Quality Assurance Project Plan
Superfund Response Actions
Former Fort Ord, California

Volume I, Groundwater

United States Department of the Army
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2924

TABLE OF CONTENTS

ACRONYM AND ABBREVIATION LIST iii

1.0 INTRODUCTION 1

1.1 Site Description 1
1.2 Quality Assurance Project Plan Description and Purpose 1
1.3 Quality Assurance Project Plan Expansion and Revisions 1

2.0 BACKGROUND – FORT ORD GROUNDWATER 3

2.1 Problem Definition and Site History 3
2.2 Hydrostratigraphic Units 3
2.2.1 A-Aquifer 3
2.2.2 180-Foot Aquifer 3
2.2.3 400-Foot Aquifer 4
2.3 Distribution of Contaminants 4

3.0 REFERENCES 5

PLATES

1 Fort Ord Location Map and Groundwater Study Areas

APPENDICES

A Draft Final Quality Assurance Project Plan, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume

ACRONYM AND ABBREVIATION LIST

ACLs	aquifer cleanup levels
Army	United States Department of the Army
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of concern
CT	carbon tetrachloride
DOD QSM	Department of Defense Quality System Manual Version 4.2
DQO	Data Quality Objective
FAAF	Fritzsche Army Air Field
FO-SVA	Fort Ord – Salinas Valley Aquitard
GWMP	groundwater monitoring program
GWTS	groundwater treatment system
HLA	Harding Lawson Associates
MACTEC	MACTEC Engineering and Consulting, Inc.
MEC	Munitions and Explosives of Concern
NPL	National Priorities List
OU1	Operable Unit 1
OU2	Operable Unit 2
OUCTP	Operable Unit Carbon Tetrachloride Plume
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act
SOP	Standard operating procedure
SVA	Salinas Valley Aquitard
TCE	trichloroethene
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds

1.0 INTRODUCTION

Volume I of this Quality Assurance Project Plan (QAPP) was prepared on behalf of the United States Department of the Army (Army) and the United States Army Corps of Engineers (USACE), Sacramento District for groundwater response actions to be performed at the former Fort Ord in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund") as amended by the Superfund Amendment and Reauthorization Act (SARA). Response actions related to soil and munitions and explosive of concern (MEC) will be addressed in Volume II of the QAPP. This QAPP will be maintained in the Fort Ord Administrative Record located at Building 4463 Room 101, Gigling Road, Seaside, California. The Administrative Record is managed by the Army, and will be maintained until site closure.

1.1 Site Description

The former Fort Ord is adjacent to Monterey Bay in northwestern Monterey County, California, approximately 80 miles south of San Francisco (Plate 1). The former Army post consists of approximately 28,000 acres adjacent to the cities of Seaside, Sand City, Monterey, and Del Rey Oaks to the south and Marina to the north. The Union Pacific Railroad and State Route 1 pass through the western part of the former Fort Ord, separating the beachfront portions from the rest of the base. Laguna Seca Recreation Area and Toro Regional Park border the former Fort Ord to the south and southeast, respectively. Land use east of the former Fort Ord is primarily agricultural.

The former Fort Ord consists of both developed and undeveloped land. The three principal developed areas are the East Garrison, the Fritzsche Army Air Field (FAAF), and the Main Garrison; these areas collectively comprise approximately 8,000 acres, and include the campus of the California State University Monterey Bay. The remaining 20,000 acres are largely undeveloped areas. With the presence of up to 15,000 active duty military personnel and 5,100 civilians during its active history, developed areas at Fort Ord resembled a medium-sized city, with family housing, medical facilities, warehouses, office buildings, industrial complexes, and gas stations.

1.2 Quality Assurance Project Plan Description and Purpose

This QAPP is the governing guidance document for groundwater and treatment system sampling associated with the Sites 2 and 12 and Operable Unit 2 (OU2) Groundwater Treatment Systems (GWTS) and for groundwater sampling conducted as part of the Sites 2 and 12, Operable Unit 1 (OU1), OU2 and Operable Unit Carbon Tetrachloride Plume (OUCTP) groundwater monitoring program (GWMP). This QAPP details quality assurance (QA) and quality control (QC) procedures to be used during sampling and analytical activities performed for both the GWTS and the GWMP so data generated is accurate, precise, complete and representative of field conditions and of sufficient quality to support project decisions.

This QAPP was prepared in accordance with the Uniform Federal Policy for Quality Assurance Project Plans (UFP QAPP) (*Intergovernmental Data Quality Task Force, March 2005*) and the Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM) (*Environmental Data Quality Workgroup, Version 4.2, 2010*).

1.3 Quality Assurance Project Plan Expansion and Revisions

This QAPP will be expanded in the future with additional appendices providing similar information for other CERCLA groundwater response actions performed by the Army and its contractors at the former

Fort Ord. Should there be changes to analytical methods, standard operating procedures (SOPs), data quality objectives (DQOs), project personnel, or other information in the QAPP, the QAPP will be revised to include the new information. The revisions will be submitted as replacement or additional worksheets, SOPs, etc. as appropriate. Future appendices and revisions to this QAPP will also be prepared in accordance with the UFP QAPP and DOD QSM.

2.0 BACKGROUND – FORT ORD GROUNDWATER

2.1 Problem Definition and Site History

Volatile organic compounds (VOCs) are present in groundwater at the former Fort Ord at concentrations ranging from trace levels to levels in excess of the Record of Decision (ROD) prescribed aquifer clean up levels (ACLs). The discovery of these VOCs and subsequent investigations led to inclusion of Fort Ord on the National Priorities List (NPL) in 1990, and implementation of a GWMP. The GWMP provides data to monitor and evaluate changes in groundwater elevation and flow as a result of seasonal or hydrologic influences. Additionally, the data collected from the GWMP is used to evaluate the concentrations and distribution of chemicals of concern (COCs) in four of the main study areas including Sites 2 and 12, OU1, OU2, and OUCTP (Plate 1). The monitoring program at the former Fort Ord includes quarterly and annual groundwater monitoring of wells within the four main study areas and selected additional investigative sites. Active groundwater remedies are in place at Sites 2 and 12 and OU2, and sampling and analytical activities conducted at the GWTS are included as part of this QAPP.

2.2 Hydrostratigraphic Units

Hydrostratigraphic units at the former Fort Ord are located in the Salinas and Seaside groundwater basins, as described in the *Draft Final Basewide Hydrogeologic Characterization Report* (*Harding Lawson Associates [HLA], 1994*). The Salinas groundwater basin units include the A-Aquifer, the Fort Ord – Salina Valley Aquitard (FO-SVA), the Upper 180-Foot Aquifer, Intermediate 180-Foot Aquitard, and Lower 180-Foot and 400-Foot Aquifers. A detailed explanation of the hydrostratigraphic units at the former Fort Ord is presented in the *Draft Final Basewide Hydrogeologic Characterization Report* (*HLA, 1994*) and the OUCTP Remedial Investigation/Feasibility Study (RI/FS) (*MACTEC, 2006*). A brief description of each hydrostratigraphic unit is presented below.

2.2.1 A-Aquifer

The A-Aquifer is unconfined and located above the FO-SVA throughout the northern portion of the former Fort Ord, and is composed predominantly of fine to medium, well-sorted dune sands. The FO-SVA is composed primarily of plastic clay with thin interbedded units of fine sand. At least one water-bearing sand layer is present within the FO-SVA in the northern portion of the study area. Where the FO-SVA is present, it forms a significant aquitard between the A-Aquifer and the underlying 180-Foot Aquifer. To the west, where the FO-SVA pinches out, the A-Aquifer and the upper portion of the 180-Foot Aquifer combine to form a continuous, unconfined hydrostratigraphic unit.

2.2.2 180-Foot Aquifer

The 180-Foot Aquifer is composed of two distinct sequences: (1) an upper unit consisting of sandy deposits with some gravel approximately 60 feet thick, and (2) a lower unit of predominantly gravel with some sand and numerous thin clay lenses approximately 50 to 150 feet thick. The two sequences are separated by a series of silt and clay units, collectively referred to as the Intermediate 180-Foot Aquitard except east of Imjin Road where this unit locally pinches out (*MACTEC, 2006*). Soil boring and water-level data indicate that this aquitard is relatively widespread in the northern portions of Fort Ord. Groundwater elevation and pressure response differences in the 180-Foot Aquifer are observed above and below the Intermediate 180-Foot Aquitard and therefore, the unit is considered to hydraulically separate the upper and lower portions of the 180-Foot Aquifer. To reflect this condition, the 180-Foot Aquifer has

been divided into an “Upper 180-Foot Aquifer” and a “Lower 180-Foot Aquifer” as defined by the silt and clay aquitard.

2.2.3 400-Foot Aquifer

The 400-Foot Aquifer consists of a fine to medium sand unit, 150 to 250 feet thick, hydraulically separated from the underlying Lower 180-Foot Aquifer by only minor head differences (i.e., less than 10 feet). Hydraulic distinction between these units appears to result from contrasting hydraulic conductivities, rather than from an aquitard. The 400-Foot Aquifer appears to be protected by the much more permeable Lower 180-Foot Aquifer as this overlying aquifer represents a preferential pathway beneath which shallower contamination does not penetrate.

2.3 Distribution of Contaminants

Dilute solvents associated with former practices at the former Fort Ord are distributed vertically within three aquifers within the four main study areas of the GWMP. Dispersal and westward migration of contaminants in the A-Aquifer led downward sequentially into the Upper and Lower 180-Foot Aquifers, with corresponding eastward migration. Additionally, the previously discussed vertical conduits have aided the migration of contaminants to lower aquifers. A detailed description of the distribution of contaminants in each of the study areas in the GWMP is provided in each quarterly and annual groundwater monitoring report. The most recent annual monitoring reports are the *Final 2009 Annual and Third Quarter Groundwater Monitoring Report, Operable Unit 1, Fritzsche Army Airfield Fire Drill Area* (*HGL, 2010*) and the *Draft Annual Report of Quarterly Monitoring, October 2008 through September 2009* (*MACTEC, 2010*). For Sites 2 and 12, OU1, and OU2 areas, trichloroethene (TCE) is the chemical compound of greatest concentration and areal distribution, and is therefore used as the indicator compound for evaluating the extent of contamination. Carbon tetrachloride (CT) is the predominant chemical compound in concentration and areal distribution in the OUCTP area, and is used to monitor and evaluate the plume in that area.

3.0 REFERENCES

Department of Defense (DOD) Environmental Data Quality Workgroup, 2010. *Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2.* www.navylabs.navy.mil/manualdocs.htm

Harding Lawson Associates (HLA), 1994. *Draft Final Basewide Hydrogeologic Characterization Report, Fort Ord, California.* Prepared for Sacramento USACE. June 10.

HydroGeoLogic, Inc. (HGL), 2010. *Final 2009 Annual and Third Quarter Groundwater Monitoring Report, Operable Unit 1, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California*. August 5.

Intergovernmental Data Quality Task Force, 2005. *Uniform Federal Policy for Quality Assurance Project Plans.* March www.navylabs.navy.mil/manualdocs.htm

MACTEC Engineering and Consulting, Inc. (MACTEC), 2006. *Final Operable Unit Carbon Tetrachloride Plume, Groundwater Remedial Investigation/Feasibility Study, Former Fort Ord, California*. May 19.

____, 2010. *Draft, Annual Report of Quarterly Monitoring, October 2008-September 2009, Groundwater Monitoring program, Sites 2/12, OU2, and OUCTP, Former Fort Ord, California.* April 30.

Draft Final Quality Assurance Project Plan
Former Fort Ord, California, Volume I
Appendix A
Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12
Groundwater Monitoring Program at Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume

Prepared for:

Department of the Army
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2924

Prepared by:

Ahtna Engineering Services
296 12th Street
Marina, California 93933-6001

USACE Contract # W912PP-10-C-0019

_____
Derek S. Lieberman, P.E.
Environmental Technical Manager

_____
Anthony Blake
Program Chemist/Project QA Officer

_____
Charles Holman
Environmental Operations Manager

April 1, 2011

Draft Final Quality Assurance Project Plan
Former Fort Ord, California, Volume I
Appendix A
Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12
Groundwater Monitoring Program at Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume

Prepared for:

Ahtna Engineering Services
296 12th Street
Marina, California 93933-6001

MACTEC Project No. 4084106578 01

Debra Leibensberger
Principal Environmental Scientist

Jeffery Fenton
Project Manager

Edward J. Ticken
Senior Principal Environmental Scientist

April 1, 2011

MACTEC Engineering and Consulting, Inc.
1465 North McDowell Blvd, Suite 200
Petaluma, CA 94954 - (707) 793-3800

TITLE AND APPROVAL PAGE (QAPP Worksheet #1)

Site Name/Project Name: Former Fort Ord/Superfund Response Actions
Site Location: Former Fort Ord, California
Document Title: Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix A, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume

Lead Organization: U.S. Army Corps of Engineers, Sacramento District

Preparer's Name and Organizational Affiliation: Debra Leibensberger, MACTEC

Preparer's Address, Telephone Number, and E-mail Address: 1465 North McDowell Blvd, Suite 200, Petaluma, California. (707) 496-3117. dlleibensberger@mactec.com

Preparation Date (Day/Month/Year): 03/25/11

Investigative Organization's Project Manager/Date:_____
Signature
Printed Name/Organization: Derek S. Lieberman, AES

Investigative Organization's Project QA Officer/Date:_____
Signature
Printed Name/Organization: Anthony Blake, AES

Lead Organization's Project Manager/Date:_____
Signature
Printed Name/Organization: David Eisen, USACE

Lead Organization Project Chemist/Date:_____
Signature
Printed Name/Organization: Tommy Waldrup, USACE

TABLE OF CONTENTS

TITLE AND APPROVAL PAGE (QAPP Worksheet #1) ..... Aiii

ACRONYM AND ABBREVIATION LIST ..... Avii

1.0 INTRODUCTION A1-1

2.0 PROJECT MANAGEMENT AND OBJECTIVES A2-1

2.1 QAPP Identifying Information (QAPP Worksheet #2) A2-1
2.2 Distribution List (QAPP Worksheet #3) A2-2
2.3 Project Personnel Sign-Off Sheet (QAPP Worksheet #4) A2-3
2.4 Project Organizational Chart (QAPP Worksheet #5) A2-6
2.5 Communication Pathways (QAPP Worksheet #6) A2-7
2.6 Personnel Responsibilities and Qualifications Table (QAPP Worksheet #7) A2-9
2.7 Special Training Requirements and Certification (QAPP Worksheet #8) A2-11
2.8 Project Planning Session Participants Sheet (QAPP Worksheet #9) A2-12
2.9 Problem Definition/DQOs QAPP (Worksheet #10) A2-13
2.9.1 Sites 2 and 12 and OU2 Groundwater Remedies (QAPP Worksheet #10a) A2-13
2.9.2 Problem Definition/DQOs – Sites 2 and 12, OU1, OU2, OUCTP Groundwater Monitoring Program (QAPP Worksheet #10b) A2-20
2.10 Project Quality Objectives/Systematic Planning Process Statements (QAPP Worksheet #11) A2-25
2.10.1 Sites 2 and 12 and OU2 Groundwater Treatment Systems; (QAPP Worksheet #11a) A2-25
2.10.2 Sites 2 and 12, OU1, OU2, and OUCTP Groundwater Monitoring Program (QAPP Worksheet #11b) A2-28
2.11 Measurement Performance Criteria Table –VOCs (Worksheet #12) A2-30
2.11.1 VOCs Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP (QAPP Worksheet #12a) A2-30
2.11.2 Metals - Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP (QAPP Worksheet #12b) A2-32
2.11.3 Wet Chemistry - Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP (QAPP Worksheet #12c) A2-33
2.12 Secondary Data Criteria and Limitations (QAPP Worksheet #13) A2-34
2.13 Summary of Project Tasks A2-35
2.13.1 Sites 2 and 12 and OU2 GWTS (QAPP Worksheet #14a) A2-35
2.13.2 Sites 2 and 12, OU1, OU2, OUCTP Groundwater Monitoring Program (QAPP Worksheet #14b) A2-36
2.14 Reference Limits and Evaluation Table A2-37
2.14.1 Sites 2 and 12 GWTS (QAPP Worksheet #15a) A2-37
2.14.2 Reference Limits and Evaluation Table OU2 GWTS (QAPP Worksheet #15b) A2-38
2.14.3 Reference Limits and Evaluation Table - Sites 2 and 12, OU1, OU2, and OUCTP GWMP (QAPP Worksheet #15c) A2-39
2.15 Project Schedule/Timeline Table/Frequency Table (QAPP Worksheet #16) A2-43

3.0 MEASUREMENT AND DATA AQUISTION A3-1

3.1 Sampling Design/Rationale (Worksheet #17) A3-1

3.1.1 Design/Rationale/SOP – Sites 2 and 12 GWTS (Part I) (QAPP Worksheet #17a1) A3-1
3.1.1 Sampling Design/Rationale - Sites 2 and 12 GWTS (Part II) (QAPP Worksheet #17a2) A3-2
3.1.2 Sampling Design/Rationale/SOP – OU2 GWTS (Part I) (QAPP Worksheet #17b1) A3-3
3.1.2 Sampling Design/Rationale - OU2 GWTS (Part II) (QAPP Worksheet #17b2) A3-5
3.1.3 Sampling Design/Rationale/SOP - Sites 2 and 12, OU1, OU2 and OUCTP GWMP (QAPP Worksheet #17c) A3-6
3.2 Sampling Locations and Methods/SOP Requirements Table (QAPP Worksheet #18) A3-20
3.3 Analytical Requirements – Sample Volumes/Preservation Requirements Table (QAPP Worksheet #19) A3-21
3.4 Field Quality Control Sample Summary (QAPP Worksheet #20) A3-22
3.5 Project Field Sampling Standard Operating Procedure (SOP) Table (QAPP Worksheet #21) A3-23
3.6 Field Equipment Calibration, Maintenance, Testing, and Inspection Table (QAPP Worksheet #22) A3-24
3.7 Analytical SOP References Table (QAPP Worksheet #23) A3-25
3.8 Analytical Instrument Calibration Table (QAPP Worksheet #24) A3-26
3.9 Analytical Instrument and Equipment Maintenance, Testing and Inspection Table (QAPP Worksheet #25) A3-34
3.10 Sample Handling System (QAPP Worksheet #26) A3-35
3.11 Sample Custody Requirements (QAPP Worksheet #27) A3-36
3.12 Analytical QC Sample Table A3-37
3.12.1 VOCs (QAPP Worksheet #28a)
3.12.2 Metals (QAPP Worksheet #28b) A3-40
3.12.3 Wet Chemistry (QAPP Worksheet #28c) A3-42
3.13 Project Documentation and Records (QAPP Worksheet #29) A3-44
3.14 Analytical Services Table (QAPP Worksheet #30) A3-47

4.0 ASSESSMENT AND OVERSIGHT A4-1

4.1 Planned Project Assessments Table (QAPP Worksheet #31) A4-1
4.2 Assessment Findings and Corrective Action Responses (QAPP Worksheet #32) A4-6
4.3 QA Management Reports Table (QAPP Worksheet #33) A4-9

5.0 DATA REVIEW A5-1

5.1 Verification (Step 1) Process Table (QAPP Worksheet #34) A5-1
5.2 Validation (Steps IIa and IIb) Process Table (QAPP Worksheet #35) A5-3
5.3 Validation (Steps IIa and IIb) Summary Table (QAPP Worksheet #36) A5-5
5.4 Usability Assessment (QAPP Worksheet #37) A5-7

6.0 REFERENCES A6-1

PLATES

1 Former Fort Ord Location Map
2 Sites 2 and 12, OU1, OU2, OUCTP Groundwater Monitoring Program Sampling Locations
3 Site Map Sites 2 and 12 Groundwater Remedy
4 Sites 2 and 12 Groundwater Treatment System Schematic and Sampling Points
5 Site Map OU2 Groundwater Remedy
6 OU2 Groundwater Treatment System Schematic and Sampling Points

APPENDICES

A Standard Operating Procedures (SOPs) (on CD)
B Resumes (on CD)
C Field Documentation Forms (on CD)
D Three Phase Quality Control Process and Documentation
E ADR Library and Qualifier Tables

ACRONYM AND ABBREVIATION LIST

°C	Degrees Celsius
%D	percent difference/percent drift
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2- dichloroethane
1,2-DCP	1,2- dichloropropane
ACLs	aquifer cleanup levels
ADR	Automated Data Review
AES	Ahtna Engineering Services
Army	United States Department of the Army
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
BFB	4-Bromofluorobenzene
BRAC	Base Realignment and Closure
CCA	Comprehensive Certificate of Analysis
CCC	continuing calibration check compounds
CCV	continuing calibration verification
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
cis-1,3-DCP	cis-1,3-dichloropropane
COD	coefficient of determination
CRWQCB	California Regional Water Quality Control Board, Central Coast Region
COC	Chemicals of concern
CQCR	Contractor Quality Control Report
CRF	Cooler Receipt Form
CPR	cardio-pulmonary resuscitation
CT	carbon tetrachloride
DQO	Data Quality Objective
DOD QSM	Department of Defense Quality System Manual Version 4.2
DTSC	Department of Toxic Substances Control
DTW	depth to water
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	Extraction well
FAAF	Fritzsche Army Air Field
FADL	Field Activity Daily Logbook
FODIS	Fort Ord Data Integration System
Fort Ord	former Fort Ord
GAC	granular activated carbon
GC/MS	Gas chromatography-mass spectrometry
GWMP	groundwater monitoring program
GWTS	groundwater treatment system
HAZWOPER	Hazardous Waste Operations and Waste Response
H_2SO_4	Sulfuric acid
HCL	Hydrochloric acid

HLA	Harding Lawson Associates
HNO_3	Nitric acid
IC	Ion Chromatography
ICAL	initial calibration
ICP	Inductively Coupled Plasma
ICP/MS	ICP-Mass Spectrometry
ICS	interference check sample
ICV	initial calibration verification
LCS	laboratory control samples
LCSD	LCS duplicate
LIMS	laboratory information management system
LOD	limit of detection
MACTEC	MACTEC Engineering and Consulting, Inc.
MC	Methylene chloride
MCL	maximum contaminant level
MCWD	Marina Coast Water District
MCWRA	Monterey County Water Resources Agency
MEC	Munitions and Explosives of Concern
µg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliter
MNA	monitored natural attenuation
MS/MSD	Matrix spike/matrix spike duplicate
N/A	not applicable
NBS	National Bureau of Standards
O&M	Operations and Maintenance
OU1	Operable Unit 1
OU2	Operable Unit 2
OUCTP	Operable Unit Carbon Tetrachloride Plume
OSHA	Occupational Safety & Health Administration
PCE	tetrachloroethene
PDB	Passive diffusion bag
PDF	Portable document format
POC	Point of Contact
PQL	Practical quantitation limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QCSR	Quality Control Summary Report
RI	Remedial Investigation
RF	response factor
RSD	relative standard deviation
ROD	Record of Decision
RPD	Relative percent difference
SARA	Superfund Amendment and Reauthorization Act
SAP	Sampling and Analysis Plan
SIM	selective ion monitoring
SM	Standard Methods
SOP	Standard operating procedure
SPCC	system performance check compounds

SQL	Structured Query Language
SRF	Sample Receipt Forms
SVA	Salinas Valley Aquitard
TAT	Turn- around Time
TBD	to be determined
TCE	trichloroethene
TDS	total dissolved solids
trans-1,3-DCP	trans-1,3-dichloropropane
TS	treatment system
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
VC	vinyl chloride
VOCs	volatile organic compounds
ZnOAc+NaOH	zinc acetate plus sodium hydroxide

1.0 INTRODUCTION

On behalf of the United States Army Corps of Engineers (USACE), Sacramento District, MACTEC Engineering and Consulting, Inc. (MACTEC) has prepared this Quality Assurance Project Plan (QAPP) under subcontract to Ahtna Engineering Services (AES) under AES Contract Number W912PP-10-C-0019 for response actions to be performed at the former Fort Ord (Fort Ord) (Plate 1) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund").

This QAPP is the governing guidance document for groundwater and treatment system sampling conducted by AES associated with the Sites 2 and 12 and Operable Unit 2 (OU2) Groundwater Treatment Systems (GWTS) and for groundwater sampling conducted by MACTEC as part of the Sites 2 and 12, Operable Unit 1 (OU1), OU2 and Operable Unit Carbon Tetrachloride Plume (OUCTP) groundwater monitoring program (GWMP). This QAPP details quality assurance (QA) and quality control (QC) procedures to be used during sampling and analytical activities performed for both the GWTS and the GWMP so data generated is accurate, precise, complete and representative of field conditions and of sufficient quality to support project decisions.

2.0 PROJECT MANAGEMENT AND OBJECTIVES

2.1 QAPP Identifying Information (QAPP Worksheet #2)

Site Name/Project Name: *Former Fort Ord/Superfund Response Actions*

Title: *Quality Assurance Project Plan: Former Fort Ord, California, Volume I, Appendix A, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program as Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume*

Site Location: *Former Fort Ord*
Site Number/Code:
Operable Unit: Various

Revision Number: *Draft Final*
Revision Date: *03/25/11*

Contractor Name: Various
Contractor Number: W912PP-10-C-0019
Contract Title: Various

Work Assignment Number: W91299-10-R-37

1. Identify regulatory program: *Comprehensive Environmental Response Compensation and Liability Act (CERCLA) as amended by Superfund Amendment and Reauthorization Act (SARA)*

2. Identify approval entity: *United States Environmental Protection Agency (EPA), California Department of Toxic Substance Control (DTSC)*, and *Regional Water Quality Control Board, Central Coast Region (CRWQCB)*

3. The QAPP is (select one): Generic **Project Specific X**

4. List dates of scoping sessions that were held: *July 6, 2010*

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
Draft Final, QAPP/CDQMP Groundwater Monitoring Program, Sites2 and 12, OU2 and OUCTP	January 20, 2010
Final Sampling and Analysis Plan, Operable Unit 2 and Sites 2 and 12 Groundwater Treatment Systems, Former Fort Ord	August 20, 2009

6. List organizational partners (stakeholders) and connection with lead organization:
USACE, United States Department of the Army (Army; Lead Agency/Owner), EPA (Lead Oversight Agency), DTSC (Support Agency), and CRWQCB (Support Agency).

7. List data users: *Army, USACE, EPA, DTSC, CRWQCB, Army/USACE contractors, and the public*.

2.2 Distribution List (QAPP Worksheet #3)

QAPP Recipients	Title	Organization	Telephone	E-mail
David Eisen	Project Manager	USACE	(831) 939-9692	David.Eisen@usace.army.mil
Gail Youngblood	Base Realignment and Closure (BRAC) Environmental Coordinator	Department of the Army	(831) 242-7918	Gail.youngblood@us.army.mil
Martin Hausladen	Project Manager	EPA	(415) 972-3007	hausladen.martin@epamail.epa.gov
Franklin Mark	Project Manager	DTSC	(916) 255-3584	FMark@dtsc.ca.gov
Grant Himebaugh	Project Manager	CRWQCB	(805) 542-4636	Ghimebaugh@waterboards.ca,gov
Tommy Waldrup	Project Chemist	USACE	(916) 557-7673	Tommy.I.Waldrup@usace.army.mil
Christopher Goddard	Environmental Engineer	USACE	(916) 557-6975	Christopher.A.Goddard@usace.army.mil
Bill Mabey	EPA technical consultant	TechLaw	(415) 281-8730 Ext. 24	bmabey@techlawinc.com
Derek Lieberman	Project Manager	AES	(831) 384-3735	dlieberman@ahtnaes.com
Tony Blake	Program Chemist	AES	(831) 384-3735	ablake@ahtnaes.com
Laurie Glantz-Murphy	Laboratory Director	Accutest	(408) 588-0200	laurieg@accutest.com

2.3 Project Personnel Sign-Off Sheet (QAPP Worksheet #4)

Project Personnel Sign-Off Sheet – AES
QAPP Worksheet #4a

Organization: AES

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Charles Holman	Program Manager	831-384-3735		
Derek Lieberman	Project Manager	831-384-3735		
Anthony Blake	Program Chemist	916-384-1325		

QAPP Worksheet #4 Continued

Project Personnel Sign-Off Sheet - MACTEC

QAPP Worksheet #4b

Organization: MACTEC

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Ed Ticken	Program Manager	707-793-3882		
Jeff Fenton	Project Manager	707-793-3832		
Steve Korbay	Field Task Manager	707-793-3856		
Debra Leibensberger	Project Chemist	707-496-3117		
Zach Carroll	Data Validation Specialist	707-793-3873		

QAPP Worksheet #4 Continued

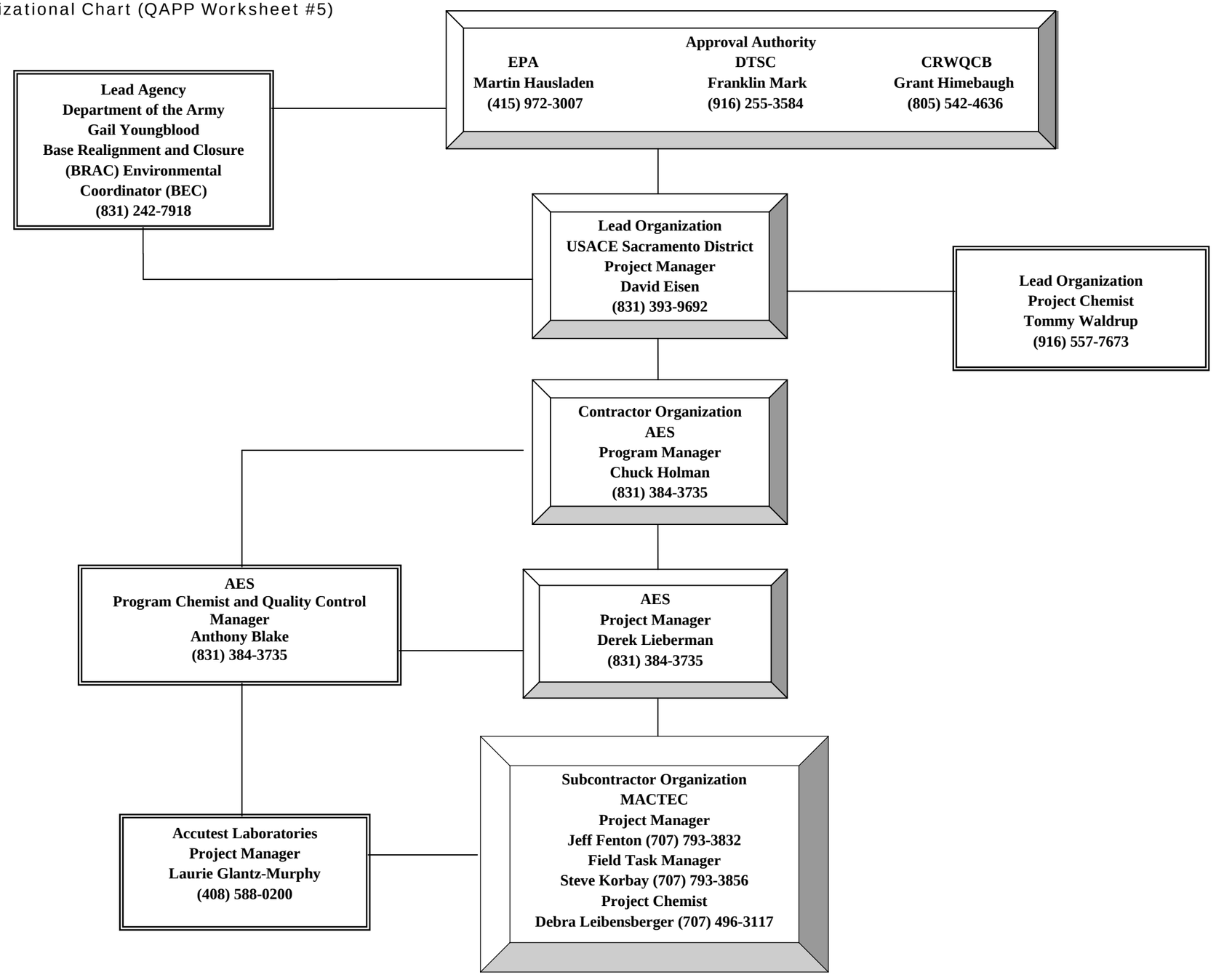
Project Personnel Sign-Off Sheet – Accutest Laboratories

QAPP Worksheet #4c

Organization: Accutest Laboratories

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Laurie Glantz-Murphy	Laboratory Director	408-588-0200		
Guergana Gueorguieva	Quality Assurance Manager	408-588-0200		

2.4 Project Organizational Chart (QAPP Worksheet #5)



2.5 Communication Pathways (QAPP Worksheet #6)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, pathways, etc)
Point of contact with Lead Oversight Agency (EPA)	Lead organization - USACE PM	David Eisen	(831) 393-9691	Materials and information regarding the project will be submitted to the EPA, DTSC, and CRWQCB as appropriate by David Eisen via written communication (e-mail or hardcopy).
Point of Contact for Lead Organization PM	AES Program Manager	Chuck Holman	(831) 384-3735	Materials and information regarding this project will be submitted to David Eisen via written communication (E-mail or hardcopy).
Manage Project – Lead organization	AES PM	Derek Lieberman	(831) 384-3735	Manage project schedule and budget. Communicate project information to project team and David Eisen. AES Team liaison to Ahtna program manager.
Manage Project – Subcontractor	MACTEC PM	Jeff Fenton	(707) 793-3832	Manage project schedule and budget. Communicate project information to project team and Derek Lieberman.
QAPP deviation in field	MACTEC Field Task Manager	Steve Korbay	(707) 793-3856	Steve Korbay will notify Deb Leibensberger and Jeff Fenton of deviations from QAPP protocol that occurred in the field prior to the end of the sampling day. Deb Leibensberger will notify Tony Blake of the deviation and reason for deviation by phone or in writing. Deviation will be documented in the quarterly monitoring report, and may be proposed for QAPP modification if appropriate.
Proposed QAPP changes in field (modification to QAPP)	MACTEC Field Task Manager/MACTEC Project Chemist AES Program Chemist USACE Project Chemist	Steve Korbay Deb Leibensberger Anthony Blake Tommy Waldrup	(707) 793-3856 (707) 496-3117 (916) 384-8603 (916) 557-7673	Steve Korbay will propose modifications to Deb Leibensberger and Jeff Fenton prior to implementation. Deb Leibensberger will propose appropriate modification to Tony Blake for approval prior to implementation. Tony Blake will propose modification to Tommy Waldrup for approval prior to change implementation. Communication regarding modification will be in writing.
Daily Field Progress Reports/Field QA/QC Issues	MACTEC Field Task Manager	Steve Korbay	(707) 793-3856	Steve Korbay will report field progress and field QA/QC issues by fax or e-mail daily to Jeff Fenton and Deb Leibensberger.

2.5 QAPP Worksheet #6 (Continued)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, pathways, etc)
Laboratory Issues	Accutest Project Manager	Laurie Glantz-Murphy	(408) 588-0200	Accutest PM to notify Deb Leibensberger of any problems with the laboratory, including receipt of samples, instrument problems, reporting limits, or any other issues that will affect the data or Turn Around Time (TAT) of reported results within 24 hours of the occurrence.
Field and Laboratory Data Quality Issues	MACTEC Project Chemist	Deb Leibensberger	(707) 496-3117	Deb Leibensberger will notify Jeff Fenton and Tony Blake by phone or e-mail of field or lab QA/QC issues within one business day.
Field and Analytical Corrective Actions[1]	MACTEC Project Chemist	Deb Leibensberger	(707) 496-3117	The need for field or laboratory corrective action will be determined by Deb Leibensberger and/or Tony Blake, which will be communicated in writing to Jeff Fenton, Derek Lieberman, and Laboratory contact (when appropriate) within two business days.
Release of Analytical Data	MACTEC Project Chemist	Deb Leibensberger	(707) 496-3117	Analytical data will not be released for use until review or validation is completed, as appropriate. Following approval of validation findings by Tony Blake, Deb Leibensberger will release the data for project team use via e-mail to the project team.

Notes:

[1] In the event significant corrective action is required for field or laboratory activities, information concerning the corrective action will be provided to EPA, DTSC, and CRWQCB by the Army within 30 days of the event, typically at the next scheduled monthly meeting of the BRAC Cleanup Team (BCT).

2.6 Personnel Responsibilities and Qualifications Table (QAPP Worksheet #7)

Name	Title	Organizational Affiliation	Responsibility	Education and Experience Qualifications
David Eisen	Project Manager	USACE	Oversees USACE Fort Ord projects.	M.S., Geology, 25 years experience
Chuck Holman	Program Manager	AES	Oversees AES Fort Ord projects.	Graduate; Structural Design, 32 Years experience
Pete Rice	Program Health and Safety Officer	AES	Oversees overall Health and Safety Program for AES; oversight of Project Health and Safety.	M.S., Environmental and Occupational Health and Safety. B.S., Environmental Health and Biology, 33 years experience
Holly Dillon	Health and Safety Officer	AES	Oversees Health and Safety for Field Operations.	B.A., Environmental Science, 7 years experience
Derek Lieberman	Project Manager	AES	Manages the Operations and Maintenance (O&M) of Sites 2 and 12 and OU2 Treatment Systems and Quarterly Monitoring at Sites 2 and 12, OU2 and OUCTP.	M.A., Science, Technology, and Public Policy. M.A., Environmental Management. B.S., Geological Engineering, 19 years experience
Tommy Waldrup	Project Chemist	USACE	Oversees USACE Chemistry for Fort Ord Projects.	B.S., Chemistry/Mathematics, 35 years experience
Anthony Blake	Program Chemist/ QA/QC Officer	AES	Oversees QA/QC, and manages the laboratory for the O&M of Sites 2 and 12 and OU2 Treatment Systems and Quarterly Monitoring at Sites 2 and 12, OU2 and OUCTP.	M.A., Management. B.S., Conservation of Natural Resources, 28 years experience
Ed Ticken	Program Manager	MACTEC	Oversees MACTEC Fort Ord Projects.	M.S., Geology, 32 years experience
Jeff Fenton	Project Manager	MACTEC	Manages the Quarterly Monitoring at Sites 2 and 12, OU2 and OUCTP.	B.S., Geology, 26 years experience
Debra Leibensberger	Project Chemist	MACTEC	Manages QAPP preparation and oversight of field and data validation.	B.A., Theater Arts, 18 years experience

2.6 QAPP Worksheet #7 (Continued)

Name	Title	Organizational Affiliation	Responsibility	Education and Experience Qualifications
Steve Korbay	Field Task Manager	MACTEC	Oversees field activities related to the Quarterly Monitoring at Sites 2 and 12, OU2, and OUCTP.	A.A., Natural Resources, 21 years experience
Mark Fisler	O&M Manager	AES	Manages O&M at Sites 2 and 12 and OU2.	B.S., Biology, 10 years experience
Zachary Carroll	Data Validation Specialist	MACTEC	Performs data validation	B.A., History, 5 years experience
Drillers	Monitoring well install	TBD	Monitoring well install	TBD
Dylan Harris	Field Technician	AES	Performs O&M of Sites 2 and 12 and OU2 Treatment Plants. Groundwater monitoring sampling.	B.S., Environmental Studies, 3 years experience.
Holly Dillon	Field Technician	AES	Performs O&M of Sites 2 and 12 and OU2 Treatment Plants. Groundwater monitoring sampling.	B.A., Environmental Science, 7 years experience.
Edison Ticken	Engineer	AES	Performs O&M of Sites 2 and 12 and OU2 Treatment Plants. Groundwater monitoring sampling.	B.S., Chemical Engineering, 6 years experience (training)
Chad Simpson	Senior Field Technician	MACTEC	Performs groundwater sampling.	B.S., Business Management, 7 years experience
Haley Garner	Staff Env. Scientist	MACTEC	Performs groundwater sampling.	B.S., Environmental Science, 4 years experience
Dave Allbut	Staff Env. Scientist	MACTEC	Performs groundwater sampling.	B.S., Environmental Science, 8 years experience
Loi Chau	Project Engineer	MACTEC	Performs groundwater sampling	B.S., Environmental Engineering, 6 years experience
Laurie Glantz-Murphy	Lab Manager	Accutest laboratory	Laboratory Point of Contact (POC), manages project samples.	B.S., Chemistry, 10 years experience
Guergana Gueorguieva	QA Manager	Accutest laboratory	Laboratory analytical data quality.	B.S., Chemistry, 4 years experience

Notes: Select project team resumes are provided on CD as Appendix B

2.7 Special Training Requirements and Certification (QAPP Worksheet #8)

Special training requirements for AES and MACTEC field personnel working on the Fort Ord GWTS or GWMP programs may include one or more of the following:

- Munitions and Explosives of Concern (MEC) Recognition and Safety Training: AES and MACTEC staff will be provided with MEC recognition and safety training by USACE personnel (or authorized subcontractor) initially as part of project orientation for new field personnel. Additional refresher training will be held periodically as determined by USACE or as field conditions change or policies are updated. Field personnel for the GWMP are also provided with a MEC Incident Reporting Form sheet during the kick off meeting for the quarterly monitoring events, which provides procedures, lines of authority, and contact information in the event that a suspected piece of MEC is encountered in the field. An example of the MEC Incident Reporting Form is included in Appendix C.

- HAZWOPER 40-Hour Training, and Annual 8-hour Refresher Training: AES and MACTEC field staff working on the GWTS or GWMP programs are required have certification of completion of the 40 hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) training course in compliance with Chapter 29 of the Code of Federal Regulations, part 1910.120 (29 CFR 1910.120). Annual re-certification of the 40 Hour Training must be maintained through the completion of annual 8 hour OSHA HAZWOPER refresher courses.

- First Aid and CPR training and certification: First Aid and Cardio-pulmonary resuscitation (CPR) training and certification are required for designated field personnel as prescribed by the Site Safety and Health Officer. For the GWMP, at least one member of each sampling team is required to be trained and certified in First Aid and CPR. Each field staff member for the GWTS will be trained and maintain certification in First Aid and CPR.

2.8 Project Planning Session Participants Sheet (QAPP Worksheet #9)

Project Name: Sites 2 and 12 and OU2 Treatment Systems and Groundwater Monitoring at Sites 2 and 12, OU1, OU2 and OUCTP **Projected Start Date:** December 2010 **Project Manager:** Derek Lieberman, AES	**Site Name:** Former Fort Ord **Site Location:** Former Fort Ord, CA
Date of Session: 7/6/2010 **Scoping Session Purpose:** Define scope of work to be included in the QAPP.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Ed Ticken	Program Manager	MACTEC	707-793-3882	EJTicken@mactec.com	QA/QC
Jeff Fenton	Project Manager	MACTEC	707-793-3832	JJFenton@mactec.com	MACTEC PM
Debra Leibensberger	Project Chemist	MACTEC	707-496-3117	dlleibensberger@mactec.com	QAPP Preparer

Comments/Decisions: MACTEC team discussed what was to be included in the QAPP to cover the scope of the project, and how to differentiate between treatment system sampling and the quarterly sampling program.

Action Items: None outstanding.

Consensus Decisions: Specific sections of the QAPP will be divided into three categories for discussion: Sampling at Sites 2 and 12 Treatment System, Sampling at OU2 Treatment System, and Quarterly Groundwater Monitoring at Sites 2 and 12, OU1, OU2 and OUCTP.

2.9 Problem Definition/DQOs QAPP (Worksheet #10)

2.9.1 Sites 2 and 12 and OU2 Groundwater Remedies

(QAPP Worksheet #10a)

Statement of the Problem:

Sites 2 and 12:

Groundwater in the Upper 180-Foot Aquifer beneath Sites 2 and 12 has been adversely impacted by eight volatile organic compounds (VOCs) (Worksheet #15a) that are identified in the Basewide Remedial Investigation Sites Record of Decision (ROD) (*Army, 1997)*. These compounds are identified as chemicals of concern (COCs) because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the Basewide Remedial Investigation Sites ROD (RI Sites ROD) requires the Upper 180-Foot Aquifer beneath and downgradient of Sites 2 and 12 be remediated using groundwater extraction with granular activated carbon (GAC) treatment.

OU2:

Groundwater in the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient from the Fort Ord Landfills has been adversely impacted by 11 VOCs. These compounds were identified as COCs (Worksheet #15b) in the OU2 ROD (*Army, 1994)* because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OU2 ROD and the OU2 Explanation of Differences ([ESD], *Army, 1995*) requires the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient of OU2 be remediated using groundwater extraction with GAC treatment and aquifer recharge with treated water.

Identification of Decisions

The primary decisions associated with the Sites 2 and 12 and OU2 remediation projects are whether the monitoring programs reflect current site conditions, and whether the sites are in continued compliance with the RI Sites ROD, and OU2 ROD and OU2 ESD, respectively. Data collected from the Sites 2 and 12 and OU2 GWTS will be used to perform the following assessments:

- Evaluate whether the GWTS is effectively and efficiently reducing concentrations of COCs in the aquifers of concern.
- Assess whether treated effluent meets discharge requirements before it is used for groundwater recharge.
- Evaluate when the treatment system GAC requires change-out.
- Evaluate whether the GWTS provides adequate hydraulic containment of the COC plume and prevents its migration.
- Assess whether aquifer clean up levels (ACLs) have been achieved for COCs within project boundaries and whether closure of the remedy is warranted.

- Assess the frequency of sampling in extraction wells to provide flexibility as the groundwater plume is remediated.

Identification of Inputs to Decisions

Inputs to decisions regarding the Sites 2 and 12 and OU2 GWTS will be as follows:

- COC concentration data from extraction well samples collected to assess relative concentrations in the aquifer and whether ACLs have been met for COCs.

- COC concentration data from locations within the GWTS collected to assess whether the GWTS is operating effectively and efficiently.

- COC concentration data from TS-212-INJ and TS-OU2-INJ collected to confirm whether site-specific discharge requirements in QAPP Worksheets #15a and #15b, respectively, are satisfied.

- COC concentration data from GAC treatment effluent collected to determine whether a GAC change-out is required.

- System flow rate data collected to evaluate and document system operation.

- Groundwater flow modeling results to determine whether the plume is being hydraulically contained.

Definition of Study Boundaries

The physical study boundaries for the Sites 2 and 12 and OU2 GWTS are described below; however, the long term temporal boundaries for the sites are indefinite. Groundwater monitoring should continue at the sites until the project objectives are met. The frequency of sampling at the Sites 2 and 12 and OU2 GWTS is based on the historical GAC lifecycle at the site.

The definition of the study boundaries at Sites 2 and 12, indicated on Plate 3, is as follows:

- The overall geographic boundary for the site is within the western Main Garrison area at the Former Fort Ord.

- The lateral boundary is defined by the zone of groundwater impacted by COCs. The vertical boundary is defined by the zone of contaminated groundwater in the Upper 180-Foot Aquifer.

The definition of the study boundaries at OU2, indicated on Plate 5, is as follows:

- The overall geographic boundary for the site is the Main Garrison area and the Fort Ord Landfills at the Former Fort Ord.

- The lateral boundary is defined by the zone of groundwater impacted by COCs. The vertical boundary is defined by the zone of contaminated groundwater in the A-Aquifer and Upper 180-Foot Aquifer.

Development of Decision Rules

Decision rules for the Sites 2 and 12 and OU2 GWTS have been developed to address the four major components of treatment system operation: Discharge limit compliance; GAC change-out; hydraulic containment; and plume remediation. Each of these components is described below.

Discharge Limit Compliance

The following decision rules are used to determine if discharge limits are being met at the Sites 2 and 12 and OU2 GWTS:

- If the analytical results of the treatment system discharge compliance sample indicate the discharge limits for COCs (Worksheets #15a and #15b, respectively) are being met, then the system will continue in operation and GWTS effluent will be recharged to the aquifer.

- If the analytical results of the treatment system discharge compliance sample indicate the discharge limit for any COC other than methylene chloride[1] is not met, then a confirmation sample will be collected from the affected system and analyzed with 24-hour data turnaround from lab receipt.

- If the analytical results of the OU2 GWTS discharge compliance sample indicate the discharge limit at the OU2 GWTS for methylene chloride is not met, then the analytical results for the OU2 GWTS discharge compliance sample will be evaluated against the analytical results for QC samples associated with the same sampling event.

    - If the evaluation indicates the presence of methylene chloride above the discharge limit is not representative of groundwater conditions due to associated QC sample detections, then the system will continue in operation and OU2 GWTS effluent will be recharged to the aquifer.

    - If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions, then a confirmation sample will be collected from the OU2 GWTS discharge point of compliance and analyzed with 24-hour data turnaround from lab receipt.

- If the analytical results of the confirmation sample indicate the discharge limit for any COC is not met, then the affected treatment system will be shut down, operating conditions and GAC loading evaluated, extraction well flow rates adjusted as necessary, and a variance report issued for any out-of-limits operation. Following operational changes, which may include GAC change-out, the treatment system will be restarted and re-sampled to verify compliance.

- If the analytical results of the verification sample indicate the discharge limits for COCs are being met then the system will continue operating and system effluent will be recharged to the aquifer.

- If the analytical results of the verification sample indicate the discharge limit for any COC is not met, then the affected treatment system will be shut down, and operating conditions and GAC

[1] Methylene chloride is a COC for OU2 only. The EPA Contract Laboratory Program (CLP) has identified methylene chloride as a common laboratory contaminant detected in the analysis for volatile and semivolatile organics.

loading re-evaluated. Following operational changes, the treatment system will be re-started and re-sampled to verify compliance.

GAC Change-out

The decision rules for determining when a GAC change-out at the Sites 2 and 12 GWTS is necessary include the following:

- If the analytical results for trichloroethene TCE from a process sample collected immediately downstream of the lag GAC vessel (upstream of the air stripper) are less than or equal to 4.5 micrograms per liter (µg/L) (90% of the ACL), then a change-out is not necessary. The Sites 2 and 12 system can continue in operation, and the final effluent stream will continue to be recharged to the aquifer.

- If the analytical results for TCE from a process sample collected immediately downstream of the lag GAC vessel (upstream of the air stripper) are greater than 4.5µg/L (90% of the ACL), then a GAC change-out will be scheduled.

At the OU2 GWTS, the average concentration of each COC in the lead GAC vessel effluent will be calculated based on analytical results from process samples collected immediately downstream of the lead GAC vessel (upstream of the lag GAC vessel) during each process sampling event (where such samples are collected). Decision rules for determining when a GAC change-out at the OU2 GWTP is necessary are:

- If the average concentration of each COC is less than 90% of its respective ACL (Table 1), then a change-out is not necessary. The OU2 system can continue in operation, and the final effluent stream will continue to be recharged to the aquifer.

- If the average concentration of any COC other than methylene chloride is equal to or greater than 90% of its ACL, a GAC change-out will be scheduled.

- If the average concentration of methylene chloride is equal to or greater than 90% of its ACL, then the analytical results for lead GAC vessel effluent sample will be evaluated against the analytical results for QC samples associated with the same sampling event.

    - If the evaluation indicates an average concentration of methylene chloride greater than 90% of its ACL is not representative of groundwater conditions due to associated QC sample detections, then a change-out is not necessary. The system will continue in operation and OU2 GWTS effluent will be recharged to the aquifer.

    - If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions and the average concentration of methylene chloride is equal to or greater than 90% of its ACL, a GAC change-out will be scheduled.

Hydraulic Containment

During remediation system operation, specific decision rules must be followed to demonstrate COC plume capture. The decision rules are:

- If groundwater monitoring and/or groundwater flow modeling demonstrate plume capture is occurring, then system operation will continue as currently configured. During operation, adjusting extraction well flow rates may be assessed to determine whether O&M costs can be reduced while maintaining plume capture.

- If the system flow rate data, in conjunction with the groundwater flow model, indicate the plume is being hydraulically contained, then the system will continue to operate.

- If groundwater monitoring and/or groundwater flow modeling indicate plume capture is not occurring, groundwater flow modeling will be initiated to determine whether adjustment of either extraction or recharge flow rates will improve capture or whether additional extraction wells or recharge points are required. Based on this analysis, system reconfiguration may be recommended.

Plume Remediation

Assessment of the progression of aquifer cleanup during operation of the Sites 2 and 12 and OU2 GWTS will be conducted through a groundwater monitoring program that evaluates plume migration and COC fluctuations. The decision rules for determining the operational status for groundwater extraction wells are:

- Extraction wells will be sampled quarterly when operating as part of the extraction system. Extraction well monitoring data will be used for evaluating the operational status of individual extraction wells and for statistical evaluations of remediation progress.

- An extraction well will continue to be operated if any COC detected is greater than the corresponding ACL (Worksheets #15a and #15b).

- An extraction well will continue to be operated if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is necessary for hydraulic containment of the plume.

- An extraction well will be shut off if COCs detected are less than the ACL for two consecutive quarterly monitoring events, and if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is no longer necessary for hydraulic containment of the plume.

- Following termination of pumping at an extraction well, the well will be incorporated into the groundwater monitoring program.

The decision rules for determining the sampling frequency and monitoring status for groundwater extraction wells following termination of operation are:

- If four consecutive quarters of monitoring data show concentrations of COCs are below their respective practical quantitation limits (PQLs, Worksheets #15a and #15b) or below 10% of their respective ACLs (Worksheets #15a and #15b), whichever is greater, then the well may be proposed for annual monitoring.

- If two annual monitoring results show concentrations of COCs are below their respective PQLs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed to be removed from the sampling program.

- If wells adjacent to a well sampled annually show detections of COCs greater than their respective PQLs or greater than 10% of their respective ACLs, whichever is larger, then the annual well will be added to a quarterly monitoring schedule.

Implementation of agency approved exit strategies for Sites 2 and 12 and OU2, or portions thereof, may result in modification of these decision rules.

Specification of Limits of Decision Errors

The null hypotheses for the Sites 2 and 12 and OU2 GWTS are:

1) Concentrations of VOCs in groundwater entering the GWTS exist above the action levels

2) Concentrations of VOCs at the discharge points of compliance for the GWTS effluents are below discharge limits

The two types of decision errors that could result are a false acceptance decision error and a false rejection decision error. A false acceptance decision error for each null hypothesis would be:

1) Assume that a measured concentration is above the action level when in fact, it is not.

2) Assume that a measured concentration at a discharge point of compliance is below discharge limits when in fact, it is not.

Consequences of the first false acceptance error might include unnecessarily treating groundwater that is not above action levels or continuation of remediation system operation after applicable ACLs have been met.

Consequences of the second false acceptance error might include delay of timely GAC change-out, resulting in discharge of water from the GWTS above discharge limits, or discontinuation of remediation system operation when applicable ACLs have not been met.

A false rejection error for each null hypothesis would be:

1) Assume that a measured concentration is not above the action level when in fact, it is

2) Assume that a measured concentration at a discharge point of compliance is above the discharge limit when in fact, it is not.

Consequences of the first false rejection error might include premature removal of extraction wells from the remediation system program before ACLs have been met.

Consequences of the second false decision error might include unnecessarily performing or initiating confirmation sampling of GWTS effluent that actually met discharge limits during normal operation or remediation system shutdown, GAC change-out, and variance report issuance for effluent that met discharge limits after GAC vessel backwashing activities.

Decision errors are most likely to occur when the measured concentration is near the action level, or in the case of non-detects, when the reporting limit is near the action level. To control decision errors when the reporting limit is near the action level, the laboratory is required to report any detections below the reporting limit (but above the method detection limit), thereby giving the data user additional information regarding trace level contamination. To control decision errors when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual sampling events and will require data from additional sampling or subsequent sampling events before modifying the treatment system network.

Optimization of the Design

As a result of the Data Quality Objective (DQO) process, the optimum sampling design is derived for the remedy to be implemented Sites 2 and 12 and OU2. Sample collection frequencies are presented for Sites 2 and 12 in Worksheets #17a1 and #17a2 and for OU2 in Worksheets #17b1 and #17b2, and were established in a manner that will allow for assurance of discharge compliance, as well as for cost-effective evaluation of the treatment of the impacted groundwater. The EPA Test Method 8260B-SIM analytical procedure specified for this project was selected to efficiently and accurately quantify the chemicals of interest. Method performance criteria for EPA Test Method 8260B-SIM are presented in Worksheets #24 through #28a.

2.9.2 Problem Definition/DQOs – Sites 2 and 12, OU1, OU2, OUCTP Groundwater Monitoring Program

(QAPP Worksheet #10b)

Statement of the Problem:

Concentrations of VOCs (primarily TCE and related breakdown products and carbon tetrachloride) are present in groundwater at the Former Fort Ord installation at concentrations above the ACLs prescribed in the relevant ROD thereby requiring periodic monitoring and reporting of groundwater conditions and VOC concentrations to the CRWQCB, DTSC, EPA, and USACE. Groundwater contamination is present in the three aquifers within the Former Fort Ord footprint: A-Aquifer, Upper 180-Foot Aquifer and the Lower 180-Foot/400-Foot Aquifer. Three main study areas have been identified, and comprise the majority of the groundwater monitoring program:

- Sites 2 and 12: Improper disposal of solvents used by former activities in this area has led to contamination of the groundwater above ACLs. The extent of the plume in this area is defined by TCE, as it is the most common and widespread chemical constituent in this area. Active remedial action at Site 2 and 12 consists of groundwater extraction and treatment by GAC and has been on-going since 1999. Additionally, monitoring wells at Sites 2 and 12 are subject to seawater intrusion due to their proximity to Monterey Bay; as a result, concentrations of chloride and total dissolved solids (TDS) are monitored annually from select wells in this area.

- OU2: COC migration from landfills covering 150 acres in the area has led to contamination of the groundwater above ACLs. Three water supply wells (FO-29, FO-30, and FO-31) are also located near the OU2 area. The extent of the plume are defined by TCE, as it is the most common and widespread chemical constituent in this area. Active remedial action at OU2 consists of extraction and GAC treatment of the groundwater, and has been on-going since 1995. In addition to VOCs, the supply wells are seasonally subject to possible seawater intrusion due to agricultural pumping in the Salinas Valley. Disposal of spent small arms ammunition in the landfill was also identified as a possible source for contamination of the groundwater.

- OUCTP: Improper disposal of carbon tetrachloride (CT), used as a cleaning solvent for activities conducted in this area lead to contamination of the groundwater. The extent of the plumes in the OUCTP are defined by CT, as it is the most common and widespread chemical constituent in this area. Remedial action at OUCTP includes a combination of in-situ enhanced biodegradation, groundwater extraction and treatment, and monitored natural attenuation (MNA). In-situ enhanced biodegradation has been on-going since 2008 and construction of extraction and MNA wells is in progress.

In addition to the three main study areas, the Sites 2 and 12, OU1, OU2 and OUCTP GMP also includes three wells associated with the OU1 groundwater plume. Improper disposal of solvents in the Fire Drill Area of the Fritzsche Army Air Field FAAF led to contamination of the groundwater in this area. The extent of the contamination of the OU1 plume is defined by TCE. A groundwater extraction pilot study was conducted from August 5, 2008 through December 8, 2009 to support the overall remediation of the OU1 plume. To support ongoing remediation and site closure, long-term quarterly monitoring of three off-site wells (EW-OU1-92-A, EW-OU1-93-A and MW-OU1-94-A) will be conducted as part of the Sites 2 and 12, OU1, OU2, and OUCTP GMP beginning with the September 2010 sampling event as described

in Memorandum dated August 25, 2010 *Long-Term Monitoring, Operable Unit 1 Off-Site Groundwater Extraction Pilot Study* (*Shaw, 2010*).

Identification of Decisions

The data collected from the Fort Ord groundwater monitoring program is used to evaluate the following decisions:

- Are concentrations of COCs in groundwater present above the relevant ROD prescribed ACLs? What is the vertical and lateral extent of relevant ROD specified COCs in groundwater?

- What are the groundwater and aquifer conditions relative to the stability of the contaminant plumes, and what trends and temporal changes in groundwater levels and COC concentrations are taking place?

- Are concentrations of chloride and TDS in monitoring wells at Sites 2 and 12 above the Monterey County Water Resources Agency (MCWRA) threshold of 500 milligrams per liter (mg/L) and 1,000mg/L respectively for classification as "seawater intruded"?

- Are concentrations of chloride and TDS in supply wells FO-29, FO-30, and FO-31above the MCWRA threshold of 500mg/L and 1,000mg/L respectively for classification as "seawater intruded"?

- Are concentrations of dissolved antimony, copper and lead above maximum contaminant levels (MCLs) for drinking water in wells associated with the Fort Ord Landfills?[2]

Identification of Inputs to Decisions

Inputs to decisions regarding the Fort Ord Groundwater Monitoring program will be as follows:

- Historical groundwater monitoring results and archived information

- Historical knowledge of geologic and hydrologic conditions at Fort Ord

- Groundwater modeling data from recent trend analysis

- Quarterly groundwater monitoring results for VOCs, water level measurements, and selected inorganic constituents (e.g., TDS, chloride, and metals)

- Data from vertical profiling of contaminants through use of Westbay™ and passive diffusion bags (PDBs)

- ROD prescribed ACLs

- State of California MCLs for drinking water

[2] Antimony, copper and lead are the primary metals found in spent ammunition deposited in the Fort Ord Landfills. MCLs are used to evaluate concentrations of these dissolved metals in groundwater near the Fort Ord Landfills; however, the groundwater being monitored is not intended for use as drinking water.

- Fort Ord GWTS operational data and monitoring results

- Drinking water production well data from local districts and municipalities

Definition of Study Boundaries

The overall geographic boundary for the site is the Main Garrison at Fort Ord including the FAAF northern area. The constituents of concern are concentrations of VOCs in groundwater. The scale of decision-making relates to potential harmful affects to human health, as defined by drinking water MCLs.

The lateral boundary is defined by the zone of groundwater impacted, or potentially impacted, by VOC's. The vertical boundary is defined by the zone of contaminated groundwater in the following aquifers or hydrogeologic units.

- A-Aquifer

- Upper 180-Foot Aquifer

- Lower 180-Foot Aquifer

- 400-Foot Aquifer

The time frame for decision-making relates to the quarterly monitoring and reporting schedule and periodic (e.g., annual) reporting and review cycles.

With the exception of certain times of the year when presence of sensitive biological resources require modification to site or well access procedures, practical constraints on data collection are not applicable to this project.

Development of Decision Rules

The statistical parameter of interest is the maximum value detected in the well or monitoring point compared to the ACLs or historical trend for that well or monitoring point. For perimeter control, the minimum value detected in the monitoring point (e.g., non-detect at the reporting limit) is the statistical parameter of interest.

The following describe the groundwater monitoring decision rules:

- If four consecutive quarters of monitoring data show concentrations of COCs below their respective PQLs, or below 10% of their respective ACLs (Worksheet #15c), whichever is greater, then the well may be proposed for annual sampling.

- If two consecutive annual monitoring results show concentrations of COCs below their respective PQLs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed to be removed from the sampling program.

- If wells adjacent to a well sampled annually show detections of COCs greater than their respective PQLs or greater than 10% of their respective ACLs, whichever is larger, then the well will be added to a quarterly monitoring schedule.

- If monitoring or modeling input indicates the GW monitoring network no longer provides vertical or lateral control of COCs, then additional groundwater wells may be proposed to be added to the program.

- If a groundwater monitoring well is no longer needed for the program, then it will be proposed for destruction.

- If a monitoring well in Sites 2 and 12 is determined to be intruded by seawater based on chloride and TDS data, the treatment system operator will be notified.

- If concentrations of chloride and TDS in supply wells FO-29, FO-30, or FO-31 are above the MCWRA threshold for seawater intrusion, the Marina Coast Water District (MCWD) will be notified.

- If concentrations of dissolved copper, lead and antimony in select A-Aquifer wells exceed MCLs, the MCWD will be notified.

Decisions regarding application of PDBs are described in a Technical Memorandum *Passive Diffusion Bag Pilot Study Results and Recommendations* (*Harding ESE, 2001*).

Specification of Limits of Decision Errors

VOCs in groundwater at Fort Ord range in concentration from non-detect to approximately 150 µg/L for TCE, and from non-detect to approximately 15µg/L for carbon tetrachloride, the primary COCs.

The null hypothesis for this project is that concentrations of VOCs in groundwater exist above the action levels. A false acceptance decision (i.e., false positive decision error) would be to assume that a measured concentration is above the action level, when in fact, it is not. The consequences of this decision error would be to incur unnecessary expense to study and potentially modify the monitoring network to address an extent of contamination that does not exist.

A false rejection decision error (i.e., false negative decision error) would be to assume that a measured concentration is not above the action level when in fact it is. The consequences of this decision error would be to not study or potentially modify the monitoring network, thereby resulting in an incomplete understanding of the extent of contamination and potential threat to groundwater quality.

Decision errors are most likely to occur when the measured concentration is near the action level, or in the case of non-detects, when the reporting limit is near the action level. To control decision errors when the reporting limit is near the action level, the laboratory is required to report any detections below the reporting limit (but above the method detection limit), thereby giving the data user additional information regarding trace level contamination. To control decision error when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual monitoring events and will require data from additional sampling or subsequent sampling events before modifying the monitoring network.

In addition, trend analysis provides a valuable tool for assessing reliability of reporting concentrations. Furthermore, data are subjected to automated data review using an electronic system of quality control checks, under the direction of a qualified chemist, using USACE and industry standards of analytical quality control.

Optimization of the Design

The overall sampling network design is described in Worksheet #17c.

Sampling design considerations regarding application of PDBs are described in *Technical Memorandum Passive Diffusion Bag Pilot Study Results and Recommendations* (*Harding ESE, 2001*).

2.10 Project Quality Objectives/Systematic Planning Process Statements (QAPP Worksheet #11)

2.10.1 Sites 2 and 12 and OU2 Groundwater Treatment Systems; (QAPP Worksheet #11a)

Who will use the data?

The data will be used by the USACE; Regulatory Agencies including CRWQCB, EPA (and its consultant TechLaw, Inc.), DTSC; citizen groups and members of the public; and AES.

What will the data be used for?

The data collected as part of the sampling at the Sites 2 and 12 and OU2 Groundwater Treatment Systems will be used for the following assessments:

- Are the groundwater treatment systems effectively and efficiently reducing concentrations of COCs in the aquifers of concern as prescribed by the RI Sites ROD for Sites 2 and 12 and the OU2 ROD for OU2?
- Does the treated effluent from the groundwater treatment systems meet discharge requirements before it is used for groundwater recharge?
- Does the treatment system GAC filter require change-out?
- Do the groundwater treatment systems provide adequate hydraulic containment of the COC plumes and prevent migration of the plumes?
- Have the ACLs been achieved for COCs within the respective boundaries of the two treatment systems, and is closure of the remedy warranted?
- Is the frequency of sampling in the extraction wells adequate for current site conditions?

What types of data are needed?

Analyses of VOCs for target compounds associated with each of the treatment systems (Worksheets #15a and #15b) are required to evaluate and assess answers to each question above.

In addition to VOC analyses, general water quality parameters including dissolved cations, nitrate/nitrite, ammonia, alkalinity, anions, and total dissolved and suspended solids are collected annually from selected wells to evaluate current aquifer conditions.

How "good" does the data need to be to support project decisions?

VOC data is used to evaluate compliance with the relevant ROD and ACLs for each of the treatment systems. As a result, the VOC data is subject to a rigorous 100% Level III data review to verify data is of a known quality that is in compliance with the criteria in this QAPP, the general guidance presented in the Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM)

(*Environmental Data Quality Workgroup, Version 4.2,* 2010), the published analytical methods, and capable of supporting project decisions. Level III review comprises an evaluation of the following:

- Holding times and sample preservation
- Initial and continuing calibrations
- Method blank contamination
- Surrogate compound recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries and relative percent differences
- Laboratory duplicate relative percent differences
- Laboratory control sample (LCS) recoveries
- Trip, Field, and Equipment Blank contamination
- Field duplicate relative percent differences
- Internal standard areas, where applicable
- Target compound detection limits

Metals and Wet Chemistry analyses are also reviewed under Level III validation using a combination of criteria from the DOD QSM (where provided) and laboratory performance based in house acceptance criteria.

Additionally, 10% of the data are subject to Level IV raw data review as described in Worksheet #35. Level IV raw data includes the parameters reviewed during the Level III review, plus an evaluation of the raw data and re-calculation of sample results. In the event that the findings of the Level IV validation indicate the potential for other reported results to be impacted by quality related issues, the Level IV effort may be expanded to include additional samples.

Where, when and how should the data be collected?

The data collected from each treatment system is collected at the frequency and manner described in Worksheets #17a and #17b.

Who will collect the data?

Data from the treatment system are collected by AES field staff, under the direction of AES O&M Manager, Mark Fisler.

How will the data be reported?

Data from the treatment system is reported in internal monthly operation reports to the USACE. A comprehensive report for each of the treatment systems is produced annually, and is distributed to the USACE, Regulatory Agencies (EPA, CRWQCB, and DTSC), citizen groups and members of the public,

and EPA's consultant TechLaw Inc. The annual reports also contain the annual Quality Control Summary Report (QCSR), which summarizes the findings of the data validation efforts and usability of the data.

Analytical data and reports are uploaded to the Fort Ord Data Integrations System (FODIS) and CRWQCB GeoTracker websites.

How will the data be archived?

Data and/or reports are archived in the GeoTracker and FODIS databases as well as in AES's proprietary database.

2.10.2 Sites 2 and 12, OU1, OU2, and OUCTP Groundwater Monitoring Program

(QAPP Worksheet #11b)

Who will use the data?

The data will be used by the USACE; Regulatory Agencies including CRWQCB, EPA (and its consultant TechLaw, Inc.) and DTSC; citizen groups and members of the public; and MACTEC.

What will the data be used for?

The data collected as part of the Sites 2 and 12, OU1, OU2, and OUCTP Groundwater Monitoring program will be used for the following assessments:

- Are concentrations of VOCs in groundwater present above the respective ROD prescribed ACLs for Sites 2 and 12, OU1, OU2 and OUCTP?
- What is the vertical and lateral extent of COCs in the Sites 2 and 12, OU2, and OUCTP plumes?
- Do concentrations of VOCs in off-site OU1 wells indicate that the current remedy is effective and support site closure?
- What are the groundwater and aquifer conditions relative to the stability of the contaminant plumes and what trends and temporal changes are taking place?
- Are Sites 2 and 12 wells and supply wells FO-29, FO-30, and FO-31 saltwater intruded?

What types of data are needed?

Analyses of VOCs for target compounds associated with each of the plumes (Worksheet #15c) and chloride and TDS from select Sites 2 and 12 wells and Fort Ord supply wells are required to evaluate and assess answers to each question above.

In addition to VOC analyses, general water quality parameters including dissolved cations, anions and TDS are collected annually from selected wells to evaluate current aquifer conditions.

How "good" does the data need to be to support project decisions?

VOC data is used to evaluate compliance with the relevant RODs and ACLs in the Sites 2 and 12, OU2, and OUCTP and to support site closure of OU1. As a result, the VOC data is subject to a rigorous 100% Level III and 10% Level IV raw data review in order to ensure data of a know quality that is in compliance with the criteria in this QAPP, the general guidance in the DOD QSM Version 4.2, the published analytical methods, and capable of supporting project decisions.

Cations, anions and TDS data are used for qualitative purposes to assess the overall condition of the aquifer and are subject to level III review only using a combination of criteria from the DOD QSM Version 4.2 (where provided) and laboratory performance based in house acceptance criteria.

Where, when and how should the data be collected?

The data collected are collected quarterly as described in Worksheet #17c.

Who will collect the data?

Data from the quarterly groundwater monitoring system are collected by MACTEC and AES field staff under the direction of MACTEC field supervisor, Steve Korbay.

How will the data be reported?

Data from the groundwater monitoring program is reported quarterly. The first, second, and fourth quarter reports consist of a summary of the data and a QCSR. The third quarter monitoring report is the annual report and is a comprehensive report of the annual monitoring period. These reports are distributed to the USACE, Regulatory Agencies (EPA, CRWQCB, and DTSC), citizen groups and members of the public, and EPA's consultant TechLaw Inc.

The analytical data and reports are also uploaded to the FODIS and GeoTracker websites.

How will the data be archived?

Paper copies and electronic copies (PDFs) of the report are submitted to the client and agencies as requested by each. Reports are archived using on-line storage in MACTEC's Centric database, Fort Ord's FODIS database, and GeoTracker. Analytical data are archived using MACTEC's Structured Query Language (SQL) database.

2.11 Measurement Performance Criteria Table –VOCs (Worksheet #12)

2.11.1 VOCs Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP

(QAPP Worksheet #12a)

Matrix: Groundwater

Analytical Group: VOCs by EPA 8260B - SIM

Sampling Procedure	DOD QSM Table	Data Quality Indicators	Measurement Performance Criteria	QC Sample or Activity Used to Assess Measurement Performance	QC Sample Assesses for Sampling (S) Analytical (A) or Both (S&A)
AES SOP MACTEC SOPs 1-4		Representativeness	0-6°C	Cooler Temp Blank	S
	Table G-3	Bias	Dibromofluoromethane 85-115% Toluene-d8 85-120%	Surrogates	A
	Table G-4	Accuracy/ Precision	1,1-DCA = 70-135% 1,1-DCE = 70-130% 1,2-DCA = 70-130% 1,2-DCP = 75-125% Benzene = 80-120% CT = 65-140% Chloroform = 65-135% cis-1,2-DCE = 70-125% cis-1,3-DCP = 70-130% MC = 55-140% PCE = 45-150% trans-1,3-DCP = 55-140% TCE = 70-125% VC = 50-145%	LCS/LCSD (RPD < 20%)	A
	N/A	Accuracy/ Precision	Determined by Test Sample Manufacturer	Performance Evaluation Test Samples	A
	N/A	Precision	<30% RPD	Field Duplicate	S&A
	N/A	Bias/ Contamination	No target analytes above ½ PQL	Method Blank Field/Trip blanks	A S&A

QAPP Worksheet #12a Continued

Sampling Procedure	DOD QSM Table	Data Quality Indicators	Measurement Performance Criteria	QC Sample or Activity Used to Assess Measurement Performance	QC Sample Assesses for Sampling (S) Analytical (A) or Both (S&A)
AES SOP MACTEC SOPs 1-4	N/A	Analytical Completeness	90%	Evaluation of number of unqualified results out of the total results reported	S&A
	N/A	Field Completeness	95%	Number of samples collected out of total samples planned	S

Notes:
°C = Degrees Celsius
1,1-DCA = 1,1-dichloroethane
1,1-DCE = 1,1-dichloroethene
1,2-DCA = 1,2-dichloroethane
1,2-DCP = 1,2-dichloropropane
cis-1,2-DCE = cis-1,2-dichloroethene
cis-1,3-DCP = cis-1,3-dichloropropene
CT = carbon tetrachloride
LCS = laboratory control samples
LCSD = LCS duplicate
MC = Methylene chloride
PCE = tetrachloroethene
PQL = practical quantitation limit
RPD = relative percent difference
SOP = standard operating procedures
TCE = trichloroethene
trans-1,3-DCP = trans-1,3-dichloropropene
VC = vinyl chloride

Measurement Performance Criteria (Continued)

2.11.2 Metals - Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP

(QAPP Worksheet #12b)

Matrix: Groundwater

Analytical Group: Metals by EPA 6010B

Sampling Procedure	DOD QSM Table	Data Quality Indicators	Measurement Performance Criteria	QC Sample or Activity Used to Assess Measurement Performance	QC Sample Assesses for Sampling (S) Analytical (A) or Both (S&A)
AES SOP MACTEC SOPs 1-4	N/A	Representativeness	Samples preserved to proper pH	Measure pH of samples upon receipt	S
	Table G-18	Accuracy/Precision	80-120%	LCS	A
	N/A	Precision	<30% RPD	Field Duplicate	S&A
	N/A	Bias/Contamination	No target analytes above ½ PQL	Method Blank Field blanks	A S&A
	N/A	Analytical Completeness	90%	Evaluation of number of unqualified results out of total results reported	S&A
	N/A	Field Completeness	95%	Evaluation of number of samples collected out of number of samples planned	S
	N/A	Performance of the method on a given matrix/bias/precision	75-125% RPD < 35%	MS/MSD	S&A

Notes:
LCS = laboratory control samples
MS/MSD = matrix spike/matrix spike duplicate
PQL = practical quantitation limit
RPD = relative percent difference
SOP = Standard Operating Procedures

Measurement Performance Criteria (Continued)

2.11.3 Wet Chemistry - Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, OUCTP GWMP

(QAPP Worksheet #12c)

Matrix: Groundwater

Analytical Group: Wet Chemistry by various methods

Sampling Procedure	Data Quality Indicators	Measurement Performance Criteria	QC Sample or Activity Used to Assess Measurement Performance	QC Sample Assesses for Sampling (S) Analytical (A) or Both (S&A)
AES SOP MACTEC SOPs 1-4	Representativeness	0-6 °C Samples preserved to proper pH	Temperature blank Measure pH of samples upon receipt	S
	Accuracy/Precision	80-120%	LCS	A
	Precision	<35% RPD	Field Duplicate	S&A
	Bias/Contamination	No target analytes above ½ PQL	Method Blank Field blanks	A S&A
	Analytical Completeness	90%	Evaluation of number of unqualified results out of total results reported	S&A
	Field Completeness	95%	Evaluation of number of samples collected out of number of samples planned	
	Performance of the method on a given matrix/bias/precision	75-125% RPD < 35%	MS/MSD	S&A

Notes:
LCS = laboratory control samples
MS/MSD = matrix spike/matrix spike duplicate
PQL = practical quantitation limit
RPD = relative percent difference
SOP = Standard Operating Procedures

2.12 Secondary Data Criteria and Limitations

(QAPP Worksheet #13)

Since the groundwater sampling activities for the Sites 2 and 12 and OU2 GWTS and the Sites 2 and 12, OU1, OU2, and OUCTP GWMP are both long-term monitoring programs, and not active investigative programs, the secondary data that will be used to evaluate performance and concentration trends for both programs consists of the most recent annual monitoring reports as listed below.

Data Source	Data Generator	How Data Will be Used	Limitations on Data Use
Final, Annual Groundwater Treatment Systems Operation Data Summary Report, January through December 2009, Sites 2 and 12 Groundwater Remedy, Former Fort Ord, Volume II (*AES, July 30, 2010a*)	AES	Historical data used to evaluate treatment system performance over time	None
Final, Annual Groundwater Treatment Systems Operation Data Summary Report, January through December 2009, Operable Unit 2 Groundwater Remedy, Former Fort Ord, Volume II (*AES, July 30, 2010b*)	AES	Historical data used to evaluate treatment system performance over time	None
Report of Off-Site Groundwater Extraction Pilot Study and Quarterly Monitoring, Operable Unit 1, January to March 2010, Former Fort Ord, Revision 0 (Shaw, August, 2010)	Shaw Environmental, Inc	Historical data used to evaluate concentration trends	None
Draft Final, Annual Report of Quarterly Monitoring, October 2008-September 2009, Groundwater Monitoring Program, Sites 2 and 12, OU2, and OUCTP, Former Fort Ord (*MACTEC April 30, 2010*)	MACTEC	Historical data used to evaluate concentration trends	None

2.13 Summary of Project Tasks

2.13.1 Sites 2 and 12 and OU2 GWTS

(QAPP Worksheet #14a)

Sampling Tasks:
1. Treatment system and associated groundwater sampling from sampling stations described in Worksheets #17a1 and #17b1. Frequency of sampling as described in Worksheets #17a2 and #17b2.
Analysis Tasks:
1. See Worksheets #15a and #15b.
Quality Control Tasks:
1. Implement AES "Field Sampling protocols" (AES SOP, Appendix A) for collection of groundwater samples, packing and transport, and post field processing prior to analysis. Collect and submit QC samples as described in Worksheet #20. Analyses to be performed in accordance with this QAPP, the guidance provided in the DOD QSM Version 4.2, and published methods.
Secondary Data:
1. See Worksheet #13.
Data Management Tasks:
1. Electronic analytical data from the laboratory for each sample will be tracked, reviewed, and loaded into the AES database and FODIS database.
2. Following receipt of analytical data packages, the data is validated and a qualifier file is created. The data qualifier file is verified against the hardcopy data validation reports at a rate of 10%. Once verified, the data qualifier file is loaded into the AES and FODIS databases.
3. Upon completion of the monitoring reports, the report and analytical files are uploaded to the GeoTracker database.
Documentation and Records:
1. Sampling methods, times, field measurements, observations, and assessments will be documented in field notes or groundwater sampling forms. Chain of custodies and courier/transportation bills will be prepared and retained in project files for each sample.
2. Copy of field and laboratory records is included in each annual monitoring report.
Assessment/Audit Tasks:
1. Sampling activities will be evaluated for compliance with the SOP by the field supervisor or project chemist. 2. Field and Laboratory audits may be performed by the project or program chemist.
Data Review Tasks:
1. 100% of the laboratory data will be subject to the equivalent of EPA Level III review and 10% will be subject to the equivalent of EPA Level IV raw data review as described in Worksheets #34 through #37 for compliance with the requirements of this QAPP, the guidance provided in the DOD QSM Version 4.2, and published methods to assess the usability of the data. The findings of the data review and validation will be used to implement corrective actions with the laboratory, if appropriate and will be published as a QCSR presented in the annual Report. Data qualifiers will be applied to sample results as needed based on the findings of the data validation, and uploaded with the analytical data to GeoTracker, FODIS and AES database.

Summary of Project Tasks

2.13.2 Sites 2 and 12, OU1, OU2, OUCTP Groundwater Monitoring Program

(QAPP Worksheet #14b)

Sampling Tasks:
1. Quarterly water level measurements using electronic depth to water (DTW) sounders at monitoring wells throughout the Sites 2 and 12, OU2 and OUCTP study areas and off-site OU1 wells.
2. Quarterly groundwater monitoring using passive diffusion bags, HydraSleeves, Westbay sampling equipment and sampling from ports as described in Worksheet #17c.
Analysis Tasks:
1. See Worksheet #15c.
Quality Control Tasks:
1. Implement MACTEC SOPs 1-4 for collection of groundwater samples, packing and transport, and post field processing prior to analysis. Collect and submit QC samples as described in Worksheet #20. Analyses to be performed in accordance with this QAPP, the guidance provided in the DOD QSM Version 4.2, and published methods.
Secondary Data:
1. See Worksheet #13.
Data Management Tasks:
1. Electronic analytical data from the laboratory for each sample will be tracked, reviewed, and loaded into SQL database and FODIS database.
2. Following receipt of analytical data packages, the data is validated and a qualifier file is created. The data qualifier file is verified against the hardcopy data validation reports at a rate of 10%. Once verified, the data qualifier file is loaded into the SQL and FODIS databases.
3. Upon completion of the monitoring reports, the report and analytical files are uploaded to the GeoTracker database. Electronic copies of the groundwater monitoring reports are maintained in the Centric database.
Documentation and Records:
1. Sampling methods, times, field measurements, observations, and assessments will be documented in field notes or groundwater sampling forms. Chain of custodies and courier/transportation bills will be prepared and retained in project files for each sample.
2. Copy of field forms will be retained in central Centric database and hardcopy library and will be included in each quarterly monitoring report.
Assessment/Audit Tasks:
1. Sampling activities will be evaluated for compliance with the SOP by the field supervisor or project chemist. 2. Kick off meeting and/or field audit will be conducted with field staff prior to each quarterly sampling event. 3. Kick off meeting and/or lab audit will be conducted with analytical laboratory prior to each quarterly sampling event. 4. USACE Chemist will perform two QA oversight audits of sampling activities per year.
Data Review Tasks:
1. 100% of the laboratory data will be subject to the equivalent of EPA Level III review and 10% will be subject to the equivalent of EPA Level IV raw data review as described in Worksheets #34-#38 for compliance with the requirements of this QAPP, the guidance provided in the DOD QSM Version 4.2, and published methods to assess the usability of the data. The findings of the data review and validation will be utilized to implement corrective actions with the laboratory, if appropriate, and will be published in the quarterly reports as a QCSR. Data qualifiers will be applied to sample results as needed based on the findings of the data validation, and uploaded with the analytical data to GeoTracker, FODIS and SQL database.

2.14 Reference Limits and Evaluation Table

2.14.1 Sites 2 and 12 GWTS

(QAPP Worksheet #15a)

Test Method	Analyte	ACL (µg/L)[1]	Discharge Limits (µg/L)[2]	Laboratory PQL (µg/L)
EPA 8260B-SIM	Chloroform	2.0	2.0	0.5
	1,2-Dichloroethane	0.50	0.50	0.50
	1,1-Dichloroethene	6.0	6.0	0.50
	cis-1,2-Dichloroethene	6.0	6.0	0.50
	1,3-Dichloropropene	0.5	0.5	0.50
	Tetrachloroethene	3.0	3.0	0.50
	Trichloroethene	5.0	5.0	0.50
	Vinyl chloride	0.10	0.10	0.10
EPA 6010B	Dissolved Calcium	N/A [3]	N/A [3]	1,000
	Dissolved Magnesium	N/A [3]	N/A [3]	5,000
	Dissolved Sodium	N/A [3]	N/A [3]	10,000
	Dissolved Potassium	N/A [3]	N/A [3]	10,000
EPA 300.0	Chloride	N/A [3]	N/A [3]	500
	Sulfate	N/A [3]	N/A [3]	500
SM 4500NO3E	Nitrite & Nitrate	N/A [3]	N/A [3]	200
SM 4500NH	Ammonia	N/A [3]	N/A [3]	1,000
SM 2320B	Alkalinity, total	N/A [3]	N/A [3]	5,000
SM 4500SD	Sulfide, total	N/A [3]	N/A [3]	100
SM 2540D	Total Suspended Solids	N/A [3]	N/A [3]	5,000
SM 2540C	Total Dissolved Solids	N/A [3]	N/A [3]	10,000

Notes:

SM Standard Methods

µg/L micrograms per liter

1 Record of Decision, Basewide Remedial Investigation Site, Fort Ord, California, January 13, 1997.

2 Discharges to areas overlying the contaminated groundwater plume need only meet aquifer cleanup levels (*HLA, 1999*).

3 Not Applicable: analyte does not have an ACL or discharge limit identified in a Fort Ord decision document; therefore, the analyte is not used for decision-making with respect to the Fort Ord CERCLA process, but may be used to qualitatively assess general water quality.

2.14.2 Reference Limits and Evaluation Table OU2 GWTS

(QAPP Worksheet #15b)

Test Method	Analyte	ACL (µg/L)[1]	Discharge Limits (µg/L)[2]	Laboratory PQL (µg/L)
EPA 8260B-SIM	Benzene	1.0	0.50	0.50
	Carbon Tetrachloride	0.50	0.50	0.50
	Chloroform	2.0	2.0	0.5
	1,1-Dichloroethane	5.0	5.0	0.5
	1,2-Dichloroethane	0.50	0.50	0.50
	cis-1,2-Dichloroethene	6.0	6.0	0.50
	1,2-Dichloropropane	1.0	0.50	0.50
	Methylene chloride	5.0	0.50 [3]	2.0
	Tetrachloroethene	3.0	0.50	0.50
	Trichloroethene	5.0	0.50	0.50
	Vinyl chloride	0.10	0.10	0.10
EPA 6010B	Dissolved Calcium	N/A [4]	N/A [4]	1,000
	Dissolved Magnesium	N/A [4]	N/A [4]	5,000
	Dissolved Sodium	N/A [4]	N/A [4]	10,000
	Dissolved Potassium	N/A [4]	N/A [4]	10,000
EPA 300.0	Chloride	N/A [4]	N/A [4]	500
	Sulfate	N/A [4]	N/A [4]	500
SM 4500NO3E	Nitrite & Nitrate	N/A [4]	N/A [4]	200
SM 2320B	Alkalinity, total	N/A [4]	N/A [4]	5,000
SM 4500SD	Sulfide, total	N/A [4]	N/A [4]	100
SM 2540C	Total Dissolved Solids	N/A [4]	N/A [4]	10,000

Notes:

µg/L micrograms per liter

1 Record of Decision, Operable Unit 2, Fort Ord Landfills, California, July 5, 1994.

2 Discharges to areas overlying the contaminated groundwater plume need only meet aquifer cleanup levels (*HLA, 1999*).

3 Laboratory PQL exceeds the discharge limit; however, the laboratory reports this compound down to the method detection limit (MDL) of 0.50 µg/L. Detection of methylene chloride above 0.50 µg/L will trigger decision rules described in Worksheet #10a.

4 Not Applicable: analyte does not have an ACL or discharge limit identified in a Fort Ord decision document; therefore, the analyte is not used for decision-making with respect to the Fort Ord CERCLA process, but may be used to qualitatively assess general water quality.

2.14.3 Reference Limits and Evaluation Table - Sites 2 and 12, OU1, OU2, and OUCTP GWMP (QAPP Worksheet #15c)

Method and Parameters	Practical Quantitation Limit (µg/L)	State Maximum Contaminant Limit [a] (µg/L)	Federal Maximum Contaminant Limit [b] (µg/L)	Aquifer Cleanup Levels [c] (µg/L)			
				Sites 2 and 12	OU1	OU2	OUCTP
Ion Chromatography				--	--	--	--
EPA Method 300.0 (Anions)			--	--	--	--	
Chloride	200	250,000	--	--	--	--	--
			--	--	--	--	
Dissolved Metals by ICP/MS				--	--	--	--
EPA Method 6010B/200.8				--	--	--	--
Antimony	6	6	6	--	--	--	--
Copper	10	1,000	1,300	--	--	--	--
Lead	10	15	15	--	--	--	--
				--	--	--	--
Gravimetric Procedures					--	--	--
EPA Method SM2540C				--	--	--	--
Total Dissolved Solids	5,000	500,000	500,000	--	--	--	--
				--	--	--	--
Volatile Organic Compounds					--	--	--
EPA Method 524.2 [d]				--	--	--	--
1,1,1,2-Tetrachloroethane	0.5	--	--	--	--	--	--
1,1,1-Trichloroethane	0.5	200	200	--	200	--	--
1,1,2,2-Tetrachloroethane	0.5	1	--	--	--	--	--
1,1,2-Trichloroethane	0.5	5	5	--	--	--	--
1,1-Dichloroethane	0.5	5	--	--	5	5	--
1,1-Dichloroethene	0.5	6	7	6	6	--	6
1,1-Dichloropropene	0.5	--	--	--	--	--	--
1,2,3-Trichlorobenzene	0.5	--	--	--	--	--	--
1,2,3-Trichloropropane	0.5	--	--	--	--	--	--
1,2,4-Trichlorobenzene	0.5	5	70	--	--	--	--
1,2,4-Trimethylbenzene	0.5	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane	2	--	--	--	--	--	--

QAPP Worksheet #15c (Continued)

Method and Parameters	Practical Quantitation Limit (µg/L)	State Maximum Contaminant Limit [a] (µg/L)	Federal Maximum Contaminant Limit [b] (µg/L)	Sites 2 and 12	Aquifer Cleanup Levels [c] (µg/L)		
					OU1	OU2	OUCTP
1,2-Dichlorobenzene	0.5	600	600	--	--	--	--
1,2-Dichloroethane	0.5	0.5	5	0.5	0.5	0.5	0.5
1,2-Dichloropropane	0.5	5	5	--	--	1	--
1,3,5-Trimethylbenzene	0.5	--	--	--	--	--	--
1,3-Dichlorobenzene	0.5	--	--	--	--	--	--
1,3-Dichloropropane	0.5	--	--	--	--	--	--
1,4-Dichlorobenzene	0.5	5	75	--	--	--	--
2,2-Dichloropropane	0.5	--	--	--	--	--	--
2-Chlorotoluene	0.5	--	--	--	--	--	--
4-Chlorotoluene	0.5	--	--	--	--	--	--
4-Methyl-2-pentanone(MIBK)	5.1	--	--	--	--	--	--
Benzene	0.5	1	5	--	1	1	--
Bromobenzene	0.5	--	--	--	--	--	--
Bromochloromethane	0.5	--	--	--	--	--	--
Bromodichloromethane	0.5	--	--	--	--	--	--
Bromoform	0.5	--	--	--	--	--	--
Bromomethane	0.5	--	--	--	--	--	--
Carbon tetrachloride	0.5	0.5	5	--	--	0.5	0.5
Chlorobenzene	0.5	--	--	--	--	--	--
Chloroethane	0.5	--	--	--	--	--	--
Chloroform	0.5	--	--	2	2	2	2
Chloromethane	0.5	--	--	--	--	--	--
cis-1,2-Dichloroethene	0.5	6	70	6	6	6	--
cis-1,3-Dichloropropene	0.5	--	--	--	--	0.5	--
Dibromochloromethane	0.5	--	--	--	--	--	--
Dibromomethane	0.5	--	--	--	--	--	--
Dichlorodifluoromethane	0.5	--	--	--	--	--	--
Ethylbenzene	0.5	300	700	--	--	--	--

QAPP Worksheet #15c (Continued)

Method and Parameters	Practical Quantitation Limit (µg/L)	State Maximum Contaminant Limit [a] (µg/L)	Federal Maximum Contaminant Limit [b] (µg/L)	Sites 2 and 12	Aquifer Cleanup Levels [c] (µg/L)		
					OU1	OU2	OUCTP
Freon 113	1	1,200	--	--	--	--	--
Hexachlorobutadiene	0.5	--	--	--	--	--	--
Isopropylbenzene	0.5	--	--	--	--	--	--
m,p-Xylenes	0.5	1,750	10,000	--	--	--	--
Methyl ethyl ketone (MEK)	5	--	--	--	1,900	--	--
Methyl-tert-butyl-ether	0.5	5	--	--	--	--	--
Methylene chloride	0.5	--	--	--	--	5	5
n-Butylbenzene	0.5	--	--	--	--	--	--
Naphthalene	0.5	--	--	--	--	--	--
o-Xylene	0.5	1,750	10,000	--	--	--	--
p-Isopropyltoluene	0.5	--	--	--	--	--	--
Propylbenzene	0.5	--	--	--	--	--	--
sec-Butylbenzene	0.5	--	--	--	--	--	--
Styrene	0.5	100	100	--	--	--	--
tert-Butylbenzene	0.5	--	--	--	--	--	--
Tetrachloroethene	0.5	5	5	3	5	3	5
Toluene	0.5	150	1,000	--	--	--	--
trans-1,2-Dichloroethene	0.5	10	100	--	--	--	6
trans-1,3-Dichloropropene	0.5	--	--	0.5	--	--	--
Trichloroethene	0.5	5	5	5	5	5	5
Trichlorofluoromethane	0.5	150	--	--	--	--	--
Vinyl chloride	0.1	0.5	2	0.1	--	0.1	0.1
EPA Method 8260B-SIM							
1,1-Dichloroethane	0.5	5	--	--	5	5	--
1,1-Dichloroethene	0.5	6	7	6	6	--	6
1,1,1-Trichloroethane	0.5	200	200	--	200	--	--
1,2-Dichloroethane	0.5	0.5	5	0.5	0.5	0.5	0.5
1,2-Dichloropropane	0.5	5	5	--	--	1	--

QAPP Worksheet #15c (Continued)

Method and Parameters	Practical Quantitation Limit (µg/L)	State Maximum Contaminant Limit [a] (µg/L)	Federal Maximum Contaminant Limit [b] (µg/L)	Sites 2 and 12	Aquifer Cleanup Levels [c] (µg/L)		
					OU1	OU2	OUCTP
Benzene	0.5	1	5	--	1	1	--
Carbon tetrachloride	0.5	0.5	5	--	--	0.5	0.5
Chloroform	0.5	--	--	2	2	2	2
cis-1,2-Dichloroethene	0.5	6	70	6	6	6	--
cis-1,3-Dichloropropene	0.5	--	--	0.5	--	--	--
Methylene chloride	0.5	--	--	--	--	5	5
Methyl Ethyl Ketone	0.5			--	1900	--	--
Tetrachloroethene	0.5	5	5	3	5	3	5
trans-1,3-Dichloropropene	0.5	--	--	0.5	--	--	--
Trichloroethene	0.5	5	5	5	5	5	5
Vinyl chloride	0.1	0.5	2	0.1	--	0.1	0.1

Notes:
µg/L = micrograms per liter.
OU = Operable Unit.
OUCTP = Operable Unit Carbon Tetrachloride Plume.
EPA = U.S. Environmental Protection Agency.
-- = Not available.

[a] MCLs from California Department of Public Health's (CDPH's) *Maximum Contaminant Levels and Regulatory Dates for Drinking Water U.S.EPA vs. California* updated September 2007 (*CDPH, 2007*).
[b] MCLs from *CDPH, 2007* and EPA's *Drinking Water Contaminants* updated June 2008 (*EPA, 2008*).
[c] ACLs from Table 4 Chemicals of Concern in Groundwater and Aquifer Cleanup Levels from *Annual Report of Quarterly Monitoring, October 2005 through September 2006* (*MACTEC, 2007*). Analytes that do not have an ACL identified in a Fort Ord decision document are not used for decision-making with respect to the Fort Ord CERCLA process, but may be used to qualitatively assess general water quality.
[d] Compounds in the EPA 524.2 analyte list with no associated ACLs, discharge limits or MCLs are not used for decision making with respect to the Fort Ord CERCLA process, and are used solely for comparison to the Marina Coast Water District data for former Fort Ord supply wells.

2.15 Project Schedule/Timeline Table/Frequency Table

(QAPP Worksheet #16)

Activities	Organization	Anticipated Dates of Initiation	Anticipated dates of Completion	Deliverable	Deliverable Due Date
Sites 2 and 12 GWTS Sampling	AES	See Worksheets #17a1, #17a2	On-going	Monthly Reports and Annual Report	Monthly reports are due on the 10th of each month. The Final Annual reports are due on July 30th of each year.
OU2 GWTS Sampling	AES	See Worksheets #17b1, #17b2	On-going	Monthly Reports and Annual Report	Monthly reports are due on the 10th of each month. The Final Annual reports are due on July 30th of each year.
Sites 2 and 12, OU1, OU2, OUCTP GWMP	MACTEC	Quarterly (March, June, September, December)	On-going	Quarterly and Annual Reports	12 weeks from receipt of laboratory data

3.0 MEASUREMENT AND DATA AQUISTION

3.1 Sampling Design/Rationale (Worksheet #17)

3.1.1 Design/Rationale/SOP – Sites 2 and 12 GWTS (Part I)

(QAPP Worksheet #17a1)

Sampling Location	Activity	EPA Test Method	Comments/Rationale[4]	AES SOP[5]
TS-212-INF	Treatment system monitoring [1]	8260B-SIM	To evaluate influent concentration. (Mass loading to the GWTP)	See Appendix A, "AES Field Sampling Protocols"
TS-212-GAC A or B			To evaluate COC breakthrough from lead or lag GAC unit.	
TS-212-EFF			To evaluate COC concentrations downstream from the air stripper unit.	
TS-212-INJ			To comply with discharge limits.	
EW-12-01-180-U	Groundwater Monitoring [2,3]	8260B-SIM	To evaluate changes in groundwater COC concentrations. To evaluate general inorganic constituents. Water levels are collected quarterly in extraction wells.	
EW-12-01-180-M				
EW-12-02-180-U				
EW-12-02-180-M				
EW-12-03-180-U				
EW-12-03-180-M				
EW-12-04-180-U				
EW-12-04-180-M				
EW-12-05-180-M				
EW-12-06-180-M				
EW-12-07-180-M				

Notes:

COC = chemicals of concern

GAC = granular activated carbon

TS = Treatment system sampling port

[1] Sampling frequency is variable based on historical GAC breakthrough rates, as shown on Worksheet #17b2.

[2] Samples and water level measurements are collected quarterly from the extraction wells.

[3] During the 3rd Quarter sampling event, inorganic parameters are analyzed, including TDS, total suspended solids (TSS), alkalinity, nitrate+nitrite, ammonia, sulfide, chloride, sulfate, calcium, sodium, magnesium, and potassium.

[4] The rationale for sampling locations and frequency is based on the RI Sites ROD, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CRWQCB.

[5] AES does not use stand-alone SOPs, and instead includes field sampling protocols in the site sampling and analysis plan (SAP). Please refer to Appendix A "AES Field Protocols" for a description of sample handling and collection in lieu of an SOP.

3.1.1 (Cont.) Sampling Design/Rationale - Sites 2 and 12 GWTS (Part II)

(QAPP Worksheet #17a2)

Sites 2 and 12 GWTS Sampling Frequencies [3] GAC change-out = 78 to 98 weeks														
Sample Point	GAC Change-out	Weeks after GAC change-out					Lead GAC TCE Breakthrough				Lag GAC TCE Breakthrough			Lag GAC TCE ≥ 50% of the Discharge Limit, continue with weekly sampling until TCE ≥ 90% of the Discharge Limit
		0	6	19	32	45		49	53	57		62	66	70
TS-212-INF			x	x	x	x		x	x	x		x	x	x
TS-212-GAC A or B [1]			x	x	x	x		x						
TS-212-GAC A or B [2]								x	x	x		x	x	x
TS-212-EFF			x	x	x	x		x	x	x		x	x	x
TS-212-INJ		x	x	x	x	x		x	x	x		x	x	x

Notes:

[1] Sample point to be immediately downstream of the lead GAC unit.

[2] Sample point to be immediately downstream of the lag GAC unit.

[3] Sampling frequency is determined based on historical GAC breakthrough rates.

3.1.2 Sampling Design/Rationale/SOP – OU2 GWTS (Part I)

(QAPP Worksheet #17b1)

Sampling Location	Activity	EPA Test Method	Comments/Rationale[4]	AES SOP[5]
TS-OU2-INF[3]	Treatment System Monitoring [1]	8260B-SIM	To evaluate influent concentration.	See Appendix A, "AES Field Sampling Protocols"
TS-OU2-GAC A or B			To evaluate COC breakthrough of GAC beds A or B.	
TS-OU2-GAC C or D			To evaluate COC breakthrough of GAC beds C or D.	
TS-OU2-EFF			To evaluate COC breakthrough downstream from GAC units.	
TS-OU2-INJ			To comply with discharge limits (point-of-compliance).	
EW-OU2-01-A	Groundwater Monitoring [2,3]	8260B-SIM	To evaluate changes in groundwater COC concentrations and to annually evaluate general inorganic constituents.	
EW-OU2-02-A				
EW-OU2-03-A				
EW-OU2-04-A				
EW-OU2-05-A				
EW-OU2-06-A				
EW-OU2-07-A				
EW-OU2-08-A				
EW-OU2-09-A				
EW-OU2-10-A				
EW-OU2-11-A				
EW-OU2-12-A				
EW-OU2-13-A				
EW-OU2-14-A				
EW-OU2-15-A				
EW-OU2-16-A				
EW-OU2-01-180				
EW-OU2-02-180				
EW-OU2-03-180				
EW-OU2-04-180				
EW-OU2-05-180				
EW-OU2-06-180				
EW-OU2-07-180				
EW-OU2-08-180				

QAPP Worksheet #17b1 Continued

Notes:

COC = chemicals of concern

EW = Extraction well

GAC = granular activated carbon

MS/MSD = Matrix spike/matrix spike duplicate

TS = Treatment system sampling port

(1) Sampling frequency is variable based on historical GAC breakthrough rates, as shown in Worksheet #17a2.

(2) Groundwater samples and water level measurements are collected quarterly from the extraction wells.

(3) During the third quarter sampling event, inorganic parameters are analyzed, including TDS, nitrate+nitrite, chloride, sulfate, calcium, sodium, magnesium and potassium. Analytical methods are listed on Table 5.

(4) The rationale for sampling locations and frequency is based on the OU2 ROD, OU2 ESD, program history and precedent established by the BRAC Cleanup Team (BCT), which includes the Army, USACE, EPA, DTSC, and CRWQCB.

(5) AES does not use stand-alone SOPs, and instead includes field sampling protocols in the site SAP. Please refer to Appendix A "AES Field Protocols" for a description of sample handling and collection in lieu of an SOP.

3.1.2 (Cont.) Sampling Design/Rationale - OU2 GWTS (Part II)

(QAPP Worksheet #17b2)

OU2 GWTS Sampling Frequencies GAC change-out = 24 to 34 Weeks												
Sample Point	GAC Change-out	Weeks after GAC change-out [3]										
		0 [2]	4	8	12	14	16	18	20	22	24	26
TS-OU2-INF				x			x			x		x
TS-OU2-600(A OR B) [1]							x		x	x	x	x
TS-OU2-600(C OR D) [1]							x		x	x	x	x
TS-OU2-INJ		x	x	x	x	x	x	x	x	x	x	x

Notes:

[1] Sample point to be immediately downstream of the lead GAC unit.

[2] Sample collected at least 2 hours after bringing a newly repacked GAC vessel on-line.

[3] If GAC change-out is not indicated by Week 26, further sampling will be performed weekly, under direction of the Project Manager.

3.1.3 Sampling Design/Rationale/SOP - Sites 2 and 12, OU1, OU2 and OUCTP GWMP (QAPP Worksheet #17c)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
Airfield				**Q**	**Q**	PDB/SOP #2	RI Sites ROD
EISB-EW-01				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-EW-02				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-EW-03				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-EW-09				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-EW-12				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-EW-15				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-MW-01				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EISB-MW-04				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EW-BW-92-A				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EW-BW-93-A				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EW-OU1-92-A				**Q**	**Q**	PDB/SOP #2	Support On-Going Remediation and Site Closure of OU1
EW-OU1-93-A				**Q**	**Q**	PDB/SOP #2	Support On-Going Remediation and Site Closure of OU1
EW-OU2-01-180				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
EW-OU2-03-A				**Q**	**Q**	PDB/SOP #2	OU2 ROD
EW-OU2-07-180				**Q**	**Q**	PDB/SOP #2	OU2 ESD
EW-12-04-180M				**Q**	**Q**	PDB/SOP #2	RI Sites ROD
FO-29			**Q**			Sampling Port/SOP #4	Drinking Water Quality
FO-30			**Q**			Sampling Port/SOP #4	Drinking Water Quality
FO-31			**Q**			Sampling Port/SOP #4	Drinking Water Quality
MCWD-08A				**Q**	**Q**	PDB/SOP #2	OUCTP ROD
Mini-storage			**Q**		**Q**	Sampling Port/SOP #4	OUCTP ROD
MP-BW-30-317				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-30-467				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-30-537				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-31-292				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-31-332				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-31-407				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-31-457				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-32-332				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-32-472				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-33-317				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-33-352				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-33-397				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-34-292				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-34-422				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-34-492				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-34-537				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-35-312				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-35-366				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-35-402				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-35-527				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-37-303				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-37-328				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-37-368				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-38-327				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-38-341				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-38-353				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-38-368				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-38-418				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-39-310				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-39-330				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-39-350				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-39-395				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-40-333				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-40-375				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-202				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-231				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-256				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-286				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-318				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-353				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-396				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-215				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-235				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-295				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-314				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-345				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-400				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-080				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-095				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-170				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-185				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-200				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-215				**A**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-48-133				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-287				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-49-316				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-336				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-368				**Q**	**Q**	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-400				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-50-289				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-50-309				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-50-339				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-50-359				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-50-384				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-51-315				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-51-340				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-51-370				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-51-405				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-52-323				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-52-338				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-52-363				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-52-388				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MP-BW-52-408				**Q**	**Q**	PDB/SOP #1	OUCTP ROD
MW-02-01-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-02-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD
MW-02-03-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-04-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-02-05-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-06-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD
MW-02-07-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD
MW-02-09-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-10-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD
MW-02-11-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-12-180				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-13-180M				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-13-180U				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-14-180M				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-14-180U				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-15-180M				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-02-15-180U				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-10-04-180				**Q**	**Q**	PDB/SOP#2	Carbon Tetrachloride Detection
MW-12-01-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-05-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-07-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-08-180	**A**			**A**	**Q**	HydraSleeve™, PDB/ SOP#3,2	RI Sites ROD
MW-12-09R-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-14-180M				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-15-180M				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-12-16-180M				**Q**	**Q**	PDB/SOP#2	RI Sites ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-14-03-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-16-01-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-18-03-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-B-12-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-B-14-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-02-180				**Q**	**Q**	PDB/SOP#2	RI Sites ROD
MW-BW-03-400				**A**	**Q**	PDB/SOP#2	RI Sites ROD
MW-BW-04-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-BW-11-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-BW-12-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-BW-13-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-BW-14-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-BW-15-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-16-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-17-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-22-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-23-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-24-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-25-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-26-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-26-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-27-A		□□		**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-28-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-30-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-31-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-32-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-34-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-35-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-36-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-38-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-39-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-41-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-42-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-43-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-44-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-44-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-45-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-45-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-46-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-47-180				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-48-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-49-180				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-49-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-50-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-50-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-51-180				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-51-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-52-180				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-52-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-53-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-53-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-54-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-55-180				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-55-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-56-180				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-56-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-57-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-58-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-59-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-60-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-61-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-62-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-63-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-64-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-65-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-66-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-67-A				**A**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-71-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-73-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-74-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-75-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-76-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-77-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-78-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-79-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-80-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-81-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-82-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-83-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-BW-84-A				**Q**	**Q**	PDB/SOP#2	OUCTP ROD
MW-OU1-94-A				**Q**	**Q**	PDB/SOP#2	Support On-Going Remediation and Site Closure of OU1
MW-OU2-01-A		**Q**		**Q**	**Q**	HydraSleeve™, PDB/ SOP#3,2	OU2 ROD
MW-OU2-02-A		**Q**		**Q**	**Q**	HydraSleeve™, PDB/ SOP#3,2	OU2 ROD
MW-OU2-03-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-04-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-05-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-06-180R				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-06-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-07-180R				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-07-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-08-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-09-180R				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-09-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-12-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-20-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-20-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-21-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-23-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-23-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-24-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-25-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-27-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-28-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-28-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-29-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-29-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-30-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-31-180R				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-34-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-39-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-40-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-41-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-42-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-43-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-44-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-44-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-45-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-46-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-46-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-47-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-49-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-50-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-51-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-52-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-53-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-54-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-55-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-56-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-57-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-59-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-60-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-61-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-62-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-63-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-64-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-66-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-67-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-69-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-70-180				**A**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-72-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-73-A		**Q**		**Q**	**Q**	HydraSleeve™, PDB/ SOP#3,2	OU2 ROD
MW-OU2-74-A		**Q**		**Q**	**Q**	HydraSleeve™, PDB/ SOP#3,2	OU2 ROD
MW-OU2-75-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-77-A				**A**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-78-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-79-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-80-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD
MW-OU2-81-A				**Q**	**Q**	PDB/SOP#2	OU2 ROD

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-81-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
MW-OU2-82-180				**Q**	**Q**	PDB/SOP#2	OU2 ESD
The Following Wells Are Measured for Groundwater Elevation Data Only:							
Beach					**Q**	SOP #2	Groundwater elevation trend analysis
MP-BW-30-282					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-30-342					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-30-397					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-31-362					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-31-522					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-32-287					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-32-366					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-32-412					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-32-522					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-33-272					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-34-357					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-35-242					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-35-467					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-35-562					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-37-178					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-37-193					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-37-398					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-37-460					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-40-353					**Q**	SOP #1	Groundwater elevation trend analysis
MP-BW-40-400					**Q**	SOP #1	Groundwater elevation trend analysis

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-42-195					**Q**	SOP #1	Groundwater elevation trend analysis
MW-BW-48-113					**Q**	SOP #2	Groundwater elevation trend analysis
MW-02-08-180X					**Q**	SOP #2	Groundwater elevation trend analysis
MW-10-05-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-10-06-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-12-12-180L					**Q**	SOP #2	Groundwater elevation trend analysis
MW-14-02-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-17-01-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-18-01-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-18-02-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-23-03-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-40-01-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-02-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-05-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-18-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-19-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-20-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-22-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-23-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-24-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-B-25-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-01-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-10-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-18-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-20-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-21-180					**Q**	SOP #2	Groundwater elevation trend analysis

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-29-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-33-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-37-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-40-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-43-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-47-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-BW-54-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-05-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-06-400					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-07-400					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-13-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-20-180X					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-22-400					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-26-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-28-400					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-30-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-32-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-33-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-35-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-36-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-36-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-37-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-37-A					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-38-SVA					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-48-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-58-A					**Q**	SOP #2	Groundwater elevation trend analysis

QAPP Worksheet #17c (Continued)

Well Name	Cl TDS	Cu, Pb, Sb (6010B)	VOCs (524.2)	VOCs (8260B-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-68-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-71-180					**Q**	SOP #2	Groundwater elevation trend analysis
MW-OU2-76-A					**Q**	SOP #2	Groundwater elevation trend analysis
PZ-02-03-180					**Q**	SOP #2	Groundwater elevation trend analysis
PZ-02-04-180					**Q**	SOP #2	Groundwater elevation trend analysis
PZ-02-05-180					**Q**	SOP #2	Groundwater elevation trend analysis
TEST2					**Q**	SOP #2	Groundwater elevation trend analysis
TEST4					**Q**	SOP #2	Groundwater elevation trend analysis

Sampling Schedule shown above is current as of September 2008, and is subject to change as agreed upon between the Army, USACE, and regulatory agencies. Changes to the sampling program are presented in the Annual reports of Quarterly monitoring.

Notes

Q: Sampled on a quarterly basis.

A: Sampled on an annual basis.

[1] The rationale for sampling locations and frequency is based on the applicable program RODs, OU2 Explanation of Significant Differences (ESD), program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CRWQCB.

3.2 Sampling Locations and Methods/SOP Requirements Table

(QAPP Worksheet #18)

This Worksheet was not used. Information that would be included in this worksheet is incorporated into Worksheets #17a-c.

3.3 Analytical Requirements – Sample Volumes/Preservation Requirements Table

(QAPP Worksheet #19)

Matrix	Analytical Group	Preparation/Analytical Method	Sample Volume	Containers	Preservation	Holding Time
Water	VOCs	EPA 5030/8260B-SIM	120mL	3) 40-mL VOA Vial	HCL to pH <2, 0-6°C	14 days
Water	VOCs	EPA 524.2	120mL	3) 40-mL VOA Vial	HCL to pH <2, 0-6°C	14 days
Water	Dissolved Metals	EPA 3010A/6010B	500mL	Polyethylene	HNO_3 to pH <2 after field filtering	6 months
Water	Nitrate+ Nitrite	SM 4500NO3 or EPA 353.2	250mL	Glass	H_2SO_4 to pH<2, 0-6°C	28 days
Water	Ammonia as N	SM 4500NH or EPA 350.1	1L	Glass	H2SO4 to pH<2, 0-6°C	28 days
Water	Alkalinity, total	SM 2320B or EPA 310.1	500mL	Plastic	0-6°C	14 days
Water	Chloride, Sulfate	EPA 300.0	500mL	Plastic	0-6°C	28 days
Water	Total Sulfide	SM 4500SD or EPA 376.2	1L	Glass	ZnOAc+NaOH to pH > 9, 0-6°C	7 days
Water	Total Suspended Solids	SM 2540D or EPA 160.2	500mL	Plastic	0-6°C	7 days
Water	Total Dissolved Solids	SM 2540C or EPA 160.1	500mL	Plastic	0-6°C	7 days

Notes:
°C = degrees Celsius
H_2SO_4 = sulfuric acid
HCL = hydrochloric acid
HNO_3 = nitric acid
mL = milliliter
ZnOAc + NaOH = zinc acetate plus sodium hydroxide

3.4 Field Quality Control Sample Summary

(QAPP Worksheet #20)

Analytical Group	Frequency - Field Duplicate Samples	Frequency - Trip Blanks	Frequency - Field Blanks	Frequency - Equip Blanks	Frequency - PE Samples
VOCs	10% of field samples collected	1 set per cooler /day	N/A	1 per sampling event (Westbay sampling only[1])	1 per quarter
Metals	10% of field samples collected	N/A	1 per sampling day	N/A	N/A
Wet Chemistry	10% of field samples collected	N/A	N/A	N/A	N/A

Notes:

N/A = Not applicable

[1] Sampling at Westbay™ wells requires re-use and decontamination of sampling equipment. Sampling with PDBs, HydraSleeves and from sampling ports is performed with non-reusable sampling equipment, and no decontamination of field equipment is required.

3.5 Project Field Sampling Standard Operating Procedure (SOP) Table

(QAPP Worksheet #21)

Reference Number	Title	Originating Organization	Equipment Type	Modified for Project Work?	Comments
MACTEC SOP #1	Westbay Sampling Protocols	MACTEC	Westbay™ Multi-port Wells	No	
MACTEC SOP #2	PDB Sampling Protocols	MACTEC	Passive Diffusion Bags	No	
MACTEC SOP #3	HydraSleeve Sampling Protocols	MACTEC	HydraSleeve	No	
MACTEC SOP #4	Supply Well Sampling Protocols	MACTEC	Sampling Ports	No	
AES SOP[1]	Field Sampling Protocols	AES	Sampling ports	No	From *Final SAP, OU2 and Sites 2 and 12* (AES, August, 2009)

Notes:

[1] AES does not use stand alone SOPs, but rather includes field sampling protocols as part of their site specific planning documents. The field sampling protocols from the 2009 SAP have been provided in lieu of an SOP.

3.6 Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(QAPP Worksheet #22)

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Electrical Water level Sounder	Quarterly, prior to use against steel tape	Maintain in proper working order, store in a secure location, decon after each use.	Check battery and sensitivity daily prior to use	Inspect tape for damage prior to use	N/A	Must calibrate with steel tape to within 0.05 ft/100 feet depth to water	Send in to factory for repair	Field Supervisor	MACTEC SOP #2 and AES SOP
Mercury Thermometer	Factory calibrated, and checked by NBS annually	Store in a secure location, avoid excessive heat	N/A	Inspect for damage prior to use	Annually	Factory calibration	Replace with new unit	Field Supervisor	AES SOP

Notes:
NBS = National Bureau of Standards
N/A = Not applicable
SOP = Standard Operating Procedures

3.7 Analytical SOP References Table

(QAPP Worksheet #23)

Worksheet #23 will not be used for this project. Data will be evaluated based on the guidance provided in the DOD QSM Version 4.2, the published methods, and the laboratory Quality Assurance Manual.

Laboratory SOPs, method detection limit studies (MDLs), in-house sample custody procedures and quality control acceptance limits, and Quality Assurance Manual are maintained on-site by the laboratory and are available for review upon request. Laboratories used for sample analysis maintain DOD Environmental Laboratory Accreditation Program (ELAP) certification, and undergo annual audits of this documentation by the independent accrediting bodies responsible for the DOD ELAP certification.

3.8 Analytical Instrument Calibration Table

(QAPP Worksheet #24)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
GC/MS – VOCs by EPA 8260B-SIM	Check of instrument tuning using BFB	Prior to ICAL and every 12 hours	Refer to method for specific ion criteria	Retune instrument Reanalyze	GC/MS Analyst
	Multipoint calibration (minimum of 5 points) Lowest point at or below PQL	Initially and as required	Average response factor (RF) for SPCCs: $\geq$ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane. $\geq$ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane RSD for RFs for CCCs: $\leq$ 30% and one option below: Option 1: RSD for each analyte $\leq$ 15% Option 2: linear least squares regression r $\geq$ 0.995 Option 3: non-linear regression – coefficient of determination (COD) $r^2 \geq$ 0.99 (six points shall be used for second order, 7 for third order)	Correct problem, then repeat ICAL	GC/MS Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
GC/MS – VOCs by EPA 8260B-SIM (Continued)	Second Source - ICV Standard	Once after each ICAL	Analytes within ± 20% of true value	Correct problem and verify second source standard. Re-run second source verification. If that fails, correct problem and repeat ICAL	GC/MS Analyst
	Instrument blanks and method blanks	After initial calibration and daily, prior to sample analysis (instrument blank) and with each batch of samples (method blank)	No target analytes present above ½ PQL	Reanalyze blank Clean system Reanalyze affected samples	GC/MS Analyst
	CCV standard	Daily before sample analysis and every 12 hours of analysis time	Average response factor (RF) for SPCCs: $\geq$ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane. $\geq$ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane % Difference/Drift for target compounds and surrogates: $\leq$ 20%D	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV	GC/MS Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
VOCs by EPA 524.2	Check of instrument tuning using BFB	Prior to ICAL and every 12 hours	Refer to method for specific ion criteria	Retune instrument Reanalyze affected samples	GC/MS Analyst
	Multipoint calibration (min of 5 points)	Initially and as required	RSD < 20%	Correct problem, then repeat ICAL	GC/MS Analyst
	Method and instrument blanks	After initial calibration and daily, prior to sample analysis	No target analytes present above ½ PQL	Reanalyze blank Clean system Reanalyze affected samples	GC/MS Analyst
	CCV	Daily before sample analysis and every 12 hours of analysis time	%D < 30%	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV	GC/MS Analyst
ICP Metals By EPA Method 6010B	Single or multipoint calibration. Minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis	If more than one calibration standard is used, $r \geq 0.995$	Correct problem, then repeat ICAL	ICP Analyst
	Second Source (ICV) Standard	Once after each ICAL, prior to sample analysis	Value of second standard source for target analytes within ± 10% of true value	Correct the problem and verify second source standard. Re-run ICV. If that fails, correct problem and repeat ICAL	ICP Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
ICP Metals By EPA Method 6010B (Continued)	CCV	After analysis of every ten samples and at the end of the analytical sequence	Within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV	ICP Analyst
	Low-level calibration check standard (low point standard from calibration)	Daily, following 1 point ICAL	Within ± 20% of true value	Correct problem, then re-analyze	ICP Analyst
	Calibration blanks	After initial calibration and daily, prior to sample analysis	No analytes detected > LOD	Calibration blanks: Correct the problem. Re-prep and re-analyze calibration blank. Samples following the last acceptable calibration blank must be re-analyzed.	ICP Analyst
	ICP Interference check	At the beginning of an analytical run	ICSA: Absolute value of concentration for non-spiked analytes < LOD. ICS-AB: Within ± 20% of true value	Terminate analysis. Locate and correct problem. Reanalyze ICS and samples	ICP Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
ICP/MS Metals by EPA 6010B	Tuning	Prior to ICAL	Mass calibration $\leq$ 0.1 amu from the true value: Resolution < 0.9 amu full width at 10% peak height. For stability, RSD $\leq$ 5% for at least four replicate analyses	Retune instrument then reanalyze tuning solutions	ICP/MS Analyst
	ICAL (minimum one high standard and a calibration blank)	Daily, prior to sample analysis	If more than one calibration standard is used, r $\geq$ 0.995	Correct problem, then repeat ICAL	ICP/MS Analyst
	ICV	Once after each ICAL, prior to beginning sample run	Value of second standard source for target analytes within ± 10% of true value	Correct the problem and verify second source standard. Re-run ICV. If that fails, correct problem and repeat ICAL	ICP/MS Analyst
	CCV	After every 10 field sample and at the end of the analytical sequence	Target analytes within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV	ICP/MS analyst
	Low-level calibration check standard	Daily, following 1 point ICAL	Within ± 20% of true value	Correct problem, them reanalyze	ICP/MS Analyst
	Calibration blanks	Prior to sample analysis, after every ten samples, and at end of run	No analytes above LOD	Calibration blanks: Correct the problem. Re-prep and re-analyze calibration blank. Samples following the last acceptable calibration blank must be re-analyzed.	ICP/MS Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
ICP/MS Metals by EPA 6010B (Continued)	Interference check solutions (ICS-A and ICS-AB)	At the beginning of every run and every 12 hours	ICS-A: Absolute value of concentration for non-spiked analytes < LOD. ICS-AB: Within ± 20% of true value	Terminate analysis. Locate and correct problem. Reanalyze ICS and samples	ICP/MS Analyst
Ion Chromatography – Anions by EPA Method 300.0	Initial Calibration (minimum three standards and one calibration blank	ICAL prior to sample analysis	$r \geq 0.995$	Correct problem, then repeat ICAL	IC Analyst
	ICV	After each ICAL and prior to sample analysis	Analytes within ± 10% of true values and retention times within appropriate windows	Correct problem and verify second source standard. Re-run ICV. If that fails, correct the problem and repeat ICAL	IC Analyst
	Retention time window position establishment	Once per multipoint calibration	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days where an ICAL is not run, the initial CCV is used	N/A	IC Analyst
	Midrange CCV	After every 10 field samples and at the end of the sequence	Project analytes within established retention time windows and within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV.	IC Analyst

QAPP Worksheet #24 (Continued)

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
Nitrate + Nitrite as N by SM 4500NO3E	Multipoint calibration (minimum 3 points). Lowest point at or below PQL	Initially and as required	r > 0.995	Correct the problem. Re-run ICAL	Wet Chemistry Analyst
	CCV	After ICAL, after every 10 samples, and at end of run	Within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV	Wet Chemistry Analyst
	Calibration blank	Following ICAL, every ten samples, and at end of run	No analyte above LOD	Calibration blanks: Correct the problem. Re-prep and re-analyze calibration blank. Samples following the last acceptable calibration blank must be re-analyzed.	Wet Chemistry Analyst
Ammonia by SM 4500NH	Multipoint calibration (minimum 3 points). Lowest point at or below PQL	Initially and as required	r > 0.995	Correct the problem. Re-run ICAL	Wet Chemistry Analyst
	CCV	After ICAL, after every 10 samples, and at end of run	Within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, the repeat ICAL. Re-analyze samples run since last successful CCV.	Wet Chemistry Analyst

QAPP Worksheet #24 Continued

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for Corrective Action
Ammonia by SM 4500NH (Continued)	Calibration blank	Following ICAL, every ten samples, and at end of run	No analyte above LOD	Calibration blanks: Correct the problem. Re-prep and re-analyze calibration blank. All samples following the last acceptable calibration blank must be re-analyzed.	Wet Chemistry Analyst
Total Sulfide by SM 4500SD	N/A	N/A	N/A	N/A	N/A
Total Alkalinity by SM 2320B	N/A	N/A	N/A	N/A	N/A
Total Suspended Solids by SM 2540D	N/A	N/A	N/A	N/A	N/A
Total Dissolved Solids by SM 2540C	N/A	N/A	N/A	N/A	N/A

Notes:

%D = Percent difference / percent drift
BFB = 4-Bromofluorobenzene
CCC = continuing check compounds
CCV = Continuing calibration verification
GC/MS = Gas Chromatography / Mass Spectrometry
ICAL = Initial Calibration
ICP = Inductively Coupled Plasma Atomic Emission Spectroscopy
ICS= Interference check sample
ICV = Initial Calibration verification
LOD – Level of Detection
N/A = Not applicable
PQL = Practical quantitation limit
RF = Response factor
RSD = Relative standard deviation
SIM = Selective Ion Monitoring
SPCC = System performance check compounds
VOC = Volatile Organic Compounds

3.9 Analytical Instrument and Equipment Maintenance, Testing and Inspection Table

(QAPP Worksheet #25)

Instrument/Equipment	Maintenance/Inspection Activity	Frequency	Person Responsible for Corrective Action
GC/MS	Inspect/Replace column Clean ion source Inspect, clean concentrator trap Change electron multiplier Back flush purge and trap Change rough oil pump	As required. Refer to Analytical Method and instrument manufacturer	GC/MS Analyst
ICP	Inspect/replace tubing and pump Inspect/replace windings Inspect/replace torch and injector	As required. Refer to Analytical Method and instrument manufacturer	ICP Analyst
ICP/MS	Same as ICP plus Incoming line voltage Vacuum oil pump Turbo pump check Ion source and analyzer cleaning	As required. Refer to Analytical Method and instrument manufacturer	ICP/MS Analyst
IC	Inspect/perform column cleanup	As required. Refer to Analytical Method and instrument manufacturer	IC Analyst

Notes:
GC/MS = Gas chromatography-mass spectrometry
IC = Ion Chromatography
ICP = Inductively Coupled Plasma
ICP/MS = ICP – Mass Spectrometry

3.10 Sample Handling System

(QAPP Worksheet #26)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): *Field Technicians AES/MACTEC*
Sample Packaging (Personnel/Organization): *Field Technician, Field Supervisor/MACTEC, O&M Manager/AES*
Coordination of Shipment (Personnel/Organization): *Field Supervisor/MACTEC, O&M Manager/AES*
Type of Shipment/Carrier: *Lab Courier/FedEx*
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): *Laboratory Receiving Personnel*
Sample Custody and Storage (Personnel/Organization): *Laboratory Sample Custodian*
Sample Preparation (Personnel/Organization): *Laboratory Personnel*
Sample Determinative Analysis (Personnel/Organization): *Laboratory Personnel, PM*
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): *Hold for a minimum 30 days before disposal: Laboratory Sample Custodian*
Sample Extract/Digestate Storage (No. of days from extraction/digestion): *Various - hold through analytical holding time: Laboratory Personnel*
Biological Sample Storage (No. of days from sample collection): *N/A*
SAMPLE DISPOSAL
Personnel/Organization: *Laboratory Sample Custodian*
Number of Days from Analysis: *No less than 30 days*

3.11 Sample Custody Requirements

(QAPP Worksheet #27)

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory).
Groundwater samples will be collected in laboratory provided bottles using methods described in QAPP Worksheet #18 and MACTEC SOPs #1-4 and AES SOP. Procedures for sample packaging, shipment, and delivery to the laboratory are included in MACTEC SOP #1-4 and AES SOP.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
Samples will be received and logged into the laboratory information management systems (LIMS) for analysis as described in the DOD QSM Version 4.2, Section 5.8.3.1. Samples will be archived following analysis as described in Worksheet #26. Samples will be disposed of following archive period in accordance with state and local requirements.
Sample Identification Procedures:
Sample identification procedures will be performed in accordance with the DOD QSM Version 4.2, Section 5.8.2 and Worksheet #29.
Chain-of-custody Procedures:
Chain-of-custody procedures will be performed in accordance with Worksheet #29.

3.12 Analytical QC Sample Table

3.12.1 VOCs (QAPP Worksheet #28a)

Matrix: Groundwater

Analytical Group/Test Method: VOCs by EPA 524.2 and 8260B-SIM

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for CA	Data Quality Indicator
Method Blank	1 per analytical batch	No target analytes detected above ½ the RL	DOD QSM Table F-4	Re-analyze method blank. If fails, clean system and re-analyze blank and affected samples	GC/MS Analyst	Accuracy/Bias Contamination
Laboratory Control Sample (LCS)/ LCSD	1 set per analytical batch. Spike target compounds. VC to be spiked at RL of 0.1µg/L	Method 524.2: Target compounds 70-130% Method 8260B-SIM: 1,1-DCA = 70-135% 1,1-DCE = 70-130% 1,2-DCA = 70-130% 1,2-DCP = 75-125% Benzene = 80-120% CT = 65-140% Chloroform = 65-135% cis-1,2-DCE = 70-125% cis-1,3-DCp = 70-130% MC = 55-140% PCE = 45-150% trans-1,3-DCP = 55-140% TCE = 70-125% VC = 50-145%	524.4: Laboratory performance based QC limits. 8260B-SIM: DOD QSM Table G-4	Re-prep and re-analyze LCS/LCSD and associated batch samples	GC/MS Analyst	Bias Accuracy/ Precision

QAPP Worksheet #28a (Continued)

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for CA	Data Quality Indicator
MS/MSD	1 per analytical batch Spike target compounds. VC to be spiked at RL of 0.1µg/L	NA for Method 524.2 Method 8260B-SIM: 1,1-DCA = 70-135% 1,1-DCE = 70-130% 1,2-DCA = 70-130% 1,2-DCP = 75-125% Benzene = 80-120% CT = 65-140% Chloroform = 65-135% cis-1,2-DCE = 70-125% cis-1,3-DCp = 70-130% MC = 55-140% PCE = 45-150% trans-1,3-DCP = 55-140% TCE = 70-125% VC = 50-145% RPD<30%	8260B-SIM DOD QSM Table F-4	If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error. If concentration in parent sample is > 4x the spiked amount, include in case narrative. No CA required.	GC/MS Analyst	Bias/ Precision
Surrogates	Field samples and laboratory QC	Method 524.2: 1,2DCB-d4 = 78-114% 4-BFB = 77-115% Method 8260B-SIM: Dibromofluorormethane = 85-125% Toluene-d_8 = 85-120%	Laboratory performance-based in-house limits DOD QSM Table G-3	Re-prep and re-analyze affected samples unless matrix interference is present	GC/MS Analyst	Bias

QAPP Worksheet #28a (Continued)

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for CA	Data Quality Indicator
Internal Standards	Field samples, standards and laboratory QC	Retention time± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within--50%to +100% of ICAL midpoint standard	DOD QSM Table F-4	Inspect mass spectrometer and GC for malfunction. Reanalysis of samples analyzed while system was malfunctioning is mandatory	GC/MS Analyst	Bias/Precision

Analytical QC Sample Table

3.12.2 Metals (QAPP Worksheet #28b)

Matrix: Groundwater

Analytical Group/Test Method: Metals by EPA Method 6010B

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action (CA)	Person Responsible for CA	Data Quality Indicator
Method Blank	1 per analytical batch	No analytes detected above ½ the RL	DOD QSM Tables F-7 and F-8	Correct problem. Re-prep and re-analyze method blank and affected samples	ICP/ICP-MS Analyst	Accuracy/Bias Contamination
Laboratory Control Sample (LCS)	1 per analytical batch. Spike target compounds	80-120%	DOD QSM Table G-18	Re-prep and re-analyze LCS and associated batch samples	ICP/ICP/MS Analyst	Bias Accuracy/ Precision
Laboratory Duplicate sample	1 per analytical batch	< 35%	Lab performance - based limit	Narrate outliers in case narrative. No CA	ICP/ICP-MS Analyst	Precision
Matrix spike (MS/MSD)	1 set per analytical batch	80-120% RPD < 35%	Lab performance -based limit	Perform additional QC test (dilution test and/or post-digestion spike [PDS]) unless concentrations in parent sample are >4x the spiked amount (no corrective action required) Perform PDS	ICP/ICP-MS Analyst	Bias/Precision

QAPP Worksheet #28b (Continued)

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action (CA)	Person Responsible for CA	Data Quality Indicator
Dilution Test	One per analytical batch when sample concentrations are >50x LOQ	5-fold dilution must agree within +/- 10% of the original measurement	DOD QSM Table F-7, F8	Run associated samples by method of standard addition or flag data	ICP/ICP/MS Analyst	Bias/Precision
Post Digestion Spike	When dilution test fails or when concentration for all samples is <50 x LOD	Recovery within 75-125%	DOD QSM Table F7, F8	Run associated samples by method of standard addition or flag data	ICP/ICP/MS Analyst	Bias/Precision

Analytical QC Sample Table

3.12.3 Wet Chemistry (QAPP Worksheet #28c)

Matrix: Groundwater

Analytical Group/Test Method: Wet Chemistry Methods

- Nitrate + Nitrite by SM 4500N03E or EPA 353.2
- Ammonia as N by SM 4500NH or EPA 350.1
- Sulfide, Total by SM 4500SD or EPA 376.2
- Alkalinity, total by SM 2320B or EPA 310.1
- Chloride and Sulfate by EPA 300.0
- Total Suspended Solids (TSS) by SM 2540D or EPA 160.2
- Total Dissolved Solids (TDS) by SM 2540C or EPA 160.1

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for CA	Data Quality Indicator
Method Blank	1 per analytical batch	No analytes detected above the RL	Laboratory limits	Correct problem. Re-prep and re-analyze method blank and affected samples	Wet Chemistry Analyst	Accuracy/Bias Contamination

QAPP Worksheet #28c (Continued)

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for CA	Data Quality Indicator
Laboratory Control Sample (LCS)	1 per analytical batch. Not applicable (N/A) for TSS, TDS	80-120%	Laboratory Performance-Based limits	Re-prep and re-analyze LCS and associated batch samples	Wet Chemistry Analyst	Bias Accuracy/ Precision
Laboratory Duplicate sample	1 per analytical batch	< 35%	Lab performance-based limit	Narrate outliers in case narrative. No CA	Wet Chemistry Analyst	Precision
Matrix spike MS/MSD	1 set per analytical batch. N/A for Alkalinity, TSS, and TDS	75-125% RPD < 35%	Lab performance-based limit	Re-prep and re-analyze MS/MSD samples and report both sets of data. If concentration in parent sample is > 4x the spiked amount, include in case narrative. No CA required.	Wet Chemistry Analyst	Bias/Precision

3.13 Project Documentation and Records

(QAPP Worksheet #29)

Project data and information will be documented, tracked, and managed in a manner that ensures the data maintains integrity, defensibility, and retrievability. Project records will be generated from various aspects of the project, including 1) Sample Collection and Field Measurement Records, 2) Analytical Records, and 3) Data Assessment Records. Project data and information are stored in the Fort Ord Administrative Record located at Building 4463 Room 101, Gigling Road, Seaside, California. The Administrative Record is managed by the Army, and will be maintained until site closure, at which time disposition of site records will be determined by the Army.

Sample Collection and Field measurement Records: At a minimum, the following documentation will be used for samples collection and field measurement activities. Examples of field forms are presented in Appendix C.

- Field Activity Daily Logbook – A bound, Field Activity Daily Logbook (FADL), with sequentially numbered pages will be used for field documentation of key sampling and analytical activities associated with the Sites 2 and 12 and OU2 GWTS and the Sites 2 and 12, OU1, OU2, and OUCTP GWMP. The FADL will contain information to include:
    - Name and Company of sampling technician
    - Date, time, and location of sample collection
    - Meteorological information at the time of sampling (e.g., wind, temperature)
    - Site observations and remarks related to sampling activities
    - Field equipment calibration documentation
- Groundwater Level Field Data Sheets – are used to record depth to groundwater measurements, and include the following information:
    - Sampling Station name, date and time of measurement
    - DTW sounder serial number and documented calibration differential from steel tape
    - Samplers initials
    - Measured depth to water (measured and recorded twice for accuracy)
    - Historical average DTW and total depth of well which are used to verify the measured reading in the field
- Groundwater Sampling Forms – are used to record collection of groundwater samples. Groundwater samples from the Sites 2 and 12, OU1, OU2 and OUCTP GWMP are collected via PDBs, Westbay™ multi-port wells, and sampling ports, while samples from the 2 and 12 and OU2 GWTS are primarily collected via sampling ports. Each of these sampling systems has a designated groundwater sampling form, specific to the data needed from each sampling method; however, each groundwater sampling form will contain the same essential information:
    - Name of sampling technician

  - Date and time of sample collection
  - Depth to water (where applicable)
  - Depth of sample collection (or port number)
  - Method of sample collection
  - Volume of sample collected
  - Preservation of samples (if any)
  - Analysis requested
  - QC samples collected at the sampling station

- Sample Labels – Sample labels will be affixed to each sample container upon collection and prior to transfer to the laboratory. Each sample will be assigned a unique sample identification number. The sample label will include the following information:
  - Project name, number and location
  - Site name
  - Name of collector
  - Date and time of collection
  - Sample identification number

- Chain of Custody Forms - A chain of custody form will be completed for every sample collected and submitted to the analytical laboratory to document custody of the sample from the time of collection to receipt at the laboratory. Chain of custodies will be completed in triplicate (at a minimum) so that one copy is kept at the field site, one copy sent to the project manager or designee, and one copy that accompanies the samples submitted to the analytical laboratory. The laboratory will send the project chemist, or designee, a copy of the completed chain of custody along with a completed cooler receipt form (CRF) and completed log-in information within 24 hours of sample receipt and log-in. The chain of custody will include the following information:
  - Name, number and location of project
  - Project Manager or "Report to" contact
  - Name and signature of sample collector, sampler or recorder
  - Date and time of sample collection
  - Sample type/matrix
  - Number of containers submitted and preservative (if any)
  - Analyses requested and turnaround time requirements
  - Signature trail of persons relinquishing and receiving samples

- Receiving laboratory address and contact information
- Date and time of sample receipt

Analytical Records: The analytical laboratory will maintain and submit the following records as part of the data deliverable for each sample. These records together make up the Comprehensive Certificate of Analysis (CCA), which is a required deliverable to report results and is used in the data validation process.

- Chain of custody records
- Sample/Cooler Receipt Forms (SRFs/CRFs) documenting the general condition of the samples upon receipt including temperature, sample preservation, and number of containers received as well as any discrepancies or issues
- Sample tracking forms
- Sample preparation and analysis forms/logbooks
- Tabulated data summary forms and raw data for field samples, QC samples, and standards. If manual integration is performed on project samples, raw data to include chromatographs from before and after manual integration is applied. The case narrative will also address the reason manual integration was performed on each affected sample.
- Case narrative
- Date and times of sample receipt, extraction and analysis
- QC sample results
- Communication logs
- Corrective action reports
- Definitions of laboratory qualifiers
- Instrument calibration data and summary reports
- Signatures for laboratory sign-off

Project Data Assessment Records will be generated and submitted as part of the quarterly or annual reporting requirements for the Sites 2 and 12, OU2, OUCTP GWMP and the Sites 2 and 12 and OU2 GWTS as necessary. Project Data Assessment reports may be created at anytime throughout the project, and typically consist of the following:

- Field Sampling Audit Report (if applicable)
- Laboratory Audit Report (if applicable)
- Data validation Quality Control Summary Report

3.14 Analytical Services Table

(QAPP Worksheet #30)

Matrix	Analytical Group	Sampling Program	Sample Location/ID Numbers	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number
Groundwater	VOCs by EPA Method 8260B-SIM	Sites 2 and 12 GWTS	See Plates 3, 4 and Worksheets #17a1, #17a2 for sampling locations	Accutest Laboratories 2105 Lundy Ave San Jose, CA 95131 Laurie Glantz-Murphy, (408) 588-0200	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200
Groundwater	VOCs by EPA Method 8260B-SIM	OU2 GWTS	See Plates 5, 6 and Worksheets #17b1, #17b2 for sampling locations	Accutest Laboratories 2105 Lundy Ave San Jose, CA 95131 Laurie Glantz-Murphy, (408) 588-0200	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200
Groundwater	VOCs by EPA Method 8260B-SIM	Sites 2 and 12, OU1, OU2, OUCTP GWMP	See Plate 2 and Worksheet #17c for sampling locations	Accutest Laboratories 2105 Lundy Ave San Jose, CA 95131 Laurie Glantz-Murphy, (408) 588-0200	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200
Groundwater	VOCs by EPA Method 524.2	Sites 2 and 12, OU2, OUCTP GWMP	See Plate 2 and Worksheet #17c for sampling locations	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200	Accutest Laboratories 4405 Vineland Rd, Ste C-15 Orlando, Florida 32811 (407) 425-6700

QAPP Worksheet #30 (Continued)

Matrix	Analytical Group	Sampling Program	Sample Location/ID Numbers	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number
Groundwater	Dissolved metals by EPA Methods 6010B	Sites 2 and 12, OU1, OU2, OUCTP GWMP	See Plate 2 and Worksheet #17c for sampling locations	Accutest Laboratories 2105 Lundy Ave San Jose, CA 95131 Laurie Glantz-Murphy, (408) 588-0200	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200
Groundwater	Wet Chemistry	Sites 2 and 12 and OU2 GWTS, Sites 2 and 12, OU1, OU2, OUCTP GWMP	See Plates 2-6 and Worksheets #17a-c for sampling locations	Accutest Laboratories 2105 Lundy Ave San Jose, CA 95131 Laurie Glantz-Murphy, (408) 588-0200	Accutest Laboratories 2235 Route 130 Dayton, New Jersey (732) 329-0200

Notes:
GWTS = Groundwater Treatment Systems
GWMP = Groundwater Monitoring Program
SIM = Selective Ion Monitoring

4.0 ASSESSMENT AND OVERSIGHT

4.1 Planned Project Assessments Table

(QAPP Worksheet #31)

Planned project assessments will be completed for both the Sites 2 and 12 and OU2 GWTS and Sites 2 and 12, OU1, OU2, and OUCTP GWMP through the use of the Three Phase Quality Control Process, The Three Phase Quality Control Process consists of the following three phases:

- Preparatory Phase: Activities and assessments conducted during the preparatory phase are conducted prior to the start of a feature of work and are performed to ensure that technical requirements and work prerequisites have been completed prior to the start of the feature of work. Discrepancies will be resolved and corrective actions implemented and verified prior to the start of work.

- Initial Phase: Activities and assessments conducted during the initial phase are performed during the first day of the feature of work and are conducted to verify compliance with the specifications and requirements described in this QAPP and approved project plans and procedures. Discrepancies will be resolved and corrective actions implemented and verified prior to work proceeding.

- Follow Up and Reporting Phase: Activities and assessments performed during the follow up and reporting phase are conducted to verify continued compliance with project requirements and to verify that project reports meet client and regulatory requirements

An overview of the Three Phase Quality Control Process and related forms used to document the process are provided in Appendix D. The activities and assessments conducted during each phase of the Three Phase Quality Control process are described below.

QAPP Worksheet #31 (Continued)

Assessment	Person(s) Responsible for Performing Assessment	Assessment Mechanism	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Phase I – Preparatory Phase					
Have planning documents been prepared in accordance with statement of work and regulatory requirements? Have regulatory comments been addressed? Are planning documents approved?	Derek Lieberman, PM, AES Jeff Fenton, PM, MACTEC	Peer review of planning documents in addition to technical editors, project management and QC review. Author and PM review of response to comments and revisions to the document. Receive sign off from USACE.	Document author and PM	Document author and PM	PM
Have planning documents been read by appropriate project personnel (including subcontractors)?	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Personnel to complete sign off form for each applicable document that it has been read and requirements are understood	Deb Leibensberger, Project Chemist, MACTEC Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Operations Manager, AES	Deb Leibensberger, Project Chemist, MACTEC Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Operations Manager, AES	Tony Blake, Program Chemist

QAPP Worksheet #31 (Continued)

Assessment	Person(s) Responsible for Performing Assessment	Assessment Mechanism	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of CA
Are staff and subcontractors prepared to implement project activities according to planning documents? Does the contract laboratory (and any approved subcontract laboratories) have current DOD Environmental Laboratory Accreditation Program (ELAP) certification for the planned analyses?	Deb Leibensberger, Project Chemist, MACTEC Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Perform project kick off meetings with laboratory and field personnel to review requirements and expectations for performance. Review copy of current DOD ELAP Certificate	Laurie Glantz-Murphy, Project Manager, Accutest Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Laurie Glantz-Murphy, Project Manager, Accutest Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Deb Leibensberger, Project Chemist, MACTEC
Is necessary field equipment available and in acceptable working order?	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Inspect field equipment and compare inventory and condition of equipment with planned activities. Inspect field equipment calibration documentations for compliance with requirements specified in this QAPP	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Deb Leibensberger, Project Chemist, MACTEC

QAPP Worksheet #31 (Continued)

Assessment	Person(s) Responsible for Performing Assessment	Assessment Mechanism	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of CA
Phase II – Initial Phase					
Is work being performed in accordance with project plans?	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Perform field audits. Laboratory audits are performed as part of the DOD ELAP certification process and are beyond the scope of this QAPP. In the event a problem is encountered with the laboratory, the Army may request an additional audit from the DOD ELAP accrediting bodies.	Laurie Glantz-Murphy, PM, Accutest Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Deb Leibensberger, Project Chemist, MACTEC Tony Blake, Program Chemist, AES Laurie Glantz-Murphy, PM, Accutest Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Deb Leibensberger, Project Chemist, MACTEC Tony Blake, Program Chemist, AES
Have necessary audits been performed?	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	Review audit report of findings from field and laboratory audits	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	N/A

QAPP Worksheet #31 (Continued)

Assessment	Person(s) Responsible for Performing Assessment	Assessment Mechanism	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of CA
Are daily Contractor Quality Control Reports being prepared?	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	Review daily Contractor Quality Control Report (CQCRs) from field supervisors	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Manager, AES	Chuck Holman, Program Manager, AES
Do project plans adequately address any changes in project activities or goals?	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Review any changes in project activities or goals for compliance with approved plans	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC
Phase III – Follow up and Reporting Stage					
Have data reports been prepared in accordance with project plans?	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	Compare data reports to specifications in the Task Order and planning documents	Document Authors	Document Authors	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC
Are reports adequate to meet client and regulatory agency requirements?	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	Review client and regulatory comments and prepare response to comments and revised reports	Document Authors	Document Authors	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC

4.2 Assessment Findings and Corrective Action Responses

(QAPP Worksheet #32)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Phase I - Preparatory Phase						
Planning Document review	Internal Memo	Document Author	Prior to the start of field activities	Response to comments documentation and USACE approval of document as applicable	Derek Lieberman, PM, AES Jeff Fenton, PM, MACTEC	One week
Planning document (QAPP) sign off by field and laboratory	Memo	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES Laurie Glantz-Murphy, PM Accutest	Prior to the start of field activities	Obtain sign off that document has been read and understood by field and lab personnel	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	One week
Review of lab and field staff readiness	Memo	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES Laurie Glantz-Murphy PM Accutest	Prior to the start of field activities	Provide Kick off meeting notes from field and lab meetings	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	One week

QAPP Worksheet #32 (Continued)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Review of field equipment	Memo	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES	Prior to the start of field activities	Provide checklist documenting field equipment is available and in good working order	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	Prior to the start of field activities.
Phase II – Initial Phase						
Field and laboratory audit	Field and Lab audit report	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES Laurie Glantz-Murphy, PM, Accutest Tony Blake, Program Chemist. AES Jeff Fenton, PM, MACTEC Derek Lieberman, PM, AES	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Tony Blake, Program Chemist, AES Deb Leibensberger, Project Chemist, MACTEC	One week

QAPP Worksheet #32 (Continued)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Review of Contractor Quality Control Reports	Memo	Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES	Within 48 hours of review	Revision of CQCRs as needed	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	One week
Review of project plans to reflect current site or lab activities	Memo	Derek Lieberman, PM, AES Jeff Fenton, PM, MACTEC Steve Korbay, Field Supervisor, MACTEC Mark Fisler, O&M Supervisor, AES Laurie Glantz-Murphy, PM Accutest	Within 10 days of observations	Update project plans to reflect current conditions (may be addendum to existing document) or documentation of changes to field or lab protocol to be in accordance with project plans	Derek Lieberman, PM AES Jeff Fenton, PM, MACTEC	Prior to next scheduled sampling event.
Phase III – Follow Up and Reporting Phase						
Review of Data Reports	Internal comments from staff and external comments from client and regulatory agencies	Document Author Derek Lieberman, PM, AES Jeff Fenton, PM, MACTEC	Internal = prior to issuance of report, External = Within 30 days of receipt of report	Provide response to comments and revise report as needed	Commenting Client and or Agencies David Eisen, PM, USACE Derek Lieberman, PM, AES Jeff Fenton, PM, MACTEC	30 days

4.3 QA Management Reports Table

(QAPP Worksheet #33)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Sites 2 and 12 and OU2 GWTS:				
Sites 2 and 12 and OU2 GWTS O&M Reports	Monthly	Monthly reports due on the 10th of each calendar month.	Derek Lieberman, PM AES	David Eisen, PM, Marc Edwards, USACE; Gail Youngblood, BRAC; Internal distribution for AES staff
Sites 2 and 12 and OU2 Annual Reports	Annually	Annual reports due July 30th each year.	Derek Lieberman, PM, AES	Chris Prescott, Tommy Waldrup, Project Chemist, Christopher Goddard, and David Eisen, PM, USACE; Gail Youngblood, FO BRAC; Lindsay Alexander, FO Admin Record; Martin Hausladen, EPA; Bill Mabey, TechLaw, Inc.; Grant Himebaugh, CRWQCB; Steve Sterling and Franklin Mark, DTSC
Sites 2 and 12, OU2, OUCTP Groundwater Monitoring Program:				
CQCR	Quarterly, following each sampling event	Within 90 days of completion of field sampling event	Jeff Fenton, Project Manager, MACTEC	David Eisen, PM, USACE; Derek Lieberman, Project Manager, AES
Non-Routine Occurrences Report	As needed	Within 48 hours of a Non-Routine Occurrence in the field or laboratory. A copy of this report will also be included in the CQCR.	Deb Leibensberger, Project Chemist, MACTEC	David Eisen, PM, USACE; Tony Blake, Program Chemist, AES; Jeff Fenton, Project Manager, MACTEC

QAPP Worksheet #33 (Continued)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Work Variance Report	As needed	Prior to implementation of proposed change or immediately following a variance implemented in the field. A copy of the Field Work Variance will also be included in the CQCR.	Steve Korbay, Onsite field supervisor, MACTEC	David Eisen, PM, USACE; Derek Lieberman, PM, AES; Tony Blake, Program Chemist AES; Jeff Fenton, PM, MACTEC; Deb Leibensberger, Project Chemist, MACTEC
Quarterly Monitoring Report	Quarterly, following each sampling event	Within 90 days of completion of field sampling event	Jeff Fenton, PM, MACTEC	David Eisen, PM, USACE; Lindsay Alexander, FO Admin Record; Derek Lieberman, PM, AES; Franklin Mark, DTSC, Martin Hausladen, EPA; Bill Mabey, TechLaw; Grant Himebaugh, Regional Board
Quality Control Summary Report	Quarterly, following each sampling event	Produced as part of the Quarterly Monitoring Report	Deb Leibensberger, Project Chemist, MACTEC	David Eisen, PM, USACE; Derek Lieberman, PM, AES; DTSC, EPA, TechLaw
Electronic Data Delivery of Preliminary data	Quarterly, following each monitoring event	Within two weeks of receipt of laboratory data	Jeff Fenton, PM, MACTEC	Franklin Mark, DTSC; Martin Hausladen, EPA; Grant Himebaugh, Regional Board

5.0 DATA REVIEW

5.1 Verification (Step 1) Process Table

(QAPP Worksheet #34)

Verification Input	Description	Internal / External	Responsible for Verification (Name, Organization)
Chain-of-custody and shipping forms	Chain-of-custody forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. When everything is verified, the shipper's signature on the chain of custody form will be initialed by the reviewer. A copy of the form will be retained in the site file, and the original and remaining copies will be taped inside the cooler for shipment. Refer to AES SOP (Appendix A) and MACTEC SOP 4 (Appendix A) for further detail	I	Sites 2 and 12 and OU2 GWTS: Mark Fisler, O&M Supervisor, AES Sites 2 and 12, OU1, OU2, OUCTP GWMP: Steve Korbay, Field Supervisor, MACTEC
	Receiving laboratory will verify chain of custody forms with contents of coolers. MACTEC project chemist will be notified of any discrepancies or issues within 24 hours of sample receipt. Resolution will be documented in writing and submitted with final data package.	E	Laurie Glantz-Murphy, Project Manager, Accutest Laboratory
	Laboratory receipt/login report will be reviewed against chain of custody internally.	I	Sites 2 and 12, OU2 GWTS Holly Dillon, data manager, AES Sites 2 and 12, OU1, OU2, OUCTP GWMP Zach Carroll, Data Validator, MACTEC

QAPP Worksheet #34 (Continued)

Verification Input	Description	Internal / External	Responsible for Verification (Name, Organization)
Field Notes	Field notes will be reviewed internally by the field supervisor for consistency with the chain of custodies and SOPs. One copy of the field notes will be retained in the on-site project file, and originals will be forwarded to the project manager for review	I	Sites 2 and 12, OU2 GWTS Mark Fisler, O&M Supervisor, AES Sites 2 and 12, OU1, OU2, OUCTP GWMP Steve Korbay, Field Supervisor, MACTEC
Laboratory Data	Analytical data packages will be verified by the laboratory performing the work for completeness prior to submittal.	I	Guergana Gueorguieva, Quality Assurance Manager, Accutest
	Received data packages will be verified according to the data validation procedures specified in Worksheet #35. Laboratory electronic deliverables will be verified against the data package hard copy reports.	I	Sites 2 and 12, OU2 GWTS Tony Blake, Program Chemist, AES 2 and 12, OU1, OU2, OUCTP GWMP Zach Carroll, Project Database Analyst, MACTEC

5.2 Validation (Steps IIa and IIb) Process Table

(QAPP Worksheet #35)

Step IIa/IIb	Validation Input	Description	Responsible for Verification -GWTS	Responsible for Verification – Sites 2 and 12, OU1, OU2, OUCTP-GWMP
IIa	Methods used for sample collection	Field data notes will be reviewed for compliance with published methods and SOPs. Deviations from SOPs and methods described in this QAPP will be summarized and provided to the Project Manager in writing	Mark Fisler, O&M Supervisor, AES	Steve Korbay, Field Supervisor, MACTEC
IIa	Methods used for analysis	Laboratory data packages will be reviewed to verify that the methods specified in this QAPP were followed. Deviations shall be documented in writing.	Tony Blake, Project Chemist, AES	Zach Carroll, Project Database Analyst, MACTEC
IIa	Sampling SOPs and Analytical Compliance	Review field notes for compliance with SOPs. Review laboratory data deliverables for compliance with QAPP and published methods	Mark Fisler, AES Tony Blake, AES	Steve Korbay, MACTEC Zach Carroll, MACTEC
IIa	Documentation of method quality control (QC) results	Review laboratory data packages to determine if QC parameters required by the referenced methods were performed and reported. The QC forms will be reviewed to determine if method acceptance criteria were met. Method QC outliers will be identified by the laboratory in the case narrative. Reviewer will determine if data will require qualification due to outliers.	Tony Blake, AES	Zach Carroll, MACTEC
IIb	Documentation of QAPP QC sample results	Verify that QC samples specified in this QAPP were analyzed and reported. Reviewer will identify QAPP QC sample results in the data validation report.	Tony Blake, AES	Zach Carroll, MACTEC

QAPP Worksheet #35 (Continued)

Step IIa/ IIb	Validation Input	Description	Responsible for Verification -GWTS	Responsible for Verification – Sites 2 and 12, OU1, OU2, OUCTP-GWMP
IIb	Laboratory data package documentation	Laboratory data packages will be reviewed to ensure that documentation requirements specified in the QAPP have been met. If deficiencies are found, the data reviewer will document the issue in a memorandum to the laboratory. The laboratory will address deficiencies in writing or submit a revised data package addressing the	Tony Blake, AES	Zach Carroll, MACTEC
IIb	Target analyte list	Laboratory report summary forms will be reviewed to verify that the target compounds and parameters specified in the QAPP were reported.	Tony Blake, AES	Zach Carroll, MACTEC
IIb	Project quantitation limits (PQLs)	Determine that the quantitation limits were achieved, as outlined in the QAPP. Verify that the laboratory analyzed a low standard at the quantitation limit in the initial calibration.	Tony Blake, AES	Zach Carroll, MACTEC
IIa	Raw data and laboratory transcription errors	Ten percent (10%) of raw data will be reviewed to confirm laboratory calculations and that there are no transcription errors. Chromatographs containing manual integrations, if any, will be evaluated as part of the raw data review.	Tony Blake, AES	Zach Carroll, MACTEC
IIa and IIb	Data Validation Report	Summarize deviations from the referenced methods, SOPS, and QAPP-specific requirements. Include qualified data and explanations of all data qualifiers.	Tony Blake, AES	Zach Carroll, MACTEC
IIa and IIb	Data Validation Report Review	Review validation reports and QCSR.	Tony Blake, AES	Debra Leibensberger Project Chemist, MACTEC

5.3 Validation (Steps IIa and IIb) Summary Table

(QAPP Worksheet #36)

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	GWTS Validator	GWMP Validator
IIa	Aqueous	Volatile Organic Compounds (VOCs)	EM-200-1-10. *Guidance for Evaluating Performance-based Chemical Data* (USACE, June 2005) and SW-846 Method 8260B-SIM	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC
IIb	Aqueous	VOCs	QAPP Worksheets and ADR Library	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC
IIa	Aqueous	Dissolved metals	EM-200-1-10 and SW-845 Methods 6010B	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC
IIb	Aqueous	Dissolved Metals	QAPP Worksheets and ADR Library	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC
IIa	Aqueous	Wet Chemistry	EM-200-1-10 and Standard Methods SM 4500NO3E, SM 4500NH, SM 300.0, SM 4500SD, SM 2540D, SM 2540C	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC
IIb	Aqueous	Wet Chemistry	QAPP Worksheets and ADR Library	Tony Blake, Program Chemist. AES	Zach Carroll, Project Database Analyst. MACTEC

ADR = Automated Data Review program

Level III review is performed using the Automated Data Review software program ADR.NET. Flagging conventions for the Test Methods included in the QAPP are incorporated with the ADR program's reference library (Appendix E) to assess compliance with project requirements. The ADR program is used as an electronic validation tool for the following Level III elements:

- Holding Times
- Instrument Performance Checks

- Method Blank Contamination
- Surrogates
- Laboratory Duplicates
- Laboratory Control Samples
- Matrix Spike Samples
- Field Blank Contamination
- Field Duplicates
- Initial and Continuing Calibration Data

Initial and continuing calibration files for each test method may need to be validated manually if the contract library is unable to provide electronic validation files.

The Data Reviewer checks the ADR generated Non-Conformance Report, identifying items that do not conform to the ADR Project Library requirements, and the results are incorporated into the assessment of the data.

The Data Reviewer proceeds with the review of the ADR files in the ADR Data Review module. The ADR Data Review module identifies outliers and applies validation qualifiers to the data based on the ADR Project Library data review requirements. The ADR Library qualification scheme files are provided as Attachment 2.

The Data Reviewer then reviews the ADR output, comparing the ADR findings with the lab reports to ensure the automated validation process is working accurately. The Data Reviewer may manually edit the validation qualifiers based on his or her professional judgment, which will be described in the Quality Control Summary Report. Flagging conventions used for data qualification are presented in Appendix D.

5.4 Usability Assessment

(QAPP Worksheet #37)

Summary of the Usability assessment process:

The suitability of the environmental data collected for its intended use from both the Sites 2 and 12 and OU2 GWTS and the Sites 2 and 12, OU1, OU2, and OUCTP GWMP will be assessed by the AES Program Chemist and the MACTEC Project Chemist, respectively. Data usability will comprise an evaluation of the quantity, type, and overall quality of the generated data against the project DQOs as presented in Worksheets #11a and #11b. The usability of data associated with QC results outside of the established acceptance criteria is dependent on the degree of the exceedance, whether the potential bias is high or low, and whether the uncertainty implied by the exceedance is significant relative to project decisions and DQOs. Data usability will be assessed in accordance with the guidance provided in the DOD QSM Version 4.2 and additional applicable USACE and EPA guidance as well as the professional experience of the decision maker during data validation.

In the event that the data quantity or quality prove to be inadequate to meet project objectives, reanalysis or re-sampling may be required. Replacement samples may be collected when existing data is insufficient or inadequate to support project objectives. The decision to take replacement samples will be made in coordination with the project team, and may include USACE, AES or MACTEC project manager and AES Program Chemist or MACTEC project chemist.

Usability of the data will be presented in the QCSR, included with each Quarterly Monitoring Report. Copies of the associated data validation reports will be presented as an attachment to the QCSR. The QCSR will contain the following information:

- Project Scope
- Project Description
- Sampling Procedures – brief description of sampling procedures and detailed description of any deviations from planned activities
- Quality Control Activities – includes a discussion of the numbers and types of laboratory and field QC samples collected and a discussion of any QC problems encountered in the data
- Analytical Procedures – brief description of laboratory procedures and detailed description of any deviations from planned activities
- Oversight Activities – summary of field and laboratory kickoff meetings and audits
- Chemical Data Quality
  - Summary Data Quality Assessment
  - Assessment of data based on project DQOs and usability
- Completeness Summary
- Conclusions and Recommendation

6.0 REFERENCES

Ahtna Environmental Services (AES), 2009. *Final Sampling and Analysis Plan, Operable Unit 2 and Sites 2 and 12, Groundwater Treatment Systems, Former Fort Ord, California.* August.

_____, 2010a. *Final, Annual Groundwater Treatment Systems Operation Data Summary Report, January through December 2009, Sites 2 and 12 Groundwater Remedy, Former Fort Ord, Volume II.* July 30.

_____, 2010b. *Final, Annual Groundwater Treatment Systems Operation Data Summary Report, January through December 2009, Operable Unit 2 Groundwater Remedy, Former Fort Ord, Volume II*. July 30.

California Department of Public Health's (CDPH), 2007. *Maximum Contaminant Levels and Regulatory Dates for Drinking Water U.S.EPA vs. California* updated September 2007.

Department of Defense (DOD) Environmental Data Quality Workgroup, 2010. *Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2.* www.navylabs.navy.mil/manualdocs.htm

Environmental Protection Agency (EPA), 2008. *Final Regulatory Determinations for Priority Contaminants on the Second Drinking Water Contaminant Candidate List.* July 2008.

Harding ESE, 2001. *Technical Memorandum, Passive Diffusion Bag Pilot Study Results and Recommendations.* July 25.

Harding Lawson Associates (HLA), 1999. *Draft Final Revised Treatment Plan, OU2 Groundwater Remedy, Fort Ord, California.* Prepared for USACE. January 29.

MACTEC Engineering and Consulting, Inc. (MACTEC), 2007. *Final, Annual Report of Quarterly Monitoring, October 2005 through September 2006, Former Fort Ord, California.* December17, 2007.

____, 2010. *Draft Final, Annual Report of Quarterly Monitoring, October 2008-September 2009, Groundwater Monitoring program, Sites 2/12, OU2, and OUCTP, Former Fort Ord, California.* April 30.

Shaw Environmental, Inc., 2010. *Memorandum: Long-Term Monitoring, Operable Unit 1 Off-Site Groundwater Extraction Pilot Study, Former Fort Ord, California*. October 6.

U.S. Army, 1994. *Final Record of Decision, Operable Unit 2, Fort Ord Landfills, Fort Ord, California*. July 15.

_____, 1995. *Explanation of Significant Differences, Operable Unit 2, Fort Ord Landfills, Fort Ord, California.* August 23.

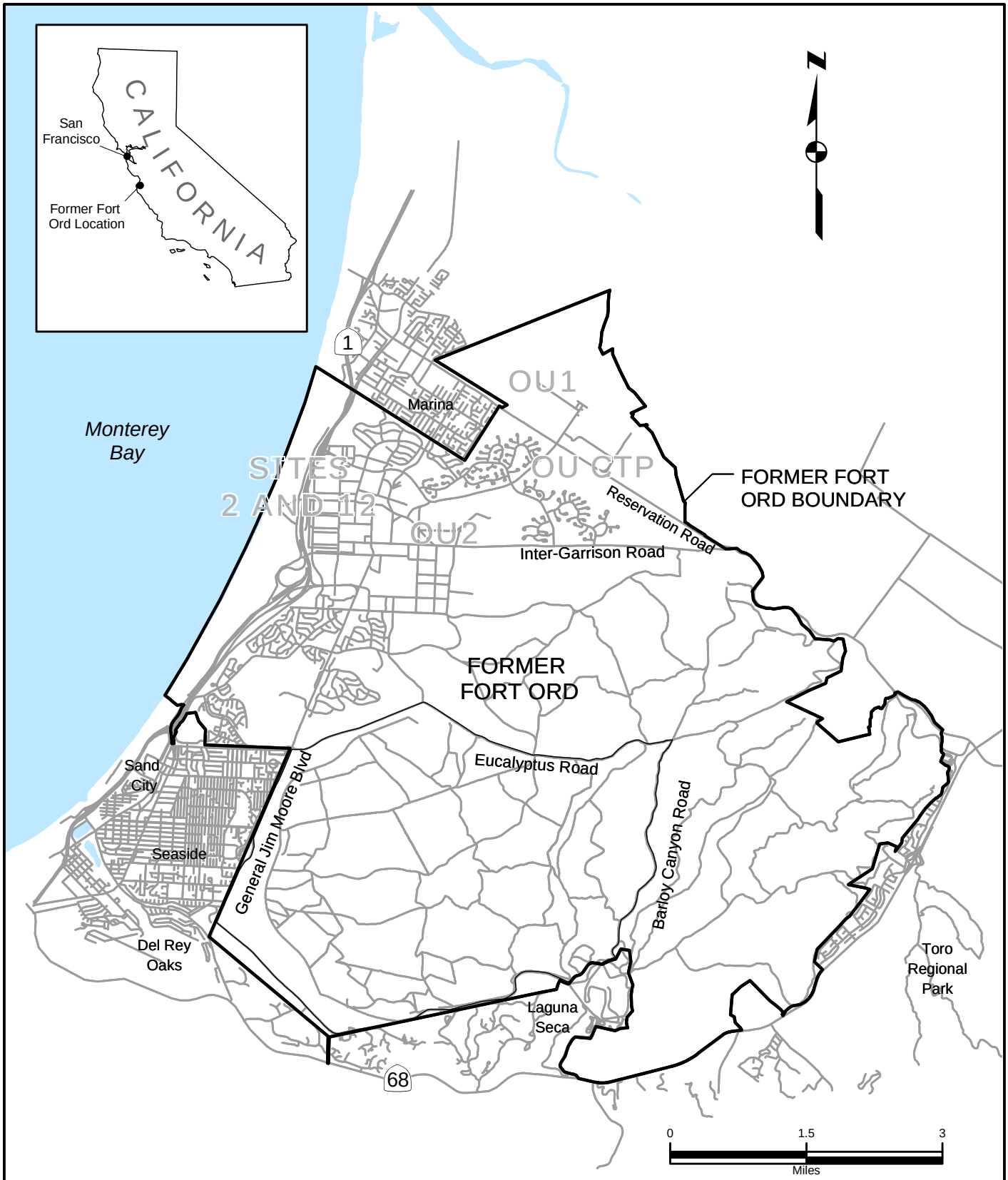
_____, 1996. *Record of Decision, Operable Unit 1, Fritzsche Army Airfield Fire Drill Area, Fort Ord, California*. May 8.

_____, 1997. *Record of Decision, Basewide Remedial Investigation Sites, Fort Ord, California*. January 13.

_____, 2008. *Record of Decision, Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California*. February 6.

U.S. Army Corps of Engineers (USACE), 2005. *EM-200-1-10, Guidance for Evaluating Performance Based Chemical Data.* June.

PLATES



MACTEC

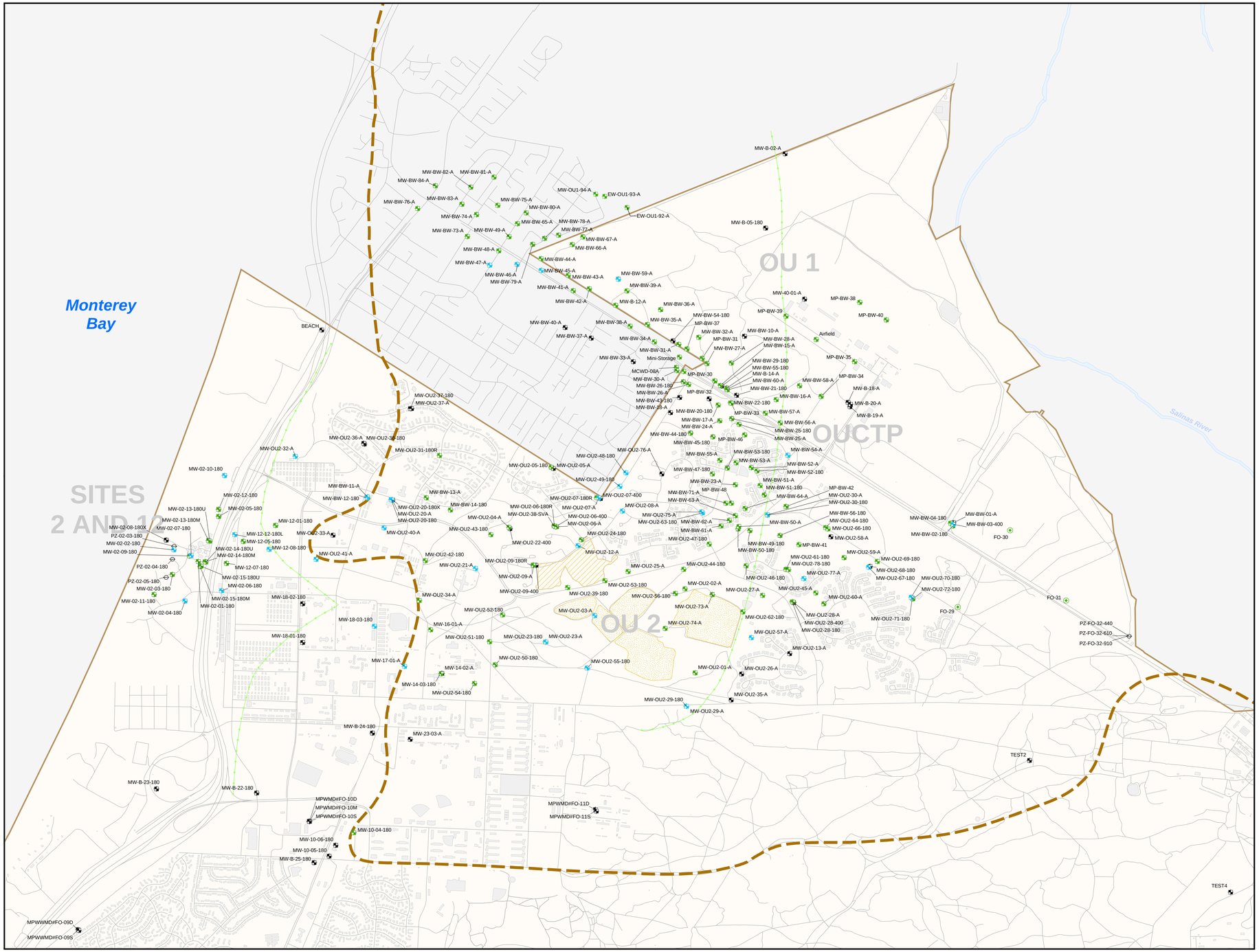
Former Fort Ord Location Map

Quality Assurance Project Plan, Volume 1, Appendix A
Groundwater Extraction and Treatment Systems at OU2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12 OU1, OU2, and Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California

PLATE **A1**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
GFA	4084106578 01	DLL	3/2011		

Monday, July 19, 2010 3:10:31 PM
P:\4084\096554_Fort Ord\GIS\Projects\QAPP\Plate1_LocationMap.mxd



EXPLANATION

Water Level Measurements Only

- Monitoring Well/Multi Port (Westbay Well) *
- Piezometer

Wells Sampled by MACTEC for VOCs Quarterly

- Monitoring Well/Multi Port (Westbay Well) *
- Supply Well

Wells Sampled by MACTEC for VOCs Annually Only

- Monitoring Well/Multi Port (Westbay Well) *

* Individual Multi Ports may be sampled quarterly, annually, or may be water level only. Please see Table 3-1 for specific Multi Port schedule.

- MW-BW-01-A — Station ID
- Approximate edge of Fort Ord-Salinas Valley Aquitard Boundary
- Approximate location of a Groundwater Divide
- Approximate outline of former Fort Ord Landfill Cell A (clean closed)
- Approximate extent of Fort Ord Landfills
- Former Fort Ord Boundary

DRAWN: TJH	PROJECT NO: 4084106578 01	MACTEC	PLATE A2
ENGINEER:	SCALE: AS SHOWN		
CHECKED: DLL	DATE: 3/2011		
APPROVED:	DATE:		

Quality Assurance Project Plan, Volume 1, Appendix A
Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12
Groundwater Monitoring Program at Sites 2 and 12 Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume

Sites 2 and 12, OU1, OU2, and OUCTP Monitoring Program Sampling Locations

Design 29, 2010 11:26:44 AM
P:\4084106578 Fort Ord GW\GIS\Projects\QAPP\Plate2_WellLocationMap.mxd

Monterey Bay

EW-12-05-180M
EW-12-06-180M
EW-12-07-180M
EW-12-03-180M
EW-12-03-180U
IW-02-01-180
IW-02-02-180
INF-02-03-180
EW-12-04-180U
EW-12-04-180M
INF-02-02-180
INF-02-01-180
Groundwater Treatment Plant

IMJIN PKWY
2ND AVE
1ST AVE
9TH ST
8TH ST
MONTEREY RD
1

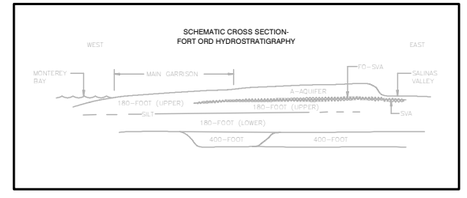
0 500 1,000 Feet

Explanation

- Extraction Well
- Injection Well
- Infiltration Gallery
- Collection and Discharge Piping
- Discharge Piping
- Facilities
- Roads
- Groundwater Treatment Plant

Base map (including piping) received from US Army Corps of Engineers, March 10, 2008

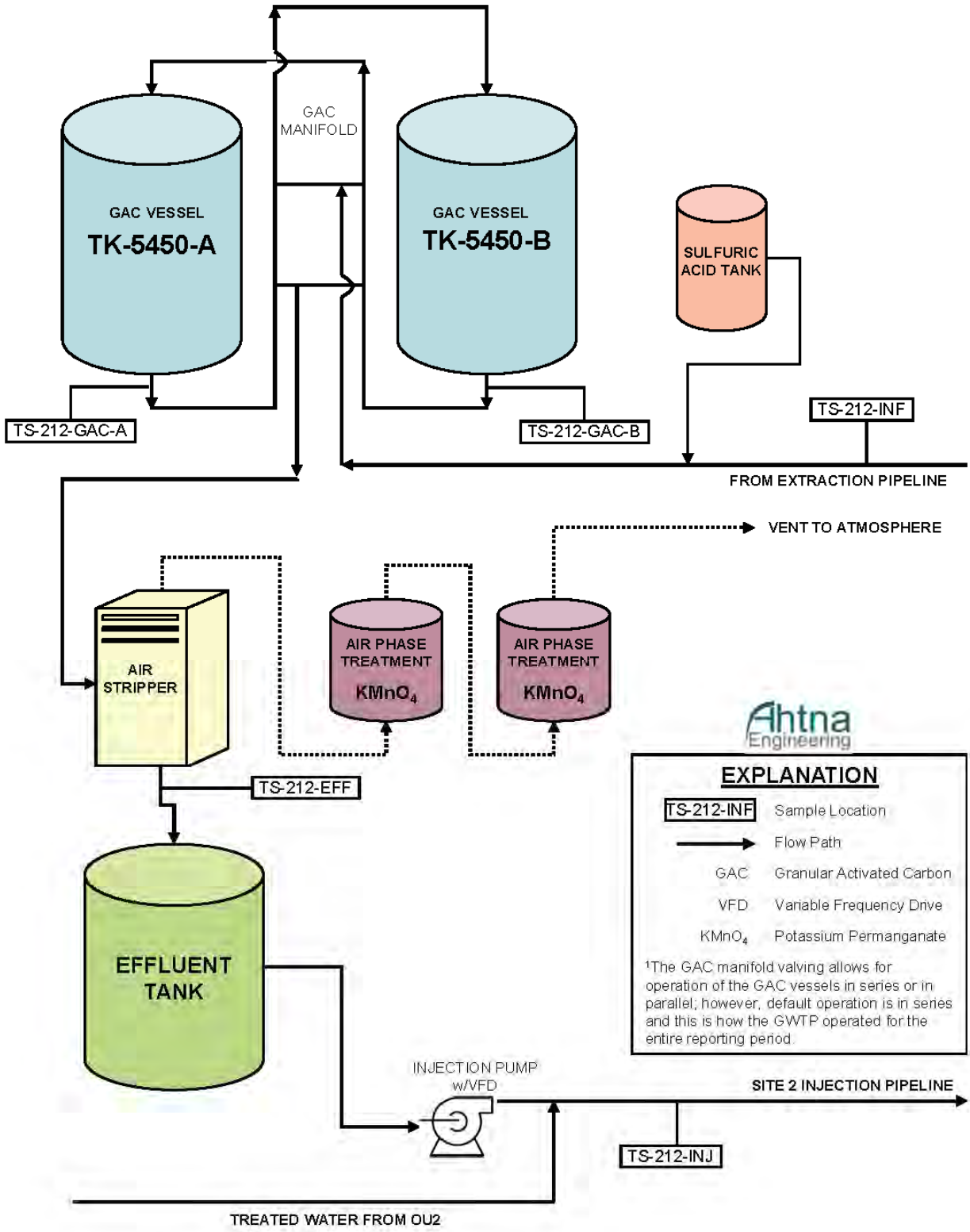
N
W E
S

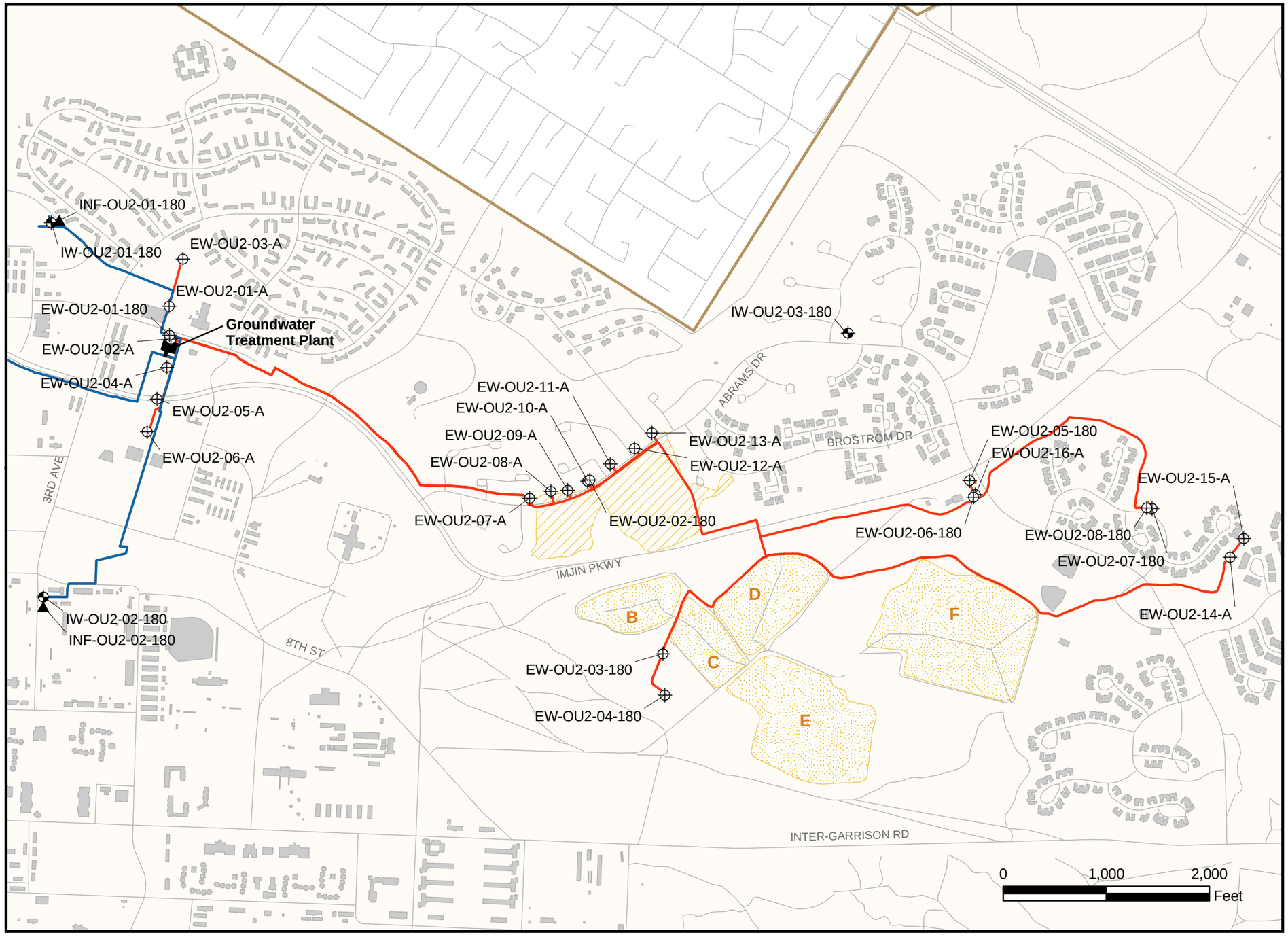


DRAWN TJH	JOB NUMBER 4084106578	Ahtna Engineering	**Quality Assurance Project Plan, Volume 1, Appendix A Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12 Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume**
ENGINEER	SCALE 1" = 500'		
CHECKED	DATE		**Site Map** **Sites 2 and 12 Groundwater Remedy**
APPROVED DLL	DATE 3/2011		PLATE **A3**

March 25, 2011 2:14:08 PM
P:\4084106578 Fort Ord GWGIS\Projects\QAPP-AppxAIPlateA3_2_12_Remedy.mxd

Plate A4. Sites 2/12 GWTS Schematic and Sampling Points [1]
Quality Assurance Project Plan, Volume 1, Appendix A, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12 Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume



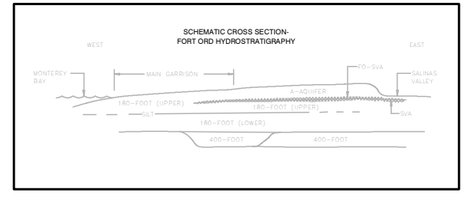


Explanation

- Extraction Well
- Injection Well
- Infiltration Well
- Collection Piping
- Discharge Piping
- Facilities
- Approximate outline of former Fort Ord Landfill Cell A (clean closed)
- Approximate extent of Fort Ord Landfills
- Roads
- Former Fort Ord Boundary
- Groundwater Treatment Plant

Base map (including piping) received from US Army Corps of Engineers March 10, 2008

N
W E
S



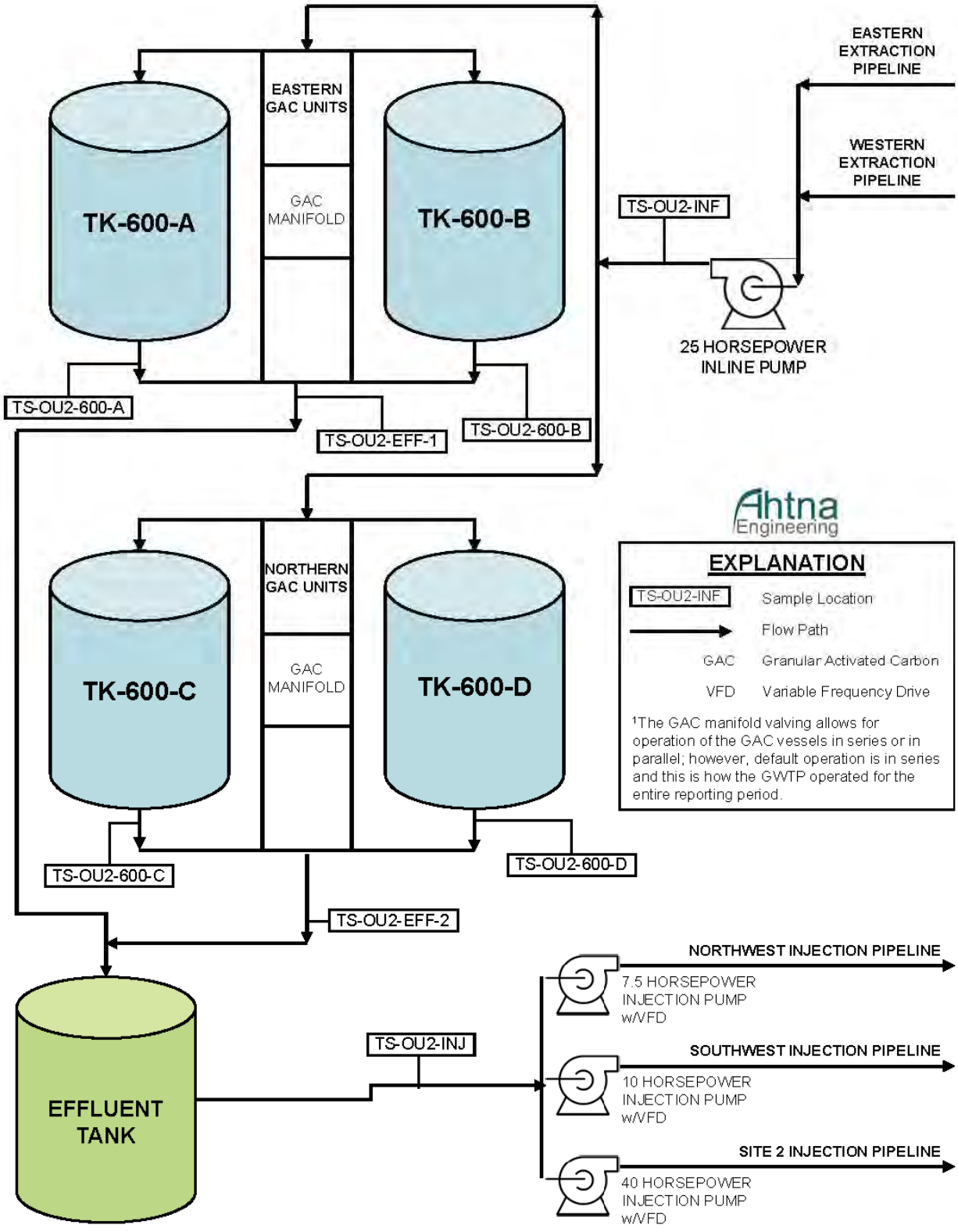
DRAWN TJH	JOB NUMBER 4084106578	Quality Assurance Project Plan, Volume 1, Appendix A Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12 Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume	PLATE A5
ENGINEER	SCALE 1" = 1000'		
CHECKED	DATE		
APPROVED DLL	DATE 3/2011		

Ahtna Engineering

Site Map
OU 2 Groundwater Remedy

March 25, 2011 2:20:38 PM
P:\4084106578 Fort Ord GW\GIS\Projects\QAPP-AppxA\PlateA5_OU2_Remedy.mxd

Plate A6. OU2 GWTS Schematic and Sampling Points [1]
Quality Assurance Project Plan, Volume 1, Appendix A, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12, Groundwater Monitoring Program at Sites 2 and 12 Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume



APPENDIX A

STANDARD OPERATING PROCEDURES (SOPS)

MACTEC SOP #1 – Westbay Sampling Protocol

A1.0 WESTBAY SAMPLING PROTOCOL

The following information is reprinted from “Model 2531 MOSDAX Sampler Manual” with permission.

NOTICE

Operation of the MP System equipment should only be undertaken by qualified instrument technicians who have been trained by Westbay authorized personnel.

This document contains proprietary information. No part of this document may be photocopied, reproduced or translated to another language without the prior written consent of Westbay Instruments Inc. The information contained in this document is subject to change without notice.

DO NOT OPEN THE SAMPLER

All warranties expressed or implied will be void if, after examination by Westbay Instruments Inc. personnel, it is established that any of the instrument housings have been opened without prior authorization from Westbay Instruments Inc.

DO NOT LET THE SAMPLER FREEZE

Extreme care should be taken to avoid freezing the MOSDAX Sampler probe. Permanent transducer damage may result from freezing.

Manual Revision: 1.1

Issued for Serial No.: _____

Date: _____

Signature: _____

© Westbay Instruments Inc
2531V11.doc

Reprinted with the permission of Westbay Instruments Inc.

Contents

1. DESCRIPTION 1
1.1 MOSDAX Sampler Probe, Model 2531 1
1.2 MOSDAX Personal Computer Interface (MPCI), Model 2522 1
1.3 Cable Reels 1
1.4 Sample Containers 1

2. PRESSURE PROFILING 2
2.1 Items Required 2
2.2 Surface Checks 2
2.3 Pressure Measurement Procedures 3

3. FLUID SAMPLING 4
3.1 Items Required 4
3.2 Surface Checks and Preparation 4
3.3 Drillhole Sampling 5
3.4 Rinsing Instructions 5

4. CARE AND MAINTENANCE 6
4.1 MPCI 6
4.2 Cable Reels and Control Cable 6
4.3 MOSDAX Sampler Probe 6
4.3.1 Face Seal 6
4.3.2 Location Arm 6
4.3.3 Button Shoe Replacement 7
4.3.4 Actuator Nut 7

5. CALIBRATION 7

6. SPARE PARTS LIST 8

1. DESCRIPTION

1.1 MOSDAX Sampler Probe, Model 2531

The MOSDAX Sampler is a downhole probe designed to collect fluid pressure information and fluid samples from MP System monitoring wells. Each MOSDAX pressure sensor is calibrated over its full pressure range for nonlinearity and temperature variation. MOSDAX Sampler probes are available in a variety of pressure ranges to permit operation to various depths. The shoe and valve motors can be operated from the surface. The power for the shoe and valve motors is supplied from the surface.

1.2 MOSDAX Personal Computer Interface (MPCI), Model 2522

The MOSDAX Sampler can be operated with an IBM compatible computer or MOSDAX Handheld Controller (HHC). The MPCI translates the signals between the computer or HHC and the MOSDAX Sampler. The MPCI requires 12 volt DC power to operate. An optional barometric transducer module is available for the MPCI which allows barometric pressures to be monitored while the probe is being operated.

1.3 Cable Reels

The manual cable reel can operate all of Westbay's probes and tools to a depth of 300m (1,000 ft) on a single-conductor cable. The manual reel is hand operated with an internal brake to control the speed of descent of the probe in the well. The two-pin cable connects the MPCI to the reel and the signals pass through a slipring located in the hub of the reel into the control cable. For maintenance information, see the appropriate cable reel manual.

Motorized cable reels are available for deeper applications.

1.4 Sample Containers

Sample containers can be used with the MOSDAX Sampler. The nonvented stainless steel sample bottles maintain samples under formation pressure while the sampler and bottle are brought to the surface.

2. PRESSURE PROFILING

2.1 Items Required

- MOSDAX Sampler Probe, Model 2531
- MOSDAX Personal Computer Interface (MPCI), Model 2522 with:
  - one two-pin data cable
  - one three-pin power cable
  - one nine-pin computer cable
- IBM compatible computer with MProfile software or a Handheld Controller.
- MOSDAX series cable reel.
- Sheave with counter and tripod.
- 12 VDC, 2 Amp power source (Battery pack, car/truck battery, or transformer).
- Water level measuring tape.
- MProfile User's Guide for computer or the Handheld Controller Operations Manual
- MP Casing Log showing depths to ports and couplings in hole to be tested.

2.2 Surface Checks

1. Remove the MOSDAX Sampler from its storage case. Inspect the probe housing and body for any damage. Please contact Westbay for advice on any cover tube damage.
2. Assemble the tripod and counter over the well. Run the cable over the counter.
3. Connect the probe to the cable. Before attaching, inspect the O-ring at the top of the probe and lubricate with silicon. The O-ring should be clean and intact. Tighten the nut hand tight only.
4. Connect the two-pin cable from the MPCI to the cable reel. With the MPCI OFF connect the three-pin cable from the MPCI to the 12 v power supply.
5. Connect the 9 pin cable from computer or HHC to the MPCI and turn the MPCI ON.
6. Perform the following surface checks to ensure that the location arm and the shoe mechanisms are operating normally: Release the location arm. The location arm should extend smoothly. The number of revolutions used to release the location arm is displayed and should be 15 to 16 revolutions. If a smaller number of revolutions is reported, retract the arm and repeat. Place the probe in a piece of MP casing or coupling. Activate the shoe. The shoe should extend and hold the probe firmly in the coupling or casing. The display should indicate 16 to 19 revolutions. A reading of 23 revolutions indicates the probe is activated in open air. Retract the backing shoe.

7. Check that the face plate for sampling and the plastic plunger are installed on the sampler.
8. The probe is now ready to be lowered down the well.

2.3 Pressure Measurement Procedures

1. Obtain the completed MP Casing Log.
2. With the location arm retracted, lower the probe into the MP casing to immediately below the lowest measurement port coupling to be monitored. If magnetic collars have been installed on the well, the Collar Detect Command can be used to detect the collars. The Collar Detect Command is cancelled by pressing any key.
3. Release the location arm. The display should update and beep after the arm is released.
4. Raise the probe about 0.5 m (1.5 ft) above this measurement port. If the probe is accidentally lifted above the next higher coupling, it will be necessary to retract the location arm and lower the probe to below the measurement port and release the arm.
5. Lower the probe gently until the location arm rests in the measurement port.
6. Record the pressure and temperature inside the MP casing.
7. Optional: If a water level tape is available, measure and record the depth to water in the MP casing.
8. Activate the shoe. The pressure on the display should change to the formation pressure.
9. When the reading has stabilized, record the formation pressure.
10. Once the pressure has been recorded, retract the shoe.
11. Record the pressure of the fluid in the MP casing. This reading should be similar to that recorded in Step 6. If a large difference is noted between the readings, record the water level inside the MP casing again using the water level tape.
12. The three pressure readings plus the time and water level constitute a complete set of readings at a measurement port coupling.
13. Continue up the MP casing to obtain the pressure data from other measurement ports.
14. Take one last set of pressure and temperature readings at the surface. These readings should be similar to those recorded in Step 2.

CAUTION: If a water level tape was used, remove the water level tape from the MP casing before removing the sampler probe from the well to prevent them from becoming jammed.

3. FLUID SAMPLING

3.1 Items Required

- MOSDAX Sampler, Model 2531
- MPCI (Model 2522), with cables as described in Section 2.1
- IBM compatible computer with MProfile software or a Handheld Controller
- MProfile Users' Guide for the computer or the Handheld Controller Operations Manual
- MOSDAX series cable reel.
- Sample containers and connecting tubes
- MP Casing Log
- Groundwater Sampling Field Data Sheet
- 12 VDC, 2 amp power source (battery pack, car/truck, or transformer)
- Counter and tripod
- Westbay Sampling Kit including vacuum hand pump

3.2 Surface Checks and Preparation

1. Set up the MOSDAX Sampler probe following Steps 1 through 8 of Section 2.2.
2. Attach the sample containers.
3. Release the location arm. Locate the probe in the vacuum coupling.
4. Activate the shoe in the vacuum coupling.
5. Close the sampler valve. The motor should run about 5 seconds. The display should indicate one revolution.
6. Use the vacuum pump to apply a vacuum through the vacuum coupling. The vacuum should remain constant. If the vacuum is not maintained, inspect for leaks at the face seal of the probe, the connection to the pump and at the probe sampling valve.
7. Once a vacuum has been maintained, open the sampler valve. Apply a vacuum again to check that all connections are sealed.
8. Close the sampler valve. A vacuum has now been applied to the sample bottles.
9. Retract the shoe.

3.3 Drillhole Sampling

1. Check recent pressure logs of the hole and ensure that the head inside the MP casing is lower than the head outside the measurement port to be sampled.
2. After completing the surface checks, follow Steps 1 to 5 of Section 2.3 to locate the sampler at the measurement port in the monitoring zone to be sampled.
3. Record the pressure reading.
4. Activate the probe and record the formation pressure.
5. Open the sampler valve. The pressure should drop and then slowly increase as the bottles fill. When the pressure in the bottle equals the zone pressure from Step 4, the bottle is full. Wait a maximum of two minutes per sample bottle even if the pressures are not equal.
6. Close the sampler valve and retract the shoe.
7. Record the pressure reading. A reading the same as in Step 3 indicates that the sample is OK.
8. Reel the sampler to the surface and remove it from the MP casing.
9. **Do not open the sampler valve as damage to the probe or injury to the operator could occur.**
10. Remove the cap from the bottom sample bottle and open the valve on the bottle to release the pressure and to transfer the sample.
11. Open the sampler valve to allow the sample to flow from the bottles. Once the pressure in the sampler and bottles has decreased to atmospheric, the bottles may be disconnected to speed the process.
12. Take particular care in handling pressurized samples.

3.4 Rinsing Instructions

Rinse the sampler around the face seal and the bottom connector. With the sampler valve open, flush the interior of the sampler from the bottom connector. Rinse the sample bottles and connectors.

Note: **Project specific procedures for decontaminating the sampler and sample bottles are the responsibility of the project manager and are not covered in this manual.**

4. Care and Maintenance

The MOSDAX Sampler System must be routinely maintained for optimum performance. The procedures outlined here are required to keep the instrument operating properly. For any additional information or advice, please contact Westbay Instruments Inc.

4.1 MPCI

The MPCI should be cleaned to remove dirt and dust and inspected for damage or wear. If any part requires replacement, contact Westbay for information.

4.2 Cable Reels and Control Cable

The cable reels should be kept clean and protected from damage. The cable and cable head should be inspected for kinks and corrosion. Rehead the cable if necessary. For more information concerning cable reels and the control cable, refer to the appropriate reel manual.

4.3 MOSDAX Sampler Probe

1. Never allow the probe to freeze or the pressure transducer may be damaged.
2. Clean and inspect the probe for dents and scratches on the cover tube. Clean the threads with a nylon brush, such as a toothbrush. DO NOT use a wire brush. Protect the O-rings from damage and dirt.

4.3.1 Face Seal

Inspect the face seal and replace if damaged or worn.

1. Remove the two screws holding the face plate to the probe body and lift the face plate off.
2. Remove the face seal and plunger. Set the location arm assembly aside. Clean the plunger and probe body.
3. When reinstalling the face plate hold the face seal, plunger and location arm assembly in place. Replace the two screws the hold the face plate on the probe.

4.3.2 Location Arm

Release the location arm. Check that the arm moves smoothly and freely and check for damage and sharp edges due to wear. Replace the location arm if necessary.

1. Release the location arm. Remove the two screws and face plate (Section 4.3.1).
2. Remove the location arm with its spring and pivot pin. Clean and inspect all parts and replace if needed.
3. Insert the spring and pivot in the location arm and place the assembly in the probe body. Place the face plate over the face seal and location arm and tighten the two

screws. Check that the arm is moving freely and the face seal insert and plunger are held securely in place.

4.3.3 Button Shoe Replacement

Activate the shoe and inspect for damage or wear. The shoe should rotate freely about the pivot pin. When the shoe is retracted it should retract quickly and smoothly back into the probe. The shoe may be replaced in the following manner:

1. Release the location arm and extend the shoe to expose the pivot pin.
2. Unscrew the shoe pivot pin from the lever arm and remove the shoe.
3. Place a new shoe in the lever arm and install the shoe pivot pin.

4.3.4 Actuator Nut

The actuator nut needs to be routinely cleaned to remove particles of grit which can interfere with its movement. Remove the actuator nut in the following manner:

1. Remove the two set screws that hold in the lever arm pivot pin. Using the Allen key, push the lever pivot pin out of the probe body.
2. Remove the set screws on the side of the probe body that holds the plastic support block.
3. Remove the screw closest to the top of the probe.
4. Lift out the lever arm, guide plate, shoe, spring and plastic support block as one unit.
5. Use the Clean Nut Command to remove the actuator nut from the actuator screw. Turn off the MPCI and remove the nut from the probe.
6. Clean the actuator nut with the cleaning tap. Use the Clean Nut Command and clean the actuator screw with a nylon brush. DO NOT use a wire brush.
7. Apply a thin coating of silicone lubricant to the actuator screw. Place the actuator nut in the probe body against the actuator screw and retract the arm to thread the nut onto the actuator screw. Allow the nut to travel along the full length of the screw. YOU MAY HAVE TO REPEAT THIS OPERATION.
8. Install the single unit from Step 4 in the probe body. Install the lever arm pin through the probe body, lever arm, and spring. Lock the pin in position with two set screws.
9. Install the top screw into the guide plate and install the set screws to secure the support block.

5. CALIBRATION

The MP System permits frequent or periodic calibration of the transducers used for pressure measurement. Contact Westbay for details.

6. SPARE PARTS LIST

Item	Part No. or Size	Qty
Face Seal Insert	200302	2
Plunger	200303	1
Shoe Button	252313	5
Shoe Spring	252318	2
Location Arm	252112	5
Location Arm Pivot	252316	2
Location Arm Spring	252319	2
Termination Sleeve	251805	1
Termination Insert	251806	1
Bulkhead Connector	PF0601JF	1
Boot	JF0602CF	1
Contact	JF0603CF	1
Fuse, 1.5 GMA	FH0150AE	2
O-ring	# 110 B	2
O-ring	# 111 B	2
O-ring	# 005 B	10
O-ring	# 006 B	10
Support Insert	253120	2
Manifold	253111	1
Bushing 4	253110	1
Pan Head Screw	# 4-40 x 1/4 - inch	2
Pan Head Screw	# 6-32 x 3/16 - inch	2
Pan Head Screw	# 6-32 x 1/2 - inch	2
Hex Socket Head Screw	# 8-32 x 1/8 - inch	4
Hex Socket Head Screw	# 10-32 x 3/16 - inch	4
Hex Socket Set Screw	# 8-32 x 5/16 - inch	2
Allen Key	5/64 - inch	1
Allen Key	3/32 - inch	1
Actuator Nut Tap	208001	1
Cable Heading Tool	208100	1

MACTEC SOP #2 – Passive Diffusion Bag Sampling Protocol

A2.0 PASSIVE DIFFUSION BAG (PDB) SAMPLING PROTOCOL

A2.1 Obtain PDB Sampler Hardware

- The hardware for each well in the sampling program will be custom-made by the PDB manufacturer (EON Products, Inc., or Columbia Analytical) or by MACTEC personnel, prior to the initiation of the field program

- Each hardware kit is labeled for each well, and should closely match the dimensions submitted to the kit manufacturer

- Open the hardware kit bag and carefully unwind the first few feet of cable or rope, to expose the first set of plastic disks from which the PDB samplers will hang

A2.2 Install PDB Sampler Hardware (Page 6, *USGS, 2001*)

- Unseal the appropriate PDB sampler hardware kit (match label to well name) and carefully retrieve hardware.

- Clip the first (bottom) PDB sampler onto the top and bottom plastic disks using the available zip-ties.

- Record time and bag position in the well.

- If this well is to be profiled, continue attaching PDB samplers to remaining disks for this monitoring well.

- Otherwise, if this well is not scheduled to be profiled and has not yet been profiled, continue unwinding the hardware kit until the uppermost set of plastic disks is exposed and then attach the second PDB sampler.

- Once a well has been profiled and a specific depth has been selected from which to monitor groundwater quality, only one PDB sampler will be installed on the hardware kit – the depth interval will be noted on the field instruction form.

- Once the necessary PDB samplers have been installed, carefully lower the hardware kit until the stainless steel weight touches the well bottom.

- Confirm that the top clip roughly equals the top of casing and adjust as necessary to ensure a snug fit (slightly taught line) when the well cap is closed.

- Attach the end of the hardware line to the well head hanging device – make sure that the PDB sampler kit does not sag when well cap is closed.

- Secure the well.

A2.3 Sample Naming/Recording

- Sample numbers will be generated as specified in the CDQMP and this SAP (Appendix B).
- Field personnel must include a depth for each sampler on the chain-of-custody.
- Record the relative position of each bag – they will be numbered in the order they will be **retrieved** (i.e., top → #1… #2… #n…. → bottom) – in other words, the first PDB sampler to be installed will have the highest number and the last PDB sampler will have the lowest number.

A2.4 PDB Sampler Retrieval (Page 9, *USGS, 2001*)

- Collect the appropriate number of VOA vials for the required number of VOC samples.
- Measure and record the corrected depth to water from the top of casing to ensure PDB are completely submerged below the water level.
- Note the time and begin reeling the PDB sampler hardware line.
- Field personnel must include a depth for each sampler on the chain-of-custody in the form of station number as recorded during bag placement.
- Important - the contents of each bag must be transferred to the VOA vials within 15 minutes to avoid losing volatile compounds to atmosphere. Once the first bag leaves the water, the time limit starts at the same time for all exposed bags.
- Remove the first PDB sampler and use clean scissors to cut across the angled portion of the PDB, if the EON Products, Inc., bags are being used puncture the bag with a "juice straw" provided.
- Carefully empty contents into VOA vials (preferably set up in a bottle holder).
- Apply completed label to each VOA vial to ensure that they are not confused later.
- Repeat until all PDB samplers have been removed and contents transferred.
- QC duplicate samples consist of two separate sets of VOA vials filled from the same diffusion sampler.
- Store all filled VOA vials in Ziploc bags inside a properly cooled container.
- Follow above guidelines to re-install new PDB samplers as scheduled (profile or single-bag scenario).
- Dispose of all used passive diffusion sample bags and components appropriately as either IDW or recyclable material.
- Decontaminate all reusable equipment with clean water and ALCONOX.

A2.5 User's Guide for Polyethylene-based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

(Reprinted with permission - see following pages)

USGS
science for a changing world

USER'S GUIDE FOR POLYETHYLENE-BASED PASSIVE DIFFUSION BAG SAMPLERS TO OBTAIN VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN WELLS

PART 1: DEPLOYMENT, RECOVERY, DATA INTERPETATION, AND QUALITY CONTROL AND ASSURANCE

Water-Resources Investigations Report 01-4060

Prepared in cooperation with the

U.S. AIR FORCE
U.S. NAVAL FACILITIES ENGINEERING COMMAND
U.S. ENVIRONMENTAL PROTECTION AGENCY
FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE
DEFENSE LOGISTICS AGENCY
U.S. ARMY CORPS OF ENGINEERS and
INTERSTATE TECHNOLOGY REGULATORY COOPERATION WORKGROUP

U.S. Department of the Interior
U.S. Geological Survey

Technical Advisory Board

U.S. Air Force Base Conversion Agency (AFBCA)
U.S. Air Force Center For Environmental Excellence (AFCEE)
Maj. Jeff Cornell (AFCEE)
Mario Ierardi (AFBCA)
Dr. Javier Santillan (AFCEE)

Defense Logistics Agency (DLA)
Lt. Col. Daniel L. Welch

U.S. Environmental Protection Agency (EPA)
Steve Schmelling, Office of Research and Development (ORD)
Dick Willey, EPA Region 1
Kathy Davies, EPA Region 3
Richard Steimle, Technology Innovation Office (TIO)

U.S. Naval Facilities Engineering Command (NAVFAC)
U.S. Naval Facilities Engineering Service Center (NFESC)
Cliff C. Casey (Southern Division)
Dennis Howe (NFESC)
Richard G. Mach, Jr. (Southwest Division)
Nick Ta (NFESC)

U.S. Army Corp of Engineers (USACE)
Dave Becker
Johnette Shockley

Federal Remediation Technologies Roundtable

Interstate Technology Regulatory Cooperative Workgroup (ITRC)
George H. Nicholas (New Jersey) Team Lead
Paul M. Bergstrand (South Carolina)
Chris A. Guerre (California)
David Randolph (Tennessee)

Funding for this Guide was provided by the U.S. AIR FORCE and NAVFAC (Southern and Southwest Divisions). Additionally, the following persons are recognized for their leadership and support to this project: Marty Faile, Joe Dunkle, Kay Wishkaemper, Vince Malott, and the Passive Diffusion Bag Sampler (PDBS) Workgroup.

User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

U.S. Geological Survey

Water-Resources Investigations Report 01–4060

Prepared in cooperation with the
U.S. AIR FORCE
U.S. NAVAL FACILITIES ENGINEERING COMMAND
U.S. ENVIRONMENTAL PROTECTION AGENCY
FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE
DEFENSE LOGISTICS AGENCY
U.S. ARMY CORPS OF ENGINEERS and
INTERSTATE TECHNOLOGY REGULATORY COOPERATION WORKGROUP

USGS
science for a changing world

Columbia, South Carolina
2001

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

Use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

Copies of this report can be obtained from:

U.S. Environmental Protection Agency
(USEPA)/National Service Center for Environmental Publications (NSCEP)
Box 42419
Cincinnati, OH 45242-0419

and

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225
Phone: 888-ASK-USGS

For additional information, write to:

District Chief
U.S. Geological Survey
Stephenson Center–Suite 129
720 Gracern Road
Columbia, SC 29210-7651

Additional information about water resources in South Carolina is available on the World Wide Web at **http://sc.water.usgs.gov**

Report can be downloaded from **http://www.itrcweb.org** and **http://www.frtr.gov**

CONTENTS

Executive Summary 1
Introduction 3
Summary of Passive Diffusion Bag Sampler Advantages and Limitations 5
Advantages 5
Limitations 5
Passive Diffusion Bag Sampler Deployment 6
Passive Diffusion Bag Sampler and Sample Recovery 9
Determining Applicability of Passive Diffusion Bag Samplers and Interpretation of Data 11
Influences of Hydraulic and Chemical Heterogeneity on Sample Quality in Long-Screened Wells 12
Comparison of Passive Diffusion Bag Sampling Methodology to Conventional Methodologies 12
Quality Control and Assurance 14
Summary 14
References 16

Figures

1. Photo showing typical water-filled passive diffusion bag samplers used in wells, including diffusion bag with polyethylene mesh, diffusion bag without mesh, and bag and mesh attached to bailer bottom 4
2. Photo showing example of multiple passive diffusion bag samplers prepared for deployment 8

Table

1. Compounds tested under laboratory conditions for use with passive diffusion bag samplers 4

Conversion Factors, Vertical Datum, Acronyms, and Abbreviations

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
foot per day (ft/d)	0.3048	meter per day
foot squared per day (ft^2/d)	0.09294	meter squared per day
gallon per minute (gal/min)	0.06308	liter per second
gallon per day (gal/d)	0.003785	cubic meter per day
inch per year (in/yr)	25.4	millimeter per year
	Volume	
gallon (gal)	3.785	liter

Temperature is given in degrees Celsius (°C), which can converted to degrees Fahrenheit (°F) by the following equation: °F = 9/5 (°C) + 32

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration in water is expressed in metric units as milligrams per liter (mg/L) or micrograms per liter (µg/L).

Additional Abbreviations	
EDB	1,2-Dibromomethane
AFCEE	Air Force Center for Environmental Excellence
*c*DCE	*cis*-1,2-Dibromoethene
ft^3/d	cubic feet per day
ft^3/mg	cubic feet per milligram
°C	degrees Celsius
g	gram
ITRC	Interstate Technology Regulatory Cooperation
LDPE	low-density polyethylene
L	liter
µg	microgram
µm	micrometer
µL	microliter
mg	milligram
mL	milliliter
mL/min	milliliter per minute
MTBE	Methyl-*tert*-butyl ether
NAVFAC	Naval Facilities Engineering Command
NAPL	non-aqueous phase liquid
PDB	passive diffusion bag
PCE	Tetrachloroethene
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOA	Volatile organic analysis
VOC	Volatile organic compound

User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

EXECUTIVE SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining concentrations of a variety of volatile organic compounds (VOCs) in ground water at monitoring wells. The suggested application of the method is for long-term monitoring of VOCs in ground-water wells at well-characterized sites.

The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-bore-hole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then a multiple deployment of PDB samplers within a well may be more appropriate for sampling the well.

A typical PDB sampler consists of a low-density polyethylene (LDPE) lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon of the well by attachment to a weighted line or fixed pipe.

The amount of time that the sampler should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for the environmental disturbance caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 degrees Celsius (°C). A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications; therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified time for sampler recovery after initial equilibration. PDB samplers routinely have been left in ground waters having concentrations of greater than 500 parts per million (ppm) of trichloroethene for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations, however. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparison to a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery consists of removing the samplers from the well and immediately transferring the enclosed water to 40-milliliter sampling vials for analysis. The resulting concentrations represent an integration of chemical changes over the most recent portion of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound).

The method has both advantages and limitations when compared to other sampling methods. Advantages include the potential for PDB samplers to eliminate or substantially reduce the amount of purge water associated with sampling. The samplers are relatively inexpensive and easy to deploy and recover. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells, and there is a minimum amount of field equipment required. The samplers also have the potential to delineate contaminant stratification in the formation across the open or screened intervals of monitoring wells where vertical hydraulic gradients are not present. In addition, the samplers integrate concentrations over time, which may range between about 48 to 166 hours depending on the compound of interest. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material, or that there is a detrimental effect on the VOC sample from the PDB material.

Water-filled polyethylene PDB samplers are not appropriate for all compounds. The samplers are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene. These factors include the molecular size and shape and the hydrophobic nature of the compound. Unpublished laboratory test data of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

VOC concentrations in PDB samplers represent concentrations in the vicinity of the sampler within the well screen or open interval. This may be a limitation for PDB samplers and some other types of sampling, such as low-flow sampling, if the ground-water contamination is above or below the screen or not in the sample intervals providing water movement to the PDB samplers. If there is a vertical hydraulic gradient in the well, then the concentrations in the sampler may represent the concentrations in the water flowing vertically past the sampler rather than in the formation directly adjacent to the sampler. Vertically spaced multiple PDB samplers may be needed in chemically stratified wells or where flow patterns through the screen change as a result of ground-water pumping or seasonal water-level fluctuations.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches to determine the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of passive diffusion sampler applicability and interpretation of the data is

suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB sampler field applications.

INTRODUCTION

The use of PDB samplers for collecting ground-water samples from wells offers a cost-effective approach to long-term monitoring of VOCs at well-characterized sites (Vroblesky and Hyde, 1997; Gefell and others, 1999). The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-borehole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then deployment of multiple PDB samplers within a well may be more appropriate for sampling the well.

The samplers consist of deionized water enclosed in a LDPE sleeve (fig. 1) and are deployed adjacent to a target horizon within a screened or open interval of a well. The suggested application is for long-term monitoring of VOCs in ground-water wells. Where the screened interval is greater than 10 feet (ft), the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is important that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. For many VOCs of environmental interest (table 1), the VOC concentration in water within the sampler approaches the VOC concentration in water outside of the PDB sampler over an equilibration period. The resulting concentrations represent an integration of chemical changes over the most recent part of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound being sampled). The approach is inexpensive and has the potential to eliminate or substantially reduce the amount of purge water removed from the well.

A variety of PDB samplers have been utilized in well applications (fig. 1). Although the samplers vary in specific construction details, a typical PDB sampler consists of a 1- to 2-ft-long LDPE tube closed at both ends and containing laboratory-grade deionized water (fig. 1). The typical diameter for PDB samplers used in a 2-inch-diameter well is approximately 1.2 inches; however, other dimensions may be used to match the well diameter. Equilibration times may be longer for larger diameter PDB samplers. On the outside of the PDB sampler, a low-density polyethylene-mesh sometimes is used for protection against abrasion in open boreholes and as a means of attachment at the prescribed depth. The PDB sampler can be positioned at the target horizon by attachment to a weighted line or by attachment to a fixed pipe.

PDB samplers for use in wells are available commercially. Authorized distributors as of March 2001 are Columbia Analytical Services (800-695-7222; www@caslab.com) and Eon Products (800-474-2490; www.eonpro.com). A current list of vendors and PDB-sampler construction details can be obtained from the U.S. Geological Survey Technology Transfer Enterprise Office, Mail Stop 211, National Center, 12201 Sunrise Valley Drive, Reston, Virginia 20192 (telephone 703-648-4344; fax 703-648-4408). PDB samplers employ patented technology (U.S. patent number 5,804,743), and therefore, require that the user purchase commercially produced samplers from a licensed manufacturer or purchase a nonexclusive license for sampler construction from the U.S. Geological Survey Technology Enterprise Office at the above address.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches for determining the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of PDB sampler applicability and interpretation of the data is suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB-sampler field applications.

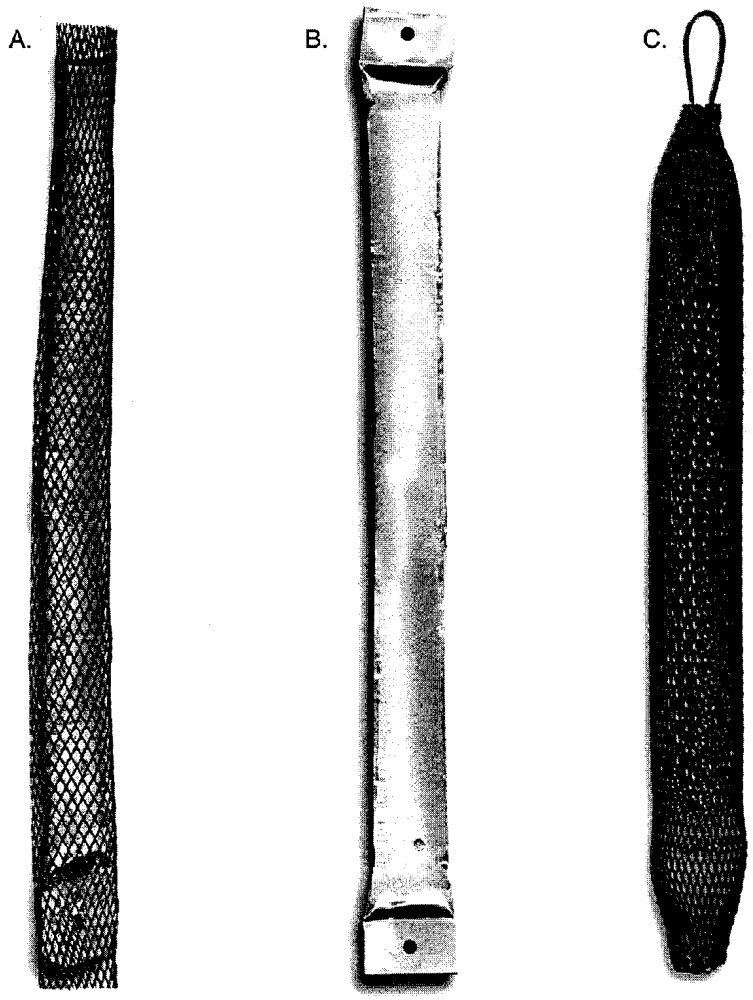


Figure 1. Typical water-filled passive diffusion bag samplers used in wells, including (A) diffusion bag with polyethylene mesh, (B) diffusion bag without mesh, and (C) bag and mesh attached to bailer bottom.

Table 1. Compounds tested under laboratory conditions for use with passive diffusion bag samplers
[From Vroblesky and Campbell, 2001]

Tested compounds showing good correlation (average differences in concentration of 11 percent or less between diffusion-sampler water and test-vessel water) in laboratory tests			
Benzene	2 Chlorovinyl ether	*cis*-1,2-Dichloroethene	1,1,1-Trichloroethane
Bromodichloromethane	Dibromochloromethane	*trans*-1,2-Dichloroethene	1,1,2-Trichloroethane
Bromoform	Dibromomethane	1,2-Dichloropropane	Trichloroethene
Chlorobenzene	1,2-Dichlorobenzene	*cis*-Dichloropropene	Trichlorofluoromethane
Carbon tetrachloride	1,3-Dichlorobenzene	1,2-Dibromoethane	1,2,3-Trichloropropane
Chloroethane	1,4-Dichlorobenzene	*trans*-1,3-Dichloropropene	1,1,2,2-Tetrachloroethane
Chloroform	Dichlorodifluoromethane	Ethyl benzene	Tetrachloroethene
Chloromethane	1,2-Dichloroethane	Naphthalene	Vinyl chloride
	1,1-Dichloroethene	Toluene	Total xylenes
Tested compounds showing poor correlation (average differences in concentration greater than 20 percent between diffusion-sampler water and test-vessel water) in laboratory tests			
Acetone*	Methyl-*tert*-butyl ether	Styrene	

*T.M Sivavec and S.S. Baghel, General Electric Company, written commun., 2000

Summary of Passive Diffusion Bag Sampler Advantages and Limitations

Advantages

1. PDB samplers have the potential to eliminate or substantially reduce the amount of purge water associated with sampling.

2. PDB samplers are inexpensive.

3. The samplers are easy to deploy and recover.

4. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells.

5. A minimal amount of field equipment is required.

6. Sampler recovery is rapid. Because of the small amount of time and equipment required for the sampling event, the method is practical for use where access is a problem or where discretion is desirable (that is, residential communities, business districts, or busy streets where vehicle traffic control is a concern).

7. Multiple PDB samplers, distributed vertically along the screened or open interval, may be used in conjunction with borehole flow meter testing to gain insight on the movement of contaminants into and out of the well screen or open interval or to locate the zone of highest concentration in the well. Analytical costs when using multiple PDB samplers sometimes can be reduced by selecting a limited number of the samplers for laboratory analysis based on screening by using field gas chromatography at the time of sample collection.

8. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material or that there is a detrimental effect from the PDB material on the VOC sample.

Limitations

1. PDB samplers integrate concentrations over time. This may be a limitation if the goal of sampling is to collect a representative sample at a point in time in an aquifer where VOC-concentrations substantially change more rapidly than the samplers equilibrate. Laboratory results obtained indicate that a variety of compounds equilibrated within 48 hours at 21 °C (Vroblesky and Campbell, 2001). Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane may require between 93 and 166 hours to equilibrate at 10 °C (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). The initial equilibration under field conditions may be longer to allow well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment.

2. Water-filled polyethylene PDB samplers are not appropriate for all compounds. For example, although methyl-*tert*-butyl ether and acetone (Vroblesky, 2000; Paul Hare, General Electric Company, oral commun., 2000) and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene membrane. These factors include the molecular size and shape and the hydrophobic nature of the compound. Compounds having a cross-sectional diameter of about 10 angstroms or larger (such as humic acids) do not pass through the polyethylene because the largest (transient) pores in polyethylene do not exceed about 10 angstroms in diameter (Flynn and Yalkowsky, 1972; Hwang and Kammermeyer, 1975; Comyn, 1985). The samplers are not appropriate for hydrophilic polar molecules, such as inorganic ions. A detailed discussion of the relation between hydrophobicity and compound transport through polyethylene can be found in Gale (1998). Unpublished laboratory test data (D.A. Vroblesky, U.S. Geological Survey, written commun., 1998) of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

3. PDB samplers rely on the free movement of water through the well screen. In situations where ground water flows horizontally through the well screen, the VOC concentrations in the open interval of the well probably are representative of the aquifer water in the adjacent formation (Gillham and others, 1985; Robin and Gillham, 1987; Kearl and others, 1992; Powell and Puls, 1993; Vroblesky and Hyde, 1997). In these situations, the VOC concentration of the water in contact with the PDB samplers, and therefore, the water within the diffusion samplers, probably represents local conditions in the adjacent aquifer. However, if the well screen is less permeable than the aquifer or the sandpack, then under ambient conditions, flowlines may be diverted around the screen. Such a situation may arise from inadequate well development or from iron bacterial fouling of the well screen. In this case, the VOC concentrations in the PDB samplers may not represent concentrations in

the formation water because of inadequate exchange across the well screen. PDB samplers have not yet been adequately tested to determine their response under such conditions.

4. VOC concentrations in PDB samplers represent ground-water concentrations in the vicinity of the screened or open well interval that move to the sampler under ambient flow conditions. This is a limitation if the ground-water contamination lies above or below the well screen or open interval, and requires the operation of a pump to conduct contaminants into the well for sampling.

5. In cases where the well screen or open interval transects zones of differing hydraulic head and variable contaminant concentrations, VOC concentrations obtained using a PDB sampler may not reflect the concentrations in the aquifer directly adjacent to the sampler because of vertical transport in the well. However, a vertical array of PDB samplers, used in conjunction with borehole flow meter testing, can provide insight on the movement of contaminants into or out of the well. This information then can be used to help determine if the use of PDB samplers is appropriate for the well, and to select the optimal vertical location(s) for the sampler deployment.

6. In wells with screens or open intervals with stratified chemical concentrations, the use of a single PDB sampler set at an arbitrary (by convention) depth may not provide accurate concentration values for the most contaminated zone. However, multiple PDB samplers distributed vertically along the screened or open interval, in conjunction with pump sampling (as appropriate), can be used to locate zone(s) of highest concentration in the well. Multiple PDB samplers also may be needed to track the zone of maximum concentration in wells where flow patterns through the screened interval change as a result of ground-water pumping or seasonal water-table fluctuations.

PASSIVE DIFFUSION BAG SAMPLER DEPLOYMENT

A variety of approaches can be used to deploy the PDB samplers in wells. A typical deployment approach, described in this section, is to attach the PDB samplers to a weighted line. It also is acceptable to attach the weights directly to the PDB sampler if the attachment point is of sufficient strength to support the weight. The weights attached to the bottom of the line are stainless steel and can be reused, but must be thoroughly decontaminated with a detergent before the first use or before using in a different well. Rope, such as 90 pound, 3/16 inch braided polyester, can be used as the line for single-use applications if it is of sufficient strength to support the weight and sampler, is nonbuoyant, and is subject to minimal stretch; however, the rope should not be reused because of the high potential for cross contamination. Stainless-steel or Teflon-coated stainless-steel wire is preferable. The weighted lines should not be reused in different wells to prevent carryover of contaminants. A possible exception is coated stainless-steel wire, which can be reused after sufficient decontamination. An alternative deployment approach, not discussed in this section, is to attach the PDB samplers to a fixed pipe in the well (Vroblesky and Peters, 2000, p. 3; also included in Part 2 of this publication). The PDB samplers should not contact non-aqueous phase liquid (NAPL) during deployment or retrieval to prevent cross contamination. An approach that can be utilized to deploy diffusion samplers through a layer of floating NAPL is described in the field test at Naval Station North Island, California (Vroblesky and Peters, 2000, p. 3-4; also included in Part 2 of this publication).

If the PDB sampler is to be compared with a conventional pumping approach to sampling, then it is suggested that both the pump and the PDB sampler be deployed at the same time, with the sampler attached near (such as directly below) the pump inlet. This approach eliminates potential concentration differences between the two methods that may result from well disturbance during equipment removal and deployment at the time of sampling. An alternative method is to deploy the PDB samplers independently of the pumps and recover the samplers immediately prior to placing the pump down the well.

PDB samplers are available either prefilled (field ready) with laboratory-grade deionized water or unfilled. The unfilled samplers are equipped with a plug and funnel to allow for field filling and sample recovery. To fill these samplers, remove the plug from the sampler bottom, insert the short funnel into the sampler, and pour laboratory-grade deionized water into the sampler. The sampler should be filled until water rises and stands at least half way into the funnel. Remove excess bubbles from the sampler. Remove the funnel and reattach the plug. A small air bubble from the plug is of no concern.

The following steps should be used for deploying PDB samplers in wells:

1. Measure the well depth and compare the measured depth with the reported depth to the bottom of the well screen from well-construction records. This is to check on whether sediment has accumulated in the bottom of the well, whether there is a nonscreened section of pipe (sediment sump) below the well screen, and on the accuracy of well-construction records. If there is an uncertainty regarding length or placement of the well screen, then an independent method, such as video imaging of the well bore, is strongly suggested.

2. Attach a stainless-steel weight to the end of the line. Sufficient weight should be added to counterbalance the buoyancy of the PDB samplers. This is particularly important when multiple PDB samplers are deployed. One approach, discussed in the following paragraphs, is to have the weight resting on the bottom of the well, with the line taut above the weight. Alternatively, the PDB sampler and weight may be suspended above the bottom, but caution should be exercised to ensure that the sampler does not shift location. Such shifting can result from stretching or slipping of the line or, if multiple samplers are attached end-to-end rather than to a weighted line, stretching of the samplers.

3. Calculate the distance from the bottom of the well, or top of the sediment in the well, up to the point where the PDB sampler is to be placed. A variety of approaches can be used to attach the PDB sampler to the weight or weighted line at the target horizon. The field-fillable type of PDB sampler is equipped with a hanger assembly and weight that can be slid over the sampler body until it rests securely near the bottom of the sampler. When this approach is used with multiple PDB samplers down the same borehole, the weight should only be attached to the lowermost sampler. An additional option is to use coated stainless-steel wire as a weighted line, making loops at appropriate points to attach the upper and lower ends of PDB samplers. Where the PDB sampler position varies between sampling events, movable clamps with rings can be used. When using rope as a weighted line, a simple approach is to tie knots or attach clasps at the appropriate depths. Nylon cable ties or stainless-steel clips inserted through the knots can be used to attach the PDB samplers. An approach using rope as a weighted line with knots tied at the appropriate sampler-attachment points is discussed below.

(a) For 5-ft-long or shorter well screens, the center point of the PDB sampler should be the vertical midpoint of the saturated well-screen length. For example, if the well screen is at a depth of 55 to 60 ft below the top of casing, and the measured depth of the well is 59 ft, then the bottom of the well probably has filled with sediment. In this case, the midpoint of the sampler between the attachment points on the line will be midway between 55 and 59 ft, or at 57 ft. Thus, for a 1.5-ft-long sampler, the attachment points on a weighted line should be tied at distances of 1.25 ft (2 ft – 0.75 ft) and 2.75 ft (2 ft + 0.75 ft) from the top of the sediment in the well, or the bottom of the well, making adjustments for the length of the attached weight. When the PDB sampler is attached to the line and installed in the well, the center of the sampler will be at 57-ft depth. If, however, independent evidence is available showing that the highest concentration of contaminants enters the well from a specific zone within the screened interval, then the PDB sampler should be positioned at that interval.

(b) For 5- to 10-ft-long well screens, it is advisable to utilize multiple PDB samplers vertically along the length of the well screen for at least the initial sampling (fig. 2). The purposes of the multiple PDB samplers are to determine whether contaminant stratification is present and to locate the zone of highest concentration. The midpoint of each sampler should be positioned at the midpoint of the interval to be sampled. For 1.5-ft-long samplers, at each sampling depth in the screened interval, make two attachment points on the weighted line at a distance of about 1.5 ft apart. The attachment points should be positioned along the weighted line at a distance from the bottom end of the weight such that the midpoint between the knots will be at the desired sampling depth along the well screen. Sampler intervals are variable, but a simple approach is to use the top knot/loop of one sampler interval as the bottom knot/loop for the overlying sampler interval.

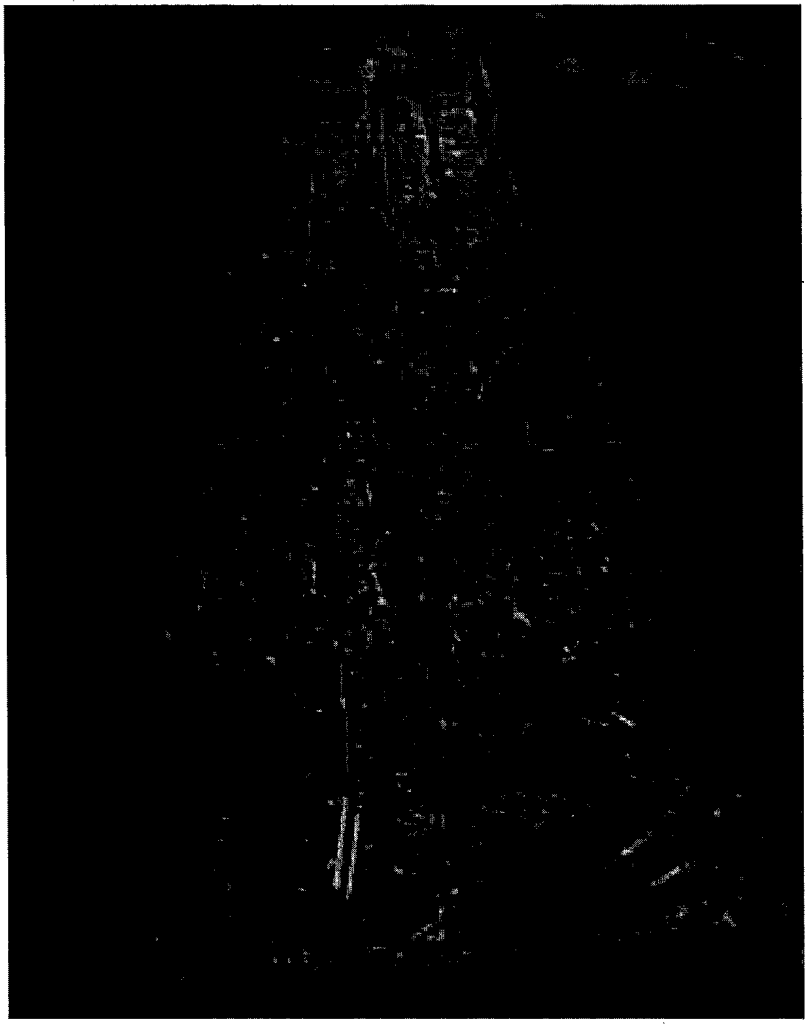


Figure 2. Example of multiple PDB samplers prepared for deployment.

(c) PDB samplers should not be used in wells having screened or open intervals longer than 10 ft unless used in conjunction with borehole flow meters or other techniques to characterize vertical variability in hydraulic conductivity and contaminant distribution or used strictly for qualitative reconnaissance purposes. This is because of the increased potential for cross contamination of water-bearing zones and hydraulically driven mixing effects that may cause the contaminant stratification in the well to differ from the contaminant stratification in the adjacent aquifer material. If it is necessary to sample such wells, then multiple PDB samplers should be installed vertically across the screened or open interval to determine the zone of highest concentration and whether contaminant stratification is present.

4. The samplers should be attached to the weights or weighted line at the time of deployment. For samplers utilizing the hanger and weight assembly, the line can be attached directly to the top of the sampler. PDB samplers utilizing an outer protective mesh can be attached to a weighted line by using the following procedure:

(a) Insert cable ties through the attachment points in the weighted line.

(b) At each end of the PDB sampler, weave the ends of the cable ties or clamp through the LPDE mesh surrounding the sampler and tighten the cable ties. Thus, each end of the PDB sampler will be attached to a knot/loop in the weighted line by means of a cable tie or clamp. The cable ties or clamps should be positioned through the polyethylene mesh in a way that prevents the PDB sampler from sliding out of the mesh.

(c) Trim the excess from the cable tie before placing the sampler down the well. Caution should be exercised to prevent sharp edges on the trimmed cable ties that may puncture the LDPE.

5. When using PDB samplers without the protective outer mesh, the holes punched at the ends of the bag, outside the sealed portion, can be used to attach the samplers to the weighted line. Stainless-steel spring clips have been found to be more reliable than cable ties in this instance, but cable ties also work well.

6. Lower the weight and weighted line down the well until the weight rests on the bottom of the well and the line above the weight is taut. The PDB samplers should now be positioned at the expected depth. A check on the depth can be done by placing a knot or mark on the line at the correct distance from the top knot/loop of the PDB sampler to the top of the well casing and checking to make sure that the mark aligns with the lip of the casing after deployment.

7. Secure the assembly in this position. A suggested method is to attach the weighted line to a hook on the inside of the well cap. Reattach the well cap. The well should be sealed in such a way as to prevent surface-water invasion. This is particularly important in flush-mounted well vaults that are prone to flooding.

8. Allow the system to remain undisturbed as the PDB samplers equilibrate.

PASSIVE DIFFUSION BAG SAMPLER AND SAMPLE RECOVERY

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene (*c*DCE), tetrachlorethene (PCE), trichloroethene (TCE), toluene, naphthalene, 1,2-dibromoethane (EDB), and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C (Vroblesky and Campbell, 2001). A subsequent laboratory study of mixed VOCs at 10 °C showed that PCE and TCE were equilibrated by about 52 hours, but other compounds required longer equilibration times (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). Chloroethane, *c*DCE, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

Under field conditions, the samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. The results of borehole dilution studies show that wells can recover to 90 percent of the predisturbance conditions within minutes to several hours for permeable to highly permeable geologic formations, but may require 100 to 1,000 hours (4 to 40 days) in muds, very fine-grained loamy sands, and fractured rock, and may take even longer in fractured shales, recent loams, clays, and slightly fractured solid igneous rocks (Halevy and others, 1967).

In general, where the rate of ground-water movement past a diffusion sampler is high, equilibration times through various membranes commonly range from a few hours to a few days (Mayer, 1976; Harrington and others, 2000). One field investigation showed adequate equilibration of PDB samplers to aquifer trichloroethene (TCE) and carbon tetrachloride (CT) concentrations within 2 days in a highly permeable aquifer (Vroblesky and others, 1999). In other investigations, PDB samplers recovered after 14 days were found to be adequately equilibrated to chlorinated VOCs (Obrien & Gere Engineers, Inc., 1997a, 1997b; Hare, 2000); therefore, the equilibration period was less than or equal to 14 days for those field conditions. Because it appears that 2 weeks of equilibration probably is adequate for many applications, a minimum equilibration time of 2 weeks is suggested. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating field data, a side-by-side comparison with conventional sampling methodology is advisable to justify the field equilibration time.

In less permeable formations, longer equilibration times may be required. It is probable that water in the well bore eventually will equilibrate with the pore-water chemistry; however, if the rate of chemical change or volatilization loss in the well bore exceeds the rate of exchange between the pore water and the well-bore water, then the PDB samplers may under-

estimate pore-water concentrations. Guidelines for equilibration times and applicability of PDB samplers in low-permeability formations have not yet been established. Therefore, in such situations, a side-by-side comparison of PDB samplers and conventional sampling methodology is advisable to ensure that the PDB samplers do not underestimate concentrations obtained by the conventional method. A detailed discussion of diffusion rates relevant to diffusion sampler equilibrium in slow-moving ground-water systems can be found in Harrington and others (2000).

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity (Paul Hare, General Electric Company, oral commun., 2000). The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds may be reduced, but not stopped, across a heavily biofouled polyethylene membrane (Ellis and others, 1995; Huckins and others, 1996; Huckins and others, in press). If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing contaminant concentrations from the PDB sampler to concentrations from a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery of PDB samplers is accomplished by using the following approach:

1. Remove the PDB samplers from the well by using the attached line. The PDB samplers should not be exposed to heat or agitated.

2. Examine the surface of the PDB sampler for evidence of algae, iron or other coatings, and for tears in the membrane. Note the observations in a sampling field book. If there are tears in the membrane, the sample should be rejected. If there is evidence that the PDB sampler exhibits a coating, then this should be noted the validated concentration data.

3. Detach and remove the PDB sampler from the weighted line. Remove the excess liquid from the exterior of the bag to minimize the potential for cross contamination.

4. A variety of approaches may be used to transfer the water from the PDB samplers to 40-mL volatile organic analysis (VOA) vials. One type of commercially available PDB sampler provides a discharge device that can be inserted into the sampler. If discharge devices are used, the diameter of the opening should be kept to less than about 0.15 inches to reduce volatilization loss. Two options are presently available to recover water from the sample using discharge devices. One option involves removing the hanger and weight assembly from the sampler, inverting the sampler so that the fill plug is pointed upward, and removing the plug. The water can be recovered by directly pouring in a manner that minimizes agitation or by pouring through a VOC-discharge accessory inserted in place of the plug. The second approach involves piercing the sampler near the bottom with a small-diameter discharge tube and allowing water to flow through the tube into the VOA vials. In each case, flow rates can be controlled by tilting or manipulating the sampler. Alternatively, the PDB sampler can be cut open at one end using scissors or other cutting devices which have been decontaminated between use for different wells. Water can then be transferred to 40-ml VOA vials by gently pouring in a manner that minimizes water agitation. Acceptable duplication has been obtained using each method. Preserve the samples according to the analytical method. The sampling vials should be stored at approximately 4 °C in accordance with standard sampling protocol. Laboratory testing suggests that there is no substantial change in the VOC concentrations in PDB samplers over the first several minutes after recovery; however, the water should be transferred from the water-filled samplers to the sample bottles immediately upon recovery.

5. A cost-effective alternative when using multiple PDB samplers in a single well is to field screen water from each sampler using gas chromatography. These results can be used to decide which of the multiple PDB samplers should be sent to an EPA-approved laboratory for standard analysis. Typically, at least the sample containing the highest concentration should be analyzed by a laboratory.

6. If a comparison is being made between concentrations obtained using PDB samplers and concentrations obtained using a conventional sampling approach, then the well should be sampled by the conventional approach soon after (preferably on the same day) recovery of the PDB sampler. The water samples obtained using PDB samplers should be sent in the same shipment, as the samples collected by the conventional approach for the respective wells. Utilizing the same laboratory may reduce analytical variability.

7. Any unused water from the PDB sampler and water used to decontaminate cutting devices should be disposed in accordance with local, state, and Federal regulations.

DETERMINING APPLICABILITY OF PASSIVE DIFFUSION BAG SAMPLERS AND INTERPRETATION OF DATA

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method during the same sampling event. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if both PDB and conventional sampling produce concentrations that agree within a range deemed acceptable by local, state, and Federal regulatory agencies and meet the site-specific data-quality objectives, then a PDB sampler may be approved for use in that well to monitor ambient VOC concentrations. If concentrations from the PDB sampler are higher than concentrations from the conventional method, it is probable that concentrations from the PDB sampler adequately represent ambient conditions because there usually is a greater potential for dilution from mixing during sampling using conventional methods than during sampling using PDB samplers.

If, however, the conventional method produces concentrations that are significantly higher than those obtained using the PDB sampler, then it is uncertain whether the PDB-sampler concentrations represent local ambient conditions. In this case, further testing can be done to determine whether contaminant stratification and/or intra-borehole flow is present. Multiple sampling devices can be used to determine the presence of contaminant stratification, and borehole flowmeters can be used to determine whether intra-borehole flow is present. When using flowmeters to measure vertical flow in screened boreholes, however, the data should be considered qualitative because of the potential for water movement through the sand pack. Borehole dilution tests (Halevy and others, 1967; Drost and others, 1968; Grisak and others, 1977; Palmer, 1993) can be used to determine whether water is freely exchanged between the aquifer and the well screen.

Once the source of the difference between the two methods is determined, a decision can be made regarding the well-specific utility of the PDB samplers. Tests may show that VOC concentrations from the PDB samplers adequately represent local ambient conditions within the screened interval despite the higher VOC concentration obtained from the conventional method. This may be because the pumped samples incorporated water containing higher concentrations either from other water-bearing zones induced along inadequate well seals or through fractured clay (Vroblesky and others, 2000), from other water-bearing zones not directly adjacent to the well screen as a result of well purging prior to sampling (Vroblesky and Petkewich; 2000), or from mixing of chemically stratified zones in the vicinity of the screened interval (Vroblesky and Peters, 2000).

The mixing of waters from chemically stratified zones adjacent to the screened interval during pumping probably is one of the more important sources of apparent differences between the results obtained from PDB sampling and conventional sampling because such stratification probably is common. Vertical stratification of VOCs over distances of a few feet has been observed in aquifer sediments by using multilevel sampling devices (Dean and others, 1999; Pitkin and others, 1999), and considerable variation in hydraulic conductivity and water chemistry has been observed in an aquifer in Cape Cod, Massachusetts, on the scale of centimeters (Wolf and others, 1991; Smith and others 1991; Hess and others, 1992). Multiple PDB samplers have been used to show a change in TCE concentration of 1,130 (µg/L over a 6-ft vertical screened interval in Minnesota (Vroblesky and Petkewich, 2000). Tests using PDB samplers in screened intervals containing VOC stratification showed that the PDB-sampler data appeared to be point-specific, whereas the pumped sample integrated water over a larger interval (Vroblesky and Peters, 2000).

The decision on whether to use PDB samplers in such situations depends on the data-quality objectives for the particular site. If the goal is to determine and monitor higher concentrations or to examine contaminant stratification within the screened interval, then the PDB samplers may meet this objective. If the goal is to determine the average concentrations for the entire screened interval, then a pumped sample or an average from multiple diffusion samplers may be appropriate.

As an aid in the decision-making process, the following section examines the influences that hydraulic and chemical heterogeneity of an aquifer can have on sample quality in long-screened wells. Because VOC concentrations from PDB samplers commonly are compared to VOC concentrations from other sampling methodologies, the second section examines the differences in sample quality between these methodologies in situations of hydraulic and chemical heterogeneity.

Influences of Hydraulic and Chemical Heterogeneity on Sample Quality in Long-Screened Wells

Sampling biases and chemical variability in long-screened wells, which can be loosely defined as wells having significant physical and chemical heterogeneity within the screened interval and in the adjacent aquifer (Reilly and Leblanc, 1998), have been the subject of numerous investigations. Sources of chemical variability in such wells include non-uniform flow into wells (Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Chiang and others, 1995; Church and Granato, 1996; Reilly and LeBlanc, 1998), lithologic heterogeneity (Reilly and others, 1989; Robbins, 1989; Martin-Hayden and others, 1991; Gibs and others, 1993; Reilly and Gibs, 1993), and in-well mixing. In a well open across a chemically or hydraulically heterogeneous section of the aquifer, differences in the sampling methodology can produce significant differences in the sampling results.

Long-screened wells have the potential to redistribute chemical constituents in the aquifer where there are vertical hydraulic gradients within the screened interval. Water can move into the well from one horizon and exit the well at a different horizon (Church and Granato, 1996; Reilly and LeBlanc 1998). If there is vertical flow in the screened or open interval, and the zone of low hydraulic head (outflow from the well) is within the contaminated horizon, then the PDB samplers (or any standard sampling methodology) can underestimate or not detect the contamination. The reason is that, in this case, the contaminated horizon does not contribute water to the well under static conditions. Instead, water from other horizons with higher hydraulic head will invade the contaminated horizon by way of the well screen. Under pumped conditions, the majority of the extracted water will be from the most permeable interval, which may not be the contaminated zone. Even when pumping induces inflow from the contaminated interval, much of that inflow will be a reflection of the residual invaded water from other horizons. In this situation, a substantial amount of purging would be required before water representative of the aquifer could be obtained (Jones and Lerner, 1995). Such sampling is not likely to reflect a significant contribution from the contaminated zone, and concentrations in the contaminated zone probably will be underestimated.

Similarly, if VOC-contaminated water is flowing into the well and is exiting the well at a different horizon, then VOCs will be present along the screened interval between the two horizons. In this case, VOC concentrations in the screened interval may be representative of aquifer concentrations at the inflow horizon, but may not be representative of aquifer concentrations near the outflow horizon.

In areas where vertical stratification of VOC concentrations is anticipated, using multiple PDB samplers may more fully characterize the contaminated horizon than using a single PDB sampler. This is particularly true in wells having screens 10 ft or longer; however, significant VOC stratification has been observed over intervals of less than 5 ft (Vroblesky and Peters, 2000). Because of the increased probability of vertical concentration or hydraulic gradients within the open interval of long-screened (greater than 10 ft) wells, it is advisable to determine the zones of inflow and outflow within the screened or open interval of these wells using borehole flowmeter analysis (Hess, 1982; 1984; 1986; 1990; Young and others, 1998).

Comparison of Passive Diffusion Bag Sampling Methodology to Conventional Methodologies

Traditional sampling methodologies, such as the purge-and-sample (or conventional purging method), low-flow or low-volume sampling, and using straddle packers and multilevel samplers, produce VOC

concentrations that may differ from VOC concentrations obtained from PDB samplers because the methodologies sometimes are influenced in different ways by aquifer hydraulic and chemical heterogeneity. This section examines potential sources of concentration differences between traditional methodologies and the PDB methodology.

The purge-and-sample approach to ground-water monitoring differs from the diffusion-sampler approach primarily because the area of the screened or open interval that contributes water to the purged sample typically is greater than for the PDB sampler and the potential for mixing of stratified layers is higher. When pumping three or more casing volumes of water prior to collecting a sample, chemical concentrations in the discharging water typically change as the well is pumped (Keely and Boateng, 1987; Cohen and Rabold, 1988; Martin-Hayden and others, 1991; Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Barcelona and others, 1994; Martin-Hayden, 2000), due to mixing during pumping and other factors, such as the removal of stagnant water in the casing and changing patterns of inflow and outflow under ambient and pumping conditions (Church and Granato, 1996). The induction of lateral chemical heterogeneity during pumping also may produce variations in the sampled concentrations. The amount of mixing during purging can be highly variable (Barber and Davis, 1987; Church and Granato, 1996; Reilly and LeBlanc, 1998; Martin-Hayden, 2000), and may result in concentrations that are not locally representative (Reilly and Gibs, 1993). Substantial vertical hydraulic gradients, even in shallow homogeneous aquifers, have been observed to bias sampling using conventional purging because the majority of the pumped water may come from a particular horizon not related to the contaminated zone and because the intra-well flow that intruded the aquifer may not be adequately removed during purging (Hutchins and Acree, 2000). Thus, differences may be observed between concentrations obtained from a pumped sample and from a PDB sample in a chemically stratified interval if the pumped sample represents an integration of water collected from multiple horizons and the PDB sampler represents water collected from a single horizon.

Low-flow purging and sampling (Barcelona and others, 1994; Shanklin and others, 1995) disturbs the local ground water less than conventional purge-and-sample methods. Thus, samples obtained by PDB samplers are likely to be more similar to samples obtained by using low-flow purging than to those obtained by using conventional purge-and-sample methods. Even under low-flow conditions, however, purging still can integrate water within the radius of pumping influence, potentially resulting in a deviation from VOC concentrations obtained by PDB sampling. One investigation found that in low hydraulic conductivity formations, low-flow sampling methodology caused excessive drawdown, which dewatered the screened interval, increased local ground-water velocities, and caused unwanted colloid and soil transport into the ground-water samples (Sevee and others, 2000). The authors suggest that in such cases, a more appropriate sampling methodology may be to collect a slug or passive sample from the well screen under the assumption that the water in the well screen is in equilibrium with the surrounding aquifer.

Isolating a particular contributing fracture zone with straddle packers in an uncased borehole allows depth-discrete samples to be collected from the target horizon (Hsieh and others, 1993; Kaminsky and Wylie, 1995). Strategically placed straddle packers often can minimize or eliminate the impact of vertical gradients in the sampled interval. However, even within a packed interval isolating inflowing fracture zones, deviations between VOC concentrations in water from PDB samplers and water sampled by conventional methods still may occur if the conventional method mixes chemically stratified water outside the borehole or if the packed interval straddles chemically heterogeneous zones.

The use of multilevel PDB samplers and other types of multilevel samplers (Ronen and others, 1987; Kaplan and others, 1991; Schirmer and others, 1995; Gefell and others, 1999; Jones and others, 1999) potentially can delineate some of the chemical stratification. Diffusion sampling and other sampling methodologies, however, can be influenced by vertical hydraulic gradients within the well screen or the sand pack. When vertical hydraulic gradients are present within the well, water contacting the PDB sampler may not be from a horizon adjacent to the PDB sampler. Rather, the water may represent a mixing of water from other contributing intervals within the borehole. In a screened well, even multilevel samplers with baffles to limit vertical flow in the well cannot prevent influences from

vertical flow in the gravel pack outside the well screen. Such vertical flow can result from small vertical differences in head with depth. A field test conducted by Church and Granato (1996) found that vertical head differences ranging from undetectable to 0.49 ft were sufficient to cause substantial flows (as much as 0.5 liters/minute) in the well bore.

QUALITY CONTROL AND ASSURANCE

The sources of variability and bias introduced during sample collection can affect the interpretation of the results. To reduce data variability caused during sampling, a series of quality-control samples should be utilized.

Replicate samples are important for the quality control of diffusion-sampler data. Sample replicates provide information needed to estimate the precision of concentration values determined from the combined sample-processing and analytical method and to evaluate the consistency of quantifying target VOCs. A replicate sample for water-filled diffusion samplers consists of two separate sets of VOC vials filled from the same diffusion sampler. Each set of VOC vials should be analyzed for comparison. Approximately 10 percent of the samplers should be replicated.

The length of the PDB sampler can be adjusted to accommodate the data-quality objectives for the sampling event. The length can be increased if additional volume is required for collection of replicate and matrix spike/matrix spike duplicate samples.

Trip blanks are used to determine whether external VOCs are contaminating the sample due to bottle handling and/or analytical processes not associated with field processing. Trip blanks are water-filled VOA vials prepared offsite, stored and transported with the other bottles used for collecting the environmental sample, and then submitted for analysis with the environmental sample. Consideration also should be given to the collection of a predeployment PDB trip blank to determine if the PDB samplers are exposed to extraneous VOCs prior to deployment. The predeployment trip blank should be a PDB sampler that is stored and transported with the field PDB samplers from the time of sampler construction to the time of deployment in the wells. An aliquot of the predeployment blank water should be collected from the PDB sampler in a VOA vial and submitted for analysis at the time of sampler deployment.

Water used to construct the diffusion samplers should be analyzed to determine the presence of background VOCs. Although many VOCs accidentally introduced into the diffusion-sampler water probably will reequilibrate with surrounding water once the diffusion samplers are deployed, some VOCs may become trapped within the diffusion-sampler water. For example, acetone, which is a common laboratory contaminant, does not easily move through the polyethylene diffusion samplers (Paul Hare, General Electric Company, oral commun., 1999). Thus, acetone inadvertently introduced into the diffusion-sample water during sampler construction may persist in the samplers, resulting in a false positive for acetone after sampler recovery and analysis.

SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining a variety of VOCs in ground water at monitoring wells. The suggested application for PDB samplers is for long-term monitoring of VOCs in ground-water wells at well-characterized sites. Where the screened interval is greater than 10 ft, the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is suggested that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. A typical PDB sampler consists of a 1- to 2-ft-long low-density polyethylene lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon by attachment to a weighted line or fixed pipe.

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. Concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an

aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C. A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications. Therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When deploying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery after initial equilibration. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers were left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. In some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing sampler results to a conventional sampling method concentrations before continuing to use PDB samplers for long-term deployment in that well.

PDB methodology is suitable for a broad variety of VOCs, including chlorinated aliphatic compounds and petroleum hydrocarbons. The samplers, however, are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. The samplers should not be used to sample for phthalates because of the potential for the LDPE to contribute phthalates to the water sample.

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if the two approaches produce concentrations that agree within a range deemed acceptable by the local, state, and Federal regulatory agencies, then use of a PDB sampler in that well will provide VOC concentrations consistent with the historical record. If concentrations from the PDB sampler are higher than concentrations from the conventional method, then it is probable that the concentrations from the PDB sampler are an adequate representation of ambient conditions. If, however, the conventional method produces concentrations that are substantially higher than the concentrations found by using the PDB sampler, then the PDB sampler may or may not adequately represent local ambient conditions. In this case, the difference may be due to a variety of factors, including mixing or translocation due to hydraulic and chemical heterogeneity of the aquifer within the screened or open interval of the well and the relative permeability of the well screen.

REFERENCES

Barber, C., and Davis, G.B., 1987, Representative sampling of ground water from short screened boreholes: Ground Water, v. 25, no. 5, p. 581-587.

Barcelona, M., Wehrmann, H.A., and Varljen,. M.D., 1994, Reproducible well-purging procedures and VOC stabilization criteria for ground-water sampling: Ground Water, v. 32, p. 12-22.

Chiang, C.C., Raven, Gary, and Dawson, Clint, 1995, The relationship between monitoring well and aquifer solute concentrations: Ground Water, v. 32, no. 5, p. 718-126.

Church, P.E., and Granato, G.E., 1996, Effects of well design and sampling methods on bias of water-quality samples: Ground Water, v. 34, no. 2, p. 262-273.

Cohen, R.M., and Rabold, R.R., 1988, Simulation of sampling and hydraulic tests to assess a hybrid monitoring well design: Ground Water Monitoring Review, v. 8, no. 1, p. 55-59.

Comyn, J., 1985, Polymer Permeability: New York, Elsevier Applied Science Publishers Ltd, 383 p.

Dean, S.M., Lendvay, J.M., Barcelona, M.J., Adriaens, P., and Katopodes, N.D., 1999, Installing multilevel sampling arrays to monitor ground water and contaminant discharge to a surface-water body: Ground Water Monitoring and Remediation, Fall 1999, p. 90-96.

Drost, W., Klotz, D., Koch, A., Moser, H., Neurnaier, F., and Rauert, W., 1968, Point dilutions methods of investigating ground water flow by means of radioisotopes: Water Resources Research, v. 4, no. 1, p. 125-146.

Ellis, G.S., Huckins, J.N., Rostad, C.E., Schmitt, C.J., Petty, J.D., and MacCarthy, Patrick, 1995, Evaluation of lipid-containing semipermeable membrane devices for monitoring organochlorine contaminants in the upper Mississippi River: Environmental Science and Technology, v. 14, no. 11, p. 1875-1884.

Flynn, G.L., and Yalkowsky, S.H., 1972, Correlation and prediction of mass transport across membrane I: Influence of alkyl chain length on flux determining properties of barrier and diffusant: Journal of Pharmaceutical Science, v. 61, p. 838-852.

Gale, R.W., 1998, Three-compartment model for contaminant accumulation by semipermeable membrane devices: Environmental Science and Technology, v. 32, p. 2292-2300.

Gefell, M.J., Hamilton, L.A., and Stout, D.J., 1999, A comparison between low-flow and passive-diffusion bag sampling results for dissolved volatile organics in fractured sedimentary bedrock, *in* Proceedings of the Petroleum and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation Conference, November 17-19, 1999, Houston, Texas, p. 304-315.

Gibs, Jacob, Brown, G.A., Turner, K.S., MacLeod, C.L., Jelinski, J.C., and Koehnlein, S.A., 1993, Effects of small-scale vertical variations in well-screen inflow rates and concentrations of organic compounds on the collection of representative ground water quality samples: Ground Water, v. 35, no. 2, p. 201-208.

Gillham R.W., II, Robin, M.J.L., Barker, J.F., and Cherry, J.A., 1985, Field evaluation of well flushing procedures: Washington, D.C., American Petroleum Institute Publication 4405.

Grisak, G.E., Merritt, W.F., and Williams, D.W., 1977, A fluoride borehole dilution apparatus for ground water velocity measurements: Canadian Geotechnical Journal, v. 14, p. 554-561.

Halevy, E., Moser, H., Zellhofer, O, and Zuber, A., 1967, Borehole dilution techniques: A critical review, Isotopes in Hydrology: Vienna, Austria, International Atomic Energy Agency, p. 531-564.

Hare, P.W., 2000, Passive diffusion bag samplers for monitoring chlorinated solvents in ground water: The Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle, May 22-25, 2000, Monterey, California.

Harrington, G.A., Cook, P.G., and Robinson, N.I., 2000, Equilibration times of gas-filled diffusion samplers in slow-moving ground-water systems: Ground Water Monitoring and Remediation, Spring 2000, p. 60-65.

Hess, A.E., 1982, A heat-pulse flowmeter for measuring low velocities in boreholes: U.S. Geological Survey Open-File Report 82-699, 44 p.

_____ 1984, Use of a low-velocity flowmeter in the study of hydraulic conductivity of fractured rock: Proceedings of National Water Well Association Conference on Surface and Borehole Geophysics, San Antonio, Texas, p. 812-831.

_____ 1986, Identifying hydraulically conductive fractures with a slow-velocity borehole flowmeter: Canadian Geotechnical Journal, v. 23, no. 1, p. 69-78.

_____ 1990, A thermal flowmeter for the measurement of slow velocities in boreholes: U.S. Geological Survey Open-File Report 87-121.

Hess, K.M., Wolf, S.H., and Celia, M.A., 1992, Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts, 3. Hydraulic conductivity variability and calculated macrodispersivities. Water Resources Research, v. 28, no. 8, p. 2011-2027.

Hsieh, P.A., Shapiro, A.M., Barton, C.C., Haeni, F.P., Johnson, C.D., Martin, C.W., Paillet, F.L., Winter, T.C., and Wright, D.L., 1993, Methods of characterizing fluid movement and chemical transport in fractured rocks, *in* Field Trip Guidebook for the Northeastern United States: 1993 Boston GSA, Cheney, J.T., and Hepburn, J.C., eds., RI-R30. Amherst: University of Massachusetts, Department of Geology and Geography.

Huckins, J.N., Petty, J.D., Lebo, J.A., Orazio, C.E., Prest, H.F., Tillitt, D.E., Ellis, G.S., Johnson, B.T., and Manuweera, G.K., 1996, Semipermeable membrane devices (SPMDs) for the concentration and assessment of bioavailable organic contaminants in aquatic environments, *in* Ostander, G.K., ed., Techniques in Aquatic Toxicology: Boca Raton, Fla., CRC-Lewis Publishers, p. 625-655.

Huckins, J.N, Petty, J.D., Prest, H.F., Clark, R.C., Alverez, D.A., Orazio, C.E., Lebo, J.A., Cranor, W.L., and Johnson, B.T., in press, A guide for the use of semipermeable membrane devices (SPMDs) as samplers of waterborne hydrophobic organic contaminants: Report for the American Petroleum Institute (API), Washington, DC., API publication number 4690.

Hutchins, S.R., and Acree, S.D., 2000, Ground water sampling bias observed in shallow, conventional wells: Ground Water Monitoring and Remediation, Winter 2000, p. 86-93.

Hwang, S.T., and Kammermeyer, K., 1975, Membranes in Separations: Malabar, Fla., Robert E. Krieger Publishing Company, Inc., 559 p.

Jones, Ian, and Lerner, D.N., 1995, Level-determined sampling in an uncased borehole: Journal of Hydrology, v. 171, p. 291-317.

Jones, Ian, Lerner, D.N., and Baines, O.P., 1999, Multiport sock samplers: Alow cost technology for effective multilevel ground water sampling: Ground Water Monitoring and Remediation, v. 19, no. 1, p. 134-142.

Kaminsky, J.F., and Wylie, A.H., 1995, Vertical contaminant profiling of volatile organics in a deep fractured basalt aquifer: Ground Water Monitoring and Remediation, v. 15, no. 2, p. 97-103.

Kaplan, Edward; Banerjee, Sujit; Ronen, Daniel; Margaritz, Mordeckai; Machlin, Alber; Sosnow, Michael; and Koglin, Eric, 1991, Multilayer sampling in the water-table region of a sandy aquifer: Ground Water, v. 29, no. 2, p. 191-198.

Kearl, P., Korte, N., and Cronk, T., 1992, Suggested modifications to ground water sampling procedures based on observations from the colloidal borescope: Ground Water Monitoring Review, v. 12, no. 2, p. 155-166.

Keely, J.F., and Boateng, K., 1987, Monitoring well installation, purging, and sampling techniques - Part 1: Conceptualizations: Ground Water, v. 25, no. 3, p. 3300-313.

Martin-Hayden, J.M, 2000, Sample concentration response to laminar wellbore flow: Implications to ground water data variability: Ground Water, v. 38, no. 1, p. 12-19.

Martin-Hayden, J.M., Robbins, G.A., and Bristol, R.D., 1991, Mass balance evaluation of monitoring well purging. Part II: Field tests at a gasoline contamination site: Journal of Contaminant Hydrology, v. 8, no. 3/4, p. 225-241.

Mayer, L.M., 1976, Chemical water sampling in lakes and sediments with dialysis bags, Limnology and Oceanography: v. 21, p. 909-912.

Obrien & Gere Engineers, Inc, 1997a, Passive bag sampling results, JMT Facility, Brockport, New York: Consultant's report to General Electric Company, Albany, New York, October 10, 1997, 10 p.

_____ 1997b, Passive bag sampling results, JMT Facility, Brockport, New York: Consultant's report to General Electric Company, Albany, New York, December 12, 1997, 10 p.

Palmer, C.D., 1993, Borehole dilution tests in the vicinity of an extraction well: Journal of Hydrology, v. 146, p. 245-266.

Pitkin, S.E., Ingleton, R.A., and Cherry, J.A., 1999, Field demonstrations using the Waterloo Ground Water Profiler: Ground Water Monitoring and Remediation, v. 19, no. 2, Spring 1999, p. 122-131.

Powell, R.M., and Puls, R.W., 1993, Passive sampling of ground water monitoring wells without purging: Multilevel well chemistry and tracer disappearance: Journal of Contaminant Hydrology, v. 12, p. 51-77.

Reilly, T.E., Frank, O.L., and Bennet, G.D., 1989, Bias in ground water samples caused by wellbore flow: ASCE, Journal of Hydraulic Engineering, v. 115, p. 270-276.

Reilly, T.E., and Gibs, J., 1993, Effects of physical and chemical heterogeneity of water-quality samples obtained from wells: Ground Water, v. 31, no. 5, p. 805-813.

Reilly, T.E., and LeBlanc, D.R., 1998, Experimental evaluation of factors affecting temporal variability of water samples obtained from long-screened wells: Ground Water , v. 36, no. 4, p. 566-576.

Robin, M.J.L., and Gillham, R.W., 1987, Field evaluation on well purging procedures: Ground Water Monitoring Review, v. 7, no. 4, p. 85-93.

Robbins, G.A., 1989, Influence of using purged and partially penetrating monitoring wells on contaminant detection, mapping and modeling: Ground Water, v. 27, no. 2, p. 155-162.

Robbins, G.A., and Martin-Hayden, J.M., 1991, Mass balance evaluation of monitoring well purging. Part I: Theoretical models and implications for representative sampling: Journal of Contaminant Hydrology, v. 8, no. 3/4, p. 203-224.

Ronen, Daniel, Magaritz, Mordeckai, and Levy, Itzhak, 1987, An *in situ* multilevel sampler for preventive monitoring and study of hydrochemical profiles in aquifers: Ground Water Monitoring and Remediation, Fall, p. 69-74.

Schirmer, M., Jones, I., Teutsch, G., and Lerner, D.N., 1995, Development and testing of multiport sock samplers for ground water: Journal of Hydrology, v. 171, p. 239-257.

Shanklin, D.E., Sidle, W.C., and Ferguson, M.E., 1995, Micro-purge low-flow sampling of uranium-contaminated ground water at the Fernald Environmental Management Project: Ground Water Monitoring and Remediation, v. 15, no. 3, p. 168-176.

Sevee, J.E., White, C.A., and Maher, D.J., 2000, An analysis of low-flow ground water sampling methodology: Ground Water Monitoring and Remediation, Spring 2000, v. 20, no. 2, p. 87-93.

Smith, R.L., Harvey, R.W., and LeBlanc, D.R., 1991, Importance of closely spaced vertical sampling in delineating chemical and microbial gradients in ground water studies: Journal of Contaminant Hydrology, v. 7, p. 285-300.

Vroblesky, D.A., 2000, Simple, inexpensive diffusion samplers for monitoring VOCs in ground water: The Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 22-25, 2000, Monterey, California.

Vroblesky, D.A., and Campbell, T.R., 2001, Equilibration times, stability, and compound selectivity of diffusion samplers for collection of ground-water VOC concentrations: Advances in Environmental Research, v. 5, no. 1, p. 1-12.

Vroblesky, D.A., and Hyde, W.T., 1997, Diffusion samplers as an inexpensive approach to monitoring VOCs in ground water: Ground Water Monitoring and Remediation, v. 17, no. 3, p. 177-184.

Vroblesky, D.A., Nietch, C.T., Robertson, J.F., Bradley, P.M., Coates, John, and Morris, J.T., 1999, Natural attenuation potential of chlorinated volatile organic compounds in ground water, TNX flood plain, Savannah River Site, South Carolina: U.S. Geological Survey Water-Resources Investigations Report 99-4071, 43 p.

Vroblesky, D.A., and Peters, B.C., 2000, Diffusion sampler testing at Naval Air Station North Island, San Diego County, California, November 1999 to January 2000: U.S. Geological Survey Water-Resources Investigations Report 00-4812, 27 p.

Vroblesky, D.A., and Petkewich, M.D., 2000, Field testing of passive diffusion bag samplers for volatile organic compound concentrations in ground water, Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota, November 1999 and May 2000: U.S. Geological Survey Water-Resources Investigations Report 00-4246, 10 p.

Wolf, S.H., Celia, M.A., and Hess, K.M., 1991, Evaluation of hydraulic conductivities calculated from multiport permeameter measurements: Ground Water, v. 29, no. 4, p. 516-552.

Young, S.C., Julian, H.E., Pearson, H.S., Molz, F.J., and Boman, G.K, 1998, Application of the electromagnetic borehole flowmeter: U.S. Environmental Protection EPA/600/R-98/058, 56 p.

USGS VROBLESKY

USER'S GUIDE FOR POLYETHYLENE-BASED PASSIVE DIFFUSION BAG SAMPLERS TO OBTAIN VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN WELLS

PART 1: DEPLOYMENT, RECOVERY, DATA INTERPETATION, AND QUALITY CONTROL AND ASSURANCE

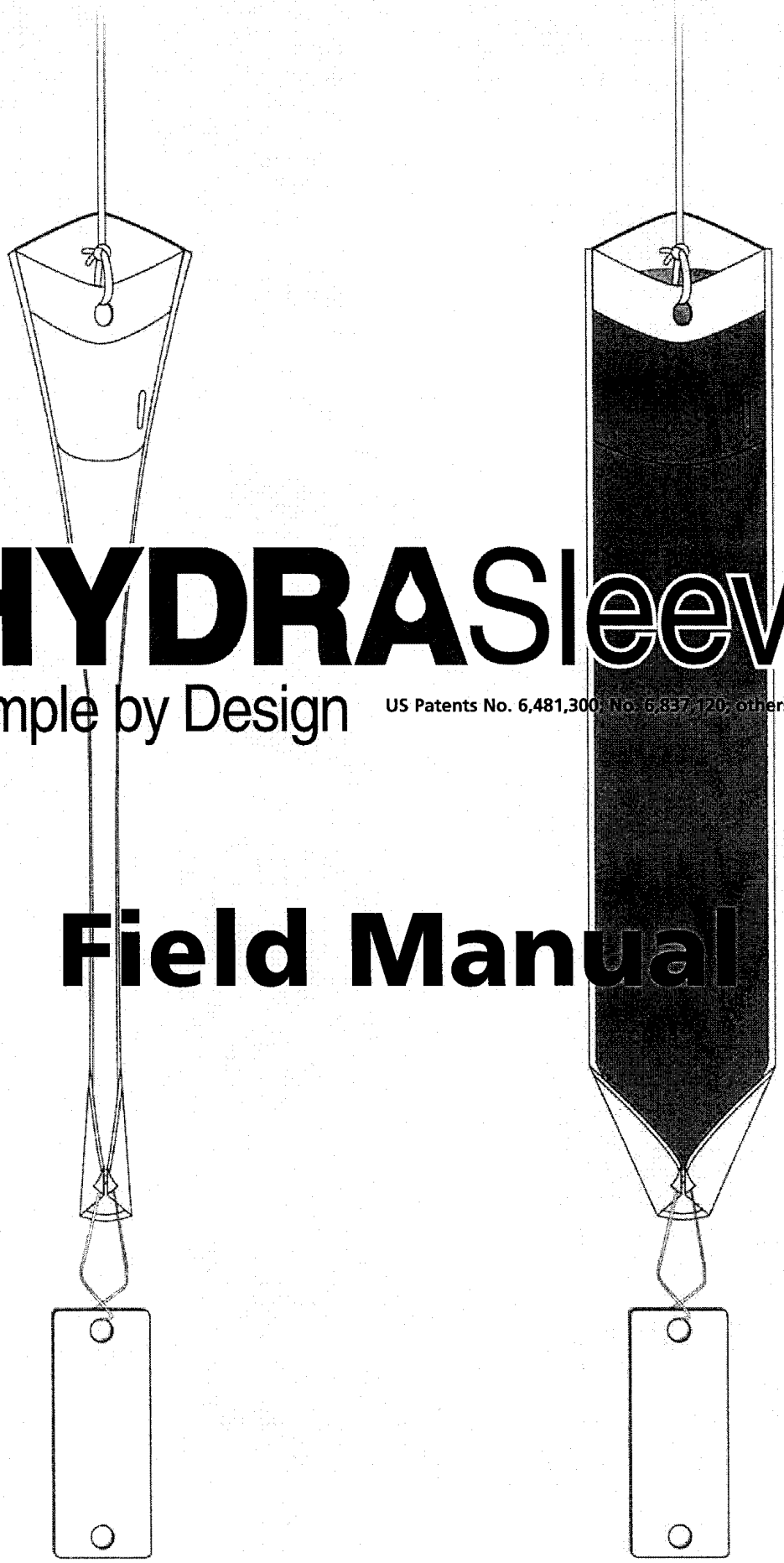
USGS WRIR 01-4060

Printed on recycled paper

MACTEC SOP #3 – Hydrasleeve Sampling Protocol

A3.0 HYDRASLEEVE SAMPLING PROTOCOL (REPRINTED WITH PERMISSION)

The following pages are from the HYDRASLEEVE Field Manual.



HYDRASleeve

Simple by Design

US Patents No. 6,481,300; No. 6,837,120; others pending

Field Manual

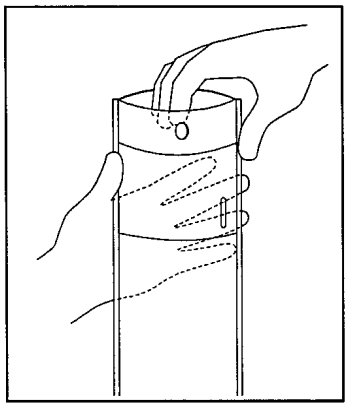
© Copyright 2006, GeoInsight

Introduction

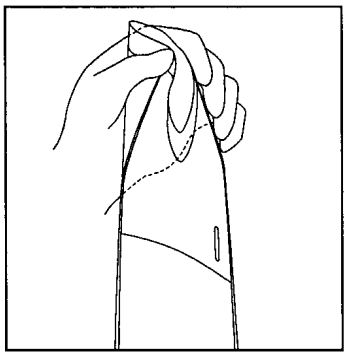
The HydraSleeve groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a whole water sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. One or more HydraSleeves are placed within the screened interval of the monitoring well, and a period of time is allocated for the well to re-equilibrate. Hours to months later, the sealed HydraSleeve can be activated for sample collection. When activated, HydraSleeve collects a sample with no drawdown and minimal agitation or displacement of the water column. Once the sampler is full, the one-way reed valve collapses, preventing mixing of extraneous, non-representative fluid during recovery.

Assembly

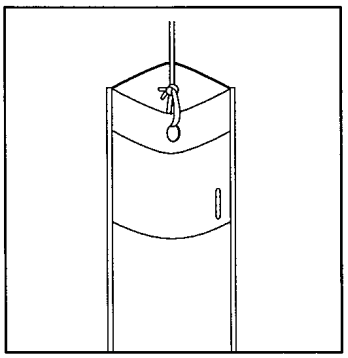
Assembling the HydraSleeve is simple, and can be done by one person in the field, taking only a minute or two.



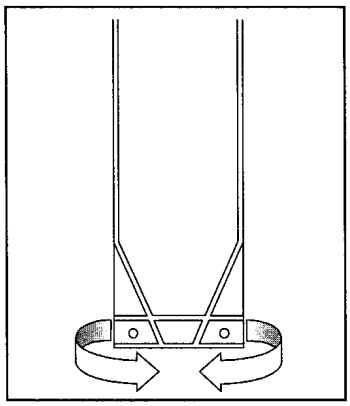
1 Remove HydraSleeve from package and grasp top to "pop" open.



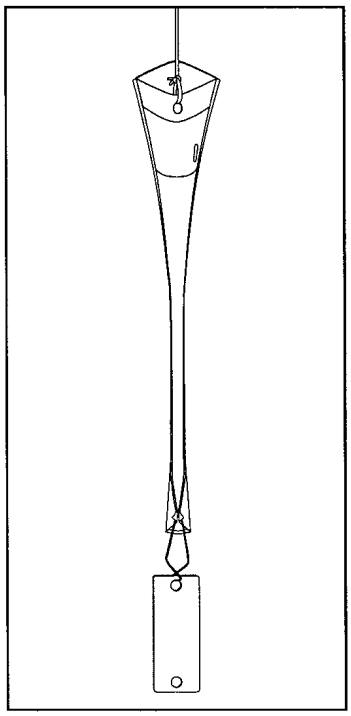
2 Squeeze side fins together at top to bend reinforcing strips outward.



3 Attach line to hole at top of HydraSleeve.



4 Fold the two holes at bottom of HydraSleeve together and attach weight



5 Sampler is ready to insert into the well.

Placing the HydraSleeve(s)

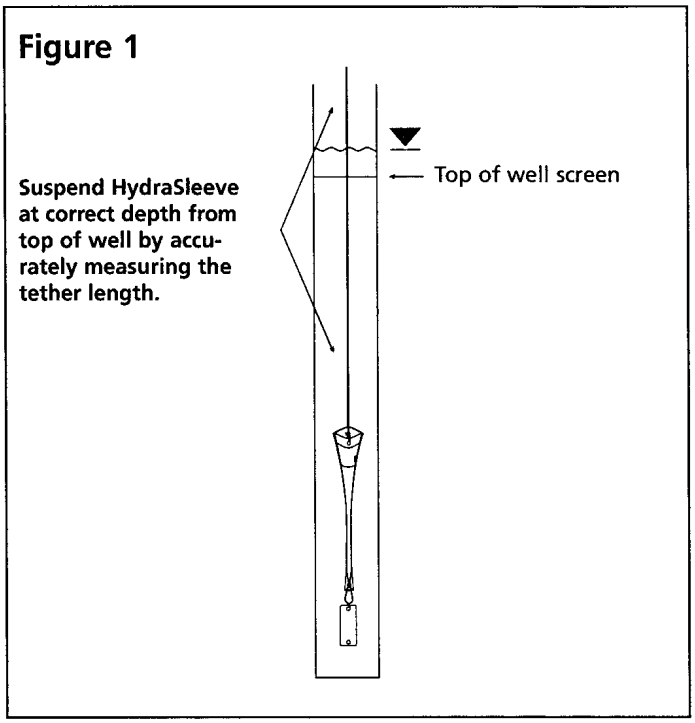
To collect a representative groundwater sample without purging, the well must be allowed time to re-equilibrate after placement of the sampler. When any device is lowered into a well, some mixing of the water column occurs. The diameter of the device and its shape greatly affect the degree of mixing. The flat cross-section of the empty HydraSleeve minimizes the disturbance to the water column as the sampler is lowered into position, reducing the time needed for the well to return to equilibrium.

There are three basic methods for holding a HydraSleeve in position as the well equilibrates.

TOP DOWN DEPLOYMENT (Figure 1)
Measure the correct amount of suspension line needed to "hang" the top of the HydraSleeve(s) at the desired sampling depth (in most cases, this will be at the bottom of the sampling zone). The upper end of the tether can be connected to the well cap to suspend the HydraSleeve at the correct depth until activated for sampling.

Note: For deep settings, it may be difficult to accurately measure long segments of suspension line in the field. Factory prepared, custom suspension line and attachment points can be provided.

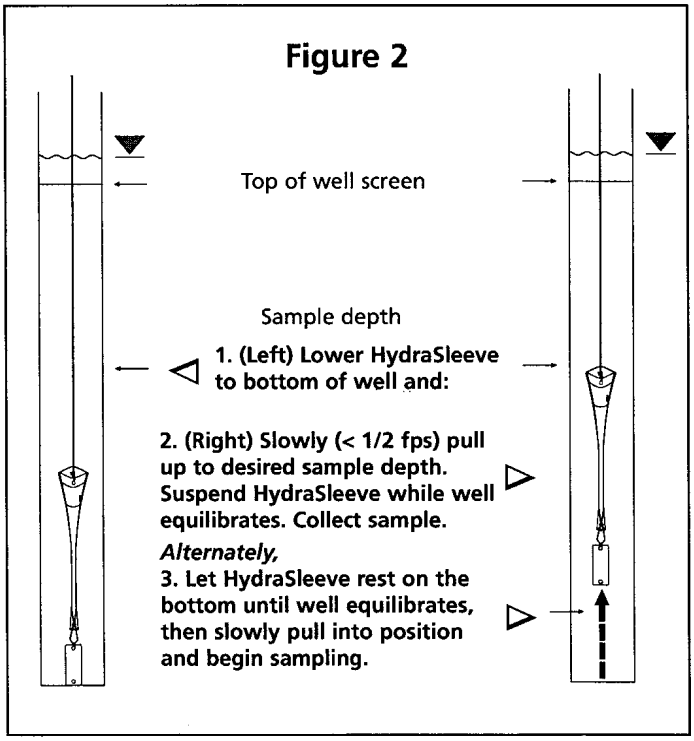
Figure 1



BOTTOM DEPLOYMENT (Figure 2)
Sound the well to determine the exact depth. Lower the weighted HydraSleeve into the well and let it touch the bottom. Very slowly (less than 1/2 foot per second) raise the sampler to the point where the check valve is at the depth the sample is to be collected. Attach the suspension line to the top of the well to suspend it at this depth. (It is often easier to measure a few feet from the bottom of the well up to the sample point, than it is to measure many feet from the top of the well down.)

Alternately, the sampler can be left on the bottom until the well re-equilibrates. For sampling, it can be very slowly pulled (< 1/2 fps) to sampling depth, then activated (see "Sample Collection," p. 6) to collect the sample, and retrieved to the surface.

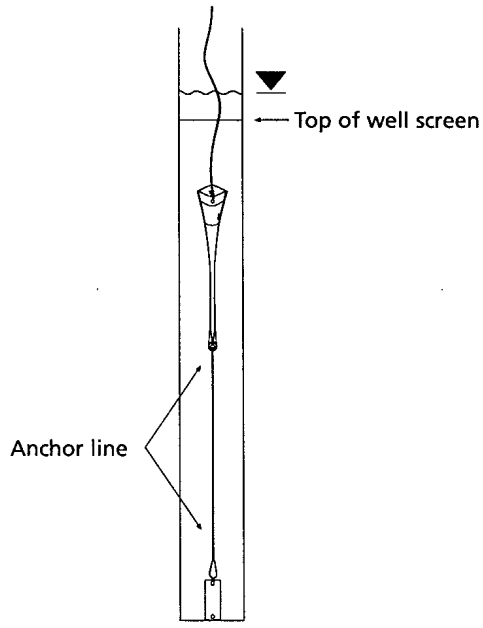
Figure 2



BOTTOM ANCHOR (Figure 3)

Determine the exact depth of the well. Calculate the distance from the bottom of the well to the desired sampling depth. Attach an appropriate length anchor line between the weight and the bottom of the sampler and lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth.

Figure 3



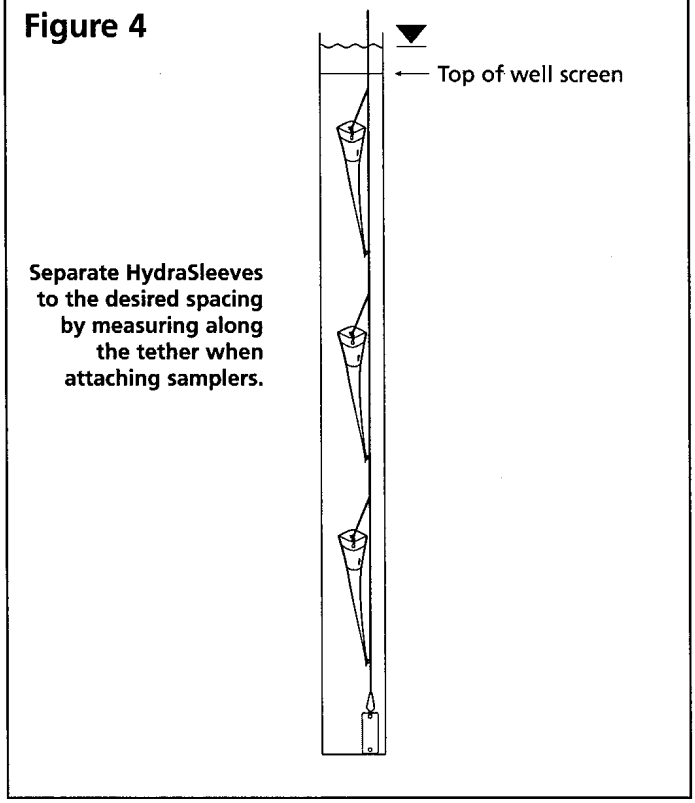
Multiple Interval Deployment

There are two basic methods for placing multiple HydraSleeves in a well to collect samples from different levels simultaneously.

ATTACHED TO A SINGLE TETHER (Figure 4)

To use 3 or more samplers simultaneously, we recommend attaching them all to a tether for support to prevent the sampling string from pulling apart. The weight is attached to a single length of suspension line and allowed to rest on the bottom of the well. The top and bottom of each HydraSleeve are attached to the tether at the desired sample intervals. Cable tie or stainless steel clips (supplied) work well for attaching the HydraSleeves to the line. Simply push one end of the clip between strands of the rope at the desired point before attaching the clip to the HydraSleeve.

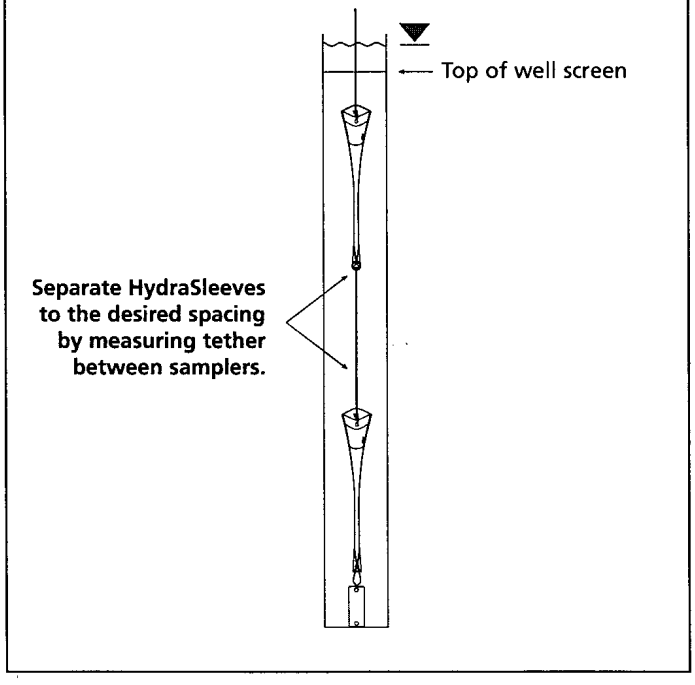
Figure 4



ATTACHED END TO END (Figure 5)

To place 2 or 3 stacked HydraSleeves for vertical profiling, use one of the methods described above to locate the bottom sampler. Attach the bottom of the top sampler to the top of the following HydraSleeve(s) with a carefully measured length of suspension cable. Connect the weight to the bottom sampler. Note: if many HydraSleeves are attached to a tether, more weight may be required than with a single sampler.

Figure 5



Sample Collection

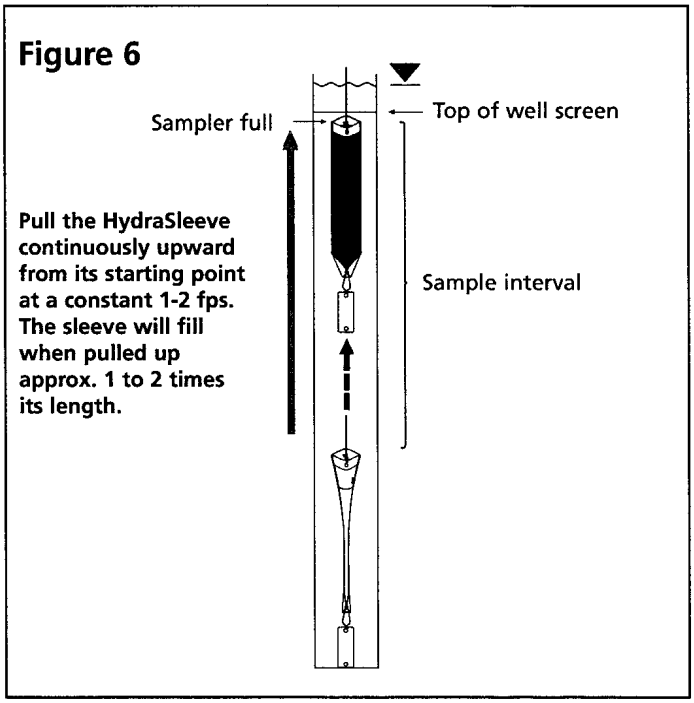
The HydraSleeve must move upward at a rate of one foot per second or faster (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve. The total upward distance the check valve must travel to fill the sample sleeve is about 1 to 2 times the length of the sampler. For example, a 24-inch HydraSleeve needs a total upward movement of 24 to no more than 48 inches to fill. The upward motion can be accomplished using one long continuous pull, several short strokes, or any combination that moves the check valve the required distance in the open position. A special technique is used for sampling low-yield wells.

CONTINUOUS PULL (Figure 6)

Pull the HydraSleeve continuously upward from its starting point at a constant 1 to 2 feet per second until full. This method usually provides the least turbid samples and is analogous to coring the water column from the bottom up.

Note: When using this method, the screen interval should be long enough so the sampler fills before exiting the top of the screen.

Figure 6

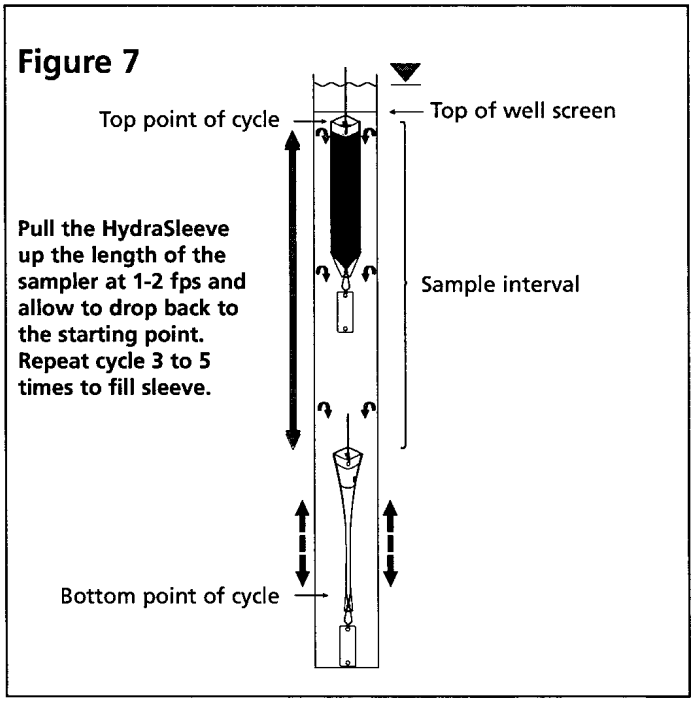


SHORT STROKES (Figure 7)

Pull the sampler upward at about 1 to 2 feet per second for the length of the sampler and let it drop back to the starting point. Repeat the cycle 3 to 5 times.

This method provides a shorter sampling interval than the continuous pull method (above), and usually reduces the turbidity levels of the sample below that of numerous rapid, short cycles (below). The sample comes from between the top of the cycle and the bottom of the sampler at its lowest point.

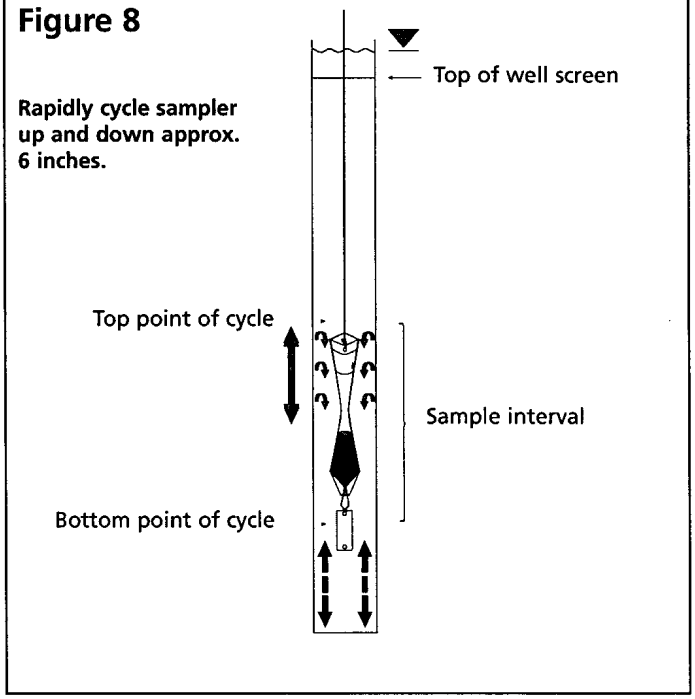
Figure 7



RAPID, SHORT CYCLES (Figure 8)

Cycle the HydraSleeve up and down using rapid, short strokes (6-inch cycle at a minimum of 1 cycle per second) 5 to 8 times. This method provides the shortest sampling interval. Dye studies have shown that when using this method the sample flows into the check valve from along the length of the sampler and immediately above the check valve. The sample interval is from the bottom the sampler at its lowest point in the cycle to the top of the check valve at the peak of the cycle.

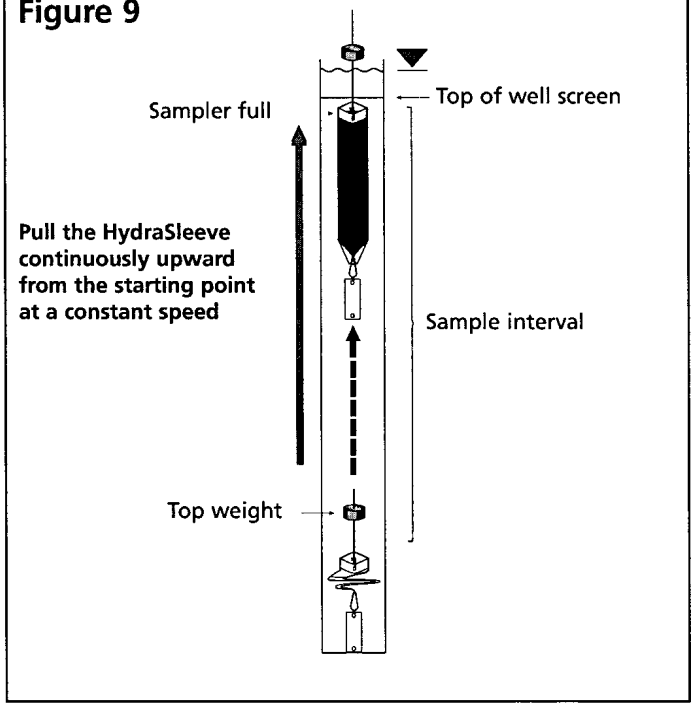
Figure 8



SAMPLING LOW-YIELD WELLS (Figure 9)

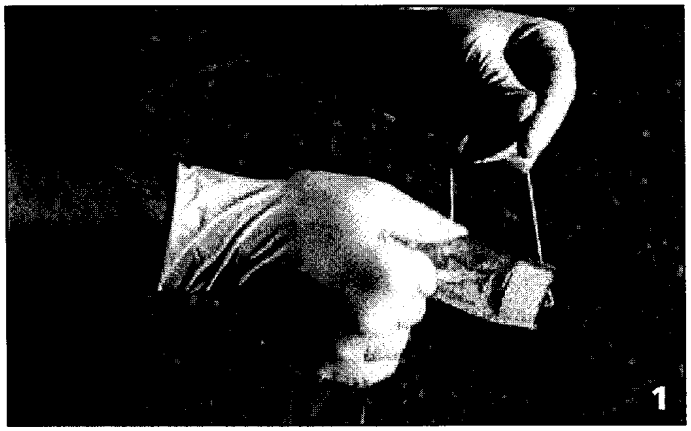
HydraSleeve provides the best available technology for sampling low yield wells. When pulled upward after the well re-equilibrates, the HydraSleeve will collect a water core from the top of the sampler to about its own length above that point. The sample is collected with no drawdown in the well and minimal sample agitation. An optional top weight can be attached to compress the sampler in the bottom of the well if needed for an extremely short water column. With a top weight, the check valve is pushed down to within a foot of the bottom of the well.

Figure 9



Sample Discharge

The best way to remove a sample from the HydraSleeve with the least amount of aeration and agitation is with the short plastic discharge tube (included).



First, squeeze the full sampler just below the top to expel water resting above the flexible check valve. (Photo 1, top left)



Then, push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips. (Photo 2, middle left)



Discharge the sample into the desired container. (Photo 3, bottom left)

Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste. With a little practice, and using a flat surface to set the sample containers on, HydraSleeve sampling becomes a one-person operation.

GeoInsight

1680 Hickory Loop, Suite B • Las Cruces, NM 88005
Phone: 1.800.996.2225 • 1.505.523.5799 • Fax: 1.505.523.0789
www.geoinsightonline.com • KentCordry@aol.com

MACTEC SOP #4 – Supply Well Sampling Protocol

A4.0 SUPPLY WELL AND MINI-STORAGE WELL SAMPLING PROTOCOL

Sample Collection:

Samples are collected from three former Fort Ord supply wells (Well 29(A), 30(B), and 31(C)) operated by the Marina Coast Water District (MCWD), and one private off post well (Mini-Storage). Samples from these wells are analyzed for Chloride by EPA Test Method 300.0, Total Dissolved Solids (TSD) by Standard Method 2540C, and VOCs by EPA Test Method 524.2 on a quarterly basis. Samples are collected in a 500 ml un-preserved poly bottle for both Chloride and TDS analysis, and three 40 ml VOA vials pre-preserved with HCL are collected for EPA 524.2 analysis. The water from these wells is collected prior to treatment or chlorination; therefore, the addition of sodium thiosulfate as a preservative is not needed.

Sampling Techniques:

Upon arriving at the supply well, the MCWD field technician will inform the sampler if the well is on (pumping) or off. If the pump is off, the sampler should remain outside the building until the MCWD field technician has started the pump due to the noise associated with the pump's initial start-up. Once the pump is running, the sampler must open the sampling port, a small Teflon® PTFE or copper tube coming from the main water flow pipe. The MCWD filed technician can help locate the sampling port if the sampler is unable to identify it. Let the spigot run approximately 1 minute at high flow to flush the sampling port tube. A drain located in the floor near the spigot collects the discharge water. Adjust the flow rate downward until you are able to fill the 40 ml VOA vials with no splashing or bubbling, letting the water flow down the side of the container. Do not overfill or rinse the container or the preservative will be lost. It is advisable to first fill the 500 ml bottle so the flow rate can be adjusted adequately prior to filling the 40 ml VOA vials. The 40 ml VOA vials should be completely filled to the point where the water's meniscus forms a convex shape above the lip of the container. Replace the container's cap and secure snugly making sure not to over tighten, and check for headspace or bubbles. VOA vials are zero headspace and therefore if a bubble appears inside the bottle after capping, a new sample must be collected. The sample bottles are to be labeled, stored in a Ziploc bag, and placed on ice in a sample cooler immediately. The chain of custody and daily field logbook shall be filled out completely prior to moving on to the next well.

The Mini-Storage well is located in the Marina Mini-Storage yard on the north side of Reservation Road in Marina. The pump head is located just north of the parking area in the main lot. Two spigots are on

top of the pump head just outside a small garden box container. A hose may be attached to one or both spigots. The spigot where the sample will be collected should be turned on and the water allowed to flow for at least a minute. A pressure gauge is located on the pipe and will indicate when the pump has been activated. After the pump has turned on, allow the water to run for another 1 to 1.5 minutes. Remove any hoses attached to the spigot, adjust the flow as low as reasonable, and collect the sample in the same fashion as described for the Supply Wells. When finished replace any hoses that have been removed from the spigots. The sample bottles are to be labeled, stored in a Ziploc bag, and placed on ice in a sample cooler immediately. The chain of custody and daily field logbook shall be filled out completely prior to moving on to the next well.

Ahtna Field Sampling Protocols, copied with permission from their Final Sampling and Analysis Plan, Operable Unit 2 and Sites 2 and 12 (Sites 2/12), Groundwater Treatment Systems, Former Fort Ord, California, August 2009

TABLE OF CONTENTS

B1.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS 1
B1.1 Sample Types 1
B1.1.1 Quality Control (QC) Samples 1
B1.1.2 Trip Blanks 1
B1.1.3 Field Duplicate Samples 1
B1.1.4 Performance Evaluation (PE) Samples 1
B1.1.5 QA Samples 1
B1.1.6 Field Water Blanks 2
B1.2 Field Documentation 2
B1.2.1 Field Logbooks 2
B1.2.2 Sample Identification and Labels 3
B1.2.3 Chain of Custody Record 5
B1.2.4 Groundwater Sampling Form 5
B1.2.5 Transfer and Review of Field Documentation 5
B1.3 Groundwater Sampling 6
B1.3.1 Sampling Preparation 6
B1.3.2 Sampling Procedures 7
B1.3.3 Water-Level Measurement 7
B1.3.4 Sampling Equipment Calibration Procedures 8
B1.3.5 Decontamination Procedures 9
B1.4 Sample Handling Procedures 9
B1.4.1 Field Sample Custody 9
B1.4.2 Sample Containers and Preservation 10
B1.4.3 Sample Transfer and Shipment 10
B1.4.4 Laboratory Custody 11

B1.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

B1.1 Sample Types

Project samples may be either extraction well groundwater samples, GWTP process water samples, or quality control samples. Standard operating procedures for the collection of these water samples are described in this Appendix.

B1.1.1 Quality Control (QC) Samples

Field QC samples will be generated to evaluate the precision, accuracy, and integrity of field sampling and laboratory analytical procedures. Quality control samples are introduced into the sample analysis stream along with environmental samples. The frequency of field QC sample generation is based on project DQOs, as well as the total number of samples submitted and the nature and intensity of the investigative process that is being monitored or evaluated. The following QC samples will be employed during the field program.

B1.1.2 Trip Blanks

Trip blanks are prepared by the laboratory using contaminant-free water (e.g., nitrogen purged deionized water) which is poured into VOA vials and shipped to AES by the laboratory along with the precleaned, acid-preserved (HCl), sample containers for collecting water samples for VOC analysis. Trip blanks will accompany sample containers into the field and will be shipped back to the laboratory with every cooler that contains samples for VOC analyses. Trip blanks will be analyzed for all VOC analytes specified for environmental samples in the corresponding cooler.

B1.1.3 Field Duplicate Samples

Duplicate samples are submitted to the contract laboratory for the purpose of assessing the effect of the sample matrix on analytical measurement precision.

The laboratory will not be informed as to the identity of duplicate samples and no special sample handling protocol will be employed during collection, shipment, or analysis of these samples. These "blind" duplicate samples will be submitted and analyzed on a frequency of one in ten of the total environmental sampling effort for each matrix sampled. Areas of known contamination or critical sampling points may be preferentially selected for submittal as blind duplicates. Duplicate samples will be analyzed for the same parameters as the corresponding primary sample.

B1.1.4 Performance Evaluation (PE) Samples

At the request of the USACE Project Chemist, PE samples are integrated into the stream of samples in quarterly batches, usually during the quarterly groundwater sample collection events. In accordance with standard operating procedures, these PE samples are submitted to the off-site analytical support laboratory "blind" samples. After the final laboratory results are reviewed by the AES Project Chemist, results are reported directly to the USACE. The "true" or expected values for the concentrations of target contaminants in the PE samples were are not provided to AES until the results have been reported.

B1.1.5 QA Samples

QA samples are duplicates that are submitted to both the primary laboratory and the QA laboratory (as specified by the USACE) to assess intra-laboratory precision. A request form and appropriate documentation will be provided to the QA chemist at least 2 weeks prior to field work, if these samples are to be generated. A signed copy of the QA sample Chain of Custody Form should be transmitted to the USACE Project Chemist via facsimile within 24 hours of sample shipment.

B1.1.6 Field Water Blanks

Field water blanks are samples of the source water used for the final step of equipment decontamination (rinsing) and are collected to check that decontamination water does not contain analytes of concern. Field water blanks will be collected for each discrete lot of water used for the final equipment rinse when reusable groundwater sampling equipment is used. Alternatively, if groundwater sampling equipment is not reusable (i.e., dedicated bailers are used) field water blanks shall of analyte-free water poured into sample containers at the site where water samples are being collected.

B1.2 Field Documentation

Field activities and sample collection will be documented using the following forms as appropriate: sample label, chain of custody form, groundwater sampling form, field log of boring, well completion details, well development form, test pit log, biological inspection form, borehole clearance record, cooler receipt form, waste management label, and hazardous waste label. The purpose of standardized field documentation and sampling procedures is to maintain integrity of field documentation and field samples throughout the RI/FS or remediation process. Each field sample will be labeled and sealed immediately after collection. Sample identification documents will be carefully prepared to maintain control of sample disposition. Field sample custody procedures are described in Section B1.4.1. Standard procedures for documentation of field activities are presented below.

B1.2.1 Field Logbooks

Field procedures relevant to sample collection and field activities will be recorded daily in permanently bound notebooks. Each individual in the field will maintain a bound field logbook with serially numbered pages. The logbook is signed and dated prior to daily initiation of field work. If logbook duties are transferred, the individuals relinquishing and receiving will both sign and date the logbook and record the transfer time. Logbook corrections are made by a single line strikeout of the incorrect entry and entering the correct information that is initialed by the person making the entry. If the correction is made at a later time or date, the correction date is also entered. Unused partial or whole logbook pages are crossed out and unused pages signed and dated at the end of each workday. All entries must be legible, in ink, and primarily factual in content. Hypothetical information can be entered but should be noted accordingly. Logbook entries may include the following information as necessary:

- Project name and number;
- Site name and location;
- Arrival and departure date/time;
- Name and affiliation of personnel onsite, and personnel contacted;
- Author name and date;
- Field instrument calibration methods, and identification number;
- Chronology and location of activities;
- Sampling locations;
- Sample identification numbers, amount collected, sampling method and container (size/type) for each sample collected, including QC samples. Sample processing techniques such as filtration, compositing, and preservation techniques should be noted. Alternatively, this information may be contained on the COC form, groundwater sampling form, or other field form. The logbook will then contain a unique identifier linking the field log book entry to the field form;
- Date and time of sample collection, name of sampler;
- Field observations and applicable comments;

- Number of shipping coolers packaged and sent;
- Name and address of all receiving laboratories;
- Any modifications or deviations from work plan.

Field logbooks are a USACE deliverable to be submitted on request by the USACE following completion of fieldwork. Written reports of all significant non-routine events for field and laboratory work will be sent to the USACE Contracting Officer within 48 hours of occurrence. These reports will identify the problem, corrective action, and verbal written instructions from the USACE PM to ~~Harding~~ AES regarding corrective action. Significant non-routine events are occurrences that impact cost of work, work schedule, work quality, and analytical data quality.

B1.2.2 Sample Identification and Labels

Sample identification system and sample labeling procedures are described in this section.

B1.2.2.1 Sample Identification

Two sample identifiers, the sample number and the station number, will be used to designate samples and sampling locations. Sample numbers will be used for coding, tracking, and reporting chemical data. Station numbers will encode sample type, site identification, and boring number or monitoring well sequence. Conventions for generating sample and station numbers are presented below.

The sample number is a coded identification designed to satisfy project and database criteria. Each sample number:

- Will contain up to 12 characters;
- Will be unique;
- Will be traceable to a specific sampling event;
- Will be traceable to a specific sampler;
- Will incorporate a specific site designation;
- Will not obviously indicate to the laboratory the sample depth, station number, or type of sample (i.e., field sample, field blank, trip blank).

All chemical data produced by the contract laboratory will be reported using the sample number. Samples will be numbered as follows (no spaces in actual sample numbers):

YR WK X SSS 000 Z

Where:

YR = calendar year;

WK = week of the year;

X = one-letter ID code assigned to each field sampler;

SSS = three-character site identification code: "OU2" or "212"

000 = three-digit sequence number for each sample;

Z = assigned QC sample code.

Assigned sample QC codes are as follows:

- A - trip blank
- B - equipment rinsate blank
- C - field water blank
- D - field duplicate
- E - QA split for USACE laboratory
- F - standard field sample.

For example, Sample 8604AXXX015C represents the fifteenth sample collected by sampler "A" and is a field blank (QC code C) collected at Site XXX during Week 4 of 1986. Each sample collector will start with sequence number 001 and continue consecutively through 888. Field personnel are responsible for keeping track of their own sequence in the field logbook. Field audits will include checks of this sample numbering system to ensure that correct procedures are being followed.

Week numbers are assigned to week-long periods ending on Friday. For example, Week 4 of 1986 is the week ending January 26. Week numbers below 9 must contain a zero (i.e., 01 through 08). For aqueous samples, multiple sample containers for each discrete sample may be required to fulfill analytical requirements. In these instances, the same sample number will be used on all sample containers, including additional containers for laboratory MS/MSD samples.

The station description is a sequence of characters designed to identify site-specific samples. Station descriptions will not be included on the laboratory copy of the chain of custody form. The station description field on the chain of custody form will be used to record the site, sample type, sequence number, and other relevant sample characteristics.

The convention for station description naming is as follows:

ST SSS 000 XXXXX

Where:

ST = sample type;

SSS = three-character site identification code; (same as for sample numbering scheme)

000 = station number sequence;

XXXXX = sample depth.

Station description names will not include spaces. Example sample type codes are as follows:

- MW - monitoring well
- SG - soil gas
- SL - sludge
- PZ - piezometer
- TS - treatment system
- WW - wastewater.

B1.2.2.2 Sample Label

All samples will be properly labeled to prevent misidentification of samples. Preprinted sample labels will be provided. The label will be affixed to the sample container prior to transportation to the laboratory and will contain the following information:

- Project name, number, and location
- Site name
- Name of collector
- Date and time of collection
- Sample identification number
- Preservative, if any
- Requested test methods or analyses.

B1.2.3 Chain of Custody Record

A chain of custody (COC) record will be filled out for and will accompany every sample to the analytical laboratory for documentation of sample possession from the time of collection to sample receipt. A carbonless copy of the chain of custody form will be retained in the investigation files according to project number. Copies of the chain of custody form will be provided by facsimile to the USACE Task Manager whenever samples are shipped from the field site to the analytical laboratory. The primary laboratory will send copies of the cooler receipt forms and associated chain of custody forms to the project chemist within 24 hours of sample receipt. The forms will contain the following information:

- Sample number or identification;
- Name and signature of collector, sampler, or recorder;
- Name, number, and location of project;
- Project manager's name;
- Date of collection;
- Place of collection (station description);
- Sample type;
- Analyses requested;
- Dates and times of possession changes;
- Signature of persons relinquishing and receiving sample;
- Laboratory sample number, where applicable;
- Date and time of laboratory sample receipt.

B1.2.4 Groundwater Sampling Form

Groundwater sampling forms are used to document groundwater physical data when conducting sampling activities. Information documented includes well purge volume calculations, pH, conductivity, temperature, turbidity, and other related data.

B1.2.5 Transfer and Review of Field Documentation

During site-specific field operations, copies of each field logbook page will be telefaxed or hand delivered to the Task Manager on a daily basis. In the absence of a facsimile, field staff will be in contact with the Task Manager, via mobile telephones.

At the end of each week of field operations, all field documentation will be copied, and originals sent to the Task Manager or Project Manager for review and verification. Original field documents will be kept in the project files.

Verification and review of field documentation will include at a minimum, the following checks:

- Consistency of dates and times of activities; among the various field records and forms;
- Consistency of sample location and identification documentation among the various field records and forms;
- Consistency, accuracy and correctness of boring log information;
- Accuracy and correctness of well completion details;
- Evaluation of field parameter results and well development details;
- Correctness of sample preservation techniques.

Errors or inconsistencies identified during the review process will trigger a nonconformance investigation to be conducted by the Project Chemist or Quality Control System Manager (QCSM). Appropriate corrective action will be implemented and documented if systemic errors are identified.

B1.3 Groundwater Sampling

This section describes groundwater sampling procedures to be followed prior to, during, and after groundwater sample collection from monitoring wells. Procedures for collecting grab groundwater samples are described at the end of this section.

B1.3.1 Sampling Preparation

Prior to sampling, the wellhead will be examined for signs of tampering or deterioration and observations noted. After a wellhead is opened, the AHA may call for the air in the wellhead vicinity to be tested for organic vapors with the PID or FID and/or for explosive atmospheres with an oxygen/combustible gas indicator. Results will be recorded in the field notebook. (Note: wellhead air testing is not required for routine groundwater sampling as long as previous results indicate that organic vapors or explosive atmosphere are not present.) For wellheads not inside vaults, a plastic sheet will be placed around the wellhead beneath all sampling equipment to prevent possible surface soil contamination. All measuring and sampling equipment will be decontaminated prior to use in any well (see Section B1.3.5).

Prior to sampling, wells will be checked for free product if past sampling events indicate free product is possible, the water level of the well will be measured, and the minimum purge volume of each well will be calculated using the purge volume calculation portion of the groundwater sampling form. A minimum of three well volumes will be purged prior to sample collection. A maximum of five well volumes may be purged. A submersible, centrifugal, or peristaltic pump, or a Teflon, stainless steel, or PVC bailer will be used to purge the well. Pumped purge volumes will be estimated using a flow meter or a stopwatch and a container of an appropriate volume to estimate flow rate, from which a time to purge the required volume will be calculated. Purge water will be placed in a calibrated container to estimate purge volumes when a bailer is used to purge the well.

If purging is accomplished using a submersible pump, the pump will be set just below the water level so that all standing water is removed from the well. Placement of the pump for purging should take into consideration the anticipated depth to which water will be drawn down during pumping. The volume of water purged and the withdrawal rates will be recorded. Purge rates will be sustainable and executed at a rate that minimizes drawdown to prevent water from cascading into the well.

Indicator parameters (temperature, electrical conductivity, dissolved oxygen, and pH) will be monitored during purging to verify complete purging of standing water in the well casing. Stabilization of these parameters will consist of three consecutive measurements with pH within ±0.1 unit, temperature within ±1.0 degree Centigrade, and conductivity readings within ±10 percent. At least six measurements will be obtained (1 measurement per $^1/_2$ well volume) to document purging parameters. If the well does not stabilize after purging a minimum of five well volumes, sampling will commence. The appearance of the discharge water and the turbidity will also be monitored and recorded on the groundwater sampling form. Instruments and calibration procedures are described in Section B1.3.4.

The calibration of each instrument will be checked after all measurements for all samples have been completed.

If a well is purged dry before three casing volumes have been removed, VOC samples will be collected immediately. Other samples will be taken after the well has recovered to within 80 percent of the static water level prior to purging, or after 4 hours, or when sufficient water volume is available to meet analytical requirements, whichever occurs first. For wells with a potential for being dewatered, the purge rate will not exceed 2 gallons per minute to avoid dewatering wells.

Pre-cleaned sample containers will be provided by the laboratory. The containers for each sample will be labeled in advance of the sampling event with the date, sample number, project name, sampler's name or initials, parameters for analysis (method numbers where possible), and preservation.

B1.3.2 Sampling Procedures

All water samples will be collected within the screened interval in each well so that the sample is representative of formation water. Samples will be collected using a stainless steel or Teflon bailer. The bailer will be carefully lowered beneath the top of the screened interval after well purging. A water sample will then be collected and carefully transferred to appropriate sample containers.

Water samples for VOC analysis will be taken with a valved-bottom emptying device so that no air passes through the sample (to prevent volatiles from being stripped from the samples). The VOA vials will be filled by inserting the spout from the bailer to the bottom of the VOA vial and keeping the spout beneath the surface of the liquid as it fills the vial until there is a convex meniscus over the neck of the bottle. The Teflon side of the septum (in the cap) will be positioned against the meniscus, and the cap screwed on tightly; the sample will be inverted, and the vial tapped lightly. The absence of an air bubble indicates a successful seal; if a bubble is evident, the sample will be discarded and the process repeated.

All sample bottles and equipment will be kept away from fuels and solvents. Gasoline (used in generators) will be transported in a different vehicle from the vehicle containing bailers, sample bottles, purging pumps, etc. If possible, one person should be designated to handle samples and another person should operate the generators and refuel equipment, if required. Disposable gloves will be worn for each separate activity and then properly disposed. Care will be taken to avoid fuel spillage.

Both filtered and unfiltered groundwater samples may be collected. For samples to be analyzed for dissolved metals, filtration will occur in the field soon after collection using a 0.45-micron membrane filter. Filtration will not be performed on samples slated for organics analysis or inorganic analyses other than metals.

Although in situ water may be anoxic, filtration prior to acid preservation is not expected to significantly change the oxidation state of dissolved metals because the filtration time (minutes) is far shorter than the time required to change oxidation state (hours). The test methods for metals analysis are not specific to oxidation state; a reduced or oxidized metal is equally quantifiable.

All samples will be packaged and transported appropriately, as described in Section B1.4.3

B1.3.3 Water-Level Measurement

The methods presented below are intended to produce water-level measurements that are consistent over multiple measurement events. Calibration and precision requirements for water-level measurements are summarized in Section B1.3.4.

Groundwater levels may be measured using an electrical sounder, a steel tape, or a pressure transducer. All water-level measurements will be taken from an obvious survey mark at the top edge of the well casing. Water levels will be measured using the following procedures.

Electrical Sounder

The standard equipment for making individual water-level measurements will be a battery-powered

sounder. The sounder must have firmly affixed or permanent marks on the sounder line at regular intervals (minimum interval of 0.01 foot). If free-phase hydrocarbon is present, measurement of hydrocarbon thickness and water level will be made using an electronic interface probe, if necessary.

Calibration checks on the electrical sounder will be made periodically. The sounder markings will first be checked for the proper spacing by physically comparing the spacing with a graduated steel tape. Accuracy rechecks will be made after any incident that might alter the measuring capability of the instrument, such as cable stretching, entanglement, or sensor tip replacement.

Portions of the cable that are inserted in wells will be decontaminated after use according to the procedure described in Section B 1.3.5. Sounders will be maintained in a clean and functional condition.

Steel Tape

A graduated steel tape (with 0.01-foot graduations) can be used for water-level measurements in conjunction with other methods, and when required, for a quality control check of other methods. The steel tape will be periodically checked for kinks, and if kinked tapes are found, the tape will be labeled as unusable and taken out of service.

If organic films exist above the water phase, a separate measurement with water-finding paste, a clear acrylic bailer, and/or an oil-water electronic interface probe will be made to determine both depth to oil and depth to water. Portions of the tape that are inserted in wells will be cleaned after use according to the procedure described in Section B1.3.5. Tapes will be maintained in a clean and functional condition.

B1.3.4 Sampling Equipment Calibration Procedures

This section describes procedures for field calibration of equipment and instrumentation. Included is a description of the procedure or a reference to an applicable standard operating procedure, the calibration frequency, and the calibration standards used. All instruments and manufacturers' instructions and specifications are maintained in the project files. All instruments are calibrated prior to being sent to the field. Field calibration procedures will be documented in the Field Logbook.

Water-Level Measurement Instruments

Electrical sounder: Checked against steel surveyor's tape prior to initial use. Battery and sensitivity checked daily.

Graduated steel tape: Referred to new steel tape; manufacturer-supplied temperature correction is applied if appropriate for field conditions.

Pressure transducer: Factory calibrated once, in-house calibration checked with water columns prior to aquifer tests, and weekly field checks made against steel tape or electrical sounder.

Hydrocarbon interface probe calibration: Checked against steel surveyor's tape prior to initial use. Battery and detection of interface checked daily.

pH Meters

pH meter: Calibrated using factory- or laboratory-supplied buffer solutions (traceable to National Bureau of Standards buffers) of pH 4, 7.0, and 10.0. Used buffer solution is discarded and new solution is used for each calibration. Only two of these buffers are used, bracketing the pH of the solution to be measured. Temperature correction applied during measurement following manufactures procedures, if appropriate.

Electrical Conductivity Meters

Calibration checked using laboratory-supplied standard (e.g., 1,000 µS/cm) daily or prior to each use. Temperature correction applied during measurement, if appropriate.

Turbidity Meters

Calibration checked using 3 structure concentrations of 0-9 NTO, 9-90 NTU, and 90-900 NTU. Calibration standard results must be within 9 percent of midpoint concentration. If not, recalibrate according to users manual.

Water Temperature Measurement Instruments

Mercury thermometer (NBS traceable): Factory-calibrated once and checked by NBS or other qualified organization at least annually.

Temperature meter and thermocouple or thermistor: Checked at the beginning of each groundwater monitoring event against NBS mercury thermometer.

B1.3.5 Decontamination Procedures

All reusable equipment that may come in contact with potentially contaminated soil, sediment, or water will be decontaminated prior to use to reduce the potential for cross-contamination during field activities. Decontamination will consist of steam cleaning (high pressure, hot water washing); nonphosphate detergent wash; solvent rinse; distilled, deionized (DI), or clean water rinse; pesticide-grade methanol rinse; and final rinse with DI water, as appropriate.

The procedures for decontaminating sampling equipment are described below:

- Steam clean the exterior surfaces and accessible interior portions of submersible, centrifugal, and positive-displacement pumps prior to each use;
- Steam clean bailers and wash in nonphosphate detergent solution DI water rinse, spray bottle rinse with pesticide-grade methanol and final rinse with DI water prior to each use;
- Wash steel tapes, well sounders, transducers, and water quality probes in a non-phosphate detergent solution, and rinse in distilled or DI water, or wipe clean after each use, depending upon site conditions. Clean the portion of these devices inserted into wells with a mild non-phosphate detergent solution.

B1.4 Sample Handling Procedures

Appropriate sample handling techniques are necessary to protect the samples and maintain sample custody protocol requirements following collection. Sample handling includes custody, container/preservative type, transfer, storage, and disposal.

B1.4.1 Field Sample Custody

Standardized sample custody procedures will be followed through sample collection, transfer, storage, analysis, and ultimate disposal. Sample custody begins with shipment of the empty sample container set to the office or site. All sample containers are shipped from the laboratory in sealed containers or cartons with appropriate seals and custody information. Sample quantities, types, and locations will be specified before the actual field work commences.

A sample is considered under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession;
- The sample is in the sampler's view;
- The sample is in a designated secure area after being in the sampler's possession.

B1.4.2 Sample Containers and Preservation

Samples should be collected and containerized in order of the analyte volatilization sensitivity. A preferred collection order is listed below.

- Volatile organic compounds;
- Total metals;
- Dissolved metals;
- Sulfate and chloride;
- Nitrate and ammonia;
- Total dissolved and suspended solids.

Methods of sample preservation are intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light.

All sample containers will be properly labeled (see Section B1.2.2) and monitored for temperature control in the field and during laboratory transport and storage. Temperature blanks will be used in all coolers containing samples requiring preservation at reduced temperature (4°C).

B1.4.3 Sample Transfer and Shipment

Samples will always be accompanied by a chain of custody record. When transferring samples, both the individuals relinquishing and receiving the samples will sign, date, and note the transference time on the chain of custody record. Samples will be packaged properly for shipment, including isolation of samples suspected of high chemical concentrations, and dispatched to the appropriate laboratory for analysis. Custody seals will be used when samples are shipped via courier service, and must be placed on the container so that the seals have to be broken before the container can be opened. The seal must be signed and dated by the field personnel. Custody seals are not deemed necessary when the samples will be in the continuous possession of project, field, or laboratory personnel. The chain of custody record(s) will accompany each sample shipment. Samples will be packaged for shipment as follows:

- Print the following information clearly in waterproof ink on the label; the test methods requested, the preservative(s) used (if any), the sample number, the project number, the initials of the sample collector, and the date and time the sample was collected.
- Fill out field sample log and chain of custody record as described in Sections B 1.2.1 and B1.2.3, respectively.
- Place each sample bottle or set of VOA vials in a separate plastic bag and seal the bag. Squeeze air from the bag before sealing.
- If using a plastic cooler as a shipping container, tape shut the drain plug from the inside and outside, and line the cooler with a large plastic bag. If sample containers are glass, place approximately 3 inches of inert packing material, such as asbestos-free vermiculite, perlite, or Styrofoam beads in the bottom of the container. Other commercial shipping containers (cardboard or fiber boxes complete with separators and preservatives) may be used but should be preapproved by the USACE. Each cooler must weigh less than 70 pounds, including ice.
- Place the bottles upright in the lined plastic cooler and position to avoid contact during shipment. Cardboard separators may be placed between the bottles at the discretion of the shipper.
- Transport all samples to the laboratory on ice chilled to 4°C ± 2°C, except for the following types of samples, which do not require shipment with ice:

- Low- and medium-concentration water and liquid matrix samples for metals analyses;
- Medium-concentration soil and sediment matrix samples for base, neutral, acids (BIN/A), polychlorinated biphenyls (PCBs), and pesticide analyses.

- Place additional inert packing material in the cooler to partially cover the sample bottles (more than halfway). If samples are required to be shipped to the laboratory with ice, place ice in double bags around, among, and on top of the sample bottles, fill the cooler with inert packing material, and tape the liner shut.
- Place paperwork going to the lab inside a plastic bag. Seal the bag and tape to the inside of the cooler lid. Include the original of the COC form in the paperwork sent to the laboratory. The last block on the COC form should indicate the over-night carrier and air bill number, if applicable. Fill out the air bill before the samples are handed over to the carrier. Notify the laboratory if the shipper suspects that the sample contains any other substance that would require laboratory personnel to take additional safety precautions.
- Close the cooler and tape it securely shut.
- Place at least two signed custody seals on the cooler, one on the front and one on the side. Additional seals may be used if the sampler or shipper deems necessary. Affix "fragile" and "this end up" labels on coolers, as appropriate.
- Samples may be hand delivered to the laboratory, transported by commercial or laboratory couriers, or shipped to the laboratory using an overnight shipper.

B1.4.4 Laboratory Custody

A designated laboratory sample custodian will accept custody of the samples and verify that the information on the sample label matches that on the chain of custody form(s). Pertinent information as to sample condition, shipment, pickup, and courier will also be checked on the chain of custody form(s). In addition, a Cooler Receipt Form (e.g., cooler receipt form) will also be completed by the custodian and copies will be sent to the project chemist within 24 hours of sample receipt. On receiving samples at the laboratory, the temperature inside the cooler and of the temperature blank will he measured immediately after opening the cooler and the results recorded on the cooler receipt form. Information on the date and time of receipt, method of shipment, and sample condition also will be recorded on this form. The custodian will then enter the appropriate data into the laboratory sample tracking system. The laboratory custodian will use the sample number on the sample label as well as assign a unique laboratory number to each sample. The custodian will then transfer the sample(s) to the proper analyst(s) or store the sample(s) in the appropriate secure area.

Laboratory personnel are responsible for the care and custody of samples from the time they are received through sample disposal. Data sheets and laboratory records will be retained by the laboratory as part of the permanent documentation for a period of at least 3 years.

APPENDIX B

RESUMES

Anthony Blake – *Quality Assurance Manager/Chemist*
28 total years of experience

EDUCATION
MA, Management
Bachelors of Science, Conservation of Natural Resources

BIOSKETCH
Mr. Blake has experience in the environmental services industry, with an emphasis on analytical environmental chemistry and quality assurance/quality control (QA/QC). He has managed, coordinated, and provided technical expertise for numerous projects concerning data quality objectives, analytical method selection, reporting requirements, QA/QC requirements, planning document preparation, field QC, and data validation, and has served as a project manager for a superfund site remedial investigation in a residential neighborhood. **Relevant Training:** Basic Mass Spectral Interpretation; Applied Environmental Geochemistry; and Probability, Statistics, and Geostatistics for Environmental Professionals.

PROJECT EXPERIENCE
Project Chemist: USACE Sacramento District, Groundwater Treatment System Operation and Maintenance, Fort Ord, California. Mr. Blake participated in development of site- and project-specific data quality objectives. Identified and selected appropriate test methods during project scoping and planning. He produced project-specific planning documents, including Quality Assurance Project Plans, Sampling and Analysis Plans, Field Sampling Plans, and Chemical Data Quality Management Plans. Coordinated subcontract laboratory scoping, costing, and subcontracting agreements and acts as primary point of contact with contract laboratory regarding all aspects of laboratory performance. Mr. Blake developed and maintained processes for collection, entry, retrieval, presentation, and archival of project data. Reviewed project data to assess overall quality, precision, accuracy, completeness, comparability, and representativeness of chemical data. He also wrote site-specific data quality assessment reports as part of the report production process. Additionally, Mr. Blake performed field audits of field sampling operations for HTRW projects and QA audits of subcontract laboratories.

Chemist: USACE Sacramento District, Groundwater Treatment System Operation and Maintenance and Long-term Monitoring, Riverbank, California. Mr. Blake performs chemical analyses and data validation. In support of the U.S. Army Environmental Command, Ahtna performs environmental restoration services at Riverbank Army Ammunition Plant (RBAAP), a government-owned, contractor-operated 173-acre facility about 10 miles northeast of Modesto, California, on the northern border of Stanislaus County.

Project Chemist: Iron Mountain Mine Remediation, Redding, California. Mr. Blake served as the Ahtna Chemist on the USEPA Superfund site clean-up of the Spring Creek portion of the Iron Mountain Mine. Mr. Blake was responsible for the installation and operation of an on-site mobile laboratory for performing process chemistry tests related to lime and polymer treatments, and for treatment system optimization activities in support of the remediation of approximately 200,000 cubic yards of sediment contaminated with acid mine drainage.

Project Manager: U.S. Army Corps of Engineers – Montrose Chemical Corporation Superfund Site, Phase II Residential Soils and Produce Investigation, Torrance, California. Mr. Blake was responsible for overall schedule, budget, QC, and client interaction for field program and preparation of the remedial investigation report. He served as task manager responsible for developing sampling and analytical strategy for a removal action and neighborhood sampling program related to DDT contamination. He worked closely with U.S. Environmental Protection Agency (EPA) Region IX to develop data quality objectives, sampling design, and project planning documents to meet project objectives. He was responsible for data validation and data quality assessment and reporting following sampling and analytical tasks.

Database Technician: Site A Environmental Site Assessment and Remediation, Torrance, California. Mr. Blake was responsible for overall schedule, budget, QC, and client interaction for field program and preparation of the remedial investigation report. He served as task manager responsible for developing sampling and analytical strategy for a removal action and neighborhood sampling program related to DDT contamination. He worked closely with U.S. Environmental Protection Agency (EPA) Region IX to develop data quality objectives, sampling design, and project planning documents to meet project objectives. He was responsible for data validation and data quality assessment and reporting following sampling and analytical tasks.

Task Manager: Pacific Gas and Electric: Moss Landing Power Plant, Moss Landing, California. Mr. Blake served as Task Manager for Groundwater Monitoring, Regulatory Response, and Resource Conservation & Recovery Act (RCRA) Facility Investigation and Risk Assessment services for the Moss Landing Power Plan project. In this capacity, he managed project schedules, budgets, and deliverables, and prepared client invoices and cost proposals for change orders.

Holly Dillon. – *Scientist Intern*
7 total years of experience

EDUCATION
Bachelor of Arts, Environmental Science

BIOSKETCH
Mrs. Dillon writes and performs field sampling for quarterly and monthly sampling events, manages and analyzes chemistry data. She is experienced at providing soil vapor extraction system sampling and operations.

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
HAZWOPER 40 Hour
OSHA Construction safety & Health
CPR
First Aid

PROJECT EXPERIENCE

Environmental Scientist: USACE Sacramento District, Groundwater Treatment System Operation and Monitoring, Fort Ord, California. Mrs. Dillon is responsible for extraction well sampling, oversight of treatment plant sampling, writing monthly and annual reports, chemistry data analysis and management, report preparation and management. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Task Manager: USACE Sacramento District, Building 194 Groundwater Monitoring and Reporting, Fort Hunter Liggett, California. Mrs. Dillon is responsible for chemistry data management, quarterly sampling oversight, quarterly and annual report writing, report preparation and management, and monthly evaluation report writing. Ahtna is performing environmental remediation services at Fort Hunter Liggett (FHL) as part of a multi-task Environmental Services IDIQ. The Ahtna management team works closely with USACE, FHL Environmental Office, California Regional Water Quality Control Board (RWQCB), and the Monterey County Department of Environmental Health to facilitate effective communications with the regulatory team and establish remediation strategies and technologies that are acceptable from a cost and regulatory perspective.

Task Manager: USACE Sacramento District, Building 258 Soil Vapor Extraction System Operation and Maintenance, Fort Hunter Liggett, California. Mrs. Dillon is responsible for oversight of installation of SVE system; construction of conveyance piping; sampling, monitoring, and operations of the SVE system; report preparation and management; monthly evaluation and semi-annual report writing; and chemistry data management and analysis. Ahtna's O&M responsibilities include SVE system installation, waste management, monthly inspections, routine housekeeping and repairs, well maintenance, monthly soil vapor sampling, and data validation. SVE system O&M activities and recommendations are presented in monthly evaluation reports. Soil vapor sampling results and analyses are included in semi-annual treatment system monitoring reports. Ahtna ensures compliance with Monterey County permitting requirements for drilling and installation of SVE wells and the Monterey Bay Unified Air Pollution Control District permitting requirements for SVE system emissions.

Environmental Scientist: USACE Sacramento District, Landfill Postclosure Monitoring, Fort Hunter Liggett, California. Mrs. Dillon provides chemistry data management, monthly evaluation report writing, semi-annual sampling oversight, report preparation and management, and semi-annual report writing. The landfill groundwater monitoring network consists of 28 wells and two piezometers and the landfill gas monitoring network consists of seven landfill gas probes and 32 landfill gas vents. The contract includes semiannual groundwater monitoring, landfill gas monitoring, laboratory analysis, data validation, waste management, reporting, well maintenance, and landfill cap inspections. Sampling and reporting is performed in accordance with the Sample and Analysis Plan and quality control procedures outlined in the Chemical Data Quality Management Plan.

Environmental Scientist: USACE Sacramento District, Riverbank Army Ammunition Plant, Riverbank, California. Mrs. Dillon provides chemistry data management and report preparation and management. Ahtna operates and maintains the RBAAP Groundwater Treatment Plant (GWTP), conducts daily, weekly, monthly, and quarterly sampling, and develops and implements alternative treatment technologies. Ahtna has complete responsibility for management of each waste stream generated. This involves the accumulation, treatment, handling and temporary storage, analysis, characterization, transport and disposal of process wastes. Groundwater systems have been optimized for removal of the specific chemicals of concern (chromium and cyanide) identified in the March 1994 Record of Decision. The remedial effort is regulated by the USEPA, California Department of Toxic Substances Control, and California Regional Water Quality Control Board.

Mark W. Fisler. – *Field Supervisor*
10 total years of experience

EDUCATION
Bachelor of Science, Biology

BIOSKETCH
Mr. Fisler performs quality control oversight on sub contractors working at two ground water treatment plants in Marina Ca. (former Ft. Ord Army Facility), one groundwater treatment plant in Riverbank, Ca (former Riverbank Army Ammunition Plant), and a soil vapor extraction unit at Ft. Hunter Liggett, Ca. Mr. Fisler has also been the Senior Plant Operator in Marina, Ca. for ten years and is responsible for the operation and maintenance of two ground water treatment plants remediating organic compounds at approximately one million gallons per day.

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
HAZWOPER 40 Hour and Refresher
Ca. Dept. of Health Services Water Distribution 2 and Water Treatment 2 certifications
USACE Construction Quality Management for Contractors certification
First Aid
CPR
OSHA Construction and Safety Health

PROJECT EXPERIENCE

Senior Plant Operator: USACE Sacramento District - Groundwater Treatment System Operation and Maintenance, Fort Ord, California. Mr. Fisler is responsible for granular activated carbon change-out oversight; extraction well sampling; treatment plant sampling; and all aspects of plant operations. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Field Supervisor: USACE Sacramento District - Groundwater Treatment System Operation and Maintenance, Fort Ord, California. Mr. Fisler is responsible for over sight of all sub-contractor work pertaining to operations and maintenance at both GWTPs on Ft. Ord as well as supervising treatment plant operators in there day to day tasks. This includes, but is not limited to, three phase inspection processes, daily field activity reports, and daily QC reports when sub-contractors are on site, assisting with monthly O&M reports, and assisting the Project Manager with operation and maintenance issues.

Field Supervisor: USACE Sacramento District - Groundwater Treatment System Operation and Maintenance, Riverbank, California. Mr. Fisler is responsible for over sight of all sub-contractor work pertaining to operations and maintenance at the GWTP on the former Riverbank Army Ammunition Plant as well as supervising the treatment plant operator in his day to day tasks. This includes, but is not limited to, three phase inspection processes, daily field activity reports, and daily QC reports when sub-contractors are on site, assisting with monthly O&M reports, and assisting the Project Manager with operation and maintenance issues.

Dylan Harris. – *Environmental Scientist*
3 total years of experience

EDUCATION
Bachelor of Arts, Environmental Science

BIOSKETCH
Mr. Harris writes and performs field investigations for Phase I and Phase II reports, Preliminary Site Assessments, Site Investigations, quarterly sampling, and baseline sampling reports. He is experienced at providing oversight on soil boring, monitoring well installation, asbestos abatement, and soil vapor extraction system installation on hazardous waste sites.

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
HAZWOPER 40 Hour
OSHA Construction safety & Health
CPR
First Aid

PROJECT EXPERIENCE

Environmental Scientist: USACE Sacramento District, Groundwater Treatment System Operation and Monitoring, Fort Ord, California. Mr. Harris is responsible for ggranular activated carbon change-out oversight; extraction well sampling; treatment plant sampling; and minor plant operations. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Task Manager: USACE Sacramento District, Building 194 Groundwater Monitoring and Reporting, Fort Hunter Liggett, California. Mr. Harris is responsible for project oversight. Ahtna is performing environmental remediation services at Fort Hunter Liggett (FHL) as part of a multi-task Environmental Services IDIQ. The Ahtna management team works closely with USACE, FHL Environmental Office, California Regional Water Quality Control Board (RWQCB), and the Monterey County Department of Environmental Health to facilitate effective communications with the regulatory team and establish remediation strategies and technologies that are acceptable from a cost and regulatory perspective.

Task Manager: USACE Sacramento District, Building 258 Soil Vapor Extraction System Operation and Maintenance, Fort Hunter Liggett, California. Mr. Harris is responsible for construction of the SVE conveyance network; sampling of the SVE system; and SVE well drilling oversight. Ahtna's O&M responsibilities include SVE system installation, waste management, weekly inspections, routine housekeeping and repairs, well maintenance, monthly soil vapor sampling, and data validation. SVE system O&M activities and recommendations are presented in monthly evaluation reports. Soil vapor sampling results and analyses are included in semi-annual treatment system monitoring reports. Ahtna ensures compliance with Monterey County permitting requirements for drilling and installation of SVE wells and the Monterey Bay Unified Air Pollution Control District permitting requirements for SVE system emissions.

Environmental Scientist: USACE Sacramento District, Landfill Postclosure Monitoring, Fort Hunter Liggett, California. Mr. Harris provides landfill oversight and is responsible for landfill cap inspection and regulatory point-of-compliance groundwater and landfill gas monitoring. The landfill groundwater monitoring network consists of 28 wells and two piezometers and the landfill gas monitoring network consists of seven landfill gas probes and 32 landfill gas vents. The contract includes semiannual groundwater monitoring, landfill gas monitoring, laboratory analysis, data validation, waste management, reporting, well maintenance, and landfill cap inspections. Sampling and reporting is performed in accordance with the Sample and Analysis Plan and quality control procedures outlined in the Chemical Data Quality Management Plan.

Chuck Holman. – ***Program Manager, Cost Engineering and Low-level Radiation Expert***
32 total years of experience

EDUCATION
Graduate, Structural Design

BIOSKETCH
Mr. Holman has experience in environmental consulting, engineering, and construction, including extensive experience in project management, technical management, quality assurance, quality control, contracting practices, project controls, and personnel management for environmental and radiological programs. His expertise includes the development of planning documents, program management, and field implementation for design control and construction projects.

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
NQA-1 Certified Lead Auditor
HAZWOPER 40 Hour and Refresher
DOT Certification
Construction Quality Management (CQC) for Contractors, US Army Corps of Engineers

PROJECT EXPERIENCE

Program Manager: USACE Sacramento District, Riverbank Army Ammunition Plant Environmental Restoration, Riverbank, California. Mr. Holman has overall responsibility for plant and technical management. As project manager, he determines budgets, assigns personnel, develops contracting relationships with specialized support contractors, and assures that all reports and plans are completed on time and cost effectively. He has established and maintains strong working relationships with regulators. On behalf of the USACE, Sacramento District and the U.S. Army Environmental Command, Ahtna operates and maintains the RBAAP Groundwater Treatment Plant (GWTP), conducts daily, weekly, monthly, and quarterly sampling, and develops and implements alternative treatment technologies. Ahtna has complete responsibility for management of each waste stream generated. This involves the accumulation, treatment, handling and temporary storage, analysis, characterization, transport and disposal of process wastes. The remedial effort is regulated by the USEPA, California Department of Toxic Substances Control, and California Regional Water Quality Control Board.

Program Manager: USACE Sacramento District - Groundwater Treatment System Operation and Maintenance, Former Fort Ord, California. Mr. Holman has the cost, compliance and regulatory management responsibilities associated with the operations of two major ground water treatment facilities and additional remedial or construction activities as required. In this role he has continuously provided highly professional technical, managerial and field services to support the long- and short-term goals established by the Army and USACE. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Program Manager: AMEC Earth & Environmental - Stuart Mesa Agricultural Field Remedial Action, Camp Pendleton, California. Mr. Holman manages Ahtna's subcontract for NAVFAC Southwest, Performance-Based Multiple Award Contract for Environmental Remediation Services at Naval and Marine Corps Installations

in California, Arizona, Nevada, New Mexico, and Utah, for AMEC Earth & Environmental, Inc. Ahtna provides all the labor, materials, and, equipment to excavate and load pesticide contaminated materials from Stuart Mesa Agricultural field. The excavation includes 319,472 bank cubic yards (BCY) of soil. The work is being accomplished in two phases (Phase VIIA and VIIB: 319,472 BCY and Future Phase: 175,036 BCY) to support the U.S. Navy site development schedule. Excavation and loading of 319,472 BCY of soils from the area designated as Phase VIIA and Phase VIIB to the depths and from the grids designated by AMEC provided sampling results.

Program Manager: USACE Sacramento District, Building 194 Groundwater Monitoring and Reporting, Fort Hunter Liggett, California. Mr. Holman manages Ahtna's multi-task IDIQ contract for environmental services at Fort Hunter Liggett (FHL) for USACE, Sacramento District. The Ahtna management team works closely with USACE, FHL Environmental Office, California Regional Water Quality Control Board (RWQCB), and the Monterey County Department of Health (MCDOH) to facilitate effective communications with the regulatory team and establish remediation strategies and technologies that are acceptable from a cost and regulatory perspective. The FHL Building 194 Area well network consists of 15 wells and three piezometers. Ahtna conducts quarterly groundwater sampling and analysis, data validation, waste management, and well maintenance. Ahtna submits three quarterly groundwater monitoring reports that present the current quarter's groundwater elevation and chemistry data, and one annual groundwater monitoring report consisting of elevation and chemistry data for the previous year.

Program Manager: USACE Sacramento District, Building 258 Soil Vapor Extraction System Operation and Maintenance, Fort Hunter Liggett, California. Mr. Holman manages Ahtna's multi-task IDIQ contract for environmental services at FHL for USACE, Sacramento District. The Ahtna management team works closely with USACE, FHL Environmental Office, RWQCB and MCDOH to facilitate effective communications with the regulatory team and establish remediation strategies and technologies that are acceptable from a cost and regulatory perspective. Hydrocarbons in the vadose zone of the Building 258 area at FHL are a continuing source of groundwater contamination. Previous investigations and a soil vapor extraction (SVE) pilot treatability study demonstrated SVE is the most effective form of remediation at this site. Initial contract responsibilities required Ahtna to develop a Remedial Action Work Plan detailing SVE system requirements for installation, start-up, and shakedown. Ahtna is responsible for O&M, including SVE system installation, waste management, weekly inspections, routine housekeeping and repairs, well maintenance, monthly soil vapor sampling and data validation. SVE system O&M activities and recommendations are presented in monthly evaluation reports and soil vapor sampling results and analysis are included in semi-annual treatment system monitoring reports. Ahtna ensures compliance with Monterey County permitting requirements for drilling and installation of SVE wells and the Monterey Bay Unified Air Pollution Control District permitting requirements for SVE system emissions.

Derek Lieberman - ***Project Manager; Environmental, Civil and Geotechnical Engineering***
19 total years of experience

EDUCATION
Master of Art, Science, Technology and Public Policy
Master of Art, Environmental Management
Bachelor of Science, Geological Engineering

BIOSKETCH
Mr. Lieberman has experience in environmental investigation and remediation projects, which include soil and groundwater, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Base Realignment and Closure (BRAC) sites, and geotechnical construction oversight. For more than nine years he has managed the preparation of analytical and descriptive reports and property transfer documentation. Mr. Lieberman has more than a decade of experience in oversight of field offices, remedial facilities, projects, personnel, and equipment, and acting as liaison to clients and regulatory agency representative. For the last three years, the majority of his project experienced has focused on environmental remediation projects in support of USACE Sacramento District.

PROJECT EXPERIENCE
Technical Manager: USACE Sacramento District, Riverbank Army Ammunition Plant Environmental Restoration, Riverbank, California. Mr. Lieberman provides QA/QC and technical and regulatory compliance oversight. This includes O&M of groundwater treatment facilities, a closed landfill, and associated reporting and documentation on behalf of USACE, Sacramento District and U.S. Army Environmental Command. Ahtna Engineering Services has a performance based firm fixed price contract to complete the time-sensitive site closure for the Riverside Army Ammunition Plant. Ahtna is responsible for operating and maintaining the RBAAP groundwater treatment plant (GWTP) and conducting quarterly groundwater monitoring.

Project Manager: USACE Sacramento District, Groundwater Treatment System Operation and Maintenance, Former Fort Ord, California. Mr. Lieberman oversees daily operations of two major ground water treatment facilities and additional remedial or construction activities as required, analyzes treatment system data and operations and new technologies, and makes recommendations to the USACE for optimization of the groundwater water treatment systems by improving overall efficiency and effectiveness. In this role he has continuously provided effective technical, managerial and field services to support the long- and short-term goals established by the Army and USACE. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Environmental Compliance Manager: USACE Sacramento District, Real Estate Actions and Land Management, Former Fort Ord, California. On behalf of the U.S. Army Base Realignment and Closure (BRAC), Fort Ord Office, Mr. Lieberman drafts documentation supporting real estate actions and transfer of former Fort Ord property, including preparing the documents listed below for regulatory agency and Army technical and legal review, and upon receipt of comments incorporating changes into documents for back check review: Findings of Suitability to Transfer (FOSTs), Findings of Suitability to Lease (FOSLs), Findings of Suitability for Early Transfer (FOSETs), Covenants to Restrict Use of Property (CRUPs), documentation for regulatory agency evaluation of USACE demonstrations that remedial actions are operating properly and successfully under CERCLA Section 120(h)(3), and requests for regulatory agency determination of RCRA Corrective Action Complete. Additionally, Mr. Lieberman is responsible for coordination with USACE on completion of deeds, assisting with completion of a Covenant Deferral Request for early transfer of property, review and providing comments to the USACE concerning Land Use Control Implementation Plans, and preparation of all documentation required for the

Army to provide the CERCLA Warranty and Covenant for property transferred under CERCLA's "Early Transfer Authority."

Technical Manager: USACE Sacramento District, Building 194 Groundwater Monitoring and Reporting, Fort Hunter Liggett, California. Mr. Lieberman provides QA/QC and technical and regulatory compliance oversight. This includes O&M of groundwater treatment facilities, a closed landfill, and associated reporting and documentation on behalf of USACE, Sacramento District and U.S. Army Environmental Command. Ahtna Engineering Services has a performance based firm fixed price contract to complete the time-sensitive site closure for the Riverside Army Ammunition Plant. Ahtna is responsible for operating and maintaining the RBAAP groundwater treatment plant (GWTP) and conducting quarterly groundwater monitoring.

Technical Manager: USACE Sacramento District, Building 258 Soil and Vapor Extraction System Operation and Maintenance, Fort Hunter Liggett, California. Mr. Lieberman oversees daily operations of two major ground water treatment facilities and additional remedial or construction activities as required, analyzes treatment system data and operations and new technologies, and makes recommendations to the USACE for optimization of the groundwater water treatment systems by improving overall efficiency and effectiveness. In this role he has continuously provided effective technical, managerial and field services to support the long- and short-term goals established by the Army and USACE. Ahtna is operating and maintaining the OU2 and Sites 2/12 GWTPs at the former Fort Ord. The GWTPs consist of a total of 30 extraction wells and six injection wells and infiltration galleries. The VOC-impacted groundwater is treated with granular activated carbon and the treated groundwater recharged to the aquifer at the leading edge of the plumes by injection wells and infiltration galleries. The total maximum flow rate is approximately 1,500 gpm for both groundwater extraction and treatment systems.

Pete Rice, CIH, REH, CSP – *Health and Safety officer*
33 total years of experience

EDUCATION
Master of Science, Environmental and Occupational Health and Safety
Bachelor of Science, Environmental Health and Biology

BIOSKETCH
Pete Rice has experience developing, implementing, and supervising environmental and occupational safety and industrial hygiene programs and was largely responsible for developing Cal/OSHA safety and health standards (i.e., respiratory protection, ventilation, hazard communication, and asbestos). He has an extensive background in site remediation and site control. Additionally, he teaches industrial hygiene and safety at the university level and has trained hundreds of industrial hygienists and safety and environmental professionals. He formerly acted as the senior industrial hygienist, area manager, and chief training officer for Cal/OSHA.

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
Certified Industrial Hygienist, American Board of Industrial Hygiene
Registered Environmental Health Specialist, California
Certified Safety Professional, Board of Certified Safety Professionals
40-Hour Hazardous Substances/Waste Safety and Health (HAZWOPER) Certified
8-Hour Hazardous Substances/Waste Safety and Health (HAZWOPER) Supervisors/Managers Certified
OSHA 10 and OSHA 500 Instructor; and Behavior Based Safety – Loss Prevention Systems

PROJECT EXPERIENCE

Health and Safety Officer: Iron Mountain Mine Remediation, Redding, California. Mr. Rice served as site safety and project industrial hygiene manager for traditional construction and HTW (Hexavalent Chromium) activities at a remote site at which Ahtna was engaged in groundwater management work. The project included underground utility location, trenching and excavation, heavy equipment operations, hazardous substances management, dust controls, confined spaces, and related activities.

Project CIC/CSP: USACE Sacramento District - Groundwater Treatment System Operation and Maintenance, Former Fort Ord, California. Mr. Rice conducts periodic safety and industrial hygiene audits of groundwater treatment facilities to include associated activities and equipment. He assisted in the development of the Site Safety and Health Plans (SSHPs), Activity Hazard Analyses (AHAs) and related documents in accordance with USACE EM 385-1-1 Safety and Health Requirements Manual. Additionally, Mr. Rice conducts periodic health and safety related training of site personnel.

Project CIH/CSP: USACE Sacramento District - Stilwell Hall Abatement and Demolition, Fort Ord, California. Mr. Rice was the Project CIH/CSP for the demolition of the former non-commissioned officer's club at the former Fort Ord. Activities included development of the SSHP and coordination and review asbestos and lead based paint abatement plans. Mr. Rice also conducted on-site audits and participated in training and related activities.

Project CIH/CSP: USACE Sacramento District - Environmental Remediation and Restoration, Riverbank, California. Mr. Rice developed SSHPs for Ahtna operations, which principally include the operations and maintenance of the groundwater treatment facilities. He conducts periodic audits and training as necessary to promote workplace safety and compliance with contractual and regulatory requirements.

Project CIH/CSP: AMEC Earth & Environmental - Stuart Mesa Agricultural Field Remedial Action, Camp Pendleton, California. Mr. Rice developed SSHPs for extensive excavation and removal activities of pesticide contaminated materials. He conducted on-site audit and air monitoring activities to evaluate employee exposure to hazardous substances.

David Allbut. – *Staff Scientist*
9 total years of experience

EDUCATION
Bachelor of Art, Environmental Sciences, Biological Emphasis, 2001, University of California at Berkeley

BIOSKETCH
Mr. Allbut has been performing groundwater characterization and investigation since 2001. His field experience includes the collection of groundwater and soil samples using a variety of innovative sampling equipment and methods.

PROJECT EXPERIENCE
Environmental Scientist: California Department of Transportation (Caltrans) Division of Environmental Analysis, Roadside Vegetated Treatment System Study Storm Water Monitoring, San Rafael California. Storm water monitoring of roadside vegetated treatment site to determine pollutant removal of area and to further refine biofilter design requirements. Tasks included collection of eight storm events at each site, management of data, and development of final reporting and performance evaluations for all 31 stations throughout state. Responsible for site maintenance, equipment calibration, and storm water sampling at the San Mateo and Napa ORVTS sites. Perform site maintenance related to pulling weeds, trimming vegetation away from collection pipes, cleaning pipes and flumes of sediment and debris, and fixing/maintenance of monitoring equipment onsite. Conduct and document pre-, during-, and post-storm event site checks. Monitor samplers and flow meters when needed during storm events. Collect sample bottles and prepare for shipment to the laboratory via courier. Prepare and compile field data from various site activities.

Environmental Scientist: California Department of Transportation (Caltrans) Division of Water Quality, San Francisco-Oakland Bay Bridge Bioretention Basin Pilot Study. Siting, installation and collection of flow-weighted composite storm water samples to Asess the performance of three Caltrans bioretention basins. Studied relevant as-built plans and specifications to identify storm water equipment requirements and the need for any modifications to the basins to assess the performance of the basins. MACTEC is Maintained bioretention systems and performed wet weather water quality monitoring.

Storm waterstorm waterstorm water**Environmental Scientist: US ARMY RESERVES, Oakland, CA, San Pablo, CA, Mountain View, CA, San Jose, CA. Project #4951071561.** Responsible for installation and sampling of storm water auto samplers at locations throughout the San Francisco Bay Area.

Environmental Scientist: Confidential Client, Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill California. Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil, and onsite and offsite groundwater extending 10 miles from the site and to depths in excess of 600 feet below ground surface. MACTEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods. MACTEC also devised several monitoring and evaluation programs to save the client additional future remediation and monitoring well installation costs. Responsible for providing field collection of groundwater samples using a variety of sampling methods and equipment, groundwater monitoring well development, water level collection, and transducer downloads, equipment maintenance and repair, field task coordination and delegation, production and IX well sampling, and training involving well sampling methods.

Environmental Scientist: Universal Paragon Corporation / BP PLT-1, LLC Former Schlage Lock and Southern Pacific Brisbane Rail Yard Operable Units (OUs) Brownfield Soil and Groundwater Remediation Services, San Francisco California. Soil, soil vapor and groundwater remediation program services for Operable Units (OUs) at northern portion of 600-acre urban industrial site formerly occupied by a national lock manufacturing facility; part of site occupied by railway operations. Site impacted with volatile organic compounds (VOCs) and chlorinated hydrocarbons generated from manufacturing process over several decades. Brownfield site is scheduled to be redeveloped into a $450 million mixed-use development, including 1,200 residential homes and

public open space. Responsible for field collection of groundwater samples, well development, water level collection, and equipment maintenance and repair.

Environmental Scientist: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting 2008-2009, Fort Ord Site (Seaside) California. Continuation of ongoing groundwater sampling, analysis and reporting program at Fort Ord site for 2008-2009 (Option Year 3). Quarterly sampling and analysis conducted at more than 300 stations along with evaluation of treatment systems operation. Responsible for field collection of groundwater levels and groundwater sampling using PDS bags, hydrosleeves, and Westbay.

Environmental Scientist: Confidential Client, Facility Regulatory Review Environmental Support Services, California. Regulatory review and litigation-related environmental support services for former industrial building products manufacturer. Services include subsurface characterization, groundwater quality testing and sampling pertaining to characterizing the extent of a groundwater plume impacted by the historic disposal of solvents (PCE and TCE). Responsible for coordinating field activities, developing, and sampling monitoring wells for contaminants (TCE, PCE) as part of a field crew.

Environmental Scientist: BPS REPROGRAPHIC SERVICES Facility, Oakland, CA. Quarterly Groundwater Monitoring. Project #4088087514. Responsible for field collection of groundwater samples, arranging and ordering of sampling equipment, and transport of samples to the lab.

Environmental Scientist: Caltrans Whitmore Wash Rack Sampling (5013100007), Forebay, CA. Responsible for collecting water samples from waste wash water treatment system, and retrofitting the system with updated equipment and sample ports. Manage paperwork generated from site activities.

Environmental Sampling Technician: Blaine Tech Services Groundwater Sampling, Central and Southern California. Most senior tech in the San Jose office, with responsibilities including sampling tech training and overseeing of multi-tech, multi-week fieldwork. Performed groundwater monitoring well sampling at sites in the San Francisco Bay area, and also in Central, and Southern California. Duties included monitoring well gauging, sampling and development using a 5-ton sampling vehicle with purge water transport capacity. Used various types of sampling equipment and methods. Training includes current OSHA 40 hour HAZWOPER certification with 8 hour refresher, MEDIC First Aid with CPR, BP/Arco passport training, CALTRAIN safety training, and BATC training for bay area refineries. Also have a class B commercial driving license.

Assistant II: University of California at Berkeley, Department of Integrative Biology, Berkeley, California. Involved in a freshwater insect Biomonitoring experiment. Duties included leaf sampling sorting and insect identification. Helped design, conduct, and apply for funding for two separate experiments involving aquatic insects. Also occasional work done with the USDA Exotic Invasive Weeds project involving a Chrysomelid beetle used for Tamarisk biocontrol. This included in lab beetle colony maintenance and in field vegetation monitoring in the Owen's and Sacramento Valleys.

Lab Assistant: University of California at Berkeley, Welter Lab, Environmental Science, Policy and Management, Berkeley, California. Duties included monitoring of insect traps located in the Sacramento Valley, and in lab insect colony maintenance.

Zachary T. Carroll - *Staff Database Analyst*
9 total years of experience

EDUCATION
Bachelor of Art, History (Social Science Program), 1999, California State University, Sonoma

BIOSKETCH
Mr. Carroll is a Data Management Technician and Analyst who has been maintaining data integrity and production of scheduled reports in a timely manner since 2000. He has reviewed all aspects of program databases for accuracy, advised on future database design needs, conducted literature reviews, produced graphs for publication, and wrote and presented reports, visual presentations, and answered questions regarding analysis.

PROJECT EXPERIENCE
Database Technician: Confidential Client, Former Manufacturing Facility, Groundwater Investigation and Remediation, Northern California. Responsible for ongoing uploading of chemistry data to SQL database and providing database support in implementation of SQL database relating both historical and incoming chemistry data in support of regulatory review and environmental support services for a former industrial building products manufacturer. Services provided include groundwater testing and sampling pertaining to nearby groundwater plume impacted by solvents (PCE and TCE).

Database Technician: Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill, California. Responsible for providing Level 3 and Level 4 data review in accordance with the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*; troubleshooting data validation issues with laboratory personnel. Conducting MAROS Mann-Kendall Analysis for determining trends in analyte concentration levels. Performing quarterly reporting of quality assurance and quality control (QA/QC) findings; regulatory uploading of data packages and written reports to Geo-Tracker online website; and conducting ongoing data loading and quality control tracking in SQL and Access databases. Work is being done in support of a Remedial Investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil and onsite and offsite groundwater.

Database Specialist: IBM Corporation Phase I Environmental Site Assessments, Groundwater Treatment System O&M and Monitoring, San Jose, California. Provided database support, including data loading, quality control, reporting, and archiving. Created and delivered to the client a data extract from SQL database in EQuIS data format. Scope: Phase I Environmental Site Assessments and other environmental services for leased properties at end of lease, prior to being returned to owner. Sites have included offices and manufacturing facilities. Activities included well installation and abandonment; operations and management of groundwater extraction system; management of Self-Monitoring Program; and various on-call services to support client's environmental program. MACTEC services saved IBM an average of $40,000-$50,000 a year over four-year period in monitoring and O&M costs by negotiating closure of over 150 monitoring wells.

Database Specialist: U.S. Army Corps of Engineers - Sacramento District, Total Environmental Restoration Contract (TERC II) Fort Ord Groundwater Investigation, System O&M, Monterey, California. Responsible for uploading laboratory reports to an FTP server for client delivery. Scope: Under TERC II contract as subconsultant to Shaw Environmental, provided groundwater investigation, groundwater remediation system operation and maintenance, small arms range investigation, human health and ecological risk assessments, habitat monitoring, and electronic database management and maintenance. The USACE received time savings and improved data management as a result of MACTEC's development of planning tools for specific actions at munitions and small arms ranges, which lead to a focused phased investigation.

Database Technician: Site A Environmental Site Assessment and Remediation, Torrance, California. Responsible for quarterly reporting of validation summary for groundwater data to assist client with making project decisions. Reviewing data for compliance with laboratory control limits and method compliance in accordance with Environmental Protection Agency (EPA) Level 2 review. Beta user and troubleshooter for Locus Focus' Geo-Tracker EDF file production tool. Work being done in support of soil and groundwater contamination remediation at a 3.2 million square feet industrial complex site comprised of numerous manufacturing buildings. Services also included indoor air monitoring for VOCs.

Database Technician: Groundwater Monitoring Program, Los Angeles, California. Responsible for reviewing data for compliance with laboratory control limits and method compliance in accordance with Environmental Protection Agency (EPA) Level 2 review. Quarterly reporting of validation summary for groundwater data to assist client with making project decisions. Beta user and troubleshooter for Locus Focus' Geo-tracker EDF file production tool. MAROS Mann-Kendall analysis to determine trends in chemicals of concern on a quarterly basis. Work is being done in support of O&M of soil SVE system and vapor enhanced recovery (VER) system and semi-annual groundwater monitoring program. Site occupies several acres on property converted from manufacturing operation (including buildings) to present day asphalt-covered commercial parking lot.

Jeffery J. Fenton - *Senior Geologist, REA*
26? total years of experience

EDUCATION
Bachelor of Science, Geology, 1981, Oregon State University, Corvallis
Coursework, Graduate field course in Geology, 0, Oregon State University, Mitchell

REGISTRATIONS
Registered Geophysicist, CA, #GP922

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
Registered Environmental Assessor, Hazardous Waste Management, CA, #1-07608, earned - 2002
HAZWOPER 40 Hour
HAZWOPER 8 Hour Refresher
HAZWOPER 8 Hour Supervisor
OSHA Confined Space Entry

BIOSKETCH
Mr. Fenton is a Senior Geologist and task manager with over 26 years of experience. He is responsible for designing and managing programs, developing work plans, performing record searches and evaluation of storage and handling of hazardous wastes, supervising field work and data reduction, and participating in agency and public meetings. He has managed numerous large and small HTRW projects, including the evaluation and characterization of sites with hydrocarbon, solvent, metals, pesticide, PCB, explosive compound, and low-level radioactive wastes. His responsibilities have included preparing RI/FS and site characterization reports, confirmation reports, IA Approval Memos, Environmental Baseline Surveys, FOSTs, FOSLs, FOSETs, environmental compliance reports, BRAC Cleanup Plans, site safety plans, and confirmation reports in compliance with BRAC, DoD, CERCLA, RCRA, USACE, EPA and State and local guidance. He has managed tasks involving industrial facilities, landfills, munitions response sites, service stations, food processing plants, and agricultural facilities for federal DoD agencies (e.g., USACE, Army, and Navy) and private sector clients.

PROJECT EXPERIENCE
Task Manager: Lennar / BVHP, LLC Hunters Point Naval Shipyard Parcel A Environmental Consulting Services, San Francisco California. Environmental consulting services to support client's legal counsel, address special requests for information from project stakeholders, and present information at planning and technical meetings as part of ongoing effort to redevelop Parcel A of area formerly occupied by U.S. Naval shipyard. Provided review of and recommendations on existing documents. ***Lennar achieved compliance with regulatory requirements with MACTEC's assistance.*** Responsible for preparing a Finding of Suitability to Lease document for 8 buildings and 2 open spaces.

Geologist: The Presidio Trust Site Closure Environmental Services, San Francisco California. Environmental services associated with site closure, including site investigation, risk assessment, feasibility study (FS), engineering design, data management, ecological risk assessment, remediation, and reporting at historic 1,416-acre former military base at the south end of the Golden Gate Bridge. Responsible for preparing a Supplemental Health and Safety Plan for Munitions and Explosives of Concern.

Task Manager: U.S. Army Corps of Engineers - Huntsville District, Fort Ord Operable Unit (OU) Habitat Remedial Investigation / Feasibility Study (RI/FS), Monterey California. Since 2004, MACTEC has been conducting full remediation investigation / feasibility study (RI/FS) to address munitions and explosives of concern (MEC) at the Impact Area Munitions Response Area (MRA) for 6,500 acres of a 8,000-acre former U.S. Army training range complex (small arms to artillery fire). Activities included planning, site characterization, archival (historic) search, risk assessment (human health), feasibility study, and community relations support. Responsible for conducting site characterization efforts.
Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site RI/FS Reports Track 0&1 Approval Memorandum, Parker Flats ROD and Public Meeting, Monterey California. Under an additional delivery order, completed the development and submittal of additional Track 0 and 1 approval

memoranda and ROD for multiple reuse parcels throughout site of former Fort Ord. Activities support remedial investigation efforts as part of Military Munitions Response Program. ***Analysis performed by MACTEC resulted in No Further Action determination for 21 of 24 Track 1 sites.*** Responsible for participating as one of the authors of the Remedial Investigation / Feasibility Studies document.

Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento District, Environmental Baseline Survey for Transfer (EBST) Documentation Services, Monterey California. Preparation of documents and associated evaluations relating to broad range of environmental issues (e.g., asbestos and lead-based paint) at Fort Ord as part of work for Environmental Baseline Survey for Transfer (EBST). In support of property transfer MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** Responsible for writing the FOST documents for 30 parcels and the FOSET documents for 64 parcels.

Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site Investigation and Documentation for FOST, Monterey California. Investigative and documentation activities performed as part of development of environmental basewide survey for transfer (EBST) and findings of suitability for transfer (FOST) at former Fort Ord site. In support of property transfer MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** Responsible for writing the FOST document for one parcel.

Project Manager: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting 2008-2009, Fort Ord Site (Seaside) California. Continuation of ongoing groundwater sampling, analysis and reporting program at Fort Ord site for 2008-2009 (Option Year 3). Quarterly sampling and analysis conducted at more than 300 stations along with evaluation of treatment systems operation. Responsible for data management, data evaluation, and reporting.

Task Leader: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Site Electronic Data Integration and Management, Monterey California. Electronic data integration and management of various environmental databases, administrative records, facilities management information and GIS applications developed for site characterization, OE investigation, and remediation activities at former Fort Ord site. Work is continuation of services under ongoing BRAC and IRP programs. The database contains over one million records. Contract Compliance Screening (CCS), Automated Data Review (ADR), and Environmental Management System software programs were developed and resulted in ***cost savings of up to 50% in labor reduction ($250K) and improvements in the data management process for numerous task orders.*** Responsible for contributing information regarding property transfer-related documents that needed to be integrated into the overall Fort Ord database.

Environmental Task Manager: U.S. Army Corps of Engineers, Sacramento District, Fort Ord Complex Site BRAC Related Environmental Services, Monterey California. Environmental and engineering services under BRAC Program since 1985 for Fort Ord Complex (28,000-acre former Fort Ord, the Presidio of Monterey, and Fort Hunter Liggett, Fritzsche Army Airfield), a National Priorities List (NPL) site. Completed several hundred multidisciplinary, multitask delivery orders, with dozens more in progress. Services have included site investigations, risk assessments, feasibility studies, including ordnance/explosives remedial investigation, remedial designs, remedial actions, environmental compliance, utilities/roads, parcel descriptions, endangered species and habitat assessments, underground storage tank investigations, asbestos assessments, groundwater remediation, planning for base reuse, and community relations. Services have been conducted under CERCLA; RCRA; NEPA/CEQA; California landfill regulations; Monterey County underground storage tank (UST) regulations; air toxics regulations; and other federal, state, and local environmental laws and regulations. ***Successful completion of RI/FS documentation as part of 40+ site RI/FS allowed the Army to meet the congressionally mandated 36 month RI/FS schedule.*** To track the status of the property transfer and to provide the most up-to-date information to community stakeholders on the environmental cleanup, MACTEC developed a public website (www.fortordcleanup.com). This allowed interested parties to view information online. ***This reduced the time***

needed for onsite staff to manage the paper administrative record by approximately 50%. Responsible for serving as the BRAC task manager, preparing appropriate documentation, including Environmental Baseline Surveys (EBSs), Findings of Suitability to Transfer (FOSTs), Findings of Suitability for Early Transfer (FOSETs), Findings of Suitability to Lease (FOSLs), and Notices of Intent (NOIs), under the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA) guidance, which accelerated real-property transfers in accordance with the Defense BRAC Act (BRAC Program). Worked closely with the U.S. Department of the Army, U.S. Army Corps of Engineers (USACE), EPA, and State of California to develop approaches that met the requirements of CERCLA 120(h) and satisfied regulatory concern for documenting the environmental condition of the property at the time of transfer. Also responsible for RCRA closure activities.

Technical Consultant: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Wetlands Habitat Monitoring 2003, Monterey California. Continuation of habitat monitoring work as part of the BRAC and IRP activities at site of former Fort Ord. Monitoring activities at wetland sites on property include vegetation sampling, wildlife surveys, and collecting and analyzing physical and hydrological data. ***Results of the habitat monitoring showed that the habitat had recovered in four years and thus eliminated the fifth year of monitoring saving $85,000.*** Responsible for review of property transfer documents related to habitat monitoring activities.

Task Manager: U.S. Army Corps of Engineers - Sacramento District, Fort Ord and Fort Hunter Liggett Groundwater Monitoring Program, Forts Ord, Hunter Liggett California. Groundwater investigations and provided quarterly monitoring; prepared property transfer documents; performed habitat monitoring and groundwater remediation system evaluation; and conducted Small Arms Range remediation pilot study evaluation at site of two former U.S. Army installations under BRAC program. ***The project has been completed and consisted of twelve sites requiring remediation that have been closed with regulatory approval resulting in a reduction in long-term O&M for the client.*** Responsible for data evaluation and management, preparation of reports and cost proposals, and review of invoices.

Task Manager: USACE, Sacramento District, Military Munitions Response Program (MMRP), FortOrd, Monterey County, California. Currently serving as Task Manager responsible for the completion of a RI/FS, Proposed Plan, and Record of Decision at former munitions response sites. Conducted and evaluation of the possible use of military munitions at 24 former military munitions sites. The evaluation included researching the history of each site (PA/SI) and completing a review of the available data to develop conceptual site model(s) for each potential site. Data gaps were identified and the potential risk remaining at each site was also evaluated. Worked directly with federal and state regulatory agencies and community stakeholders throughout the review and approval process. The RI/FS is being conducted following EPA, DoD, and CERLA guidance. Other documentation prepared in support of the Fort Ord MMRP include IA Approval Memorandums, and Notices of Intent (NOI) for Removal Actions and Land disposal Site Plans prepared in support of the Army's Time-Critical Removal Action (TCRA) program. The NOI complies with 40 CFR, Part 300, Section 415 and notifies the regulatory agencies and the public of upcoming removal actions, intended to mitigate or eliminate the threat to public safety presented by the presence of munitions and explosives of concern (MEC).

Task Manager: USACE, Sacramento District, Closure of RCRA Solid Waste Management Units, Former Fort Ord, Monterey County, California. Implementing the closure of two solid waste management units under the Fort Ord RCRA program. Closure involves the site investigation and characterization of a former PCB storage facility and a former Open Burning/Open Detonation (OB/OD) munitions disposal unit. Investigation involved conducting a field investigation including the sampling and analysis for chemicals of concern, and completion of a closure certification report following RCRA guidance.

Task Manager: USACE, Sacramento District, Investigation of Solid Waste Management Units, Former Fort Ord, Monterey County, California. Task manager for the evaluation of former hazardous waste storage units. Evaluation involves physical inspection of the units including a review of the cleanliness and integrity, waste handling and storage practices, determining whether a release has occurred and making sampling recommendations if necessary. Information including any recommendations made to state and federal regulatory agencies through a

status report. Wastes stored and evaluated include waste oil, fuel, solvents and paint, PCBs, pesticides, asbestos, used ethylene glycol, adhesives and polymers. Created a detailed historic account of the solid waste management units which has been instrumental in the regulatory approval of the transfer of property containing the units.

Project Geologist: Confidential Client, Regulatory Compliance Audits, Processing and Distribution Facilities, Western U.S. Served on audit teams performing regulatory compliance audits for a major food production, processing and distribution company. The project entailed the completion of audits in a 5-month period at 37 facilities in California, and several other facilities in four states. The audit protocol prepared by HLA addressed facility compliance with regulations for hazardous waste, hazardous materials, air quality, water quality, drinking water and transportation. The protocol further provided for the completion of a preliminary screening evaluation that involves the local facility management in targeting relevant operations and matters of concern for the audit, prior to proceeding with the on-site phase of the program.

Task Manager: USACE, Site Investigations, Fort Ord, Monterey, California. Served as task manager for the investigation of several UST sites. Was responsible for determination of MACTEC and subcontractors scope of work, calculation of excavation volumes, oversight of subcontractors, collection of samples, review of analytical data, preparation of clearance and characterization reports, and budget tracking.

Task Manager: USACE, Remedial Investigation/Feasibility Study, Fort Ord, Monterey, California. Served as task manager for the remedial investigation/feasibility study (RI/FS) of two IRP sites at Fort Ord. Was responsible for the interpretation of chemical and hydrogeologic data, oversight of chemical and geologic database, coordination with risk assessment and engineering personnel, determination of contaminant fate and transport, coordination and production of final RI/FS report, and budget tracking.

Task Manager: Alameda County Department of Public Works, Landfill Investigation, Winton Avenue Landfill, Hayward, California. Served as task manager for landfill investigation under the state Solid Waste Assessment Test (SWAT) program. Was responsible for the preparation of work plan, installation and quarterly sampling of groundwater and leachate monitoring wells, aquifer testing, data evaluation, assessment of impact of leachate on waters of the state, and preparation of SWAT report.

Task Manager: U.S. Navy/PRC, Utilities Investigation, Hunters Point Naval Shipyard, San Francisco, California. Was task manager for a cross-base underground utilities investigation. Study involved the review of as-built drawings of sanitary sewer, storm drain, steam pipelines, and fuel lines, and the collection of soil and water samples adjacent to and within utility systems. Was responsible for the review and interpretation of analytical data, recommendations on remediation and mitigation measures, and the presentation of the results at a series of client and agency meetings.

Task Manager: U.S. Navy/PRC, Remedial Investigation, Hunters Point Naval Shipyard, San Francisco, California. Served as task manager for RI of five sites for contaminants including petroleum hydrocarbons, PNAs, pesticides, and metals. Completed interim-action evaluation in accordance with the EPA Superfund Accelerated Cleanup Model. Was responsible for budget and schedule tracking, chemical and hydrogeologic data interpretation, report preparation, and client representation at regulatory agency meetings.

Field Manager: U.S. Navy/PRC, Field Coordination, Hunters Point Naval Shipyard, San Francisco, California. Managed all aspects of field work, including the development, implementation and tracking of field schedules; coordination with client, subcontractors, and regulatory agencies; scheduling field personnel and reviewing all field documentation; and calculating and ordering all field supplies.

Task Manager: U.S. Navy/PRC, Aquifer Testing, San Francisco, California. Developed and implemented site-wide aquifer characterization program. Work included the development of the scope of work assessment of well construction and suitability, performing step-tests, and constant rate discharge tests.

Project Manager: Confidential Client, Product Removal Investigation, Hunters Point Naval Shipyard, San Francisco, California. As project manager, supervised the field investigation involving the removal of free-phase floating hydrocarbons from monitoring wells. Calculated and tracked the volume of product removed to determine the feasibility of installing a pumping system.

Task Manager: Confidential Client, Monitoring Well Network Installation, Longview, Washington. Installed, developed, and sampled network of groundwater monitoring wells in bedrock to investigate the impacts of a long-term release of mercury.

Task Manager: Montecito Heights Landfill, Monitoring Well Installation, Napa County, California. Installed monitoring well in deep aquifer using air rotary drilling method.

Task Manager: Former Fuel Storage and Dispensing Facility, Contra Costa County, California. Supervised and directed excavation of hydrocarbon-contaminated soil at former oil tank farm.

Task Manager: Site Assessment and Remediation, Richmond, California. Installed and developed monitoring wells and collected soil and groundwater samples. Supervised and directed contractor's removal of lead-, hydrocarbon-, and lime-contaminated soils at former shipyard site.

Field Manager: Well Installation, Morgan Hill, California. Installed double-cased well in deep aquifer using mud rotary drilling methods.

Field Manager: Well Installation, Vorhees, New Jersey. Installed monitoring well nests in shallow and deep aquifers using mud rotary and hollow stem auger methods.

Well Site Geologist: Exploration Logging Geothermal Division, Geothermal Exploration,California, Nevada, and Japan. Experienced in mud rotary, air rotary, and aerated mud drilling systems. Performed geologic logging of deep exploration geothermal boreholes. Responsibilities included descriptive lithologic sample analysis, monitoring of borehole temperature, borehole pressure and borehole gas levels; collection of borehole gas samples for chemical analysis; geothermal well production testing and reservoir analysis. Health and safety monitoring of carbon dioxide, methane and hydrogen sulfide gas levels around the drill site. Field experience in the Geysers California, Steamboat Nevada, Takigami and Fushime Fields, Kyushu Japan.

Haely Garner. – ***Staff Environmental Scientist***
5 total years of experience

EDUCATION
Bachelor of Art, Environmental Studies (minor in geology), 2005, University of California, Santa Barbara

BIOSKETCH
Ms. Garner has been performing groundwater characterization and investigation since 2005. Her field experience includes the collection of groundwater and soil samples using a variety of innovative sampling equipment and methods. She has also been responsible for planning and procurement related to sonic and direct push drilling, monitoring well installation, permitting, and well development.

PROJECT EXPERIENCE
Environmental Scientist: California Department of Transportation (Caltrans) Division of Environmental Analysis, Roadside Vegetated Treatment System Study Storm Water Monitoring, San Rafael California. Storm water monitoring of roadside vegetated treatment site to determine pollutant removal of area and to further refine biofilter design requirements. Tasks included collection of eight storm events at each site, management of data, and development of final reporting and performance evaluations for all 31 stations throughout state. Responsible for site maintenance, equipment calibration, and storm water sampling at the San Mateo and Napa ORVTS sites. Perform site maintenance related to pulling weeds, trimming vegetation away from collection pipes, cleaning pipes and flumes of sediment and debris, and fixing/maintenance of monitoring equipment onsite. Conduct and document pre-, during-, and post-storm event site checks. Monitor samplers and flow meters when needed during storm events. Collect sample bottles and prepare for shipment to the laboratory via courier. Prepare and compile field data from various site activities.

Environmental Scientist: California Department of Transportation (Caltrans) Division of Water Quality, San Francisco-Oakland Bay Bridge Bioretention Basin Pilot Study. Siting, installation and collection of flow-weighted composite storm water samples to assess the performance of three Caltrans bioretention basins. Studied relevant as-built plans and specifications to identify storm water equipment requirements and the need for any modifications to the basins to assess the performance of the basins. MACTEC is Maintained bioretention systems and performed wet weather water quality monitoring.

Field Supervisor: Confidential Client, Facility Regulatory Review Environmental Support Services, California. Regulatory review and litigation-related environmental support services for former industrial building products manufacturer. Services include subsurface characterization, groundwater quality testing and sampling pertaining to characterizing the extent of a groundwater plume impacted by the historic disposal of solvents (PCE and TCE). Responsible for coordinating field activities, developing, and sampling monitoring wells for contaminants (TCE, PCE) as part of a field crew.

Environmental Scientist: Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill California. Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil, and onsite and offsite groundwater extending 10 miles from the site and to depths in excess of 600 feet below ground surface. MACTEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods. MACTEC also devised several monitoring and evaluation programs to save the client additional future remediation and monitoring well installation costs. Responsible for coordination of field crew and on-site collection of groundwater samples to be analyzed for contaminants.

Environmental Scientist: Universal Paragon Corporation / BP PLT-1, LLC Former Schlage Lock and Southern Pacific Brisbane Rail Yard Operable Units (OUs) Brownfield Soil and Groundwater Remediation Services, San Francisco California. Soil, soil vapor and groundwater remediation program services for Operable Units (OUs) at northern portion of 600-acre urban industrial site formerly occupied by a national lock manufacturing facility; part of site occupied by railway operations. Site impacted with volatile organic compounds (VOCs) and chlorinated hydrocarbons generated from manufacturing process over several decades. Brownfield site

is scheduled to be redeveloped into a $450 million mixed-use development, including 1,200 residential homes and public open space. Responsible for field collection of groundwater samples, well development, water level collection, and equipment maintenance and repair.

Environmental Scientist: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting 2008-2009, Fort Ord Site (Seaside) California. Continuation of ongoing groundwater sampling, analysis and reporting program at Fort Ord site for 2008-2009 (Option Year 3). Quarterly sampling and analysis conducted at more than 300 stations along with evaluation of treatment systems operation. Responsible for field collection of groundwater levels and groundwater sampling using PDS bags, hydrosleeves, and Westbay.

Environmental Scientist: Caltrans Whitmore Wash Rack Sampling (5013100007), Forebay, CA. Responsible for collecting water samples from waste wash water treatment system, and retrofitting the system with updated equipment and sample ports. Manage paperwork generated from site activities.

Stephen Korbay, Jr. – *Staff Engineer*
? total years of experience

EDUCATION
Associate of Applied Science, Natural Resources, 1998, Santa Rosa Junior College

BIOSKETCH
Mr. Korbay, a Staff Engineer, has been working in the environmental and geotechnical engineering fields since 1988. His experience includes construction observation; well installation and development; groundwater, soil, and air sampling; aquifer testing; well destruction; soil gas surveying; HydroPunch sampling; stream gauging; and operation and maintenance of soil and groundwater treatment systems at various types of facilities, including hazardous waste, landfills, wastewater and water treatment, and vehicle maintenance facilities. Mr. Korbay's experience includes projects for the U.S. Army, U.S. Postal Service, and for facilities involved in water supply, wastewater collection, and wastewater treatment.

PROJECT EXPERIENCE

Field Technician: California Department of Transportation (Caltrans) Districts 1, 4 and 5 Long-Term Discharge Characterization for Multiple Sites, Various Cities and Locations, California. Responsible for working on repair and operation of water treatment systems and performed wash rack sampling at several Northern California facilities. Sampling was performed to determine extent of contaminants that were being transported by Caltrans vehicles. Scope: Long-term discharge characterization for multiple sites throughout Caltrans Districts 1,4, and 5. Services performed under technical / professional services contract for stormwater quality monitoring and reporting in compliance with NPDES permit requirements.

Field Technician: California Department of Transportation (Caltrans) - Environmental Programs Office, Monitoring of ASBS / SWQPA Sites, Various Locations Statewide, California. Responsible for providing documentation, evaluation, and modification of four water recycling washracks in preparation for sampling to determine discharge requirements; required capacities, functionality, and the installation of precision flow metering devices prior to wash water sampling at each station. Scope: Siting, installation and collection of flow-weighted composite stormwater samples from three Caltrans highway locations discharging to Areas of Special Biological Significance (ASBS) and State Water Quality Protection Areas (SWQPA) within boundaries of three separate Regional Water Quality Control Boards (RWQCB) in Central and Northern California. Evaluated previous studies and conducted site visits to select sites for successful automated sampler installation.

Field Technician: Casmalia Resources Superfund Site Maintenance, Remedial Investigation/Feasibility Study (RI/FS), Groundwater Monitoring, Casmalia, California. Responsible for updating chemical contour and depth to water plates. Scope: Site maintenance and management, RI/FS, regulatory compliance and support of investigation at a 252-acre, former Class I Superfund, Hazardous Waste Management Facility comprising five separate landfills and which included approximately 40,000 tons of industrial waste on site (with acids, caustics, solvents, pesticides and metals). Implemented 24-hour operating leachate collection and contaminated groundwater treatment system, and over 300 monitoring wells.

Field Technician: Confidential Client, Environmental Support Services, Chico, California. Responsible for performing quality control on sampling tables to check accuracy of sampling data and chain of custody information. Scope: Regulatory review and litigation-related environmental support services for former industrial building products manufacturer. Services include subsurface characterization, groundwater quality testing and sampling

pertaining to characterizing the extent of a groundwater plume impacted by the historic disposal of solvents (PCE and TCE).

Field Technician: Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill, California. Responsible for depth-to-water measurement, door-to door sampling, multi port well sampling, and well development activities; conducted aquifer pump tests and modified existing development techniques to improve water production and clarity; utilized new high-pressure air injection techniques for cleaning well screens after well installations were complete; performed water sampling; assisted with data validation to meet constricted schedule, resulting in work completed within the schedule mandated. Scope: Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil, and onsite and offsite groundwater extending from the site and to depths in excess of 600 feet below ground surface. MACTEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods. MACTEC also devised several monitoring and evaluation programs to save the client additional future remediation and monitoring well installation costs.

Field Technician: IBM Corporation Phase I Environmental Site Assessments, Groundwater Treatment System O&M and Monitoring, San Jose, California. Responsible for assisting with and providing coordination services for field activities, including groundwater elevation data collection and groundwater sampling. Scope: Phase I Environmental Site Assessments and other environmental services for leased properties at end of lease, prior to being returned to owner. Sites have included offices and manufacturing facilities. Activities included well installation and abandonment; operations and management of groundwater extraction system; management of Self-Monitoring Program; and various on-call services to support client's environmental program. MACTEC services saved IBM an average of $40,000-$50,000 a year over four-year period in monitoring and O&M costs by negotiating closure of over 150 monitoring wells.

Field Technician: Konocti Unified School District Burns Valley Elementary School Work Plan Groundwater Monitoring, Clearlake, California. Responsible for conducting groundwater elevation and sampling of monitoring wells. Utilized 12v Geosquirt pumps for low flow sampling. Scope: Implementation of work plan involving installation and survey of three monitoring wells, and initiation of one-year quarterly groundwater monitoring, sampling and reporting program for underground storage tank area adjacent to elementary school, uncovered during construction of new classrooms; monitoring to follow groundwater levels, flow direction and dissolved concentrations of hydrocarbons.

Field Technician: Lennar/BVHP, LLC Hunters Point Naval Shipyard Parcel A Environmental Consulting Services, San Francisco, California. Responsible for conducting air monitoring/sampling of various on- and off-site stations to determine the effectiveness of on-site dust prevention activities. Scope: Environmental consulting services to support client's legal counsel, address special requests for information from project stakeholders, and present information at planning and technical meetings as part of ongoing effort to redevelop Parcel A of area formerly occupied by U.S. Naval shipyard. Provided review of and recommendations on existing documents. Lennar achieved compliance with regulatory requirements with MACTEC's assistance.

Field Technician: National Semiconductor Corporation Superfund Site Remedial Investigation/Feasibility Study (RI/FS), Santa Clara, Palo Alto, California. Responsible for collecting soil and groundwater samples and groundwater elevation data, performing air monitoring, and conducting operation and maintenance of soil vapor extraction system. Scope: Provided environmental engineering services including remedial design, implementation,

monitoring and management over 14-year period at Superfund site affected by chemicals used in manufacture of semiconductors, including VOCs, semivolatiles, aromatics and metals in soil and groundwater. Recent services to develop health & safety plan. Complex, multi-scope project noted for regional groundwater plume issues with multiple stakeholders.

Field Technician: Shorenstein Realty Services, LP Environmental Health & Safety (EH&S) Outsource Support Services 2006-2010, Multiple Locations Nationwide. Responsible for assisting with indoor air quality sampling and setup and removal of real time air sampling equipment. Scope: MACTEC has been providing environmental health and safety (EH&S) support services since 1999 for more than 20 million square feet of Class A high-rise properties, and providing corporate EH&S functions for Shorenstein's owned and managed properties nationwide. MACTEC's services include asbestos and lead-based paint surveys, indoor air quality studies, preparation of survey reports, preparation of abatement specifications, compliance air sampling, and preparation of final closure letters and reports, building health and safety audits, and emergency response for chemical spills and exposures. MACTEC's excellent service has resulted in MACTEC's receiving the sole source corporate-wide service contract for over 10 years.

Field Technician: The Presidio Trust Site Closure Environmental Services, San Francisco, California. Responsible for supporting field operations and performing quality control on chemical data table to insure information from laboratory was correctly displayed on contour maps. Scope: Environmental services associated with site closure, including site investigation, risk assessment, feasibility study (FS), engineering design, data management, ecological risk assessment, remediation, and reporting at historic 1,416-acre former military base at the south end of the Golden Gate Bridge.

Field Supervisor: U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site RI/FS Reports Track 0&1 Approval Memorandum, Parker Flats ROD and Public Meeting, Monterey, California. Responsible for inspections of field crews for compliance with site protocol, managing all aspects of groundwater elevation collection, sample collection, preservation, and documentation; produced a weekly quality control report containing water level data, sampling forms, health and safety forms, and chains of custody. Scope: Under an additional delivery order, completed the development and submittal of additional Track 0 and 1 approval memoranda and ROD for multiple reuse parcels throughout site of former Fort Ord. Activities support remedial investigation efforts as part of Military Munitions Response Program. Analysis performed by MACTEC resulted in No Further Action determination for 21 of 24 Track 1 sites.

Field Supervisor: U.S. Army Corps of Engineers - Huntsville and Sacramento District, Environmental Baseline Survey for Transfer (EBST) Documentation Services, Monterey, California. Responsible for supporting field operations, including managing field crew in all aspects of groundwater elevation collection, sample collection, preservation, and documentation; producing a weekly quality control report containing water level data, sampling forms, health and safety forms, and chains of custody; and observing field crew procedures for compliance with site protocol. Scope: Preparation of documents and associated evaluations relating to broad range of environmental issues (e.g., asbestos and lead-based paint) at Fort Ord as part of work for Environmental Baseline Survey for Transfer (EBST). In support of property transfer MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). Early transfer was approved saving $1 million in infrastructure and maintenance cost.

Field Supervisor: U.S. Army Corps of Engineers - Huntsville District and Department of the Army, Fort Hunter Liggett Building 258 Field Sampling, Monterey, California. Responsible as Lead technician for installation of piping at three soil vapor extraction (SVE) wells for a six-month pilot study test; performed all

necessary tasks involved with setting up the correct valves, meters, ports; involved with initial start up of SVE unit and conducted field measurements with a PID and Anemometer; collected vapor samples using Suma Canisters and Tedlar Bags; produced a weekly quality control report containing water level data, sampling forms, health and safety forms, and chains of custody; managed field crew in all aspects of groundwater elevation collection, sample collection, preservation, and documentation; performed inspections of field crews for compliance with site protocol. Scope: Sampling and analytical procedures and other field investigation activities at Building 258 Area, former Fort Hunter Liggett Annex of Fort Ord site in Monterey County. Services included performance of a pilot study to assess the effectiveness of chemical oxidation and soil vapor extraction as remedial alternatives to cleanup of petroleum-contaminated groundwater. The Army, with MACTEC's assistance in negotiating with regulatory agencies, was able to use in situ innovative remedial technologies to cleanup petroleum-containing groundwater.

Field Supervisor: U.S. Army Corps of Engineers, Sacramento District, Fort Ord Complex Site BRAC Related Environmental Services, Monterey, California. Responsible for managing field crew in all aspects of groundwater elevation collection, sample collection, preservation and documentation; performed inspections of field crews for compliance with site protocol; produced a weekly quality control report containing water level data, sampling forms, health and safety forms and chains of custody. Scope: Environmental and engineering services under BRAC Program since 1985 for Fort Ord Complex (28,000-acre former Fort Ord, the Presidio of Monterey, and Fort Hunter Liggett, Fritzsche Army Airfield), a National Priorities List (NPL) site. Completed several hundred multidisciplinary, multitask delivery orders, with dozens more in progress. Services have included site investigations, risk assessments, feasibility studies, including ordnance/explosives remedial investigation, remedial designs, remedial actions, environmental compliance, utilities/roads, parcel descriptions, endangered species and habitat assessments, underground storage tank investigations, asbestos assessments, groundwater remediation, planning for base reuse, and community relations. Services have been conducted under CERCLA; RCRA; NEPA/CEQA; California landfill regulations; Monterey County underground storage tank (UST) regulations; air toxics regulations; and other federal, state, and local environmental laws and regulations. Successful completion of RI/FS documentation as part of 40+ site RI/FS allowed the Army to meet the congressionally mandated 36 month RI/FS schedule. To track the status of the property transfer and to provide the most up-to-date information to community stakeholders on the environmental cleanup, MACTEC developed a public website www.fortordcleanup.com). This allowed interested parties to view information online. This reduced the time needed for onsite staff to manage the paper administrative record by approximately 50%.

Field Supervisor: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Study 2003, Monterey, California. Responsible for performing inspections of field crews for compliance with site protocol; producing a weekly quality control report containing water level data, sampling forms, health and safety forms, and chains of custody; managing field crew in all aspects of groundwater elevation collection, sample collection, preservation, and documentation. Scope: Groundwater study and investigations during 2003-2005 as part of continued quarterly monitoring work at Fort Ord. Groundwater activities included investigations, quarterly sampling, and participation in two Army peer reviews. Groundwater quarterly sampling methods were modified to employ passive diffusion bag (PDB) samplers to reduce sampling costs by as much as 60%.

Field Technician: KEMRON Environmental Services, Inc., Site Characterization and Remediation Services at the Parks Reserve Forces Training Area (PRFTA 13), Dublin, California. Performed installation of QED low-flow micropurge pumps in three shallow aquifer monitoring wells. Conducted groundwater sampling and quarterly monitoring of five monitoring wells that included depth to water measurements, field parameter readings, use of a QED micropurge controller, and collection of samples for lab analysis. These new methods/techniques have helped us comply with government requirements and provide the most accurate results.

Lead Technician: McKesson Corporation, Soil Vapor Extraction/Treatment System at Former Chemical Distribution Facility, Union City, California. Lead technician responsible for troubleshooting and conducting operation and maintenance of SVE system. Duties included collecting soil and groundwater samples, repairing pumps, collecting product condensate, and coordinating field activities of subcontractors and analytical laboratories.

Field Technician: Confidential Client, Groundwater Monitoring Well Program, San Jose, California. Field technician with responsibilities for groundwater elevation data collection and groundwater sampling. System consists of over 400 monitoring, production, and observation wells in multi-level aquifer system covering an area larger than three square miles.

Field Technician: PRC Environmental Management, Inc., as Prime Contractor to Naval Facilities Engineering Command, RI/FS at Federal Superfund Site, Hunters Point Annex, San Francisco, California. Field technician responsible for assisting with installation and sampling of monitoring wells using Level C protection at this 950-acre Superfund site.

Field Technician: Redwood Landfill, Solid Waste Assessment Test Program at 600-ton-per-day Class II and III Landfill, Novato, California. Field technician responsible for monitoring groundwater in accordance with SWAT program. Duties included supervising field activities involving storm water runoff sampling and catch basin monitoring, field chemistry screening, water-level measurement, soil and groundwater sampling, and coordination with analytical laboratory.

Field Technician: W.R. Grace, Van Waters & Rogers, Romic Chemical, Sumitomo Metal Mining, Inc., Teledyne MEC, Shell, Chevron, and Exxon, Groundwater Sampling, California. Field technician responsible for groundwater sampling for several projects in San Francisco Bay Area.

Debra L. Leibensberger – *Principal Environmental Scientist*
18 total years of experience

EDUCATION
Bachelor of Art Theater Arts, 1984
Coursework Certificate Program in Project Management

BIOSKETCH
Ms. Leibensberger, a Project Manager and Senior Environmental Specialist, has been working in the environmental services industry since 1989, with particular emphasis on analytical environmental chemistry, quality assurance / quality control (QA/QC), and project management. She has provided technical expertise for numerous projects concerning data quality objectives, analytical method selection, sampling protocols, chain-of-custody procedures, reporting requirements, QA/QC requirements, planning document preparation, and data validation for a variety of commercial programs, federal DoD programs (U.S. Army, U.S. Navy), and U.S. Environmental Protection Agency programs. Many of the military facilities on which she has worked involved CERCLA, RCRA, and NEPA regulatory issues. Ms. Leibensberger is experienced in U.S. Army Corps of Engineers' requirements for chemical quality control and contract compliance, and serves as the first point of contact with U.S. Army Corps of Engineers technical personnel.

PROJECT EXPERIENCE

Senior Chemist Casmalia Resources Superfund Site Maintenance, Remedial Investigation / Feasibility Study (RI/FS), Groundwater Monitoring, Casmalia, California. Site maintenance and management, RI/FS, regulatory compliance and support of investigation at a 252-acre, former Class I Superfund, Hazardous Waste Management Facility comprising five separate landfills and which included approximately 40,000 tons of industrial waste on site (with acids, caustics, solvents, pesticides and metals). Implemented 24-hour operating leachate collection and contaminated groundwater treatment system, and over 300 monitoring wells. Responsible for overseeing analytical studies and data quality.

Data Manager CONFIDENTIAL CLIENT Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, California. Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil, and onsite and offsite groundwater extending 10 miles from the site and to depths in excess of 600 feet below ground surface. MACTEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods that provided over $1 million of cost avoidance for the client. MACTEC also devised several monitoring and evaluation programs to save the client over $3 million in future remediation and monitoring well installation costs. Responsible for coordinating all data validation efforts and serving as liaison between analytical laboratory and data validators; reviews data validation reports to assess overall quality, precision, accuracy, and completeness of the analytical data. Key team member in setting up sample tracking procedures for hundreds of highly sensitive and litigious samples from the field to the laboratory, through data validation and into the database.

Senior Chemist The Presidio Trust Site Closure Environmental Services, San Francisco, California. Environmental services associated with site closure, including site investigation, risk assessment, feasibility study (FS), engineering design, data management, ecological risk assessment, remediation, and reporting at historic 1,416-acre former military base at the south end of the Golden Gate Bridge. Responsible for a thorough review of historical records and previous site investigations; discovered inaccuracies in work previously performed by other consultants. Correct classification of each site and the correct identification of compounds of concern for each site saved the client significant time and expense. Participated in preparation of remedial action plans (RAPs) for 24 sites involving contamination primarily from metals, TPH, pesticides, and PCBs, among other contaminants, in soil and groundwater.

Task Manager U.S. Army Corps of Engineers - Huntsville District and Department of the Army, Fort Hunter Liggett Building 258 Field Sampling, Monterey, California. Sampling and analytical procedures and other field investigation activities at Building 258 Area, former Fort Hunter Liggett Annex of Fort Ord site in Monterey County. Services included performance of a pilot study to assess the effectiveness of chemical oxidation and soil vapor extraction as remedial alternatives to cleanup of petroleum-contaminated groundwater. ***The Army, with MACTEC's assistance in negotiating with regulatory agencies, was able to use in situ innovative remedial technologies to cleanup petroleum-containing groundwater.*** Responsible for providing oversight and management for the quarterly groundwater monitoring program and for the design and installation of a pilot study test for remediation of free product, soil gas, and groundwater. Upon completion of the pilot study, will also be responsible for the installation and operation of the full scale remediation system.

Task Manager U.S. Army Corps of Engineers - Sacramento District, U.S. Army Environmental Center (USAEC) Fort Hunter Liggett RCRA Investigation, Fort Hunter Liggett, California. Provided broad range of HTRW services for a basewide investigation, cleanup, and closure, including geophysical investigations, pilot treatability studies, groundwater monitoring, field investigations, feasibility studies, waste characterization studies, environmental design and construction, and health and safety planning to support ongoing active installation operation and maintenance, as well as cleanup and closure of sites contaminated with dioxins, solvents, fuels, waste oils and metals. Work performed continuously at site since 1996 under three contracts. In 2000 and 2001, MACTEC assisted FHL in performing natural attenuation studies as part of a pilot study to assess enhanced natural attenuation as a remedial alternative to cleanup groundwater. The pilot studies were performed at two sites with groundwater contamination: one site that has petroleum hydrocarbons, and one site with solvents. The studies evaluated the effectiveness of ORC and hydrogen peroxide at the site with petroleum hydrocarbons, and injecting HRC at the site with VOCs. Groundwater monitoring and sampling services by MACTEC were ongoing at Fort Hunter Liggett through the end of 2004. Responsible for: (1) supervision of quarterly groundwater sampling activities and database tasks, including review of laboratory quality control; (2) participating in producing Sampling and Analysis Plans, Chemical Data Quality Management Plans, and Work Plans that are site-specific; (3) supervising field operations and coordinating and implementing USACE 3-phase quality control; (4) coordinating subcontract laboratory scoping, costing and subcontract agreements, and serving as primary point of contact with contract laboratory regarding all aspects of laboratory performance; (5) serving as the primary contact for the USACE Project Chemist; (6) writing site-specific Quality Control Summary Reports at the end of each sampling event; (7) conducting both field and laboratory Quality Assurance audits; and (8) reviewing project data and coordinating data validation functions to assess chemical data for overall quality, precision, accuracy, completeness, comparability, and representational aspects.

Task Manager U.S. Army Corps of Engineers - Sacramento District (South Pacific Division) Former Montrose Chemical Superfund Site Soil Investigation, Torrance, California. Environmental restoration services at a 13-acre Superfund site which was contaminated with DDT, BHC and manufacturing constituents for 35 years. Contamination extended to soils, groundwater and ocean sediments (in nearby Gateway Harbor). Encompassed sampling, testing and analysis of soils in residential lots, fill areas, ponds and stormwater pathways; GIS design services for investigative and remediation efforts; sampling of area homegrown fruits and vegetables and chicken eggs for contaminant levels; and community relations services for high-profile project. ***Residential areas were sampled and final report and risk assessment has been approved by the EPA. No further investigation was required.*** Responsible for serving as analytical laboratory Task Manager for investigation and remediation project for USACE and EPA Region IX, coordinating with USACE to set up and maintain project to meet data quality and time schedule objectives. Coordinated delivery of samples to the laboratory and supplies to field personnel. Generated and reviewed final laboratory report, data package, and invoice.

Task Manager U.S. Army Corps of Engineers, Sacramento District, Fort Ord Complex Site BRAC Related Environmental Services, Monterey, California. Environmental and engineering services under BRAC Program since 1985 for Fort Ord Complex (28,000-acre former Fort Ord, the Presidio of Monterey, and Fort Hunter Liggett, Fritzsche Army Airfield), a National Priorities List (NPL) site. Completed several hundred multidisciplinary, multitask delivery orders, with dozens more in progress (as of 9/04). Services have included site investigations, risk assessments, feasibility studies, including ordnance / explosives remedial investigation, remedial designs, remedial actions, environmental compliance, utilities / roads, parcel descriptions, endangered species and habitat assessments, underground storage tank investigations, asbestos assessments, groundwater remediation, planning for

base reuse, and community relations. Services have been conducted under CERCLA; RCRA; NEPA/CEQA; California landfill regulations; Monterey County underground storage tank (UST) regulations; air toxics regulations; and other federal, state, and local environmental laws and regulations. ***Successful completion of RI/FS documentation as part of 40+ site RI/FS allowed the Army to meet the congressionally mandated 36 month RI/FS schedule.*** To track the status of the property transfer and to provide the most up-to-date information to community stakeholders on the environmental cleanup, MACTEC developed a public website (<http://www.fortordcleanup.com/>www.fortordcleanup.com). This allowed interested parties to view information online. ***This reduced the time needed for onsite staff to manage the paper administrative record by approximately 50%.*** Responsible for groundwater monitoring, groundwater treatment systems, and other ongoing investigations. Duties included: (1) assisting transition from traditional purge and bail methods to passive diffusion bag sampling, resulting in significant time and cost savings for the program; (2) supervising field operations and coordinating and implementing USACE 3-phase quality control; (3) participating in producing site-specific planning documents, including Sampling and Analysis Plans, Chemical Data Quality Management Plans, and Work Plans; (4) coordinating subcontract laboratory scoping, costing and subcontract agreements, and serving as primary point of contact with contract laboratory regarding all aspects of laboratory performance; (5) reviewing project data and coordinating data validation functions to assess chemical data for overall quality, precision, accuracy, completeness, comparability, and representational aspects; (6) writing site-specific Quality Control Summary Reports at the end of each sampling event; (7) conducting both field and laboratory Quality Assurance audits; and, (8) serving as the primary contact for the USACE Project Chemist.

Task Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Study 2003, Monterey, California. Groundwater study and investigations during 2003-2005 as part of continued quarterly monitoring work at Fort Ord. Groundwater activities included investigations, quarterly sampling, and participation in two Army peer reviews. Groundwater quarterly sampling methods were modified to employ passive diffusion bag (PDB) samplers to reduce sampling costs by as much as 60%. Responsible for providing continuing support, including groundwater monitoring, groundwater treatment systems, and other ongoing investigations. Duties included: (1) assisting transition from traditional purge and bail methods to passive diffusion bag sampling, resulting in significant time and cost savings for the program; (2) supervising field operations and coordinating and implementing USACE 3-phase quality control; (3) participating in producing site-specific planning documents, including Sampling and Analysis Plans, Chemical Data Quality Management Plans, and Work Plans; (4) coordinating subcontract laboratory scoping, costing and subcontract agreements, and serving as primary point of contact with contract laboratory regarding all aspects of laboratory performance; (5) reviewing project data and coordinating data validation functions to assess chemical data for overall quality, precision, accuracy, completeness, comparability, and representational aspects; (6) writing site-specific Quality Control Summary Reports at the end of each sampling event; (7) conducting both field and laboratory Quality Assurance audits; and, (8) serving as the primary contact for the USACE Project Chemist.

PROFESSIONAL AFFILIATIONS (NATIONAL AND INTERNATIONAL ORGANIZATIONS)

Member, Society of American Military Engineers

ADDITIONAL TRAINING

Center for Creative Land Recycling (CCLR) Brownfields Funding Conference, San Francisco, CA, 2007
CCLR North Coast Brownfields Conference, Eureka, CA, 2006
EPA Quality Systems Training Conference, Denver CO, 2005
EPA Quality Systems Training Conference, Washington DC, 2002

Chad Simpson. – *Senior Engineering Technician*
8 total years of experience

EDUCATION
Bachelor of Science, Business Management, 2002, Menlo College

BIOSKETCH
Mr. Simpson has been serving as a field technician since 2002. His experience includes sampling of soil borings, aquifer testing, groundwater sampling and monitoring, and soil sampling for federal and commercial clients in Northern California.

PROJECT EXPERIENCE
Environmental Technician: California Department of Transportation (Caltrans) Division of Environmental Analysis, Roadside Vegetated Treatment System Study Storm water Monitoring, San Rafael California. Storm water monitoring of roadside vegetated treatment site to determine pollutant removal of area and to further refine biofilter design requirements. Tasks included collection of eight storm events at each site, management of data, and development of final reporting and performance evaluations for all 31 stations throughout state. Responsible for storm water monitoring at the San Rafael site.

Field Technician: California Department of Transportation (Caltrans) - Environmental Programs Office, Monitoring of ASBS / SWQPA Sites, Various Locations Statewide California. Siting, installation and collection of flow-weighted composite storm water samples from three Caltrans highway locations discharging to Areas of Special Biological Significance (ASBS) and State Water Quality Protection Areas (SWQPA) within boundaries of three separate Regional Water Quality Control Boards (RWQCB) in Central and Northern California. Evaluated previous studies and conducted site visits to select sites for successful automated sampler installation. Responsible for providing documentation, evaluation, and modification of four water recycling washracks in preparation for sampling to determine discharge requirements; required capacities, functionality, and the installation of precision flow metering devices prior to wash water sampling at each station.

Field Technician: California Department of Transportation (Caltrans) Division of Water Quality, San Francisco-Oakland Bay Bridge Bioretention Basin Pilot Study. Siting, installation and collection of flow-weighted composite storm water samples to Asess the performance of three Caltrans bioretention basins. Studied relevant as-built plans and specifications to identify storm water equipment requirements and the need for any modifications to the basins to assess the performance of the basins. MACTEC is Maintained bioretention systems and performed wet weather water quality monitoring.

Field Technician: Casmalia Resources Superfund Site Maintenance, Remedial Investigation / Feasibility Study (RI/FS), Groundwater Monitoring, Casmalia California. Site maintenance and management, RI/FS, regulatory compliance and support of investigation at a 252-acre, former Class I Superfund, Hazardous Waste Management Facility comprising five separate landfills and which included approximately 40,000 tons of industrial waste on site (with acids, caustics, solvents, pesticides and metals). Implemented 24-hour operating leachate collection and contaminated groundwater treatment system, and over 300 monitoring wells. Responsible for working with and overseeing groundwater sampling crew at a high profile former hazardous waste landfill. Maintain good relationship with EPA onsite representative, which allows the sampling program to proceed without regulatory holdup. Field activities have been conducted without health and safety incidents, in sampling environments that require primarily Level D, although both full face respirator (Level C) and supplied air (Level B) are frequently required.

Field Technician: Confidential Client, Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill California. Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil, and onsite and offsite groundwater extending 10 miles from the site and to depths in excess of 600 feet below ground surface. MACTEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods. MACTEC also devised several monitoring and evaluation

programs to save the client additional future remediation and monitoring well installation costs. Responsible for performing groundwater sampling and daily operations for quarterly monitoring program.

Field Technician: Innovative Technical Solutions, Inc. / U.S. Department of the Navy Alameda Point Redevelopment Groundwater Monitoring Field Services, Alameda California. Field services for quarterly groundwater monitoring for soil and groundwater remediation as part of redevelopment of Alameda Point area in the wake of closure of NAS Alameda, closed under U.S. Department of Defense BRAC program. Area is planned for redevelopment to provide a mixed-use development on the 1,560-acre site impacted with various environmental contaminants that included petroleum and chemicals associated with aircraft and vehicle repair, metal plating, painting, engine testing, pest control and fire response. Total of 28 initial restoration (IR) sites identified and grouped into 10 Operable Units (OUs). Responsible for assisting with the Alameda Basewide Groundwater Monitoring Program for sampling and analysis of well specific groundwater sourced from 14 different installation restoration sites located throughout Alameda Point. Specific responsibilities are to first assist with depth to water measurements of all program wells (310 wells). Following this initial effort, responsible for the low-flow purging, monitoring of water quality criteria, and sampling of well specific groundwater. Contaminants of concern sampled are organic compounds, inorganic compounds, total dissolved solids, and radionuclides.

Field Technician: Universal Paragon Corporation / BP PLT-1, LLC Former Schlage Lock and Southern Pacific Brisbane Rail Yard Operable Units (OUs) Brownfield Soil and Groundwater Remediation Services, San Francisco California. Soil, soil vapor and groundwater remediation program services for Operable Units (OUs) at northern portion of 600-acre urban industrial site formerly occupied by a national lock manufacturing facility; part of site occupied by railway operations. Site impacted with volatile organic compounds (VOCs) and chlorinated hydrocarbons generated from manufacturing process over several decades. Brownfield site is scheduled to be redeveloped into a $450 million mixed-use development, including 1,200 residential homes and public open space. Responsible for the preparation of field documentation and sampling equipment for the quarterly groundwater sampling program. Following initial depth to water measurements at specific locations, sample and take field parameters using low flow sampling techniques. Monitor operation and maintenance of soil vapor extraction and pump and treat environmental remediation systems involving granular activated carbon for contaminated groundwater.

Field Technician: U.S. Navy - Naval Facilities Command (NAVFAC) SWDIV Point Molate Environmental Support, Point Molate / Richmond California. Field technical services, as a sub to TetraTech Foster Wheeler for three years, for groundwater sampling and operation and maintenance of soil vapor extraction (SVE) and pump and treat and environmental remediation systems involving granular activated polishing for contaminated groundwater containing diesel, gasoline, and other petroleum hydrocarbons at a former Navy fuel depot for ship refueling closed in 1993 under BRAC. Involved two delivery orders to date (07/02) at a former Navy fuel depot and Moffett Federal Airfield. Responsible for performing all daily operations, maintenance, and groundwater sampling at a former fuel depot.

Field Engineer / Technician: U.S. Army Corps of Engineers - Sacramento District, Fort Ord and Fort Hunter Liggett Groundwater Monitoring Program, Forts Ord, Hunter Liggett California. Groundwater investigations and provided quarterly monitoring; prepared property transfer documents; performed habitat monitoring and groundwater remediation system evaluation; and conducted Small Arms Range remediation pilot study evaluation at site of two former U.S. Army installations under BRAC program. ***The project has been completed and consisted of twelve sites requiring remediation that have been closed with regulatory approval resulting in a reduction in long-term O&M for the client.*** Responsible for performing soil and groundwater sampling for quarterly groundwater monitoring program and inland range characterization.

Edward J. Ticken, RGP - *Senior Principal Environmental Scientist/Chief Scientist*
32 total years of experience

EDUCATION
Master of Science Geology, 1983
Bachelor of Science Geology, 1972

REGISTRATIONS
Registered Geophysicist, CA, #GP922

CERTIFICATIONS AND NON PROFESSIONAL LICENSES
Certified SCUBA Diver #574441

BIOSKETCH
Mr. Ticken, a Senior Principal Environmental Scientist, has been working in the environmental field since 1978. His experience includes designing and managing programs, developing work plans, overseeing field work and data reduction, performing quality assurance / quality control functions, and preparing reports for various types of sites, including RCRA, CERCLA, and BRAC sites. He has managed numerous projects for contaminated site characterizations; surveyed offshore oil platforms, docks, pipelines, supertanker terminals, and reservoirs; and conducted geothermal exploration projects in the western United States and Alaska for various clients. His clients have included the U.S. Army, U.S. General Services Administration, power utilities, and oil and gas exploration and production companies. His responsibilities have included collecting and interpreting geophysical, geologic, and hydrogeologic data, preparing Remedial Investigation / Feasibility Studies (RI / FS) and site characterization reports, and interacting with regulatory agencies, military personnel, technical review committees, and citizen advisory boards.

PROJECT EXPERIENCE

Program Manager U.S. General Services Administration, Federal Supply Schedule to Provide Environmental Planning, Documentation, Compliance, Occupational Training and Waste Management Services Worldwide 2000-2007 and 2008-2013, Nationwide Locations, Nationwide U.S. Environmental services for evaluating and disposing of hazardous waste, supporting RI/FS programs, providing Pollution Prevention (P2) services, monitoring groundwater, performing asbestos / lead-based paint surveys, developing exit strategies, maintaining environmental compliance, providing environmental training and other services at military and other installations nationwide. This contract has included groundwater remediation activities for more than 6 federal facilities and NPL sites, including assessment and implementation of remedial alternatives for carbon tetrachloride, chlorinated solvents, chlorobenzenes, and petroleum. Responsible for oversight of various tasks at Fort Ord.

Principal Review U.S. Army Corps of Engineers - Huntsville District, Fort Ord Operable Unit (OU) Habitat Remedial Investigation / Feasibility Study (RI/FS), Monterey, California. Since 2004, MACTEC has been conducting full remediation investigation / feasibility study (RI/FS) to address munitions and explosives of concern (MEC) at the Impact Area Munitions Response Area (MRA) for 6,500 acres of a 8,000-acre former U.S. Army training range complex (small arms to artillery fire). Activities included planning, site characterization, archival (historic) search, risk assessment (human health), feasibility study, and community relations support. Responsible for principal-level technical review of project activities and QC review of documentation.

Project Manager U.S. Army Corps of Engineers - Huntsville District, Fort Ord INRMP Technical and Biological Review, Fort Ord Site (Monterey), California. Technical and biological review of current POM Integrated National Resource Management Plan (INRMP) at former Fort Ord site; INRMP reviewed for operations and effect to determine whether implementation of INRMP was in compliance with the Sikes Act. Responsible for oversight of review and providing recommendations for update.

Project Manager U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord BRAC Summary Report Preparation, Monterey, California. Preparation, including technical support, and review of BRAC program summary report pertaining to former Fort Ord site in Monterey County. Also arranged on-site

review meeting. The BRAC Summary documents and presentations provided the regulatory agency representatives a concise summary of the primary documents related to the project. ***This greatly reduced the time and cost necessary to brief new regulatory representatives on the project.*** Responsible for oversight of report preparation and document review.

Principal Review U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site RI/FS Reports Track 0&1 Approval Memorandum, Parker Flats ROD and Public Meeting, Monterey, California. Development and submittal of Tracks 0 and 1 approval memoranda and ROD for multiple reuse parcels throughout site of former Fort Ord; activities support remedial investigation efforts as part of Military Munitions Response Program. ***Analysis performed by MACTEC resulted in No Further Action determination for 21 of 24 Track 1 sites.*** Responsible for performing Approval Memorandum review.

Project Manager U.S. Army Corps of Engineers - Huntsville and Sacramento District, Environmental Baseline Survey for Transfer (EBST) Documentation Services, Monterey, California. Preparation of documents and associated evaluations relating to broad range of environmental issues (e.g., asbestos and lead-based paint) at Fort Ord as part of work for Environmental Baseline Survey for Transfer (EBST). In support of property transfer MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved, saving $1 million in infrastructure and maintenance cost.*** Responsible for oversight of documentation preparation services.

Project Manager U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site Investigation and Documentation for FOST, Monterey, California. Investigative and documentation activities performed as part of development of environmental basewide survey for transfer (EBST) and findings of suitability for transfer (FOST) at former Fort Ord site. In support of property transfer, MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** Responsible for overseeing investigative and reporting activities.

Project Manager U.S. Army Corps of Engineering - Huntsville and Sacramento Districts, Fort Ord Site Biomonitoring Services, Monterey, California. Biomonitoring monitoring, data analysis, and reporting in various range areas and wetland area at former Fort Ord site as follow-up to Habitat Management Plan. ***Results of the habitat monitoring showed that the habit had recovered in four years and thus eliminated the fifth year of monitoring saving $85,000.*** Responsible for oversight of biomonitoring procedures and activities, and resolving any project issues as needed.

Program Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord Site Carbon Tetrachloride Groundwater Investigation, Monterey (Fort Ord Site), California. Remedial investigation and feasibility study (RI/FS), development and proposal of remedial plan, and acquiring of Record of Decision for contamination of groundwater with carbon tetrachloride in 500-acre area at former Fort Ord site. Also refined investigative strategy for SOW, evaluated and managed data, and developed reports Responsible for quality control review of project documents, developing investigation strategies, negotiating cleanup levels with regulatory agencies, and preparation of the Record of Decision. *Timely completion and regulatory agency acceptance of the RI/FS and ROD provided the necessary approval for the remediation of the Carbon Tetrachloride groundwater plume.*

Principal Environmental Engineer U.S. Army Corps of Engineers - Sacramento District, TERC II Administrative Records and Database Support for Former Fort Ord Site, Monterey, California. Administrative records support, web hosting support and maintenance, and GIS and database support as part of TERC II biological services contract for USACE Sacramento District. Responsible for Principal-level consultation and serving as liaison between MACTEC and the primary client.

Principal U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting 2008-2009, Fort Ord Site (Seaside), California. Continuation of ongoing groundwater sampling, analysis and reporting program at Fort Ord site for 2008-2009 (Option Year 3). Quarterly sampling and analysis

conducted at more than 300 stations along with evaluation of treatment systems operation. Responsible for providing Principal consultation and review.

Project Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord Site Electronic Data Integration and Management, Monterey, California. Electronic data integration and management of various environmental databases, administrative records, facilities management information and GIS applications developed for site characterization, OE investigation, and remediation activities at former Fort Ord site. Work is continuation of services under ongoing BRAC and IRP programs. The database contains over one million records. Contract Compliance Screening (CCS), Automated Data Review (ADR), and Environmental Management System software programs were developed and resulted in ***cost savings of up to 50% in labor reduction ($250K) and improvements in the data management process for numerous task orders.*** Responsible for overseeing GIS and data management tasks.

Project Manager U.S. Army Corps of Engineers, Sacramento District, Fort Ord Complex Site BRAC Related Environmental Services, Monterey, California. Environmental and engineering services under BRAC Program since 1985 for Fort Ord Complex (28,000-acre former Fort Ord, the Presidio of Monterey, and Fort Hunter Liggett, Fritzsche Army Airfield), a National Priorities List (NPL) site. Completed several hundred multidisciplinary, multitask delivery orders, with dozens more in progress (as of 9/04). Services have included site investigations, risk assessments, feasibility studies, including ordnance / explosives remedial investigation, remedial designs, remedial actions, environmental compliance, utilities / roads, parcel descriptions, endangered species and habitat assessments, underground storage tank investigations, asbestos assessments, groundwater remediation, planning for base reuse, and community relations. Services have been conducted under CERCLA; RCRA; NEPA/CEQA; California landfill regulations; Monterey County underground storage tank (UST) regulations; air toxics regulations; and other federal, state, and local environmental laws and regulations. ***Successful completion of RI/FS documentation as part of 40+ site RI/FS allowed the Army to meet the congressionally mandated 36 month RI/FS schedule.*** To track the status of the property transfer and to provide the most up-to-date information to community stakeholders on the environmental cleanup, MACTEC developed a public website (<http://www.fortordcleanup.com/>www.fortordcleanup.com). This allowed interested parties to view information online. ***This reduced the time needed for onsite staff to manage the paper administrative record by approximately 50%.*** Responsible for supervising MACTEC projects at Fort Ord Complex since 1986. From 1986 to 1991, managed the geophysical investigations at the complex, including delineating landfill limits at Fort Ord and Fort Hunter Liggett, mapping UST locations, locating buried well locations, and providing clearance for intrusive activities. In 1991, he became Task Manager for site characterization investigations at 43 Fort Ord sites. As Task Manager, he oversaw geophysical and soil gas surveys, drilling and sampling soil borings, trenching, installing monitoring wells and sampling groundwater, and performing data analysis. He prepared the Work Plan and Sample and Analysis Plans, Site Characterization Reports, Interim Action and No Action Approval Memoranda, Confirmation Reports, Proposed Plans, Records of Decision, and the Basewide RI/FS Report. In 1995 he became Project Manager for the Fort Ord RI/FS Program. This program included both firm fixed price and cost plus fixed fee delivery orders under eight different contracts. He has provided tours of Fort Ord investigation sites for numerous groups, has participated in all RAB workshops, and provides technical presentations at monthly RAB meetings. In addition, he has made presentations to regulatory agencies, military groups, and the public. Designed and operated bioremediation cell to treat petroleum contaminated soil. ***Two years usage resulted in savings of over $1 million in disposal costs***. In support of property transfer, a basewide EBS was prepared, as well as subsequent Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** MACTEC prepared documentation to designate the Fort Ord Landfill as a Corrective Action Management Unit (CAMU) to allow consolidation of remedial waste in the landfill. As a result of our investigation studies and value engineering, **we were able to save over $1 million related to *soil treatment and/or offsite disposal for soil remedial units.***

Program Manager U.S. Army Corps of Engineers - Sacramento District, Total Environmental Restoration Contract (TERC II) Fort Ord Groundwater Investigation, System O&M, Monterey, California. Under TERC II contract as subconsultant to Shaw Environmental, provided groundwater investigation, groundwater remediation system operation and maintenance, small arms range investigation, human health and ecological risk assessments, habitat monitoring, and electronic database management and maintenance. ***The USACE received time savings and***

improved data management as a result of MACTEC's development of planning tools for specific actions at munitions and small arms ranges, which lead to a focused phased investigation.
1) Assisted in preparation of an explanation of significant differences to allow the Army to place soil with bullet fragments directly into the Fort Ord Landfill ***saving approximately $1 million in soil screening costs.*** 2) Project Manager under TERC II contract as a subconsultant responsible for managing the preparation of a Remedial Design/Remedial Action (RD/RA) Work Plan for the Track 2 Parker Flats MRA at the former Fort Ord. The report provided an implementation plan for land use controls outlined in the Record of decision for the site where a munitions and explosives of concern (MEC) removal action was completed. The preparation of the work plan was coordinated with the Army, USACE, USEPA, and California Department of Toxic Substances Control. The timely completion of the work plan will allow the Army to proceed with transfer of parts of Parker Flats to Monterey County.

Program Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Study 2003, Monterey, California. Groundwater study and investigations during 2003-2005 as part of continued quarterly monitoring work at Fort Ord. Groundwater activities included investigations, quarterly sampling, and participation in two Army peer reviews. Groundwater quarterly sampling methods were modified to employ passive diffusion bag (PDB) samplers to reduce sampling costs by as much as 60%. Responsible for managing biological survey activities; attended regulatory meetings and prepared and negotiated proposals.

Project Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord Wetlands Habitat Monitoring 2003, Monterey, California. Continuation of habitat monitoring work as part of the BRAC and IRP activities at site of former Fort Ord. Monitoring activities at wetland sites on property include vegetation sampling, wildlife surveys, and collecting and analyzing physical and hydrological data. ***Results of the habitat monitoring showed that the habitat had recovered in four years and thus eliminated the fifth year of monitoring saving $85,000.*** Responsible for managing habitat monitoring throughout contract year 2003.

Program Manager U.S. Army Corps of Engineers - Sacramento District, Fort Ord and Fort Hunter Liggett Groundwater Monitoring Program, Forts Ord, Hunter Liggett, California. Groundwater investigations and provided quarterly monitoring; prepared property transfer documents; performed habitat monitoring and groundwater remediation system evaluation; and conducted Small Arms Range remediation pilot study evaluation at site of two former U.S. Army installations under BRAC program. ***The project has been completed and consisted of twelve sites requiring remediation that have been closed with regulatory approval resulting in a reduction in long-term O&M for the client.*** As Program Manager for the Fort Ord site, managed habitat monitoring and groundwater investigations and prepared and negotiated overall contract proposal.

PROFESSIONAL AFFILIATIONS (NATIONAL AND INTERNATIONAL ORGANIZATIONS)

Member, Society of American Military Engineers,

PROFESSIONAL AFFILIATIONS (STATE OR LOCAL ORGANIZATIONS)

Society of American Military Engineers Sacramento Post - Member

PUBLICATIONS AND PRESENTATIONS

2002. "Interim Action for Vegetation Clearance, Ordnance and Explosives Remedial Action, and Ordnance and Explosives Detonation, Former Fort Ord, California." The UXO Forum (with Margaret Stemper, Pamela Couch, and David Eisen).

1998. "Exposure Assessment: Evaluation of the Distribution of Lead in Soil at aFormer Firing Range." 24th Annual Environmental Symposium and Exhibition (with B.R. DeShields and others).

1998. "An Ecological Risk Assessment for Lead at a Former Firing Range." 24th Annual Environmental Symposium and Exhibition (with B.R. DeShields and others).

1997. "The Successful Application of a Risk-Based Categorization and Early Records of Decision at Fort Ord." 23rd Annual Environmental Symposium and Exhibition (with Christopher Smith).

1997. "Designation of a Corrective Action Management Unit (CAMU) for Placement of Hazardous Remediation Waste at a Former Army Base Sanitary Landfill." 23rd Annual Environmental Symposium and Exhibition. (with Margaret Stemper).

1993. "A Geophysical Program to Aid in the Environmental Investigation of the U.S. Army Base at Fort Ord, California." 17th Annual Army Environmental R & D Symposium (with Carlene Merey).

1993. "A Geophysical Program to Aid in the Environmental Investigation of the U.S. Army Base at Fort Ord, California." Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems.

1992. "Hydrogeologic Characterization Using a Shallow Seismic Reflection Survey at Fort Ord, California" (Exp. Abs.); in Expanded Abstracts of the Technical Program: Society Exploration Geophysicists 61st Annual Meeting (with Carlene Merey and others).

1992. "Characteristics of Newly Formed Ice Gouges in the Beaufort Sea, Alaska," OMAE 1992 (with Lawrence J. Toimil).

1991. "Surface Geophysical Methods in Groundwater Investigations." Presentation at the Las Vegas Valley Water District Hydrologic Short Course, Las Vegas, Nevada.

1991. "Geophysical Methods for Geothermal Exploration." Presentation at the Philippine National Oil Company Technology Transfer Seminar, Manila, Philippines.

1990. "Variations in Ice Gouge Parameters Related to Different Seabed Soil Types," OMAE 1990 (with Lawrence J. Toimil).

1988. "Ice-gouge processes in the Alaskan Beaufort Sea in Arctic Coastal Processes and Slope Protection Design," ASCE Monograph (with Douglas Rearic).

1984. "The Offshore Newport-Inglewood Fault Zone: Its Changing Character," (abs.), AAPG/SEPM Pacific Section, April 1984 (with Peter J. Fischer).

1983. "Geology of the Inner Basin Margin: Dana Point to San Onofre, California ," Master's thesis, California State University , Northridge.

1981. "Shelf Sediment Volumes, Southern California Continental Border &Shyland," (abs) GSA abstracts with programs, vol. 12, no. 7, p. 426 (with Peter J. Fischer et al.).

1981. "Mapping of Significant Rock Habitats Using Seismic Reflection Techniques, Beaufort Sea, Alaska," (abs.), SEG, October 1981 (with Lawrence J. Toimil).

1980. "The Inner Margin of the Southern California Borderland: Quaternary Tectonics, Seismic Stratigraphy and Evolution," (abs.), AAPG/SEPM Pacific Section, April 1980 (with Peter J. Fischer and others).

1979. "Recognition of Active (Holocene) Faulting, Southern California Borderland," (abs.), GSA abstracts with programs, vol. 11, no. 3, p. 78 (with Peter J. Fischer and John Rudat).

ADDITIONAL TRAINING

MACTEC project management training course

Laurie Glantz- Murphy
Laboratory Director

EDUCATION:

University of Nebraska-Lincoln Lincoln, Nebraska 68510
Graduate courses in Chemistry.
Hastings College - Hastings, Nebraska 68901
BA, Chemistry

EXPERIENCE

Laboratory Director for Accutest Northern California
Accutest Laboratories San Jose CA
February 2008 - Present

- Facilitated the transition from Entech to Accutest systems; LIMS and administrative.
- ANC received their initial NELAP Certification in July 2008.
- ANC received Washington State, Oregon State, Nevada State Certifications.
- ANC received their Foreign Soil Permit from the USDA.
- ANC received their Dept. of Defense (DoDELAP) accreditation in December 2009
- ANC received their Arizona DH accreditation in November 2010
- Add capabilities: NWTPH methods, Appendix IX compound lists, TCLP, STLC, SPLP leaching procedures for organics, Perchlorate by IC (314.0) and Hexavalent Chromium by IC (7199).

Operations Director
Entech Analytical Labs, Inc. Santa Clara CA
August 2007 – February 2008

- Responsible for all technical operations for the laboratory.
- Designed a customer feedback system and a Non-conformance-Corrective Action Reporting System based on Adobe Acrobat Forms in support of our NELAP certification.

Monterey Bay Analytical Services, Inc. Monterey, CA
March 2007 – August 2007

- Setup and received ELAP certification for Volatiles by GC/MS; EPA 524.2, 624, and 8260.
- Assisted with general lab testing; FLAA, TKN, Ammonia, Alkalinity, etc.

Laboratory Director
Entech Analytical Labs, Inc. Santa Clara Ca
October 2003 to January 2007

- Responsible for all technical issues concerning the laboratory.
- Increased “on-time” delivery of reports 40%.
- Laboratory was profitable in 2006 for the first time in 8 years.
- All laboratory production systems were reviewed and streamlined along with crosstraining in many departments.
- Developed a back-up and archiving system for data and reports allowing quick retrieval.
- All QA/QC management systems were reviewed and revised.
- The LIMS was upgraded and redesigned for efficiency and clarity.
- Designed reporting system to move from paper hardcopy and mailing to pdf format and emailing.
- Out-dated equipment was replaced with new.
    1. Perkin-Elmer ICP 5300
    2. Agilent 6890 with 5975MS
    3. 2 X Volatile GC/MS systems - Agilent 6890 with 5975MS and Archon/OI P&T.
    4. TOC Analyzer

Environmental Quality Laboratory Supervisor.
Laboratory Director for Pratt & Whitney’s CDHS-ELAP Certification
United Technologies Corp./ Pratt & Whitney / Space Propulsion, San Jose,
September 2002 to September 2003
CA UTC announced the closure of this site in September 2003.

- Laboratory Director for Pratt & Whitney’s CDHS-ELAP Certification.
- Responsible for both sampling and analysis for Pratt & Whitney’s in-house environmental Laboratory established to support the cleanup and monitoring of their Metcalf Road Site.
- Turn around time for sample analysis was cut 47% by restructuring the sample reporting, both hard copy and electronic deliverables. Setup a Dionex 500 Ion Chromatograph to electronically transfer data to the in-house LIMS based on MS Access.
- Work Instructions reviewed and updated for ISO 9001 certification.
- Received my 40hour HazWoper training.
- Troubleshooting all analyses.
- Setup a new GC/MS volatiles system for EPA 8260B Agilent 6890 GC / Agilent 5973 MS / Varian Archon auto-sampler
- Method development for 1,4-Dioxane at a 1ppb level in water.

Laboratory Operations Manager.
Entech Analytical Labs, Inc.
December 2001 to September 2002

- Reviewing analytical systems for technical correctness, increased productivity, and cost cutting.
- Configured HP-ChemStation and Excel to electronically transfer data to Entech's LIMS(SampleMaster).

Laboratory Manager and founding principal with varied responsibilities.
AN/EN, Inc. as a quality environmental analytical laboratory.
May 1990 to December 2002
Closed the Laboratory in December 2002 due to illness in the family

- Technical - Chemical Analyses
- Setup GC analytical systems based on EPA methods (SW-846)
- Established QA/QC programs including databases and reporting. Certification from the State of California, Dept. of Health Services, Environmental Laboratory Accreditation Program. ELAP Cert. #1183
- Proficiency Evaluation consistently scored 100%
- Technical - Computers and Information Management.
- Installed all computer hardware systems including networking.
- Hardware and software installation for GC data acquisition, processing, and reporting.
- Database design.
- Administrative
- Establish AN/EN, Inc. as a California Corporation (Sub-chapter S).
- Articles of Incorporation with the Sec. of State.
- By-laws.
- Issuance of stock certificates.
- Setting up accounting systems including A/R, A/P, Payroll.
- Estimated initial startup cost for facilities and equipment.
- Secured funding.
- Designed and secured permitting for AN/EN's laboratory facilities.
- Hazardous Materials Management Plan for Monterey and Santa Cruz Counties.
- Business Response Plan.
- Chemical Hygiene Plan.
- Sales and Marketing.
- Brochure design, printing, mailing.
- Customer service and satisfaction.

ToxScan Inc. Watsonville, CA 95076
1988 to 1990

- Sample control system designed and implemented.
- Administrative operations and personnel.
- SOP with QC guidelines for inorganic and organic analyses.
- Performed volatile and semi-volatile analyses.

City of Santa Cruz Pollution Control Facility.
1987 to 1988

- Routine plant monitoring, chemical and biological.
- Analyses for NPDES ocean outfall monitoring.
- Sample collection both fresh and ocean water.

Leader of the Inorganic section.
Emcon Associates, San Jose, CA 95131
1985 to 1987

- Wrote standard operational procedures for inorganic analyses.
- Supervised and trained chemists on AA Spectrophotometer.
- Supervised and trained chemists on TOC Analyzer.

GUERGANA I. GUEORGUIEVA
Quality Assurance Manager

EDUCATION

- Master of Science in Chemistry, Bulgaria, Europe 1992
- Certificate program of Bioinformatics, UCSC Extension, Cupertino, CA 2007
- Good Clinical Practice (GCP), UCSC Extension, Cupertino, CA 2008
- Drug Development Process, ROCHE Bioscience, Palo Alto, CA 2009
- Clinical Trial Site Monitoring, UCSC Extension, Cupertino, CA 2009

Additional courses/ certificates 2001 – 2007

- H5928A Agilent HPLCChem Station Data Analysis and Reporting, H5313A Agilent Intro to Mass
- Spectral Interpretation I and II, HPLC Laboratory Technique, DNA Electrophoresis Systems
- The Practice of Modern HPLC, LC Resources, CA
- Advanced HPLC Method Development, LC Resources, CA
- Introductory Molecular Biology, UCSC Extension, CA
- Bioinformatics Tools, Databases and Methods, UCSC Extension, CA
- Data Analysis, Modeling and Visualization for Bioinformatics, UCSC Extension, CA
- Experimental Methods in Molecular Biology, UCSC Extension, CA
- Gene Expression and Pathways, UCSC Extension, CA
- In Silico Approaches for Target Discovery, UCSC Extension, CA

EXPERIENCE

Quality Assurance Manager
Accutest Laboratories, San Jose, CA
August 2010-Present

- Implement and revise QA plan through the company. Coordinate and oversees the data quality and corrective action , review quality control data to determine if test is acceptable. Update all quality control markers; accuracy, precision and method detection limits, QSM, SOPs, Documentation Control, CAPA, Change Control Requests (CCR). Review Quality Assurance Project Plans(QAPP) per client request.
- Perform quality assessments, inspections, quality reviews and root-cause analysis.
- Conduct training and orientation.
- Periodically perform internal system audit to assure compliance with quality assuarance plan. Generate audit report with list of observations and corrective actions, oversees correction of performance audit. Prepare quality reports to

management, clients and regulatory agencies. Review new or proposed protocols to determine appropriate use, review in house method validation performance and data.
- Communicate with regulatory agency auditors during and after audit. Report PE studies to regulatory agencies. Issuance of new SOP revisions.
- Responsible for developing and maintaining of the Corrective Action and Non-Compliance Tracking systems.
- Manage all electronic audit related documentation, including audit plans, audit reports, certificates, responses to findings, and closure documentation, for each audit.
- Keep up to date company certification. Review and keep up to date regulatory publication and abstracts to stay abreast of regulatory changes in the industry. Recommend program improvement or correction.

Research Associate/Analytical Development Chemist
Relypsa, Santa Clara, CA
Dec 2009–July 2010

- Provide support to the internal development CMC team. Bioanalytical support in preclinical research, discovery and development of novel non-absorbed polymeric drugs for important applications in cardiovascular and renal disease.
- LC/MS/MS(Quadropole) for quantization of small molecules in biological samples, HPLC, ICS-3000 quantitative analysis, perform in-vivo/in-vitro sample analysis to support the efficacystudies, data analysis/interpretation and instruments troubleshooting, buffer preparation.
- Particle size characterization, TGA.

Research Associate III /QA
Hoffmann-La Roche /Roche Bioscience, Palo Alto, CA
March 2005–Oct 2009

- Supporting small molecule drug development from discovery to early clinical phase.
- Reviewed and Validated GMP data of raw materials and process intermediates. Reviewed, revised and wrote analytical methods and SOPs.
- Developed analytical methods to analyze raw materials, solvents, and process intermediates for GMP synthesis.
- Utilized HPLC, LC/MS, IC, GC, GC/MS, UPLC(UltraPerformanceLC), Super Critical Fluid Chromatography for chiral separation.
- Performed GMP analysis of raw materials, Active Pharmaceutical Ingredients (APIs), the irintermediates, and impurities upon receipt. Entered the data in Laboratory Information Management Systems (LIMS). Experienced with 21 CFR 11 electronic data management and archival of HPLC data.
- Maintain electronic records and paper archives (lot history records, reports, logbooks) Member of the safety committee. Conducted safety audits to ensure employees' compliance with the safety guidelines and protocols.

- Performed internal laboratory inspection to ensure GMP compliance and laboratory safety.
- Responsible for scheduling PM on all HPLC Systems and performed annual systems qualifications .Ordering supplies for operation of the laboratory.

Quality Assurance Manager/Data Validation Specialist
Entech Environmental Analytical Labs, Santa Clara, CA,
1999 -2005

- Submission and approval of new method registrations, Certificate renewals.
- Ensured the processes for the QMS (Quality Management System) are established, implemented and maintained.
- Conducted audits according to the audit plans. Oversaw external auditors/Inspectors schedules and organizing audits.
- Validated customer reports and project deliverables before issue (sample basis).Maintain all regulatory Return Materials Authorization (RMA).
- Administered and maintained the quality documents and records including SOPs or other quality documents received by external clients.
- Supervised QA approval of SOPs before issue.
- Managed a group of data entry analysts and conducted OJT training

Chemist Lab Assistant
Oral-B Laboratories, Belmont, CA
1998

Chemist/Project Manager
MVSS Medicus OOD/Hoffmann-La Roche Wien GmbH, Bulgaria
1992 -1997

APPENDIX C

FIELD DOCUMENTATION FORMS

PM Jeff Fenton
Ft. Ord. GW monitoring Q406
12/14

Team 2
SB/JK
Sounder 36392.
Cor. -.06

0746 @ MW-02-04-180 WL - 94.57
SN2 @ 103' Cor - -.06

0757 Sampled # 065ØLØØ2Ø24F
Dropped 1@2

0808 @ MW-12-05-180 WL - 74.61
SN3 @ 88' Cor - -.06

0820 sampled # 0650L012025F & 026D
Dropped 1@3

0835 @ MW-10-04-180 WL - 259.75
SN2 @ 271' Cor. -.06

0845 sampled # 0650L010027F
Dropped 1@2

0902 @ MW-002-25-A WL - 129.38
SN4 @ 146' Cor. -.06

0910 sampled # Ø65ØL002Ø28F
Dropped 1@4

0919 @ MW-002-53-180 WL-204.09
SN5 @ 259' Cor. -.06

0927 sampled # 065Ø002Ø29F
Dropped 1@5

0934 @ MW-002-39-180 WL- 203.99
SN 4 @ 244' Cor. -.06

0943 sampled # Ø65ØL002Ø3ØF
Dropped 1@4

Team 2
SB/JK
12/14/06

0950 @ MW-002-24-180 WL - 187.97
SN 3 @ 214 Cor. -.06

1002 sampled # Ø65ØL002Ø31F
Dropped 1@3

1009 @ MW-002-09-180R
SN2 @ 199' WL - 156.08
Cor. -.06

1022
1024 sampled # Ø65ØL002Ø32F & Ø33D
Dropped 1@2

1029 @ MW-002-06-A WL-106.26
SN6 @ 128' Cor. -.06

1039 Sampled # Ø65ØL002Ø34F
Dropped 1@6

1046 @ MW-002-06-180R WL-157.87
SN 4 @ 214' Cor. -.06

1053 sampled # Ø65Ø002Ø35F (MS/MSD)
Dropped 1@4

1110 @ MW-002-07-180R WL-182.36
SN3 @ 233' Cor. -.06

1117 sampled # 0650L002036F
Dropped 1@3

1123 @ MW-002-05-180 WL-155.49
SN4@ 215' Cor. -.06

1130 sampled # Ø65ØL002Ø37F
Dropped 1@1

Project: _____ Job No.: _____
Subject: FIELD INVESTIGATION DAILY REPORT Date: _____
Equipment Rental: _____ Company: _____ To: _____
Equipment Hours: _____ F.E. Time from: _____ to: _____ By: _____

(Outside service and expense record must be attached for any outside costs)

Attachments:

Initial

Water Level Field Data Worksheet

Sampling DB; Version 7EX

For Event: WL2008Q2, 2008 2nd Quarter water levels

Team: 1 Sounder Serial #:_____ Calibration Diff :_____ Initials::_____ Scheduled Sampling Date: 06/23/ 2008

Station Name	Plate #	Notes	Avg. DTW (ft)	Date	Time	Measured DTW:1	Measured DTW: 2	Calibration Difference from Steel Tape	Calc. DTW	Total Depth (ft)	Measured Total Depth	Comments
MW-B-02-A	2		67							80.		
MW-B-05-180	4		126							210.		
MW-BW-67-A	4		77							88.		
MW-BW-66-A	4		52							67.5		
MW-BW-44-A	4		69							85.		
MW-BW-43-A	4		23							39.		
MW-BW-42-A	4		45							58.		
MW-BW-59-A	4		35							69.		
MW-BW-39-A	4	Biosensitive	32							57.		
MW-B-12-A	4		51							75.		
MW-BW-35-A	4	Biosensitive	60							91.		
MW-BW-36-A	4	Biosensitive	63							87.		
MW-BW-54-180	4		134							201.		
MW-BW-31-A	4	Biosensitive	68							96.5		
MW-BW-32-A	4	Biosensitive	55							83.		
MW-BW-27-A	7		90							111.		
MW-BW-15-A	7		78							104.5		
MW-BW-29-180	7		156							221.		
MW-BW-55-180	7		152							201.5		
MW-B-14-A	7		73							101.		
MW-BW-60-A	7		70							95.		
MW-BW-21-180	7		152							196.4		
MW-BW-28-A	7		74							104.2		
MW-BW-10-A	4		76							105.		
MW-BW-58-A	8		62							90.		

Reviewed by _____ Date _____

MACTEC

Passive Diffusion Sampler (PDS) Groundwater Sampling Form
Former Fort Ord Groundwater Sampling Program

Project_Task Number: 4084086506 Well Name: _____ Number of Bag Stations: _____

Task Manager: Jeff Fenton Sampled By: _____ (Team Members Initials) Depth to Water: _____

Recorded By: _____ (Signature) Sample Date: 6/ /08 Depth to 1st Sample Bag : _____ Station Number

Reviewed By: _____ (Signature) / (Initials) Sample Time: Start: _____ Water Level Indicator Serial #: _____

Finish: _____ Team Number: _____

	Sample #	Vol./Cont.	Analysis	Pres.	Lab	Comments	Bags Replaced
Bag 1							Bag 1 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 2							Bag 2 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 3							Bag 3 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 4							Bag 4 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 5							Bag 5 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 6							Bag 6 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 7							Bag 7 Date:
							Lot #:
Hydrasleeve ☐							# of bags:
Bag 8							Bag 8 Date:
							Lot #:
Hydrasleeve ☐							# of bags:

QUALITY CONTROL SAMPLES

Duplicate Samples		Blank Sample		Other Samples	
Original Sample No.	Duplicate Sample No.	Type	Sample No.	Type	Sample No.

General Comments: _____ Cooler Temp.: _____

MACTEC

Groundwater Sampling and Pressure Levels Form for Westbay Wells

Project Number: _____ **Well Name:** MP - BW - _____ **Client:** USACE

Task Manager: _____ **Sample Date:** ____ / ____ / ____ **Location:** Former Fort Ord

Technicians: _____ **Barometric Pressure:** _____ **Probe Type:** West Bay

Recorded By: _____ / _____ **Sample Time:** **Start:** _____ **DTW:** _____
(Signature) (Initials) **Finish:** _____

Reviewed By: _____ / _____ **Probe Serial No.:** _____
(Signature) (Initials)

Sample # First Port: _____

Port Identification			Surface Functioning Tests (Probe in Flushing Collar)						Position Sampler	Pressure Test and Sample Collection Check at Port (Pressure Test)				(Sample Collection)				
Port No.	Port Name	Port Depth (Cable)	Arm Out Land Probe Shoe Out	Close Valve	Check Vacuum	Open Valve	Evacuate Container	Close Valve Shoe In	1. Locate Port 2. Arm Out 3. Land Probe	Pressure in MP (Internal)	Shoe Out	Zone Pressure (External)	Open Valve	Zone Pressure (External)	Close Valve	Shoe In	Pressure in MP (Internal)	Last 4 Digits of Sample #
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		

General Comments: **Cooler Temp:** °C

QC Sample # Associated Sample:

Second Quarter, 2008
4084086506 02.1.1

Fort Ord Quarterly Groundwater Monitoring Program

Water Level Indicator Calibration by Steel Tape

Well #:	
Steel Tape DTW:	
Date:	

Serial No.	Measured DTW	Calibration Differential

Reviewed by:	
Date:	

UNITED STATES ARMY CORPS OF ENGINEERS
PROJECT SITE SAFETY LOG

GENERAL DATA

Job # _____

Activity _____

Location Description _____

_____

DOCUMENTATION OF DAILY MORNING SAFETY MEETING:
TOPICS OF DISCUSSION (check all that apply)

_____scope of work/SAP
_____potential hazards
_____health and safety plan highlights/revisions
_____emergency procedures
_____PPE requirements
_____equipment calibration
_____special topics (specify)_____
_____

MEETING ATTENDEES:

NAME	DATE	COMPANY	SIGNATURE

DAILY INSPECTIONS: (Site crew chief shall initial each completed inspection)

_____PPE
_____field equipment
_____vehicles
_____safety equipment
_____field health and safety binder in vehicle
_____first aid kit
_____required eyewash station filled, and charged
_____fire extinguisher
_____communication check
method_____
time_____

Note any deficiencies:

_____
_____

I acknowledge that the above health and safety program self audit and inspections have been performed prior to the initiation of scheduled work.

Signature of Site Health and Safety Officer (SHSO)_____

LIST OF AUTHORIZED VISITORS NOT NORMALLY ASSIGNED TO THIS SITE

(Note: SHSO must initial verification that each personnel record is present in the field binder.)

NAME	HAZWOPER CERTIFICATION	MEDICAL CLEARANCE	RESPIRATOR FIT TEST	FIRST AID/CPR

MACTEC

FORMER FORT ORD COMPLEX
TASK SPECIFIC HEALTH AND SAFETY WORKSHEET
SUPPLEMENT TO THE PROGRAM HEALTH AND SAFETY PLAN

This worksheet shall be used in conjunction with the MACTEC Engineering and Consulting, Inc. (MACTEC) Draft Final Program Health and Safety Plan (HASP), November 2004, the MACTEC Health and Safety Policy and Procedure Manual, the U.S. Army Corps of Engineers Safety and Health Manual, EM 385-1-1, November 2003, and additional MACTEC addendums.

GENERAL PROJECT INFORMATION

Project Number:_____ Date:_____
Site or Activity Description:_____ Prepared by:_____
_____
Location Description:_____ Reviewed by:_____

TASK DESCRIPTION (Check all that apply)

_____Sample Location Marking
_____Geophysics borehole clearance
_____Biological borehole clearance
_____Monitoring well installation
_____Soil Borings
_____Trenching
_____Hand augering
_____Soil gas survey
_____Geophysics
_____Groundwater sampling
_____Soil sampling
_____Other (specify)_____
____Water level surveys
____Sediment sampling
____Biological inventory
____Hazardous waste handing /mgmt
____Hydropunch

SITE HAZARDS (check all that apply)

_____Contaminated water
- ____VOC
- ____SOC
- ____Metals
- ____PCB
- ____Pesticides
- ____Petroleum
- ____Chlorinated hydrocarbons
- ____Other (specify_____

_____Contaminated Soil
- ____VOC
- ____SOC
- ____Metals
- ____PCB
- ____Pesticides
- ____Petroleum
- ____Chlorinated hydrocarbons
- ____Other (specify)_____

_____Contaminated Air
- ____VOC
- ____SOC
- ____Metals
- ____PCB
- ____Pesticides
- ____Petroleum
- ____Chlorinated hydrocarbons
- ____Other (specify)_____

_____Ionizing radiation (specify)_____
_____
_____Non-ionizing radiation (specify)
_____
_____Noise
_____Biological hazards (specify)_____
_____
_____Temperature extremes Heat_____Cold_____
_____Overhead/underground utilities
_____Vehicle traffic
_____Air traffic/noise
_____Unexploded ordnance (UXO)
_____Equipment/mechanical
_____Other (specify)_____
_____

LEVEL OF PROTECTION REQUIRED (A, B, C, or D) _____minimum_____maximum
PPE REQUIRED (Check all that apply)

Head:_____hardhat
Eye: _____safety glasses
_____chemical goggles
_____faceshield
Ear: _____earplug
_____earmuff
Foot: _____steel-toed boots (specify)_____
_____disposable overbooties (specify)_____
Hand: _____gloves (check type)
_____Neoprene
_____Viton
_____Nitrile
_____PVC
_____Underglove (type)_____
_____Other (specify)_____

Body: _____fully encapsulated suit
_____two-piece rainsuit
_____apron
_____tyvek suit
_____Saranex suit
_____hooded tyvek suit
_____hooded Saranex suit
_____hooded polyethylene suit
_____cloth overalls
_____high visibility vest
_____Other (specify)_____

Respiratory: _____SCBA (pressure demand)
_____airline respiratory (pressure demand)
_____full face respirator, cartridge=____
_____half mask respirator cartridge=____
_____escape mask/bottle (specify)_____

OTHER SAFETY EQUIPMENT REQUIRED (Check all that apply)

_____ventilation blower/fan
_____traffic cones
_____barrier tape
_____blast alarm
_____ground fault circuit interrupter
_____lifeline with harness
_____radiation dosimeter
_____first aid kit
_____fire extinguisher
_____emergency eye wash
_____cellular telephone
_____Other (specify)_____

REQUIRED CLEARANCES

_____Utilities Date Completed:_____
_____Biological Date Completed:_____
_____Airfield Date Completed:_____
_____UXO/EOD Date Completed:_____
_____Military Operations Date Completed:_____
_____Vehicle traffic area: Date Completed:_____
_____Archaeological: Date Completed:_____
_____Other (specify):_____Date Completed:_____

LIST OF PERSONNEL ASSIGNED TO SITE AND RECORDS VERIFICATION

(Note: SHSO must initial verification that each personnel record is present in field binder.)

NAME	HAZWOPER CERTIFICATION	MEDICAL CLEARANCE	RESPIRATOR FIT TEST	FIRST AID/CPR	CELL PHONE NUMBER

I have read and become familiar with all aspects of the Safety, Health, and Emergency Response Plan (SHERP) and Site Specific Health and Safety Plan (HASP). I also understand that the SHERP may be supplemented with other site-specific health and safety documents for which I will be held equally responsible.

NAME	DATE	COMPANY	SIGNATURE

FORT ORD MUNITIONS AND EXPLOSIVES OF CONCERN (MEC)
INCIDENT REPORTING FORM

If you recognize any object that resembles munitions or explosives on current or former Fort Ord property, retreat to a safe location, and report the finding to the **appropriate agencies immediately** (see below)

A. PROVIDE THE FOLLOWING INFORMATION:

Name of Person Reporting:	Telephone:
Agency:	Fax:
Date & Time of Incident/Discovery:	
Description of Item Found (refer to the "Safety Alert" pamphlet if possible):	
Location (direction from nearest road/building, attach map if possible):	
GPS Coordinate Location: (Type of Instrument, NAD83 California State Plan Coordinates Zone IV, feet)	
Describe how the item was found:	

CONTACT THE APPROPRIATE AGENCIES IMMEDIATELY:

Initial when completed	Mon– Thu (6 a.m. – 5 p.m.) Contact and FAX Form to:	Contact Number	Date & Time Called
	USACE Ordnance Safety Specialist or MMRP Site Safety Manager	Ph: (831) 884-9925 ext.226 Cell: (831) 760-2571 Fax:(831) 884-9030 Ph: (831) 242-7919 Fax:(831) 242-7019 Cell: (831) 760-2575	
	Fri – Sun (24 Hours) 60th Civ Engr Sqdn EOD	Phone: (707) 424-5517	
	Note: If 60th Civ Engr Sqdn EOD is contacted, notify the MMRP Site Safety Manager: (831) 242-7919, Cell (831) 760-2575.		

B. To be completed by USACE Ordnance Safety Specialist when applicable (Mon – Thu)

Form Received By:		Date & Time:
Identification of Item Found:		
Extent of Area Surveyed:		Name of digital file for picture (date):
Disposition of Item:		
Fax completed form to MMRP Site Safety Mgr Bldg 4463 Gigling Rd, POM (Fort Ord) when response complete	Fax: (831) 242-7091 Phone: (831) 242-7919	Date & Time:

C. To be completed by MMRP Site Safety Manager:

Acknowledge Completed Form Received:	Date & Time:
Regulatory Agencies Notified (Date):	

MACTEC

5341 Old Redwood Highway
Suite 300
Petaluma, CA 94954
(707) 793-3800

CHAIN OF CUSTODY FORM

Seq. No.: № 1189

Samplers: _____

Lab: _____

Job Number: _____

Name/Location: _____

Project Manager: _____ Recorder: _____
(Signature Required)

MATRIX				# CONTAINERS & PRESERV.						SAMPLE NUMBER		DATE				STATION DESCRIPTION		ANALYSIS REQUESTED
Water	Soil	Air		Unpres.	H_2SO_4	HNO_3	HCL			YR	SEQ	YR	MO	DAY	TIME		DEPTH	

ADDITIONAL INFORMATION

SAMPLE NUMBER		TURNAROUND TIME/ REMARKS
YR	SEQ	

CHAIN OF CUSTODY RECORD

Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time

Method of Shipment:

Laboratory Copy Project Office Copy Field or Office Copy

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

MACTEC E&C 4084086506 02.1.2
Ft. Ord GW Monitoring-
Samplers:
Date: Time:_____
Sample #:

Field Work Variance No. _____

Page 2 of 2

FIELD WORK VARIANCE CONTINUATION SHEET

Continue FWV discussions below by noting section title(s) to be continued (i.e., Problem Description, Solution/disposition, Final Disposition, etc). Use additional continuation sheets as needed.

APPENDIX D

THREE PHASE QUALITY CONTROL PROCESS AND DOCUMENTATION

AHTNA Engineering Services
California Environmental Operations
Procedure 2: Three Phase Quality Control

Background

Three-phase quality control (QC) activities are required for the performance of contract work for the US Army Corps of Engineers (USACE). In addition, three-phase procedures represent best practices at non-USACE projects for planning, performing and verifying work quality. Although USACE three-phase QC requirements were initially designed for construction projects, procedures can be applied to non-construction type projects as well. This procedure provides implementation tools that represent a generalized approach for both construction and non-construction projects. Project-specific requirements may supersede the requirements of this procedure, which represents minimum standards for California Environmental Operations QC activities.

Attachments

- Attachment 1 – Submittal Register
- Attachment 2 – Three Phase Checklist for Investigation, Monitoring and O&M projects
- Attachment 3 – Three Phase Checklist for Construction or Excavation projects.

Related Procedures

- Quality Procedure 1: Quality Control Plan
- Quality Procedure 3: Document Quality Control

Overview of Three-phase requirements

The three-phases of QC are the (1) Preparatory Phase (2) Initial phase and (3) Follow-up phase. Each control phase is important for obtaining a quality product. However, the preparatory and initial inspections are particularly valuable in preventing problems. Three-phase QC inspections are applicable to definable features of work (DFW) for the project. Therefore, the first step in developing three-phase QC procedures for each project is to develop a list of the DFWs.

Implementation of three-phase requirements for each project is the responsibility of the project manager. Specifically, identification of the DFWs, development of the submittal register, scheduling of inspections and assignment of QC activities to project staff shall by the responsibility of the project manager. However, the project manager may delegate three-phase quality control activities to the project QC Manager or QC Reviewer, and project staff as appropriate. In particular, quality audits are to be conducted by the QC Manager or QC Reviewer.

The following sections of this procedure provide additional details regarding DFW identification, submittal register preparation, and three-phase inspection activities.

Definable Features of Work

A DFW is a task or activity that is separate and distinct from other tasks and has a separate control requirement, or results in a physical product or deliverable. For construction projects, the DFW list shall be linked to the construction schedule. When more than one subcontractor is involved with a task or activity, then the DFW list must indicate so.

Project-specific safety and health requirements are detailed in the separate Safety and Health plan required for each project. As such, DFW listings do not describe specific safety and health activities; however, the DFW and associated three-phase inspections will serve to verify safety and health activities are being conducted as required.

The following are example DFW lists for three different common project types. Each project shall create a detailed project-specific DFW list, which may include additional tasks or activities.

Investigation or Monitoring:

1. Safety and Health
2. Permitting
3. Site clearance
4. Mobilization
5. Drilling
6. Sampling
7. Demobilization
8. Analysis
9. Reporting

Excavation

1. Safety and health
2. Pre-construction preparation activities
3. Permitting
4. Mobilization
5. Site preparation
6. Clearing and grubbing
7. Demolition and removal of above ground items
8. Excavation of impacted fill material
9. Transportation and disposal of impacted fill material
10. Backfill and utility replacement
11. Restoration
12. Demobilization
13. Reporting

Construction

1. Safety and health
2. Pre-construction preparation activities
3. Permitting
4. Mobilization
5. Site preparation
6. Grading
7. Pad installation
8. Building construction
9. Plumbing
10. Electrical
11. Communication (phone and data)
12. Site clean-up and restoration
13. Demobilization
14. Reporting

Submittal Register

Contract required deliverables shall be tracked on a submittal register. A blank USACE submittal register (engineering form 4288) is included as **Attachment 1** of this procedure. Alternate submittal register forms may be used, depending on project- or contract-specific requirements.

Three-Phase Inspections

The three phase inspections process includes the (1) preparatory phase (2) initial phase and (3) follow-up phase. Generalized guidelines contained in this procedure represent minimal expectations for identifying inspection activities. **Attachment 2** contains a three-phase checklist for investigation, monitoring and operation and maintenance (O&M) projects. **Attachment 3** is a checklist for construction or excavation projects. These example checklists shall be modified as appropriate to meet project specific requirements or activities.

Preparatory Phase

Prior to performing each previously identified DFW, using the checklist in Attachment 2, the Project Manager or designee is responsible for verifying technical requirements have been planned and work prerequisites have been identified and met. Discrepancies between existing conditions and approved plans/procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions identified during a preparatory inspection are to be verified by the Project Manager or designee. Notification of the USACE is required at least 48 hours in advance of the start of each definable feature of work. Additionally, the Project Chemist will hold a kick-off meeting with the analytical laboratory to discuss the data quality and deliverable requirements for the project.

Initial Phase

During the first day a DFW is performed, the project team is to monitor the work being done and verify compliance with the specifications and requirements of the contract, delivery order, and approved plan and procedures. The Project Manager or designee is responsible for verifying discrepancies between site practices and approved specifications are identified and resolved. Corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the Project Manager or designee (project chemist, engineer, or scientist) prior to granting approval to proceed. Client notification of the initial phase inspection is required at least 48 hours in advance.

Follow-up Phase

During each day of field activities, the Project Manager or designee is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the contract, delivery order, and approved project plans and procedures. During follow-up phase inspections, the Project Manager or designee is also responsible for verifying a daily health and safety (H&S) inspection is performed and documented as required by the site health and safety plan. Discrepancies between site practices and approved plans/procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the Project Manager prior to granting approval to continue work.

Documentation

A copy of each three-phase inspection checklist for each DFW for which they are required shall be stored in project files in both hardcopy and electronic form.

ATTACHMENT 1: SUBMITTAL REGISTER

SUBMITTAL REGISTER

CONTRACT NUMBER

TITLE AND LOCATION

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION OF ITEMS SUBMITTED	Paragraph	Classification Govt or A/E Reviewer	CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR ----- DATE RCD FROM APPR AUTH	REMARKS
						SUBMIT	APPR NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE TO APPR AUTH ----- DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION			
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)		(Q)	(R)

ATTACHMENT 2
THREE PHASE CHECKLISTS
INVESTIGATION, MONITORING, O&M PROJECTS

INVESTIGATION, MONITORING, O&M PROJECTS
PREPARATORY PHASE INSPECTION COVER SHEET

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

B. Submittals:

1. Review submittals and/or submittal register. Have all applicable submittals been approved? Yes___ No___

If No, what items have not been submitted?

a. _____
b. _____
c. _____

_____ _____
USACE Representative Signature Quality Control Manager Signature

INVESTIGATION, MONITORING, O&M PROJECTS: PREPARATORY PHASE INSPECTION CHECKLIST				
Assessment Activity	**Assessment Mechanism**	**Person(s) Responsible**	**Response Action**	**Completed by/Date**
Have planning documents been prepared in accordance with the statement of work, regulatory requirements, and contract requirements?	Quality control review of document by Project Manager and QC reviewer.	Project Manager, QC Reviewer	Modify document as directed by reviewers	
Prior to project activities: Have planning documents been read by appropriate project personnel (including subcontractors) before work is conducted.	Documentation (e.g., sign-off form, note to file, email acknowledgement) that document has been read and requirements are understood.	Subcontractors as required. Project Manager, Task Manager, and Project Chemist to check signoff and forms.	Direct project personnel to read relevant documents.	
Prior to project activities: Has required preliminary work (e.g., clearance activities, permits, site access) been completed in accordance with project plan.	Comparison of information obtained from preliminary work completion assessment as specified in the project planning document(s).	Project Manager, Safety and Health Officer, QC Manger/Reviewer, Task Manager, Project Chemist, Field Staff	Delay startup if necessary preliminary work has not been completed. Implement corrective actions by directing appropriate personnel or subcontractors to complete necessary preliminary work.	
Prior to project activities: Are staff and subcontractors prepared to implement project activities according to planning documents?	Review and discussion of planned activities prior to implementation.	Project Manager, Safety and Health Officer, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Delay startup if staff and subcontractors are not prepared to implement activities *in* accordance with specification.	
Prior to project activities: Is necessary field equipment available and in acceptable working order?	Compare field equipment list with planned activities. Compare field equipment calibration documentation with project goals specified in the SAP.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Delay startup if equipment is unavailable or not in proper working order. Implement corrective actions to include use of alternate equipment, or recalibration of available equipment.	

INVESTIGATION, MONITORING, O&M PROJECTS
INITIAL PHASE INSPECTION COVER SHEET

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

Description and Location of Work Inspected: _____

_____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

_____
Quality Control Manager Signature

INVESTIGATION, MONITORING, O&M PROJECTS: INITIAL PHASE INSPECTION CHECKLIST				
Assessment Activity	**Assessment Mechanism**	**Person(s) Responsible**	**Response Action**	**Completed by/Date**
Beginning of project activity: Is work being performed according to project plans?	Conduct field and laboratory audits.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Stop work if audits indicate significant deviation from project plan. Implement immediate or long- term corrective actions. Communicate deficiencies to USACE Project Manager.	
Early phase of project: Have necessary audits been performed?	Review project phase and check to see if required audits have *been* satisfactorily completed.	Project Manager, Project Manager, Quality Control System Manager	Stop work if reviewer decides that absence of audit jeopardizes successful implementation of project plans. Immediately schedule necessary audits.	
Ongoing throughout project: Are daily quality control reports being prepared according to contract requirements?	Review Content and delivery schedules of daily quality control reports.	Project Manager, Task Manager, Project Chemist, Project Staff	Correct deficiencies in reports or reporting delays.	
Ongoing throughout project: Do project plans adequately address any changes in project activities or goal?	Compare data gathered to assess conformance to the project plan and conceptual site model.	Project Manager, Safety and Health Officer, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Stop work if assessor decides that project plan deficiencies are significant. Implement corrective action to include modification of project plans. Notify USACE Project Manager.	
Ongoing throughout project: Do project plans adequately address any changes in project activities or goals?	Compare data gathered to assess conformance to the conceptual site model, data quality objectives, and project plan.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, data users and evaluators.	Propose additional data collection activities to fill data gaps. Notify USACE Project Manager. Revise or update planning documents as appropriate.	

INVESTIGATION, MONITORING, O&M PROJECTS
FOLLOW-UP PHASE INSPECTION COVER SHEET

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

Project/Area of Inspection: _____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

B. Definable Features of Work: Status of Inspection:

_____

_____

Quality Control Manager

INVESTIGATION PROJECT FOLLOW-UP PHASE INSPECTION CHECKLIST				
Assessment Activity	**Assessment Mechanism**	**Person(s) Responsible**	**Response Action**	**Completed by/Date**
Reporting phase of project: Have data reports been prepared in accordance with project plans?	Compare data reports to specifications detailed in planning documents.	Project Manager, Quality Control Manager, Task Manager, Project Chemist, data users and evaluators.	Revise documents and reports as appropriate.	
After draft report submittal or project completion: Are reports adequate to meet client and regulatory agency requirements?	Review client and agency comments. Prepare responses to comments.	Project Manager, Quality Control Manager, Task Manager, Project Chemist, data users and evaluators.	Revise documents and reports as appropriate.	
Have other definable features of work been completed in accordance to project requirements	Compare definable features of work with project requirements.	Project Manager, Quality Control Manager	Complete definable feature of work as required.	

ATTACHMENT 3
THREE PHASE CHECKLISTS
CONSTRUCTION AND INVESTIGATION

CONSTRUCTION PROJECT PREPARATORY PHASE INSPECTION

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

C. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			

(List additional personnel on reverse side)

D. Submittals:

1. Review submittals and/or submittal register. Have all applicable submittals been approved? Yes___ No___

   If No, what items have not been submitted?

   a. _____
   b. _____
   c. _____

2. Are all materials on hand? Yes___ No___

   If No, what items are missing?

   a. _____
   b. _____
   c. _____

3. Check approved submittals against delivered materials. (This should be done as materials arrive.)

   Comments: _____

E. Material Storage:

1. Are materials stored properly? Yes___ No___

   If No, what actions were taken?

   a. _____
   b. _____
   c. _____

F. Specifications:

1. Review each paragraph of Specification.

2. Discuss procedure for accomplishing the work.

3. Clarify any differences.

_____

_____

_____

G. Preliminary Work and Permits:

1. Ensure preliminary work is correct and permits are on file. Yes___ No___

   If No, what actions were taken?

   a. _____
   b. _____
   c. _____

H. Testing:

1. Identify test to be performed, frequency, and by whom.

_____

_____

2. When is the test required?

_____

_____

3. Where is the test required?

_____

_____

4. Review testing plan.

_____

_____

5. Have test facilities been approved?

_____

_____

I. Safety:

1. Review applicable portion of the Task order Site Health and Safety Plan.

_____

_____

_____

2. Activity Hazard Analysis approved? Yes___ No___

J. USACE Comments During Meeting:

_____

_____

_____

_____

_____ _____

USACE Representative Signature Quality Control Manager Signature

CONSTRUCTION PROJECT INITIAL PHASE INSPECTION

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

Description and Location of Work Inspected: _____

_____

Reference Contract Drawings: _____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			

B. Materials used are in strict compliance with the contract plans and specifications: Yes ___ No ___

If not, explain: _____

_____

_____

_____

C. Procedures and/or work methods witnessed are in strict compliance with the contract specifications:
Yes ___ No ___

If not, explain: _____

_____

_____

_____

D. Workmanship is acceptable: Yes ___ No ___

State where improvement is needed: _____

_____

_____

_____

E. Workmanship is free of safety violations: Yes ___ No ___

If no, corrective action taken: _____

_____

_____

_____

_____

Quality Control Manager

CONSTRUCTION PROJECT FOLLOW-UP PHASE INSPECTION

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

Project/Area of Inspection: _____

A. Definable Features of Work: Status of Inspection:

_____

_____

Quality Control Manager

B. Final Acceptance is Approved, Subject to the Correction of the Punch List Items Below:

_____

CONSTRUCTION PROJECT FOLLOW-UP PHASE INSPECTION

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

I. Persons in Attendance: See Meeting Attendance List (attached).

II. Resolution of Punch List Items:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

_____
Quality Control Manager

CONSTRUCTION PROJECT FOLLOW-UP MEETING ATTENDANCE LIST

Contract No.: _____ Date: _____
Task No.: _____
Location/Project: _____

Meeting: _____

Name	Organization	Phone Number

REWORK ITEMS LIST

Contract No. and Title: ____________________

Contractor: ____________________

NUMBER	DATE IDENTIFIED	DESCRIPTION	CONTRACT REQUIREMENT (Spec. Section and Par. No., Drawing No. and Detail No., etc.)	ACTION TAKEN BY QC MANAGER	RESOLUTION	DATE COMPLETED

CONTRACTOR PRODUCTION REPORT

(CONTINUATION SHEET)

DATE

CONTRACT NO	TITLE AND LOCATION	REPORT NO

CONTRACTOR		SUPERINTENDENT	
AM WEATHER	PM WEATHER	MAX TEMP F	MIN. TEMP F

WORK PERFORMED TODAY

Schedule Activity No.	WORK LOCATION AND DESCRIPTION	EMPLOYER	NUMBER	TRADE	HRS

WAS A JOB SAFETY MEETING HELD THIS DATE?	☐ yes	☐ no	TOTAL WORK HRS. ON JOBSITE THIS DATE:
If yes attach copy of the meeting minutes.			
WERE THERE ANY LOST TIME ACCIDENTS THIS DATE?	☐ yes	☐ no	CUMULATIVE TOTAL OF WORK HRS. FROM PREVIOUS REPORT
If yes attach copy of completed OSHA report.			
WAS CRANE/MANLIFT/TRENCHING/SCAFFOLD/HVELECTRICAL/HIGH WORK DONE?	☐ yes	☐ no	TOTAL WORK HOURS FROM START OF CONSTRUCTION:
If yes attach statement or checklist showing inspection performed.			
WAS HAZARDOUS MATERIAL/WASTE RELEASED INTO THE ENVIRONMENT?	☐ yes	☐ no	**SAFETY REQUIREMENTS HAVE BEEN MET.** ☐
If yes attach description of incidents and proposed actions.			

Schedule Activity No.	LIST SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED

EQUIPMENT/MATERIAL RECEIVED TODAY TO BE INCORPORATED IN JOB (INDICATE SCHEDULE ACTIVITY NUMBER)

Schedule Activity No.	Submittal #	Description of Equipment/Material Received

CONSTRUCTION AND PLANT EQUIPMENT ON JOB SITE TODAY. INDICATE HOURS USED AND SCHEDULE ACTIVITY NUMBER.

Schedule Activity No.	Owner	Description of Construction Equipment Used Today (incl Make and Model)	Hours Used

Schedule Activity No.	REMARKS

Contractor/Superintendent Date

INCLUDE ALL PERSONNEL WORK HOURS IN THE WORK PERFORMED SECTION ON THIS SHEET INTO THE FRONT CONTRACTOR PRODUCTION REPORT

CONTRACTOR QUALITY CONTROL REPORT CONTINUATION SHEET

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE

REPORT NO.

PHASE				
	WORK COMPLIES WITH CONTRACT AS APPROVED DURING INITIAL PHASE?	YES ☐	NO ☐	
	WORK COMPLIES WITH SAFETY REQUIREMENTS?	YES ☐	NO ☐	
FOLLOW-UP	Schedule Activity No.	Description of Work, Testing Performed & By Whom, Definable Feature of Work, Specification Section, Location and List of Personnel Present		

REMARKS (Also Explain Any Checklist Item From Above That Was Answered "NO"), Manuf. Rep. On-Site, etc.

Schedule Activity No.	Description

COMBINED FORM 01450-2 (9/98)

CONTRACTOR QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE
REPORT NO.

PHASE

PREPARATORY

WAS PREPARATORY PHASE WORK PREFORMED TODAY? YES ☐ NO ☐
IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

INITIAL

WAS INITIAL PHASE WORK PREFORMED TODAY? YES ☐ NO ☐
IF YES, FILL OUT AND ATTACH SUPPLEMENTAL INITIAL PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

FOLLOW-UP

WORK COMPLIES WITH CONTRACT AS APPROVED DURING INITIAL PHASE? YES ☐ NO ☐
WORK COMPLIES WITH SAFETY REQUIREMENTS? YES ☐ NO ☐

Schedule Activity No.	Description of Work, Testing Performed & By Whom, Definable Feature of Work, Specification Section, Location and List of Personnel Present

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)

Schedule Activity No.	Description

REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)

Schedule Activity No.	Description

REMARKS (Also Explain Any Follow-Up Phase Checklist Item From Above That Was Answered "NO"), Manuf. Rep On-Site, etc.

Schedule Activity No.	Description

On behalf of the contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report.

AUTHORIZED QC MANAGER AT SITE DATE

GOVERNMENT QUALITY ASSURANCE REPORT

DATE

QUALITY ASSURANCE REPRESENTATIVE'S REMARKS AND/OR EXCEPTIONS TO THE REPORT

GOVERNMENT QUALITY ASSURANCE MANAGER DATE

APPENDIX E

ADR LIBRARY AND QUALIFIER TABLES

Project Accuracy and Precision Report

eQapp Name: FtOrd_UFP_QAPP
Description:

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: 300 **Matrix: AQ**						
QC Type: LCS						
Chloride	1003		80.00	120.00		20.00
SULFATE AS SO4	14808-79-8		80.00	120.00		20.00
QC Type: MS						
Chloride	1003		80.00	120.00		35.00
SULFATE AS SO4	14808-79-8		80.00	120.00		35.00
Method: 6010B **Matrix: AQ**						
QC Type: LCS						
CALCIUM	7440-70-2		80.00	120.00		20.00
MAGNESIUM	7439-95-4		80.00	120.00		20.00
Potassium	7440097		80.00	120.00		20.00
SODIUM	7440-23-5		80.00	120.00		20.00
QC Type: MS						
CALCIUM	7440-70-2		80.00	120.00		35.00
MAGNESIUM	7439-95-4		80.00	120.00		35.00
Potassium	7440097		80.00	120.00		35.00
SODIUM	7440-23-5		80.00	120.00		35.00
Method: 6020 **Matrix: AQ**						
QC Type: LCS						
ANTIMONY	7440-36-0		80.00	120.00		20.00
COPPER	7440-50-8		80.00	120.00		20.00
LEAD	7439-92-1		80.00	120.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: 6020	**Matrix: AQ**					
QC Type: MS						
ANTIMONY	7440-36-0		75.00	125.00		35.00
COPPER	7440-50-8		75.00	125.00		35.00
LEAD	7439-92-1		75.00	125.00		35.00
Method: EPA 524.2 REV 4.1	**Matrix: AQ**					
QC Type: LCS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	10.00	70.00	130.00		20.00
1,1,1-TRICHLOROETHANE	71-55-6	10.00	70.00	130.00		20.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	10.00	70.00	130.00		20.00
1,1,2-TRICHLOROETHANE	79-00-5	10.00	70.00	130.00		20.00
1,1-DICHLOROETHANE	75-34-3	10.00	70.00	130.00		20.00
1,1-DICHLOROETHYLENE	75-35-4	10.00	70.00	130.00		20.00
1,1-DICHLOROPROPENE	563-58-6	10.00	70.00	130.00		20.00
1,2,3-TRICHLOROBENZENE	87-61-6	10.00	70.00	130.00		20.00
1,2,3-TRICHLOROPROPANE	96-18-4	10.00	70.00	130.00		20.00
1,2,4-TRICHLOROBENZENE	120-82-1	10.00	70.00	130.00		20.00
1,2,4-TRIMETHYLBENZENE	95-63-6	10.00	70.00	130.00		20.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	10.00	70.00	130.00		20.00
1,2-DIBROMOETHANE	106-93-4	10.00	70.00	130.00		20.00
1,2-DICHLOROETHANE	107-06-2	10.00	70.00	130.00		20.00
1,2-DICHLOROPROPANE	78-87-5	10.00	70.00	130.00		20.00
1,3,5-TRIMETHYLBENZENE	108-67-8	10.00	70.00	130.00		20.00
1,3-DICHLOROPROPANE	142-28-9	10.00	70.00	130.00		20.00
2,2-DICHLOROPROPANE	594-20-7	10.00	70.00	130.00		20.00
2-BUTANONE	78-93-3	10.00	70.00	130.00		20.00
4-METHYL-2-PENTANONE	108-10-1	10.00	70.00	130.00		20.00
BENZENE	71-43-2	10.00	70.00	130.00		20.00
BROMOBENZENE	108-86-1	10.00	70.00	130.00		20.00
BROMOCHLOROMETHANE	74-97-5	10.00	70.00	130.00		20.00
BROMODICHLOROMETHANE	75-27-4	10.00	70.00	130.00		20.00
BROMOFORM	75-25-2	10.00	70.00	130.00		20.00
BROMOMETHANE	74-83-9	10.00	70.00	130.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA 524.2 REV 4.1	**Matrix:** AQ					
QC Type: LCS						
CARBON DISULFIDE	75-15-0	10.00	70.00	130.00		20.00
CARBON TETRACHLORIDE	56-23-5	10.00	70.00	130.00		20.00
CHLOROBENZENE	108-90-7	10.00	70.00	130.00		20.00
CHLOROETHANE	75-00-3	10.00	70.00	130.00		20.00
CHLOROFORM	67-66-3	10.00	70.00	130.00		20.00
CHLOROMETHANE	74-87-3	10.00	70.00	130.00		20.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	10.00	70.00	130.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	70.00	130.00		20.00
DIBROMOCHLOROMETHANE	124-48-1	10.00	70.00	130.00		20.00
DIBROMOMETHANE	74-95-3	10.00	70.00	130.00		20.00
DICHLORODIFLUOROMETHANE	75-71-8	10.00	70.00	130.00		20.00
ETHYLBENZENE	100-41-4	10.00	70.00	130.00		20.00
FREON 113	76-13-1	10.00	70.00	130.00		20.00
HEXACHLOROBUTADIENE	87-68-3	10.00	70.00	130.00		20.00
ISOPROPYLBENZENE	98-82-8	10.00	70.00	130.00		20.00
m,p-Xylene	136777-61-2	10.00	70.00	130.00		20.00
m-Dichlorobenzene	541-73-1	10.00	70.00	130.00		20.00
Methyl Tert Butyl Ether	1634-04-4	10.00	70.00	130.00		20.00
METHYLENE CHLORIDE	75-09-2	10.00	70.00	130.00		20.00
NAPHTHALENE	91-20-3	10.00	70.00	130.00		20.00
N-BUTYLBENZENE	104-51-8	10.00	70.00	130.00		20.00
N-PROPYLBENZENE	103-65-1	10.00	70.00	130.00		20.00
O-CHLOROTOLUENE	95-49-8	10.00	70.00	130.00		20.00
o-Dichlorobenzene	95-50-1	10.00	70.00	130.00		20.00
O-XYLENE	95-47-6	10.00	70.00	130.00		20.00
P-CHLOROTOLUENE	106-43-4	10.00	70.00	130.00		20.00
p-Dichlorobenzene	106-46-7	10.00	70.00	130.00		20.00
P-ISOPROPYLTOLUENE	99-87-6	10.00	70.00	130.00		20.00
SEC-BUTYLBENZENE	135-98-8	10.00	70.00	130.00		20.00
STYRENE	100-42-5	10.00	70.00	130.00		20.00
TERT-BUTYLBENZENE	98-06-6	10.00	70.00	130.00		20.00
Tetrachloroethylene	127-18-4	10.00	70.00	130.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA 524.2 REV 4.1 **Matrix:** AQ						
QC Type: LCS						
TOLUENE	108-88-3	10.00	70.00	130.00		20.00
TRANS-1,2-DICHLOROETHYLENE	156-60-5	10.00	70.00	130.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	70.00	130.00		20.00
Trichloroethylene	79-01-6	10.00	70.00	130.00		20.00
TRICHLOROFLUOROMETHANE	75-69-4	10.00	70.00	130.00		20.00
VINYL CHLORIDE	75-01-4	10.00	70.00	130.00		20.00
Xylenes (total)	1330-20-7	10.00	70.00	130.00		20.00
QC Type: MS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	10.00	80.00	120.00		35.00
1,1,1-TRICHLOROETHANE	71-55-6	10.00	80.00	120.00		35.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	10.00	80.00	120.00		35.00
1,1,2-TRICHLOROETHANE	79-00-5	10.00	80.00	120.00		35.00
1,1-DICHLOROETHANE	75-34-3	10.00	60.00	140.00		35.00
1,1-DICHLOROETHYLENE	75-35-4	10.00	70.00	130.00		35.00
1,1-DICHLOROPROPENE	563-58-6	10.00	80.00	120.00		35.00
1,2,3-TRICHLOROBENZENE	87-61-6	10.00	80.00	120.00		35.00
1,2,3-TRICHLOROPROPANE	96-18-4	10.00	80.00	120.00		35.00
1,2,4-TRICHLOROBENZENE	120-82-1	10.00	80.00	120.00		35.00
1,2,4-TRIMETHYLBENZENE	95-63-6	10.00	80.00	120.00		35.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	10.00	80.00	120.00		35.00
1,2-DIBROMOETHANE	106-93-4	10.00	80.00	120.00		35.00
1,2-DICHLOROETHANE	107-06-2	10.00	60.00	140.00		35.00
1,2-DICHLOROPROPANE	78-87-5	10.00	60.00	140.00		35.00
1,3,5-TRIMETHYLBENZENE	108-67-8	10.00	80.00	120.00		35.00
1,3-DICHLOROPROPANE	142-28-9	10.00	60.00	140.00		35.00
2,2-DICHLOROPROPANE	594-20-7	10.00	60.00	140.00		35.00
2-BUTANONE	78-93-3	10.00	70.00	130.00		35.00
4-METHYL-2-PENTANONE	108-10-1	10.00	60.00	140.00		35.00
BENZENE	71-43-2	10.00	70.00	130.00		35.00
BROMOBENZENE	108-86-1	10.00	70.00	130.00		35.00
BROMOCHLOROMETHANE	74-97-5	10.00	80.00	120.00		35.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA 524.2 REV 4.1	**Matrix:** AQ					
QC Type: MS						
BROMODICHLOROMETHANE	75-27-4	10.00	80.00	120.00		35.00
BROMOFORM	75-25-2	10.00	60.00	140.00		35.00
BROMOMETHANE	74-83-9	10.00	80.00	120.00		35.00
CARBON DISULFIDE	75-15-0	10.00	80.00	120.00		35.00
CARBON TETRACHLORIDE	56-23-5	10.00	80.00	120.00		35.00
CHLOROBENZENE	108-90-7	10.00	80.00	120.00		35.00
CHLOROETHANE	75-00-3	10.00	60.00	140.00		35.00
CHLOROFORM	67-66-3	10.00	80.00	120.00		35.00
CHLOROMETHANE	74-87-3	10.00	60.00	140.00		35.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	10.00	60.00	140.00		35.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	80.00	120.00		35.00
DIBROMOCHLOROMETHANE	124-48-1	10.00	80.00	120.00		35.00
DIBROMOMETHANE	74-95-3	10.00	80.00	120.00		35.00
DICHLORODIFLUOROMETHANE	75-71-8	10.00	80.00	120.00		35.00
ETHYLBENZENE	100-41-4	10.00	70.00	130.00		35.00
FREON 113	76-13-1	10.00	80.00	120.00		35.00
HEXACHLOROBUTADIENE	87-68-3	10.00	80.00	120.00		35.00
ISOPROPYLBENZENE	98-82-8	10.00	60.00	140.00		35.00
m,p-Xylene	136777-61-2	10.00	70.00	130.00		35.00
m-Dichlorobenzene	541-73-1	10.00	70.00	130.00		35.00
Methyl Tert Butyl Ether	1634-04-4	10.00	60.00	140.00		35.00
METHYLENE CHLORIDE	75-09-2	10.00	60.00	140.00		35.00
NAPHTHALENE	91-20-3	10.00	60.00	140.00		35.00
N-BUTYLBENZENE	104-51-8	10.00	80.00	120.00		35.00
N-PROPYLBENZENE	103-65-1	10.00	60.00	140.00		35.00
O-CHLOROTOLUENE	95-49-8	10.00	80.00	120.00		35.00
o-Dichlorobenzene	95-50-1	10.00	80.00	120.00		35.00
O-XYLENE	95-47-6	10.00	70.00	130.00		35.00
P-CHLOROTOLUENE	106-43-4	10.00	80.00	120.00		35.00
p-Dichlorobenzene	106-46-7	10.00	80.00	120.00		35.00
P-ISOPROPYLTOLUENE	99-87-6	10.00	60.00	140.00		35.00
SEC-BUTYLBENZENE	135-98-8	10.00	80.00	120.00		35.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA 524.2 REV 4.1 **Matrix: AQ**						
QC Type: MS						
STYRENE	100-42-5	10.00	80.00	120.00		35.00
TERT-BUTYLBENZENE	98-06-6	10.00	80.00	120.00		35.00
Tetrachloroethylene	127-18-4	10.00	80.00	120.00		35.00
TOLUENE	108-88-3	10.00	80.00	120.00		35.00
TRANS-1,2-DICHLOROETHYLENE	156-60-5	10.00	60.00	140.00		35.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	80.00	120.00		35.00
Trichloroethylene	79-01-6	10.00	80.00	120.00		35.00
TRICHLOROFLUOROMETHANE	75-69-4	10.00	80.00	120.00		35.00
VINYL CHLORIDE	75-01-4	10.00	60.00	140.00		35.00
Xylenes (total)	1330-20-7	10.00	50.00	130.00		35.00
QC Type: SURR						
1,2-DICHLOROBENZENE-D4	2199-69-1	10.00	78.00	114.00		
4-Bromofluorobenzene	460-00-4	10.00	77.00	115.00		
Method: SM18 2540C **Matrix: AQ**						
QC Type: LCS						
Solids, Total Dissolved	00515		80.00	120.00		20.00
Method: SM18 2540D **Matrix: AQ**						
QC Type: LCS						
Solids, Total Suspended	1009		80.00	120.00		20.00
Method: SM18 4500 NH3F/G **Matrix: AQ**						
QC Type: LCS						
Nitrogen, Ammonia	7664-41-7		80.00	120.00		20.00
QC Type: MS						
Nitrogen, Ammonia	7664-41-7		75.00	125.00		35.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: SM18 4500NO3E **Matrix: AQ**						
QC Type: LCS						
Nitrogen, Nitrate + Nitrite	35900		80.00	120.00		20.00
QC Type: MS						
Nitrogen, Nitrate + Nitrite	35900		75.00	125.00		35.00
Method: SM18 4500SD **Matrix: AQ**						
QC Type: LCS						
SULFIDE	18496-25-8		80.00	120.00		20.00
QC Type: MS						
SULFIDE	18496-25-8		75.00	125.00		35.00
Method: SW846 8260B BY SIM **Matrix: AQ**						
QC Type: LCS						
1,1,1-TRICHLOROETHANE	71-55-6	10.00	70.00	130.00		20.00
1,1-DICHLOROETHANE	75-34-3	10.00	70.00	135.00		20.00
1,1-DICHLOROETHENE	75-35-4	10.00	70.00	130.00		20.00
1,2-DICHLOROETHANE (EDC)	107-06-2	10.00	70.00	130.00		20.00
1,2-DICHLOROPROPANE	78-87-5	10.00	75.00	125.00		20.00
1,3-Dichloropropene (total)	542-75-6	10.00	80.00	120.00		20.00
2-BUTANONE (MEK)	78-93-3	10.00	70.00	130.00		20.00
BENZENE	71-43-2	10.00	80.00	120.00		20.00
CARBON TETRACHLORIDE	56-23-5	10.00	65.00	140.00		20.00
CHLOROFORM	67-66-3	10.00	65.00	135.00		20.00
CIS-1,2-DICHLOROETHENE	156-59-2	10.00	70.00	125.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	70.00	130.00		20.00
METHYLENE CHLORIDE	75-09-2	10.00	55.00	140.00		20.00
TETRACHLOROETHENE (PCE)	127-18-4	10.00	45.00	150.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	55.00	140.00		20.00
Trichloroethene (TCE)	79-01-6	10.00	70.00	125.00		20.00
VINYL CHLORIDE	75-01-4	10.00	50.00	145.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: SW846 8260B BY SIM	**Matrix:** AQ					
QC Type: MS						
1,1,1-TRICHLOROETHANE	71-55-6	10.00	70.00	130.00		30.00
1,1-DICHLOROETHANE	75-34-3	10.00	70.00	135.00		30.00
1,1-DICHLOROETHENE	75-35-4	10.00	70.00	130.00		30.00
1,2-DICHLOROETHANE (EDC)	107-06-2	10.00	70.00	130.00		30.00
1,2-DICHLOROPROPANE	78-87-5	10.00	75.00	125.00		30.00
1,3-Dichloropropene (total)	542-75-6	10.00	80.00	120.00		30.00
2-BUTANONE (MEK)	78-93-3	10.00	70.00	130.00		30.00
BENZENE	71-43-2	10.00	80.00	120.00		30.00
CARBON TETRACHLORIDE	56-23-5	10.00	65.00	140.00		30.00
CHLOROFORM	67-66-3	10.00	65.00	135.00		30.00
CIS-1,2-DICHLOROETHENE	156-59-2	10.00	70.00	125.00		30.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	70.00	130.00		30.00
METHYLENE CHLORIDE	75-09-2	10.00	55.00	140.00		30.00
TETRACHLOROETHENE (PCE)	127-18-4	10.00	45.00	150.00		30.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	55.00	140.00		30.00
Trichloroethene (TCE)	79-01-6	10.00	70.00	125.00		30.00
VINYL CHLORIDE	75-01-4	10.00	50.00	145.00		30.00
QC Type: SURR						
DIBROMOFLUOROMETHANE	1868-53-7	30.00	70.00	130.00		
TOLUENE-D8	2037-26-5	30.00	70.00	130.00		

Project Holding Time Report

eQapp Name: FtOrd_UFP_QAPP
Description:

Analyte Group	Sampling to Analysis (preserved)	Sampling to Analysis (unpreserved)	Sampling to Extraction (preserved)	Sampling to Extraction (unpreserved)	Sampling to Leaching	Leaching to Extraction	Leaching to Analysis	Extraction to Analysis	Units	Rejection Factor
Method: 300				**Matrix: AQ**						
Primary	28.00	28.00							Days	2.00
Method: 6010B				**Matrix: AQ**						
Primary	180.00								Days	2.00
Method: 6020				**Matrix: AQ**						
Primary	180.00								Days	2.00
Method: EPA 524.2 REV 4.1				**Matrix: AQ**						
Primary	14.00								Days	2.00
Method: SM18 2320B				**Matrix: AQ**						
Target Analytes	14.00	14.00							Days	2.00
Method: SM18 2540C				**Matrix: AQ**						
Primary	7.00	7.00							Days	2.00
Method: SM18 2540D				**Matrix: AQ**						
Primary	7.00	7.00							Days	2.00

Analyte Group	Sampling to Analysis (preserved)	Sampling to Analysis (unpreserved)	Sampling to Extraction (preserved)	Sampling to Extraction (unpreserved)	Sampling to Leaching	Leaching to Extraction	Leaching to Analysis	Extraction to Analysis	Units	Rejection Factor
Method: **SM18 4500 NH3F/G**			**Matrix:** **AQ**							
Primary	28.00	28.00							Days	2.00
Method: **SM18 4500NO3E**			**Matrix:** **AQ**							
Primary	28.00								Days	2.00
Method: **SM18 4500SD**			**Matrix:** **AQ**							
Primary	7.00								Days	2.00
Method: **SW846 8260B BY SIM**			**Matrix:** **AQ**							
Primary	14.00								Days	2.00

Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria

eQapp Name: FtOrd_UFP_QAPP
Description:

Target Analyte Name	Analyte Label (CAS)	Reporting Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: 300 Matrix: AQ							
Chloride	1003	0.2		mg/L	5.00	35.00	
SULFATE AS SO4	14808-79-8	0.5		mg/L	5.00	35.00	
Method: 6010B Matrix: AQ							
CALCIUM	7440-70-2	1000		ug/L	5.00	35.00	30.00
MAGNESIUM	7439-95-4	5000		ug/L	5.00	35.00	30.00
Potassium	7440097	10000		ug/L	5.00	35.00	30.00
SODIUM	7440-23-5	10000		ug/L	5.00	35.00	30.00
Method: 6020 Matrix: AQ							
ANTIMONY	7440-36-0	6.00		ug/L	5.00	35.00	30.00
COPPER	7440-50-8	10.00		ug/L	5.00	35.00	30.00
LEAD	7439-92-1	10.00		ug/L	5.00	35.00	30.00
Method: EPA 524.2 REV 4.1 Matrix: AQ							
1,1,1,2-TETRACHLOROETHANE	630-20-6	0.50		ug/L	5.00	20.00	35.00
1,1,1-TRICHLOROETHANE	71-55-6	0.50		ug/L	5.00	20.00	35.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.50		ug/L	5.00	20.00	35.00
1,1,2-TRICHLOROETHANE	79-00-5	0.50		ug/L	5.00	20.00	35.00
1,1-DICHLOROETHANE	75-34-3	0.50		ug/L	5.00	20.00	35.00
1,1-DICHLOROETHYLENE	75-35-4	0.50		ug/L	5.00	20.00	35.00
1,1-DICHLOROPROPENE	563-58-6	0.50		ug/L	5.00	20.00	35.00
1,2,3-TRICHLOROBENZENE	87-61-6	0.50		ug/L	5.00	20.00	35.00
1,2,3-TRICHLOROPROPANE	96-18-4	0.50		ug/L	5.00	20.00	35.00
1,2,4-TRICHLOROBENZENE	120-82-1	0.50		ug/L	5.00	20.00	35.00
1,2,4-TRIMETHYLBENZENE	95-63-6	0.50		ug/L	5.00	20.00	35.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	2.00		ug/L	5.00	20.00	35.00
1,2-DIBROMOETHANE	106-93-4	0.50		ug/L	5.00	20.00	35.00
1,2-DICHLOROETHANE	107-06-2	0.50		ug/L	5.00	20.00	35.00
1,2-DICHLOROPROPANE	78-87-5	0.50		ug/L	5.00	20.00	35.00

Target Analyte Name	Analyte Label (CAS)	Reporting Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA 524.2 REV 4.1 **Matrix: AQ**							
1,3,5-TRIMETHYLBENZENE	108-67-8	0.50		ug/L	5.00	20.00	35.00
1,3-DICHLOROPROPANE	142-28-9	0.50		ug/L	5.00	20.00	35.00
2,2-DICHLOROPROPANE	594-20-7	0.50		ug/L	5.00	20.00	35.00
2-BUTANONE	78-93-3	5.00		ug/L	10.00	20.00	35.00
4-METHYL-2-PENTANONE	108-10-1	5.10		ug/L	5.00	20.00	35.00
BENZENE	71-43-2	0.50		ug/L	5.00	20.00	35.00
BROMOBENZENE	108-86-1	0.50		ug/L	5.00	20.00	35.00
BROMOCHLOROMETHANE	74-97-5	0.50		ug/L	5.00	20.00	35.00
BROMODICHLOROMETHANE	75-27-4	0.50		ug/L	5.00	20.00	35.00
BROMOFORM	75-25-2	0.50		ug/L	5.00	20.00	35.00
BROMOMETHANE	74-83-9	0.50		ug/L	5.00	20.00	35.00
CARBON DISULFIDE	75-15-0	0.50		ug/L	5.00	20.00	35.00
CARBON TETRACHLORIDE	56-23-5	0.50		ug/L	5.00	20.00	35.00
CHLOROBENZENE	108-90-7	0.50		ug/L	5.00	20.00	35.00
CHLOROETHANE	75-00-3	0.50		ug/L	5.00	20.00	35.00
CHLOROFORM	67-66-3	0.50		ug/L	5.00	20.00	35.00
CHLOROMETHANE	74-87-3	0.50		ug/L	5.00	20.00	35.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.50		ug/L	5.00	20.00	35.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.50		ug/L	5.00	20.00	35.00
DIBROMOCHLOROMETHANE	124-48-1	0.50		ug/L	5.00	20.00	35.00
DIBROMOMETHANE	74-95-3	0.50		ug/L	5.00	20.00	35.00
DICHLORODIFLUOROMETHANE	75-71-8	0.50		ug/L	5.00	20.00	35.00
ETHYLBENZENE	100-41-4	0.50		ug/L	5.00	20.00	35.00
FREON 113	76-13-1	1.00		ug/L	5.00	20.00	35.00
HEXACHLOROBUTADIENE	87-68-3	0.50		ug/L	5.00	20.00	35.00
ISOPROPYLBENZENE	98-82-8	0.50		ug/L	5.00	20.00	35.00
m,p-Xylene	136777-61-2	0.50		ug/L	5.00	20.00	35.00
m-Dichlorobenzene	541-73-1	0.50		ug/L	5.00	20.00	35.00
Methyl Tert Butyl Ether	1634-04-4	0.50		ug/L	5.00	20.00	35.00
METHYLENE CHLORIDE	75-09-2	0.50		ug/L	10.00	20.00	35.00
NAPHTHALENE	91-20-3	0.50		ug/L	5.00	20.00	35.00
N-BUTYLBENZENE	104-51-8	0.50		ug/L	5.00	20.00	35.00
N-PROPYLBENZENE	103-65-1	0.50		ug/L	5.00	20.00	35.00

Target Analyte Name	Analyte Label (CAS)	Reporting Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA 524.2 REV 4.1 Matrix: AQ							
O-CHLOROTOLUENE	95-49-8	0.50		ug/L	5.00	20.00	35.00
o-Dichlorobenzene	95-50-1	0.50		ug/L	5.00	20.00	35.00
O-XYLENE	95-47-6	0.50		ug/L	5.00	20.00	35.00
P-CHLOROTOLUENE	106-43-4	0.50		ug/L	5.00	20.00	35.00
p-Dichlorobenzene	106-46-7	0.50		ug/L	5.00	20.00	35.00
P-ISOPROPYLTOLUENE	99-87-6	0.50		ug/L	5.00	20.00	35.00
SEC-BUTYLBENZENE	135-98-8	0.50		ug/L	5.00	20.00	35.00
STYRENE	100-42-5	0.50		ug/L	5.00	20.00	35.00
TERT-BUTYLBENZENE	98-06-6	0.50		ug/L	5.00	20.00	35.00
Tetrachloroethylene	127-18-4	0.50		ug/L	5.00	20.00	35.00
TOLUENE	108-88-3	0.50		ug/L	10.00	20.00	35.00
TRANS-1,2-DICHLOROETHYLENE	156-60-5	0.50		ug/L	5.00	20.00	35.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.50		ug/L	5.00	20.00	35.00
Trichloroethylene	79-01-6	0.50		ug/L	5.00	20.00	35.00
TRICHLOROFLUOROMETHANE	75-69-4	0.50		ug/L	5.00	20.00	35.00
VINYL CHLORIDE	75-01-4	0.10		ug/L	5.00	20.00	35.00
Xylenes (total)	1330-20-7	0.50		ug/L	5.00	20.00	35.00
Method: SM18 2320B Matrix: AQ							
Alkalinity, Carbonate	477730600	5	5	mg/L	5.00	35.00	
Alkalinity, Total as CaCO3	477520600	5	1.5	mg/L	5.00	35.00	
Method: SM18 2540C Matrix: AQ							
Solids, Total Dissolved	00515	5		mg/L		35.00	
Method: SM18 2540D Matrix: AQ							
Solids, Total Suspended	1009	10		mg/L		35.00	
Method: SM18 4500 NH3F/G Matrix: AQ							
Nitrogen, Ammonia	7664-41-7	1		mg/L	5.00	35.00	
Method: SM18 4500NO3E Matrix: AQ							
Nitrogen, Nitrate + Nitrite	35900	0.2		mg/L	5.00	35.00	
Method: SM18 4500SD Matrix: AQ							
SULFIDE	18496-25-8	0.1		mg/L	5.00	35.00	

Target Analyte Name	Analyte Label (CAS)	Reporting Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: SW846 8260B BY SIM **Matrix: AQ**							
1,1,1-TRICHLOROETHANE	71-55-6	0.50		ug/L	5.00	20.00	30.00
1,1-DICHLOROETHANE	75-34-3	0.50		ug/L	5.00	20.00	30.00
1,1-DICHLOROETHENE	75-35-4	0.50		ug/L	5.00	20.00	30.00
1,2-DICHLOROETHANE (EDC)	107-06-2	0.50		ug/L	5.00	20.00	30.00
1,2-DICHLOROPROPANE	78-87-5	0.50		ug/L	5.00	20.00	30.00
1,3-Dichloropropene (total)	542-75-6	0.50		ug/L	5.00	20.00	30.00
2-BUTANONE (MEK)	78-93-3	0.50		ug/L	5.00	20.00	30.00
BENZENE	71-43-2	0.50		ug/L	5.00	20.00	30.00
CARBON TETRACHLORIDE	56-23-5	0.50		ug/L	5.00	20.00	30.00
CHLOROFORM	67-66-3	0.50		ug/L	5.00	20.00	30.00
CIS-1,2-DICHLOROETHENE	156-59-2	0.50		ug/L	5.00	20.00	30.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.50		ug/L	5.00	20.00	30.00
METHYLENE CHLORIDE	75-09-2	0.50		ug/L	10.00	20.00	30.00
TETRACHLOROETHENE (PCE)	127-18-4	0.50		ug/L	5.00	20.00	30.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.50		ug/L	5.00	20.00	30.00
Trichloroethene (TCE)	79-01-6	0.50		ug/L	5.00	20.00	30.00
VINYL CHLORIDE	75-01-4	0.10		ug/L	5.00	20.00	30.00

Appendix E - ADR Data Qualification Table

Description	VOA	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Difference Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Difference Lower Rejection	J-	R
Continuing Calibration Verification Percent Difference Upper Estimation	J+	
Continuing Calibration Verification Percent Difference Upper Rejection	J+	UJ
Continuing Calibration Verification Relative Response Factor	J	UJ
Continuing Tune	J	R
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial calibration Correlation Coefficient	J	UJ
Initial Calibration Percent Relative Standard Deviation	J	UJ
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Difference Lower Estimation	J-	UJ
Initial Calibration Verification Percent Difference Lower Rejection	J-	R
Initial Calibration Verification Percent Difference Upper Estimation	J+	
Initial Calibration Verification Percent Difference Upper Rejection	J+	UJ
Initial Calibration Verification Relative Response Factor	J	UJ
Initial Tune	J	R
Internal Standard Estimation	J	UJ
Internal Standard Rejection	J	R
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Preservation	J-	UJ
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Surrogate Recovery Lower Estimation	J-	UJ
Surrogate Recovery Lower Rejection	J-	R
Surrogate Recovery Upper Estimation	J+	
Surrogate Recovery Upper Rejection	J+	R
Temperature Estimation	J-	UJ
Temperature Rejection	J-	R
Trip Blank Contamination	U	

Appndix E - ADR Data Qualification Table

Description	Metals	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Recovery Lower Rejection	R	R
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	R	
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Initial Calibration Verification Percent Recovery Lower Rejection	R	R
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	R	
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Trip Blank Contamination	U	

Appendix E - ADR Data Qualification Table

Description	GenChem	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Recovery Lower Rejection	R	R
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	R	
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Initial Calibration Verification Percent Recovery Lower Rejection	R	R
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	R	
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Trip Blank Contamination	U	