCTIONS:

Complete all sections below for incidents involving motor vehicle accidents. Do NOT leave any blanks. Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

INCIDENT DETAILS

Name of road, street, highway or location where accident occurred	**Name of intersecting road, street or highway if applicable**

County	**City**	**State**

Did police respond to the accident?	**Did ambulance respond to the accident?**
Yes ☐ No ☐	Yes ☐ No ☐
Name and location of responding police department	**Ambulance company name and location**
Officer's name/badge #	

Did police complete an incident report? Yes ☐ No ☐ If yes, police report number: _____
Request a copy of completed investigation report and attach to this form.

VEHICLE INFORMATION

How many vehicles were involved in the accident? _____ (Attach additional sheets as applicable for accidents involving more than 2 vehicles.)

Vehicle Number 1 – Tetra Tech Vehicle		**Vehicle Number 2 – Other Vehicle**	
Vehicle Owner / Contact Information		**Vehicle Owner / Contact Information**	
Color		**Color**	
Make		**Make**	
Model		**Model**	
Year		**Year**	
License Plate #		**License Plate #**	
Identification #		**Identification #**	
Describe damage to vehicle number 1		**Describe damage to vehicle number 2**	
Insurance Company Name and Address		**Insurance Company Name and Address**	
Agent Name		**Agent Name**	
Agent Phone No.		**Agent Phone No.**	
Policy Number		**Policy Number**	

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INCIDENT FORM IR-C

DRIVER INFORMATION

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
Driver's Name		**Driver's Name**	
Driver's Address		**Driver's Address**	
Phone Number		**Phone Number**	
Date of Birth		**Date of Birth**	
Driver's License #		**Driver's License #**	
Licensing State		**Licensing State**	
Gender	Male ☐ Female ☐	**Gender**	Male ☐ Female ☐
Was traffic citation issued to Tetra Tech driver? Yes ☐ No ☐		Was traffic citation issued to driver of other vehicle? Yes ☐ No ☐	
Citation #		**Citation #**	
Citation Description		**Citation Description**	

PASSENGERS IN VEHICLES (NON-INJURED)

List all non-injured passengers (excluding driver) in each vehicle.
Driver information is captured in the preceding section.
Information related to persons injured in the accident (non-Tt employees) is captured in the section below on this form.
Injured Tt employee information is captured on FORM IR-A

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
How many passengers (excluding driver) in the vehicle? _____		How many passengers (excluding driver) in the vehicle? _____	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	

INJURIES TO NON-TETRATECH EMPLOYEES

Name of injured person 1				Address of injured person 1		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐
Name of injured person 2				**Address of injured person 2**		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐

OTHER PROPERTY DAMAGE

Describe damage to property other than motor vehicles	
Property Owner's Name	**Property Owner's Address**

COMPLETE AND SUBMIT DIAGRAM DEPICTING WHAT HAPPENED

AMERICAN INTEGRATED SERVICES / TETRA TECH EM INC.

ACCIDENT PREVENTION PLAN AMENDMENT

Site Name: _____

Amendment Date: _____

Purpose or Reason for Amendment: _____

_____

_____

_____

_____

_____

Required Changes in PPE: _____

_____

_____

_____

_____

Action Level Changes: None._____

_____

_____

AMENDMENT APPROVAL

	Name	Signature	Date
HSD or Designee			
Site Safety Coordinator			

Date presented during daily site safety meeting: _____

ATTACHMENT B3
SITE-SPECIFIC PLANS

- Emergency Response Plan
- Plan for prevention of alcohol and drug abuse (*Note: This document is the policy statement*)
- Site sanitation plan
- Hazard communication program
- Heat/Cold Stress Monitoring Plan
- Fire Prevention Plan

EMERGENCY RESPONSE PLAN
ORION PARK HOUSING AREA
FORMER NAVAL AIR STATION MOFFETT FIELD, MOUTAIN VIEW, CALIFORNIA

This Emergency Response Plan describes site-specific procedures to be implemented during the field activities at the Orion Park Housing Area (OPHA) located at the Former Naval Air Station (NAS) Moffett Field, Mountain View, California. The following sections discuss on-site communications, evacuation routes and procedures, hospital route directions, and emergency equipment and facilities.

1.0 ON-SITE COMMUNICATIONS

Successful communication between field teams and personnel in the support zone is essential. In non-combustible atmospheres, the cellular telephones will be used during on-site activities. Personnel are required to report all injuries, illnesses, spills, fires, and property damage to the AIS/Tetra Tech Site Safety Coordinator (SSC). The SSC must be notified of any on-site emergencies and is responsible for ensuring that the appropriate emergency procedures described in this section are followed.

For work during the field activities at OPHA, it has been determined that the AIS/Tetra Tech SSC shall communicate directly with the Army Contracting Officer Representative (COR), Cynthia Burris (916-557-6745) after on-site and off-site emergency assistance has been obtained. A list of emergency contacts and their telephone numbers is provided below.

2.0 EVACUATION ROUTES AND PROCEDURES

In the event of an emergency that necessitates evacuation of a work task area or the site, the AIS/Tetra Tech SSC shall contact all nearby personnel using the on-site communications to advise the personnel of the emergency. The personnel will proceed along site roads to a safe distance upwind from the hazard source, and will remain in there until the SSC or an authorized individual provides further instructions.

3.0 HOSPITAL ROUTE DIRECTIONS

The closest hospital to the site is Kaiser Permanente Mountain View Medical Center located at 550 Castro Street in Mountain View, California. Directions to this hospital, as well as contact numbers for both the hospital and ambulance services, are included below.

4.0 EMERGENCY MEDICAL TREATMENT PROCEDURES

If a person on-site suffers an illness or injury, first aid should be administered until an ambulance or paramedics arrive. All injuries and illnesses must be reported immediately to the AIS/Tetra Tech project manager and Health and Safety Manager. If personnel decontamination can be performed, it should be performed.

5.0 EMERGENCY EQUIPMENT AND FACILITIES

The following emergency equipment will be available on site during field activities:

- First aid kit
- Eye wash (portable) (ANSI-Z358.1-2004 compliant)
- Fire extinguisher
- Mobile telephone

EMERGENCY CONTACTS AND ROUTE TO HOSPITAL

Emergency Contact	Telephone No.
California Poison Control System	(800) 222-1222
WorkCare	(800) 455-6155
Fire Department (Mountain View Fire Department)	911 or (650) 903-6365
Police Department (Mountain View Police Department)	911 or (650) 903-6364
AIS/Tetra Tech Personnel:	
Human Resource Development: Amy Clark	(626) 470-2516
AIS Health and Safety Manager: David Herrera	(310) 522-1168
Tetra Tech Health and Safety Manager: Dave Brown	(619) 525-7188
AIS/Tetra Tech Program Manager: Kelly Stater	(805) 639-0884
AIS/Tetra Tech Task Order Manager: Kevin Bricknell	(510) 302-6306,
AIS/Tetra Tech Deputy Task Order Manager: Dayna Yocum	(510) 302-6242
Field Team Lead: O. Kelly Murphy	(805) 636-6005
Site Safety Coordinator (Phases 2, 3, and 4): O. Kelly Murphy	(805) 636-6005
Site Safety Coordinator (Phases 1 and 5): Dayna Yocum	(510) 302-6242
Chemist: Sara Woolley	(510) 302-6311
Environmental Scientist: Rebecca Johnson	(510)302-6258
Professional Geologist: Jim Wulff	(303) 312-8834
IDW Management: AIS, Jennifer Sherman,	(310) 522-1168
Subcontractors:	
Utility Locator: Precision Locating, Julie	(925) 516-2860
Surveying: Hunter Surveying, James White	(916) 988-5600
Driller: RSI Drilling, David Boggs	(510) 532-2424
USACE Client Contact:	
Army Remedial Project Manager : Guy Romine	(443) 567-1772
Contracting Officer: Angie Hermenson	(916) 547-7945
Contracting Officer Representative: Cynthia Burris	(916) 557-6745

** In case of emergency, always dial 911.*

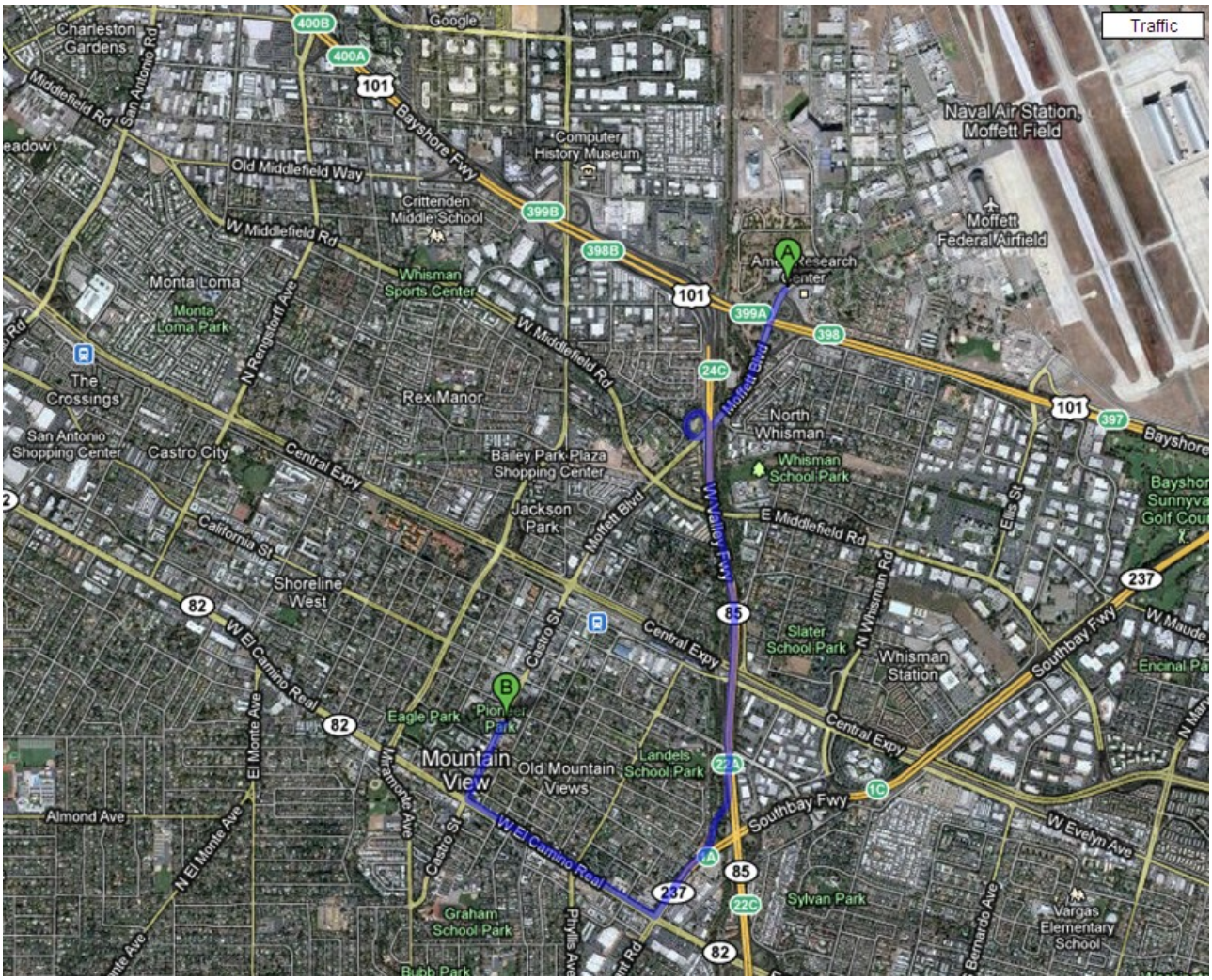
Emergency Evacuation Meeting Location:
Upwind of the location where work is being performed.

Medical Emergency

Hospital Name:	Kaiser Permanente Mountain View Medical Center
Hospital Address:	**555 Castro Street** Mountain View, California
Hospital Telephone No.:	General (650) 903-3022
Ambulance Telephone No.:	911

Directions to Kaiser Permanente Mountain View Medical Center:

START:	**OPHA**	
1.	**(A)** Head southwest on Moffett Boulevard	1.2 mile
2.	Continue onto Castro St	0.2 mile
3.	Turn right at Mercy St	0.1 mile
4.	Take the 1st left onto Franklin Street	0.1 mile
5.	Take the 1st left onto Church Street	0.1 mile
6.	Take the 1st left onto Castro Street	0.1 mile
7.	**(B)** Destination on RIGHT:	
END:	**End at Kaiser Permanente Mountain View Medical Center: 555 Castro Street, Mountain View, CA (Total Distance = 2.1 miles; Total Time = about 7 minutes)**	



AIS/TETRA TECH
SUBSTANCE ABUSE POLICY STATEMENT

I. INTRODUCTION

AIS/Tetra Tech are committed to providing employees with a safe and healthy work environment, free from the effects of drug and alcohol abuse. To demonstrate our commitment to that goal, AIS/Tetra Tech has implemented a substance abuse policy.

II. POLICY STATEMENT

This policy prohibits the unlawful manufacture, distribution, dispensation, possession, or use of controlled substances on any Company-owned or leased space, client facility or work site. The policy further states that employees shall not use alcohol or drugs on or off Company property where its usage affects their ability to perform their jobs.

In order to enforce this policy, the Company may investigate potential violations and require personnel to undergo drug/alcohol screening, including urinalysis, blood tests or other appropriate tests. The Company may also conduct searches of all areas of the Company premises, including, but not limited to work areas, rest rooms, break areas, personal articles, employee's clothes, desks, work stations, lockers, and personal and Company-owned vehicles.

Violation of this policy or any of its provisions may result in disciplinary action up to and including termination of employment. Employees may be subject to discipline up to and including termination for refusing to cooperate with searches or investigations, refusing to submit to screening, or failing to execute consent forms when required by supervisors.

Employees who are convicted of any criminal drug statute for a violation occurring in the workplace are required to notify their human resources representative no later than five days after the conviction. It shall also be the responsibility of each employee who observes or has knowledge of another employee in a condition which impairs the employee to perform his or her job duties or who presents a hazard to the safety and welfare of others to promptly report that fact to his or her immediate supervisor.

III. EMPLOYEE ASSISTANCE PROGRAMS

Employees who are experiencing problems with drug and/or alcohol abuse are urged to participate in a Company-sponsored Employee Assistance Program (EAP) where available. Volunteering to participate in an EAP to address substance abuse problems does not relieve an employee of the obligation to satisfy the Company's standards regarding an employee's performance, and participation will not prevent the Company from administering discipline for violation of its policies.

It is the responsibility of the employee to seek and accept assistance before drug and alcohol problems lead to disciplinary actions. Confidentiality of records and information will be maintained in accordance with all local, state, and federal laws.

IV. TESTING

AIS/Tetra Tech shall conduct drug and alcohol test in the following circumstances:

A. Where there is reasonable suspicion that an employee may have violated the rules set forth in this policy. Reasonable suspicion may rise from, among other factors, supervisory observation, co-worker reports or complaints, performance decline, attendance or behavioral changes, results of drug searches or other detection methods or involvement in a workplace or vehicular accident indicating a possible error in judgment or negligence.

B. Prior to employment as required by any Tetra Tech entity which has implemented a pre-employment drug screening program. All offers of employment for those entities will be contingent upon the results of the drug test. Job applicants must submit to a drug test. Refusal to submit or a positive confirmed drug test may be used as a basis for refusal to hire the applicant.

C. The company shall subject applicants and current employees to pre-employment drug testing and/or random drug testing when required through specific project contracts. Affected employees will be notified of such drug testing requirements and will be included in project specific drug testing programs in accordance with applicable local, state, and federal regulations.

D. Drug testing may also be conducted as part of or as follow up to a prescribed treatment program for substance abuse.

Note: Some Tetra Tech entities have a Supplemental Substance Abuse Policy with additional guidelines that are required due to the Drug Free Workplace Act or contractual requirements. Copies of these policies are available for review from your Human Resource Department.

SITE SANITATION PLAN
ORION PARK HOUSING AREA
FORMER NAVAL AIR STATION MOFFETT FIELD, MOUTAIN VIEW, CALIFORNIA

This Site Sanitation Plan was prepared by AIS/Tetra Tech in accordance with Section 2 of U.S. Army Corp of Engineers, Engineer Manual 385-1-1 (USACE 2008). The following sections describe the sanitation provisions that will be established and maintained by AIS/Tetra Tech during the field activities to be conducted at OPHA.

1.0 DRINKING WATER

An adequate supply of drinking water shall be provided during the field activities. Commercially bottled drinking water will be provided at the site. Cool water shall be provided during hot weather. Sharing of drinking water bottles between employees is prohibited. Storage containers for non-potable water, such as water for decontamination, will be clearly labeled to indicate that the water is not suitable for drinking.

2.0 TOILETS

Portable bathrooms will be available at OPHA for using during field activities.

3.0 WASHING FACILITIES

A source of running water and facilities for cleaning up at the end of the day will be available next to the portable bathroom. All employees are required to use hand sanitizers after using the toilet, before eating or drinking, and as often as necessary. Employees will remove and properly dispose of any disposable protective clothing prior to leaving the site.

4.0 FOOD SERVICE

Food service will not be provided. Employees who bring food or beverage shall not consume food or beverage in an unsanitary area such as a toilet facility or in any area exposed to a toxic material. Trash will be disposed of in a waste receptacle.

AIS/TETRA TECH
HAZARD COMMUNICATION PROGRAM

The hazard communication program was developed to protect the right of AIS/Tetra Tech, employees and subcontractors to access information on the chemical and physical hazards of materials they use in their work. Specifically, this written hazard communication program defines the measures to communicate these hazards and ensure that AIS/Tetra Tech employees and subcontractors are informed of chemical hazards in accordance with the requirements outlined in Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.1200, the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard. The OSHA standard applies to all work places where personnel are occupationally exposed to hazardous chemicals. In addition, to ensure employee rights, this hazard communication program shall be available upon request to employees and their representatives. The hazard communication program does not apply to hazardous wastes but does apply to all hazardous materials, such as acids and caustics, used in sample preparation and to cleaning solvents brought onto and used at a work site. The responsibilities and elements associated with the hazard communication program are discussed below.

1.0 HAZARD COMMUNICATION PROGRAM RESPONSIBILITIES

Corporate Health and Safety Manager (CHSM): The CHSM shall ensure compliance with the requirements identified in this hazard communication program by conducting annual regional and subsidiary audits. The CHSM shall also act as a resource to regions and subsidiaries regarding hazard communication compliance issues.

Regional Health and Safety Representative (RHSR) and Subsidiary Health and Safety Representative (SHSR): The RHSRs and SHSRs shall ensure that all offices within their region or organization are familiar with the hazard communication program and that its program elements are implemented at each office.

Operations Manager: All operations managers shall support an effective hazard communication program within their office or area. Operations managers may elect to delegate the day-to-day administration of the hazard communication program to the office health and safety representative (OHSR).

Office Health and Safety Representative (OHSR): The OHSR, upon assignment by the operations manager, shall implement the hazard communication program within his or her office. Specifically, the OHSR shall perform the following duties:

- Communicate program requirements to employees included in the Health and Safety Program or required to implement program requirements off site
- Provide for the necessary hazard communication training
- Maintain chemical inventories and material safety data sheet (MSDS) files within their respective office

Task Order Manager: Task order manager shall ensure that all hazard communication program requirements have been identified and addressed within site safety and health plans (SSHP) for their projects. This task may include, but is not limited to, the following:

- Identification of work tasks (routine and nonroutine) and performance of an associated hazard analysis
- Completion of a chemical inventory for the project
- Procurement of MSDSs for chemicals used exclusively for the project
- Labeling of containers used on site for hazardous materials
- Identification of any additional hazard communication training requirements

Site Safety Coordinator (SSC): The SSC shall be the main point of contact for hazard communication program compliance during on-site phases of project operations. The SSC shall have the following duties:

- Maintain current chemical inventories and MSDS files for the project
- Ensure compliance with container labeling requirements
- Identify new chemicals brought on site that present new hazards requiring additional training then add information to chemical inventory and MSDS files

2.0 HAZARD COMMUNICATION PROGRAM ELEMENTS

The following program elements describe how the criteria specified by the OSHA Hazard Communication Standard shall be implemented and maintained. Program elements include the following:

- Hazard determination
- Hazardous chemical inventory
- Labeling and containers
- Material Safety Data Sheets
- Employee training
- Subcontractors

Each of these elements is described below.

2.1 HAZARD DETERMINATION

In most cases, the determination of chemical hazards will be based on information provided by the chemical's manufacturer. In situations where this is not possible, a hazard determination shall be conducted by AIS/Tetra Tech based on the criteria established in Appendices A and B of the hazard communication standard of 29 CFR, Part 1910.1200.

Additionally, the chemicals listed in the following resources are to be considered hazardous and shall fall under the scope of this hazard communication program:

- 29 CFR, Part 1910, Subpart Z, "Toxic and Hazardous Substances," OSHA
- *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment*, American Conference of Governmental Industrial Hygienists (ACGIH), latest edition
- *Annual Report on Carcinogens*, National Toxicology Program (NTP), latest edition
- International Agency for Research on Cancer (IARC) *Monographs*, latest edition

It is important to note that some chemicals not specifically defined as hazardous and regulated under the OSHA Hazard Communication Standard are subject to the State of California Health and Safety Code "Safe Drinking Water and Toxic Enforcement Act" (Proposition 65). As necessary, AIS/Tetra Tech will provide the appropriate warnings for these chemicals as required by California Code of Regulations, Title 22, Section 12601(c). The warning may consist of a label on the container or a sign in the work area where the exposure may occur.

Chemical mixtures are defined as any combination of two or more chemicals if the combination is not in whole or in part the result of a chemical reaction. If a chemical mixture has not been tested as a whole to determine whether the mixture is hazardous, then the mixture shall be assumed to present the same health hazards as each component that makes up 1 percent or greater of the mixture by weight or volume. A mixture will be considered potentially carcinogenic if it contains a carcinogenic component at a concentration of 0.1 percent or greater.

If evidence indicates that a component in a mixture at a concentration of less than 1 percent (or, in the case of carcinogens, less than 0.1 percent) could be released at a concentration that exceeds an established OSHA permissible exposure limit or ACGIH threshold limit value or that could present a health risk to employees at the released concentration, the mixture is assumed to present the same hazard as that component.

If the mixture has not been tested as a whole to determine whether the mixture presents a physical hazard (such as combustible or explosive), AIS/Tetra Tech will use whatever scientifically valid data are available to evaluate the physical hazard potential of the mixture.

2.2 HAZARDOUS CHEMICAL INVENTORY

For each field project, the project manager will develop and maintain a current list of hazardous materials (hazardous chemical inventory) brought on site. Ideally, the list will be contained within or attached to the HASP. The existence and location of these documents shall be communicated to all employees and subcontractors prior to start of project. Small quantities of hazardous chemicals may also be present at AIS/Tetra Tech offices and storage areas. For purposes of this program or as required by the OSHA Hazard Communication Standard, chemicals and consumer products not used in the same manner, duration, or frequency intended by consumers shall be included on the hazardous chemical inventory. A list of hazardous chemicals present in the office or storage area shall be maintained by the OHSR of each AIS/Tetra Tech and subsidiary office.

2.3 LABELING AND CONTAINERS

When a chemical is received from a manufacturer or distributor, the employee responsible for its receipt will verify that the container is properly labeled with the following information:

- The contents
- Appropriate hazard warning(s) [as listed on the MSDS(s)]
- Name and address of the chemical manufacturer

All chemicals associated with a project should be stored, dispensed from, or otherwise used in their original containers. The use of secondary containers should be avoided. However, secondary containers may be used when the chemical will be immediately used by the employee that made the transfer. Container labeling is not required for secondary immediate uses.

All original labels, warnings, and other printed information must be maintained intact and plainly visible at all times. Original labels shall not be defaced. Hazardous materials will not be allowed on a project site if they are not in the original or approved containers or if the containers are unlabeled or improperly labeled. When stationary process containers, such as tanks that cannot be moved, are used on a project, AIS/Tetra Tech may elect to use signs, placards, operating procedures, or other such written materials instead of affixing labels to individual stationary containers as long as the required label information is conveyed. If written materials are used, then this information shall be readily available to employees in the area.

2.4 MATERIAL SAFETY DATA SHEETS

All chemicals brought on or used at a work site must be accompanied by MSDSs provided by the manufacturer. Chemicals will not be permitted at the work site without MSDSs. Whenever a chemical is purchased, it is the responsibility of the individual in charge of the purchase to obtain a current and complete MSDS as part of the order. A written request will be made for an MSDS if one is not received. If an MSDS is still not received after the original written request, a second request will be made in writing or by telephone. If the supplier refuses to provide an MSDS, the local OSHA office will be contacted for further assistance. If a supplier MSDS is not readily available, a generic MSDS can be used instead.

Once received, the MSDS shall be reviewed and evaluated by the purchaser and the SSC for completeness and to determine if the new chemical will pose any new or significant risks that require additional hazard communication training.

A copy of each MSDS will be maintained in the project file and included in the site-specific HASP. Employees will have unhindered access to the MSDSs at all times.

In addition, prior to beginning work, subcontractors will be required to provide the project manager with a list of all chemicals that they will use and an MSDS for each chemical. The OHSR or SSC will evaluate the MSDSs and list of chemicals to determine if the chemicals used pose any new or significant risks to AIS/Tetra Tech employees. Additional training will be provided, if required.

Each MSDS shall contain, at a minimum, the following information:

- Name of the product on the label
- Chemical and common names of each ingredient if the product is a mixture
- Physical and chemical characteristics of the chemical
- Physical hazards of the chemical
- Health hazards of the chemical
- Primary routes of exposure
- OSHA permissible exposure limits, ACGIH threshold limit values, and any other exposure limit used or recommended by the chemical manufacturer or importer
- Whether the hazardous chemical is listed in the NTP *Annual Report on Carcinogens* or has been found to be a potential carcinogen in the IARC *Monographs* or by OSHA
- Precautions for safe handling
- Exposure control measures
- Emergency and first aid procedures
- Date of MSDS preparation or the last date of the last revision
- The name, address, and telephone number of the chemical manufacturer or importer, or of someone who can provide additional information on the chemical and appropriate emergency procedures, if necessary

If no information is available for any given category on the MSDS, the chemical manufacturer is required to mark the MSDS to indicate that no applicable information was found. Blanks are not allowed.

2.5 EMPLOYEE TRAINING

The project manager or designee will provide information and training to employees upon assignment to a job task involving the use of hazardous materials and whenever a new material posing new physical or health hazards is introduced.

General information and training will be provided in the initial 40-hour health and safety training class and refresher training classes as required under 29 CFR 1910.120. Information conveyed to employees during training will include the following:

- Requirements of the hazard communication standard in 29 CFR 1910.1200
- The types of operations in an employee's work zone that involve hazardous materials
- The location of copies of the hazard communication program, MSDSs, and the chemical inventory
- Methods and observations that may be used to detect the presence or release of a hazardous material in the work area (such as monitoring conducted by the employer, continuous monitoring devices, or visual appearance or odor of hazardous materials being released)
- Recognition of signs and symptoms that may indicate exposure to hazards such as dizziness, nausea, skin rash, and other symptoms
- Signs and symptoms of chemical exposure
- Physical and health hazards associated with materials in the work area
- Protective measures, including specific procedures such as appropriate work practices, emergency procedures, and use of personal protective equipment (PPE), that AIS/Tetra Tech has implemented to protect employees from exposure to hazardous materials
- Details of the hazard communication program developed by AIS/Tetra Tech, including an explanation of the labeling system and MSDSs and how employees can obtain and use the appropriate hazard information
- How to read and use MSDSs
- When to include MSDSs in site-specific HASPs

2.6 SUBCONTRACTORS

AIS/Tetra Tech shall provide subcontractors at a work site with a copy of the site-specific HASP. The HASP shall include the following hazard communication information:

- Hazard analysis of work tasks
- Chemical hazards anticipated at the site
- Recommended PPE
- Air monitoring instruments to be used for site hazards
- Information on the major chemical hazards in the form of MSDSs or a chemical hazard information table

AIS/Tetra Tech will make available to subcontractors copies of MSDSs, by including all of them in the HASP, for each hazardous chemical brought on site by AIS/Tetra Tech that the subcontractor may be exposed to while working on site. Subcontractors will be informed of any precautionary measures that need to be taken to protect their employees using hazardous materials brought on site by AIS/Tetra Tech during the site's normal operating conditions and during potential emergency situations.

AIS/Tetra Tech will inform subcontractors of the hazardous materials labeling system used on site. Each subcontractor will be required to have its own hazard communication program in accordance with 29 CFR 1910.1200 and applicable state and local regulations. An MSDS is also required for each hazardous material a subcontractor brings to the site.

HEAT AND COLD STRESS MONITORING PLAN

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 104 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as • Possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

AIS/TETRA TECH
EMERGENCY ACTION AND FIRE PREVENTION PLAN

This program was developed by AIS/Tetra Tech to establish guidelines and procedures to be followed in emergency situations and to meet the requirements of Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.38, and of Title 8 of the *California Code of Regulations*, Sections 3220 and 3221. This program applies to all offices in the State of California and may be used by all other AIS/Tetra Tech offices.

This program must be used in conjunction with the "Emergency Action and Fire Prevention Plan" (EAFPP), Form EAFP-1 in Volume III.

Because emergency situations require quick action and careful attention to detail, it is important that all individuals involved in coordinating emergency actions and all personnel understand specific procedures to follow in case of an emergency. Not all emergency situations can be anticipated and planned for. The following sections describe EAFPP coordination, program responsibilities, emergency reporting, evacuation procedures, training, and fire prevention.

1.0 EAFPP COORDINATION

The operations manager (OM) is responsible for implementing the EAFPP. The OM may delegate dayto-day tasks and training responsibilities to the office health and safety representative (OHSR). The OM and OHSR shall take the lead and be responsible for determining actions for emergencies not specifically outlined in the EAFPP. The OM and OHSR shall act as contacts for both employee and outside information requests.

The EAFPP shall be accessible to all staff, as well as to corporate health and safety personnel and federal or state health and safety inspectors.

2.0 PROGRAM RESPONSIBILITIES

Generally, AIS/Tetra Tech personnel are not trained for or allowed to conduct emergency rescues. However, the OM and OHSR will be responsible for advising trained rescue personnel (such as fire fighters, police, emergency medical technicians, and so on) as necessary regarding facility layout, number of personnel, and other pertinent information.

Office personnel holding current certification in cardiopulmonary resuscitation (CPR) or first-aid are authorized to provide medical assistance within the limits of their training.

At this time, AIS/Tetra Tech offices do not use or maintain equipment that is critical to business operations that will require a specific shutdown or continuation of operation during an emergency.

3.0 EMERGENCY REPORTING

General emergencies and office evacuations will be reported by telephone and the intercom system. Any individual can report an emergency. Some offices, such as those in high-rise buildings, may have additional alarm systems. Employees should be aware of these systems. A general building alarm could indicate a fire or emergency in another section of the building but will trigger evacuation of a AIS/Tetra Tech office unless building management indicates that the signal was a false alarm. Any additional office specific reporting procedures shall be documented on Form EAFP-1.

An emergency in a AIS/Tetra Tech office, especially a fire, requires activation of the building alarm. The first available individual should trip a building alarm to warn other building occupants.

Telephone numbers besides 911 for local emergency providers will be maintained at the reception desk and by the OHSR. The OHSR will have primary responsibility for contacting the appropriate service, followed by the receptionist.

4.0 EVACUATION PROCEDURES

The following are examples of incidents that could initiate an office evacuation:

- Fire
- Earthquake
- Power outage

Evacuation routes and office-specific procedures to account for personnel after an evacuation must be included in the EAFPP (see Attachment A to Form EAFP-1 in Volume III). A diagram of the evacuation route shall also be posted prominently in common areas of the office. The EAFPP must designate a meeting location (rendezvous point) after an evacuation. A head count shall be conducted at the rendezvous point by the OM or, in his or her absence, the OHSR. No re-entry into the evacuated building will be allowed until the emergency situation is over and the building is deemed safe for entry by emergency responders. The names of individuals noted as missing will be reported to the emergency service providers.

No specific office employee is assigned the responsibility for evacuation assistance. If an injured individual or disabled staff member is unable to evacuate a building on his or her own, any nearby employee is expected to offer assistance.

5.0 TRAINING

All employees shall be trained or notified of the following:

- Emergency telephone numbers
- Evacuation routes
- Outdoor meeting location or rendezvous point
- Location of the hard copy of the EAFPP, including Attachments A, B, and C, in the office
- Whom to contact for further information
- Accident and illness reporting procedures
- Location and basic use of alarms and fire extinguishers

This training shall be repeated if changes are made to the EAFPP. Training will be documented through class sign-in sheets that will be maintained by the OHSR.

6.0 FIRE PREVENTION

Attachment B of the EAFPP contains a chart of typical fire hazards in an office, as well as handling and storage methods to reduce the hazards. Attachment C of the EAFPP contains a chart of potential ignition sources and control methods for an office. Additional fire hazards and ignition sources and controls should be added to Attachments B and C, respectively, to indicate office-specific hazards.

At this time, all AIS/Tetra Tech offices are located in private buildings. Fire extinguishers and sprinkler systems are generally provided by and the responsibility of the building owner or management. However, escape route maps based on office floor plans shall be coded to indicate the location of fire extinguishers within the office.

Proper housekeeping is an essential component of fire prevention. Rubbish pickup from each office will be provided by building maintenance services. Storage of excessive quantities of empty boxes and other combustible materials is discouraged. Employees are advised to avoid placing flammable materials near baseboard heaters. Materials stored until pickup for recycling shall be stacked neatly in a freely accessible area. Storage of office supplies and field equipment shall not be allowed to interfere with access to doors, exits, fire ladders, or fire extinguishers. Stairways should be kept clear of items that can be tripped over. All areas under stairways that are egress routes should not be used to store combustibles.

ATTACHMENT B4
EMPLOYEE TRAINING/QUALIFICATIONS

ENVIRONMENTAL TRAINING AND COMPLIANCE

CERTIFICATE OF COMPLETION

40-HOUR HAZARDOUS WASTE WORKERS' & 24-HOUR FIRST RESPONDERS – OPERATIONS LEVEL HEALTH & SAFETY TRAINING

O. Kelly Murphy

has successfully completed ETAC's Health and Safety Training course, satisfying the OSHA Hazardous Waste Operations and Emergency Response Standards [29 CFR 1910.120(e),(q)(6)(ii); and 8 CCR 5192(e), (q) (6) (B)].

Class Date: October 14-15, 21-22, 2005
Expiration Date: October 22, 2006

Certificate # 23860

JThomps

Joseph T. Thompson, MPH

1979 State College Boulevard • Anaheim, CA 92806 • Phone: 800-949-4473

№ HWR162010

American Integrated Services, Inc.

This Certifies that

O.Kelly Murphy

Has successfully completed the training requirements for:

OSHA/CAL-OSHA 8 Hour Hazardous Waste Operation and Emergency Response Refresher Training

Per 29 CFR 1910.120, 29 CFR 1926, 40 CFR Part 311 and 8 CCR SEC. 5192

Marta Riojas Marta Riojas AIS Health and Safety Director
M. A. Ed., OSHA Authorized Trainer and Qualified Safety Instructor
1502 E. Opp Street, Wilmington, CA 90744

Training Date: June 12, 2010
Exp. Date: June 11, 2011

OSHA 600331497

U.S. Department of Labor
Occupational Safety and Health Administration

Kelly Murphy

has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety & Health

Marta Riojas — 9/28/09

(Trainer) (Date)

NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST

NAVFAC

PRESENTS THIS CERTIFICATE TO

O. Kelly Murphy

WHO HAS SUCCESSFULLY COMPLETED

CONSTRUCTION QUALITY MANAGEMENT (CQM) FOR CONTRACTORS

AGC San Diego, Education Class

May 20-21, 2010

Instructors
Walter Buchanan PE / Kugan Panchadsaram PE, PMP

NAVFAC SW Field Training Officer
Michael Haliburton PE, PMP

"This Certificate expires in 5 years from Class Date"

American Red Cross

Together, we can save a life

This recognizes that

O. Kelly Murphy

has completed the requirements for

CPR/AED - ADULT

conducted by

ORANGE COUNTY CHAPTER

Date completed 10/16/09

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

American Red Cross

This recognizes that

O. Kelly Murphy

has completed the requirements for

STANDARD FIRST AID

conducted by

ORANGE COUNTY CHAPTER, CA

Date Completed 10/16/09

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

KLEINFELDER
Bright People. Right Solutions.

Loss Prevention System

Training Certification

O. Kelly Murphey / American Integrated Services

Trainee Name/Company

American Integrated Services / 1-14-10 / Neil Bryant

Company/Date/Trainer

- [ ] Sub Train-the-Trainer Course
- [ ] LPS 8 hour Training Course
- [ ] Awareness Training Course
- [x] Refresher Training Course

Compliance Solutions

"Today's Training... Tomorrow's Solution"

10515 E 40th Ave, Suite 116, Denver Colorado 80239 800-711-2706

Student Affiliation:
Tetra Tech EM, Inc.
13039

Certificate of Completion

This is to certify that

Dayna Yocum

has successfully completed the classroom requirements for

40 Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, October 26, 2007

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *75473093*

Neval Gupta
Vice President

Dawn Brownlee
Instructor

Compliance SolutionsOccupational Trainers, Inc.
Certificate of Completion

Student Name: Dayna Yocum

Company: Tetra Tech EM, Inc.

I Certify that the above named student has completed the

40 Hour HAZWOPER

29 CFR 1910.120(e)

Date of Issue: 10/26/2007

By: _____

Dawn Brownlee **Instructor**

AdvanceOnline Solutions Online Institute

Certificate of Completion

Dayna Yocum

has met the online course completion requirements for

HAZWOPER 8-Hour Refresher

Certificate ID: 358296-307
Continuing Education Units: 0.8

Date: 11/29/2009 3:39:26 PM

AdvanceOnline Solutions, Inc.
5858 Westheimer Road, Suite 405
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

AdvanceOnline Solutions, Inc. has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 8405 Greensboro Drive, Suite 800, McLean, VA 22102.

AUTHORIZED IACET PROVIDER

Compliance Solutions

"Today's Training... Tomorrow's Solution"

3980 Quebec St, 2nd Floor Denver, CO 80207-1633 800-711-2706

Student Affiliation:
Tetra Tech EM, Inc
13039

Certificate of Completion

This is to certify that

Dayna Yocum

has successfully completed the training requirements for

OSHA Site Supervisor

29 CFR 1910.120

Presented

Wednesday, October 15, 2008

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: 754788351

Neval Gupta
Vice President

Jeffrey Kline
President/CEO

CLICKSAFETY®

TEMPORARY CERTIFICATE OF COMPLETION

This acknowledges that

DAYNA YOCUM

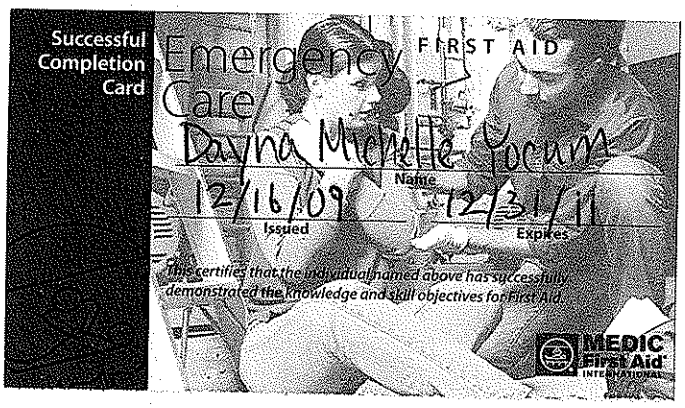
Has successfully completed

OSHA 30 Hour Construction

The course was developed by ClickSafety.
Official OSHA completion card to follow within 6 weeks

Serial Number: 3756623

Completed: 2/7/2010



Instructor Marcus Bronfeld

Registry Number 129633

Training Center (510) 836-6011

129631

MEDIC FIRST AID® Emergency Care follows ILCOR, AHA, and ASTM recommendations and guidelines for CPR, first aid, and emergency care. Additional source authority information can be found in your *Student Guide* and at medicfirstaid.com.

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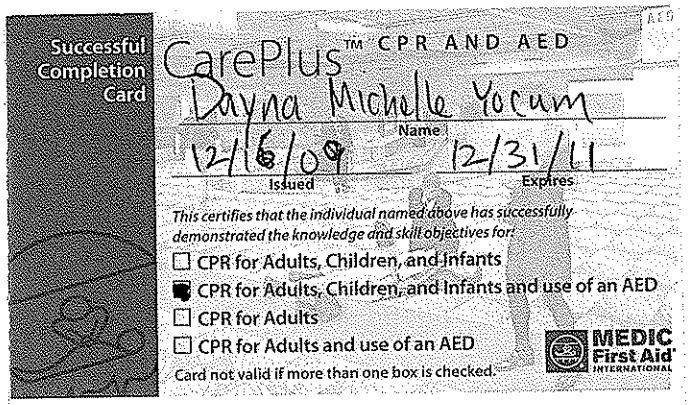

Instructor Marcus Bronfeld

Registry Number 129633

Training Center Phone No. (510) 836-6011

Training Center ID 129631

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Student Affiliation:
Tetra Tech EM, Inc
13039

Certificate of Completion

This is to certify that

Rebecca Johnson

has successfully completed the training requirements for

40 Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, November 14, 2008

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *754789311*

Neval Gupta
Vice President

Michael Johnson
Instructor

TETRA TECH EMI

This Certifies that

Rebecca Johnson

has satisfactorily completed 8 hours of
Hazardous Waste Operations and Emergency Response
Refresher Training
As Per 29 CFR 1910.120(e)

November 2, 2009

Dave Brown, RSO-West Region

Successful Completion Card

CarePlus™ CPR AND AED

Rebecca Johnson
Name

11.6.09 — Issued
11.30.2011 — Expires

This certifies that the individual named above has successfully demonstrated the knowledge and skill objectives for:

- ☐ CPR for Adults, Children, and Infants
- ☐ CPR for Adults, Children, and Infants and use of an AED
- ☐ CPR for Adults
- ☐ CPR for Adults and use of an AED

Card not valid if more than one box is checked.

MEDIC First Aid INTERNATIONAL

Instructor *Marcus Bronfeld*

Registry Number 129633

Training Center Phone No (510) 836-6011

Training Center ID 129631

MEDIC FIRST AID® CarePlus™ CPR and AED follows ILCOR, AHA, and ASTM recommendations and guidelines for CPR, first aid, and emergency care. Additional source authority information can be found in your *Student Guide* and at medicfirstaid.com.

Continued proficiency as a MEDIC FIRST AID Provider requires frequent retraining. This card expires as documented on the front of the card or within 24 months of issue.

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Successful Completion Card

Emergency Care FIRST AID

Rebecca Johnson
Name

11.6.09 — Issued
11.30.2011 — Expires

This certifies that the individual named above has successfully demonstrated the knowledge and skill objectives for First Aid.

MEDIC First Aid INTERNATIONAL

Instructor *Marcus Bronfeld*

Registry Number 129633

Training Center (510) 836-6011

129631

MEDIC FIRST AID® Emergency Care follows ILCOR, AHA, and ASTM recommendations and guidelines for CPR, first aid, and emergency care. Additional source authority information can be found in your *Student Guide* and at medicfirstaid.com.

Continued proficiency as a MEDIC FIRST AID Provider requires frequent retraining. This card expires as documented on the front of the card or within 24 months of issue.

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APPENDIX C
FIELD FORMS

Tetra Tech EM Inc.

American Integrated Services, Inc.

Quality Control Report

Project Name: Orion Park Housing Project (OPHA)	**Date:**
Daily Safety & Coordination Meeting Completed: __Yes _____ No	**Day:** __ _____ **Day #:** __ _____
Weather:	**Wind:**
Temperature:	**Humidity:**

Personnel on Site (AIS, Tt, Subcontractors)

Subcontractors & Equipment on Site

LOC # and Decision Steps Taken (See Figures A-14 to A-16), Notes

Work Performed (Including Sampling)

Quality Control Activities

Health and Safety Levels and Activities

Problems Encountered / Corrective Action Taken

Deviations from Field Work Plan

Planned Work for Tomorrow

Distribution: **Daily – TOM** **Weekly - USACE**	**Submitted By:** _____ _____ **Signature** **Date**

Figure 2 - LOC # : **Site:** Former OPHA **Final Determination (source or plume):** **Comments:**

Decison Logic Summary Table **Contractor:** AIS/Tetra Tech **Field Personnel:** **Date:**

Steps and Data Input			Decision Criteria		Results					
Decision Logic Step #	**Order of Steps Taken in Field**	**Data Input**	**Decision Criteria** [k]	**Decision Criteria Details**	**Peak MIP Response (µV)**[a]	**Result**[b]	**Total Score** [c]	**MIP Boring Type** [l]	**MIP Boring Number** [m]	**Notes**
1		Historical DPT sample results, MIP response	MIP #0 response reflects historical VOC detection?	Does MIP Profile [d] indicate detection of VOCs within depth interval of historical VOC detection? If yes, proceed with investigation, if no, recalibrate MIP	NA	Yes/No	NA	MIP #0		
2a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #0		
2b		MIP Profile[d]	MIP profile indicates source at suspected source location?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS0		
3a		No input, MIP drilled			NA					
3b										
3c										
4a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #S1		
4b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P1		
4b2		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P1		
4c		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #B1		
5a		No Input, MIP drilled	Step 75 feet upgradient (or as determined by EVS for iteration)		NA					
5b		Boring Logs	Direction for next MIP?	Qualitative review of historical boring logs			NA			
5c		No Input, MIP drilled	Step 50 feet upgradient		NA					
6a		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #S2		
6b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P2		
6b2		MIP Profile[d]	MIP profile indicates source?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P3		
6c		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #B2		
7a		No step 7a	NA			left or right	NA			
7b		No Input, MIP drilled			NA					
7c		No Input, MIP drilled	Step 50 feet downgradient		NA					

h. Response Profile Detail

	Score
A) Is MIP response greatest in the capillary fringe?	2
B) Does MIP response indicate a peak ≥ 7.0×10^6 microvolts?	2
C) Does MIP response indicate a peak ≥ 4.0×10^6 microvolts (but < 7.0×10^6 microvolts) ?	1
D) Does MIP response have a decreasing trend with depth in the uppermost saturated zone?	1
E) Is MIP response greatest in low-permeability (clayey silt or clay) formations?	1
Maximum Possible Score =	**6**

Total Score ≥ 2 Adequate indication of a nearby source, select "source" branch

Total Score 0-1 Inadequate indication of a nearby source, select "plume" branch

Figure 2 - LOC # : **Site:** Former OPHA **Final Determination (source or plume):** **Comments:**

Decison Logic Summary Table **Contractor:** AIS/Tetra Tech **Field Personnel:** **Date:**

Steps and Data Input			Decision Criteria		Results					
Decision Logic Step #	**Order of Steps Taken in Field**	**Data Input**	**Decision Criteria** [k]	**Decision Criteria Details**	**Peak MIP Response (µV)**[a]	**Result**[b]	**Total Score** [c]	**MIP Boring Type** [l]	**MIP Boring Number** [m]	**Notes**
8b1		MIP response	MIP response <MIP #0?	Is peak MIP response < 1/2 order-of-magnitude of peak MIP #0 response?		Yes/No	NA	MIP #P3		
8b2		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #P3		
8c		MIP Profile[d]	MIP profile indicates source is unbounded downgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS1		
9a		Terminal Point	MIP complete. Confirm results with DPT.	NA						
9b		MIP responses & CPT readings[g]	Determine appropriate distance.	EVS modelling	upgadient or downgradient			MIP #S2		
9c		Terminal Point	MIP complete. Confirm results with DPT.	NA						
9d		Terminal Point for Source Investigation	Continue Investigation as indefinite source	Proceed to Step 1	NA					
10a		MIP responses & CPT readings[g]	Evaluate preferential pathway	EVS: Concentrations indicate an off-site plume. Investigation complete, unless EVS drill guide indicates need for additional MIP.[i]	NA					
10b		MIP responses & CPT readings[g]	Investigation complete.	EVS: Localized dissolved concentration from offsite plume. Investigation complete.[i]	NA					
11		No Input, MIP drilled	Step 50 feet downgradient	NA						
12		MIP Profile[d]	MIP profile indicates source is unbounded upgradient?	Screening Protocol Total Score between zero and 6[h]		A B C D E		MIP #SS2		

Notes:

(a) MIP Response = multiphase interface probe (MIP) quantitative reading in millivolts (µV) at specific depths below ground surface; readings correlated to VOC concentration

(b) Applicable result for each step circled: yes/no, left/right, upgradient/downgradient, or A, B, C, D, or E

(c) Total Score = Sum of A, B, C, D, and E

(d) MIP Profile = VOC concentrations recorded at 0.05? foot depth intervals from ground surface to bottom of boring

(e) Monitoring Well Boring Log = lithologic description of geology from ground surface to bottom of boring

(f) Monitoring Well VOC chemical analytical results

(g) CPT readings = cone pentrometer technology (CPT) pressure readings recorded continuously from ground surface to bottom of borin

(h) Decision Criteria Details for "MIP Profile = source?"

Response Profile Detail	**Score**
A) Is MIP response greatest in the capillary fringe?	2
B) Does MIP response indicate a peak ≥ 7.0×10^6 microvolts?	2
C) Does MIP response indicate a peak ≥ 4.0×10^6 microvolts (but < 7.0×10^6 microvolts) ?	1
D) Does MIP response have a decreasing trend with depth in the uppermost saturated zone?	1
E) Is MIP response greatest in low-permeability (clayey silt or clay) formations?	1
Maximum Possible Score =	**6**

Total Score ≥ 2 Adequate indication of a nearby source, select "source" branch

Total Score 0-1 Inadequate indication of a nearby source, select "plume" branch

(i) EVS: Use EVS Drill Pro to determine if an MIP is required to show continuity along a preferential pathway between this MIP location and an already-identified offsite plume. The MIP would target a location to verify a preferntial pathway.

(j) EVS: Use EVS to demonstrate that the concentrations are from an offsite plume, but the result of site-specific hydrogeologic/lithologic characteristics (soil variability, other) that is causing a localized variation in concentrations. A preferntial pathway to assess off-site movement has been identified.

(k) Decision criteria corresponds to Figures A-13 and A-14 of the SAP.

(l) MIP Boring number corresponds to boring ID in Worksheet #27 of the SAP

(m) MIP Boring type corresponds to Figures A-13 and A-14 of the SAP