FINAL

SITE-SPECIFIC WORK PLAN FOR THE AIR FORCE ENVIRONMENTAL DIRECTORATE PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION AT COLUMBUS AFB

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Prepared for:

Air Force Center for Environmental Excellence
Technology Transfer Division
and
Air Force Environmental Directorate

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Prepared by:

Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290

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LIST OF ACRONYMS AND ABBREVIATIONS

AFILEV	Air Force Environmental Directorate
AFB	Air Force Base
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
ANOVA	analysis of variance
cm/sec	centimeters per second
COPC	chemical o potential concern
DoD	Department of Defense
ft/day	feet per day
GIS	Geographical information system
HASP	Health and Safety Plan
IRP	Installation Restoration Program
LTM	long-term monitoring
LTMO TM	long-term monitoring optimization technical memorandum
µg/L	micrograms per liter
MDEQ	Mississippi Department of Environmental Quality
Parsons	Parsons Engineering Science, Inc.
PDBS	passive diffusion bag sampler
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SOW	Statement of Work
SVOC	semivolatile organic compound
TCE	trichloroethene
TO	task order
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Project Description

On 27 February 2001, Parsons Engineering Science, Inc. (Parsons) was awarded a task order (TO) under Air Force Center for Environmental Excellence (AFCEE) contract F41624-00-D-8024 (TO24, Project Air Force Environmental Directorate [AFILEV]) to demonstrate the use of passive diffusion bag samplers (PDBSs) in existing groundwater monitoring programs at selected AFILEV installations. The site of the PDBS demonstration outlined in this work plan is Columbus Air Force Base (AFB), Mississippi. The Technology Transfer Division of AFCEE (AFCEE/ERT) has initiated the PDBS demonstration to introduce this technology to multiple Department of Defense (DoD) installations and to improve the cost effectiveness of groundwater monitoring programs for volatile organic compounds (VOCs).

Diffusion sampling is a relatively new technology designed to utilize passive sampling techniques that eliminate the need for well purging. Specifically, a diffusive-membrane capsule is filled with deionized/distilled water, sealed, suspended in a well-installation device, and lowered to a specified depth below the water level in a monitoring well. Over time (no less than 72 hours), the VOCs in the groundwater diffuse across the membrane, and the water inside the sampler reaches equilibrium with groundwater in the surrounding formation. The sampler is subsequently removed from the well, and the water in the diffusion sampler is transferred to a sample container and submitted for laboratory analysis of VOCs. Benefits of diffusion sampling include reduced sampling costs and reduced generation of investigation-derived waste.

1.2 Objective

The PDBS demonstration at Columbus AFB Has two primary objectives:

- Develop vertical profiles of VOC concentrations across the screened intervals of the sampled monitoring wells, and

- Assess the effectiveness of PDBS by statistically comparing groundwater analytical results for VOCs obtained using the current (conventional) sampling method (i.e., 3-casing-volume purge/sample) during the previously scheduled May 2001 long-term monitoring (LTM) event with results obtained using the PDBS method.

Vertical contaminant profiles will be developed by placing three PDBSs at discrete screened depths in each monitoring well included in the demonstration, and analyzing the resulting samples for VOCs. The resulting information will aid the Base in evaluating contaminant migration and fate in the saturated zone, and will allow optimization of the LTM through collection of future groundwater samples from the depth interval of greatest contaminant concentrations. The statistical comparison of the conventional and diffusion sampling results will allow assessment of the appropriateness of implementing diffusion sampling for VOCs at each sampled well.

1.3 Scope

The Columbus AFB PDBS sampling demonstration will require two mobilizations to the site: one to place the diffusion samplers in the selected monitoring wells, and a second to retrieve the samplers from the wells. The PDBSs will be installed during the second week of May 2001 to provide adequate equilibration time before the incumbent environmental contractor for Columbus AFB, CH2M Hill, begins the scheduled LTM sampling event scheduled to begin on May 28, 2001. The PDBSs will be retrieved immediately prior to the conventional LTM sampling event to ensure temporal comparability of the analytical results obtained using the two methods. The PDBSs will be in place for a minimum of 18 days, which fulfills the 14-day minimum equilibration time period specified in the AFILEV PDBS Project Work Plan (Parsons, 2001).

1.4 Document Organization

This work plan is organized into seven sections, including this introduction, and four appendices. The Columbus AFB site description is presented in Section 2. Section 3 presents the scope of the PDBS investigation at Columbus AFB. Project organization, schedule, and an overview of the PDBS site-specific results report are summarized in Sections 4, 5, and 6, respectively. References used in the preparation of this work plan are presented in Section 7. Appendix A provides the site-specific addendum to the Project Health and Safety Plan (HASP) (Parsons, 2001). Appendix B contains supporting historical site documentation, and Appendix C presents a list of equipment that will be used during the field sampling effort.

2.0 SITE DESCRIPTION

2.1 Location and Description of Columbus Air Force Base Mississippi

Columbus AFB is located in Lowndes County in northeastern Mississippi, approximately 9 miles north of downtown Columbus, Mississippi (Figure 2.1). The Base covers approximately 4,411 acres in a lightly urbanized area (Figure 2.2).

The current mission at Columbus AFB is to provide specialized undergraduate pilot training and introduction to fighter fundamentals training for US Air Force (USAF) personnel and for students from foreign countries. The 14th flying training wing provides support for administrative, transportation and supply, civil engineering, communications, security, financial, religious, educational, legal, social and medical services, as well as morale, welfare, and recreational facilities and activities (USAF, 1997 and 1998).

Investigations conducted under the Installation Restoration Program (IRP) have identified contamination in environmental media at the Base due to chemical releases during past operations. The sites at Columbus AFB at which contaminants in soil and/or groundwater have been previously detected are summarized in Table 2.1.

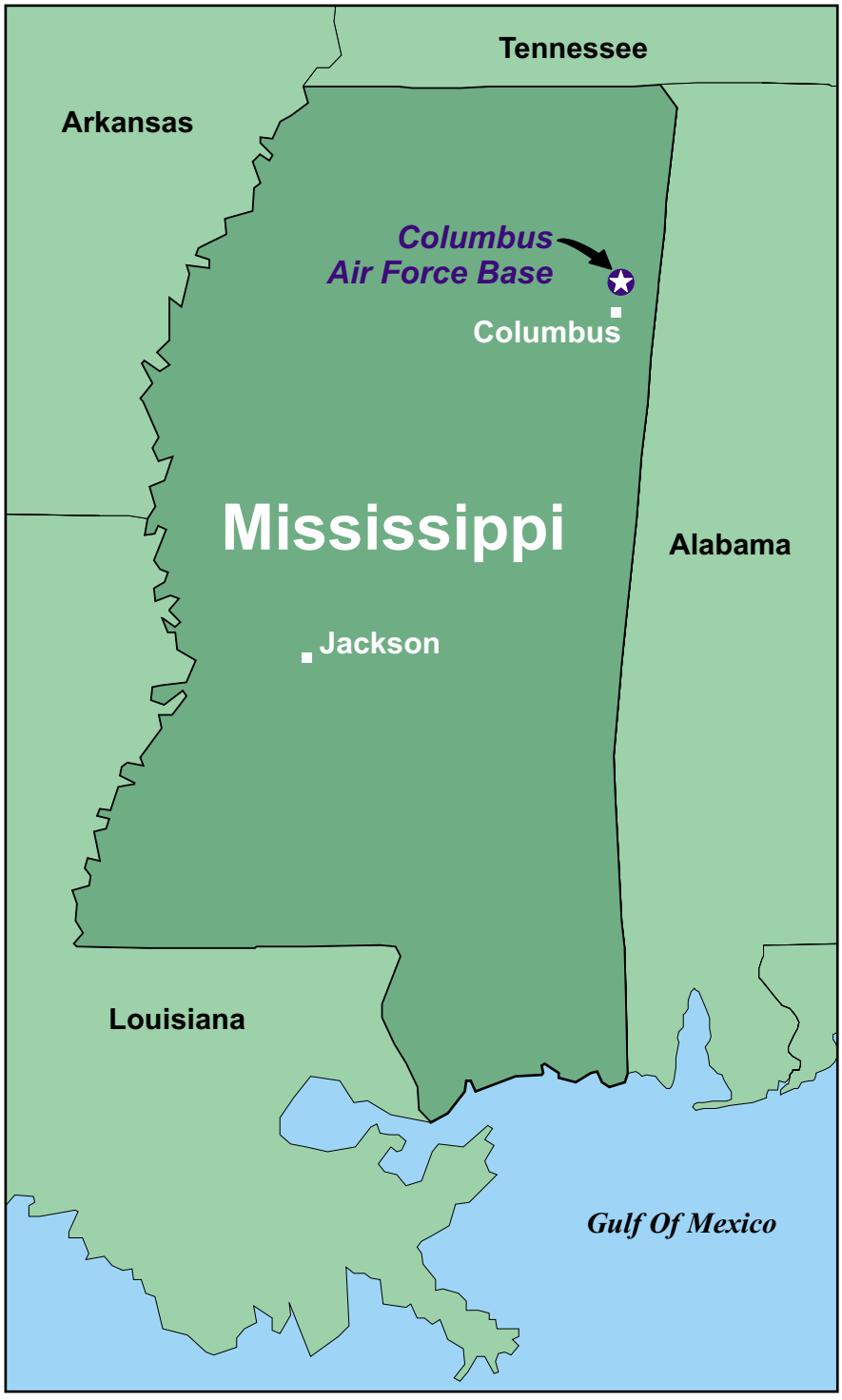

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FIGURE 2.1

LOCATION OF COLUMBUS AFB

Passive Diffusion Bag Sampler Demonstration
Columbus AFB, Mississippi

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Denver, Colorado

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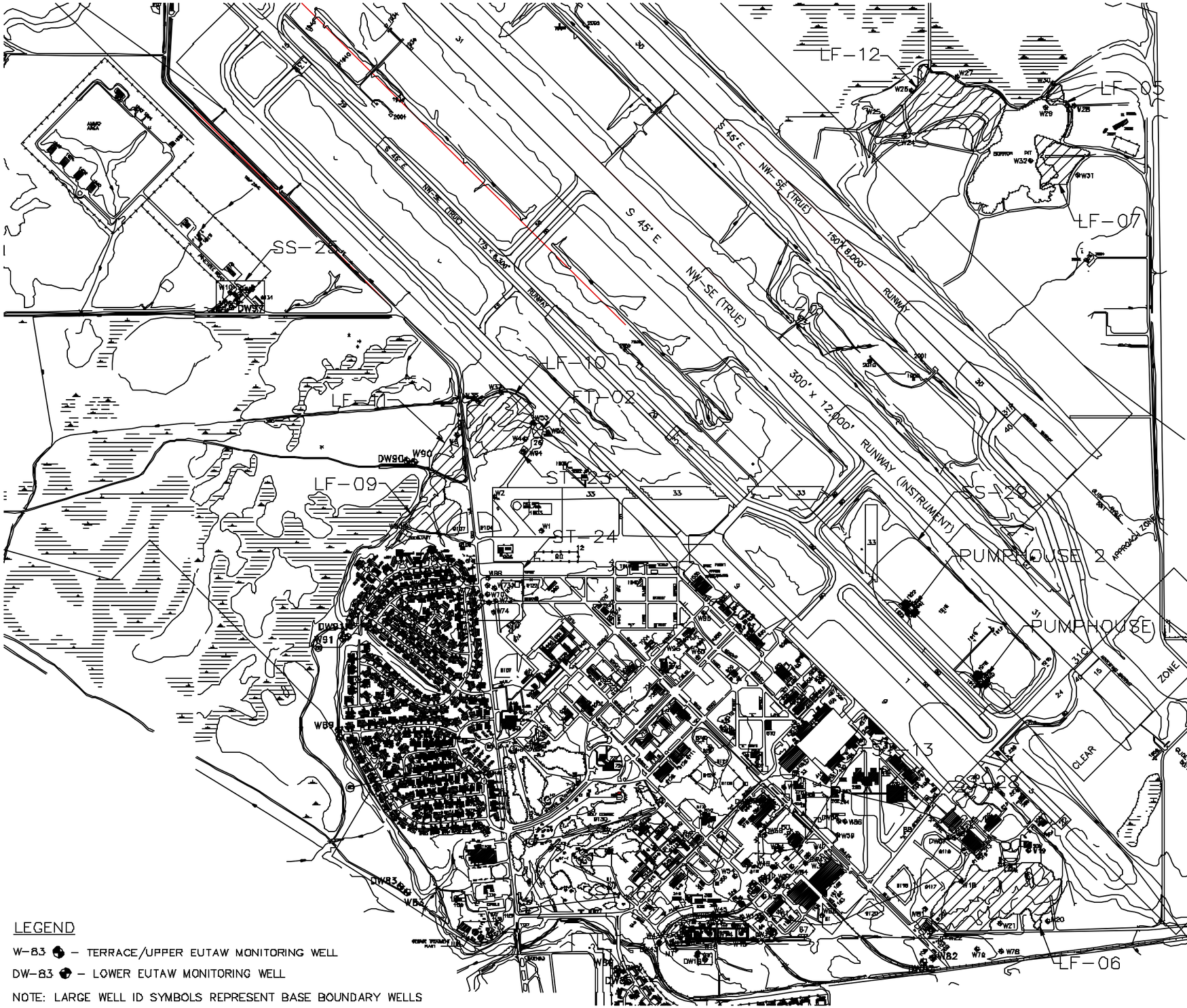

FIGURE 2.2

SITE LOCATION

PASSIVE DIFFUSION BAG SAMPLER
DEMONSTRATION
Columbus AFB, Mississippi

PARSONS
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TABLE 2.1
SITE SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
COLUMBUS AFB, MISSISSIPPI

Site ID	Site Type	Description	Material Disposed of	Date of Operation
LF-05	IRP/CERCLA	Old Landfill #5	Sanitary Trash, Waste Oil, Construction Debris, and Possibly Waste Solvents and Other POL	1964 - 1967
LF-06	IRP/CERCLA	Old Landfill #6	Sanitary Trash, Metal Debris, Concrete, and Possibly Waste Solvents and POL	1964 - 1974
LF-07	IRP/CERCLA	Old Landfill #7	Sanitary Trash and Construction Debris	1974 - 1976
LF-09	IRP/CERCLA	Old Landfill #1	Solid Debris, Concrete, Metal, Large trees, Sanitary Fill, Incinerator Ash, and Possibly Waste Solvents and POL	Mid -1940s and early-1950s
LF-10	IRP/CERCLA	Old Landfill #2	Sanitary Trash, Solid Debris, Metal, and Industrial Waste	1956 - 1960
LF-11	IRP/CERCLA	Old Landfill #3	Sanitary Waste and Possibly Waste Solvents and POL	1960 and 1961
LF-12	IRP/CERCLA	Old Landfill #4	Sanitary Trash, Airplane Parts, Waste Oil, and Possibly Waste solvents and Other POL	1962 - 1964
ST-13	IRP/MS UST Regulations	322 UST Area (10 USTs)	Jet Fuel, Diesel, Gasoline	1941 -1992
SS-25	IRP/CERCLA	Entomology Shop Drainage	Herbicides, Pesticides	1969 - 1991
SS-26	IRP/CERCLA	Fuel Tank Farm	Jet Fuel, Diesel, Lubricating Oil	1960s - Present
SS-28	IRP/CERCLA	Central Base Groundwater VOCs	TCE	1958 - 1970

Notes:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
IRP = Installation Restoration Program
LTM = Long-Term Monitoring
MS = Mississippi
POL = Petroleum, Oil, and Lubricants
TCE = Trichloroethene
UST = Underground Storage Tank
VOC = Volatile Organic Compound

2.2 Environmental Setting

2.2.1 Geology

The shallow subsurface geology in northeastern Mississippi consists of Cretaceous Gulf Coastal Plain sediments overlain by Quaternary alluvial sediments (CH2M Hill, 1989). The Cretaceous Coastal Plain sediments unconformably overlie an irregular surface of Paleozoic basement rocks (CH2M Hill, 1989).

Unconsolidated sediments comprise the upper 40 feet of subsurface geology at the Base. These sediments are alluvial and lower terrace deposits composed of sand and gravel overlying clay and sandy clay. Upper units of the Cretaceous Coastal Plain sediments consist of sand, silt, gravel, clay, and calcareous marine strata. Lower units of the Cretaceous Series comprise a southward-thickening wedge of sand, clay, shale, gravel, and calcareous strata of marine origin (CH2M Hill, 1989). The unconsolidated sediments overlie Coastal Plain clay and sandy clay deposits (USAF, 1997).

2.2.2 Hydrogeology

The primary aquifers beneath Columbus AFB consist of sand and gravel beds associated with surficial terrace and alluvial deposits, and the underlying Eutaw Formation and Tuscaloosa Group (also referred to as the Gordo Formation). The Tuscaloosa Group and the overlying Eutaw Formation have been classified as hydraulically separate aquifer systems based on the presence of laterally extensive clay confining beds at the top of the Tuscaloosa Group. The Tuscaloosa Group is not discussed further in this work plan because of its depth and degree of confinement.

The uppermost aquifer at the Base is composed of the surficial terrace and alluvial deposits and the underlying Eutaw Formation (Parsons, 1999). This aquifer is estimated to have a combined thickness of approximately 250 feet and is used as a source of water for domestic wells in the Base vicinity (Parsons, 1999). The aquifer generally is subdivided into a "surficial" and Lower Eutaw Aquifer on the basis of geologic borehole logs and differences in hydraulic properties, including hydraulic conductivity and degree of aquifer confinement.

2.2.2.1 Surficial Aquifer

Recharge to the unconfined "surficial" aquifer occurs by downward infiltration of precipitation through the relatively permeable overlying deposits. The water-table depth in wells completed in the surficial aquifer generally ranges from 10 to 20 feet. The upper 5 to 10 feet of soil at the Base generally consists of silty, sandy clay (Parsons, 1999), and the aquifer consists of terrace and alluvial sand and gravel deposits. The surficial aquifer averages about 40 feet in saturated thickness. Based on slug tests performed in 10 monitoring wells screened in the surficial aquifer at the Base, a horizontal hydraulic conductivity log average value of 4.4E-03 centimeter per second (cm/sec) (12.5 feet per day [ft/day]) was calculated (Parsons, 1999). Groundwater flow in the surficial aquifer beneath the northern portion of the Base is northwest toward the Buttahatachie River . Groundwater flow in the southern half of the Base generally is toward the Tombigbee

River and varies from west to southwest, depending on the specific location and season of the year.

2.2.2.2 Eutaw Aquifer

The Eutaw Aquifer is approximately 150 to 200 feet thick and receives most of its recharge north of Columbus AFB in the formation's outcrop area (Parsons, 1999). Soil borehole descriptions suggest that this unit is characteristically heterogeneous in composition, thickness, and continuity throughout the Base. Borehole data also indicate that the upper 40 to 100 feet of this unit generally consists of relatively low-permeability beds of silty, clayey sand, sandy clay, and thinly-laminated beds of dense, fine sand, silt, and clay. Small fractions of gravel also have been documented. In 1989, five core samples were collected and submitted to a geotechnical laboratory for analysis of vertical hydraulic conductivity. Laboratory results from vertical hydraulic conductivity triaxial tests performed on these samples ranged from 6.0E-08 cm/sec (1.7E-04 foot per day) to 6.6E-06 cm/sec (1.87E-02 feet per day) (CH2M Hill, 1995). The lowest hydraulic conductivity was measured in a clayey silt, and the highest was measured in a silty fine sand.

Relatively permeable sand beds,7 used as a source of water for domestic wells in the area, also are present in the Lower Eutaw at depths ranging from 80 to 250 feet below ground surface. Slug test results from five wells screened in the Lower Eutaw Formation sand beds indicated an average horizontal hydraulic conductivity of 6.2E-03 cm/sec (17.6 ft/day). The regional groundwater flow direction in the Eutaw Aquifer within the vicinity of Columbus AFB is to the west-southwest.

2.3 Chemicals of Concern

Historically, contaminants that have exceeded regulatory limits at Columbus AFB have consisted primarily of chlorinated solvents, their associated breakdown products, and fuel hydrocarbons. Some metals and semivolatile organic compounds (SVOCs) also are present at Site LF-06 (Figure 2.2). Table 2.2 summarizes contaminants that were detected in groundwater at concentrations exceeding regulatory limits during the CH2M Hill (2001) LTM groundwater sampling event of November 2000. The primary chemicals of potential concern (COPCs) in groundwater at Columbus AFB include trichloroethene (TCE), TCE degradation compounds, fuel compounds, lead, and other metals (CH2M Hill, 2000).

2.4 Current Groundwater Monitoring Program

During a November 9 and 10, 1999 Partnering Meeting at the Base, personnel from Columbus AFB, the Mississippi Department of Environmental Quality (MDEQ), and CH2M Hill discussed changes to the existing groundwater LTM program. These changes included a reduction in the sampling frequency at certain monitoring locations, removal of specific wells and sites from the program, installation of new wells at key monitoring locations, and development of a new 3-year LTM program plan. An LTM Optimization Technical Memorandum (LTMO TM) subsequently was developed following the *Long Term Monitoring Optimization Guide* developed by AFCEE (1997). The LTMO TM was designed to optimize the technical and cost effectiveness of the LTM program, while

TABLE 2.2
SUMMARY OF GROUNDWATER CONTAMINANTS OF CONCERN DETECTED DURING THE NOVEMBER, 2000 LTM SAMPLING EVENT
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
COLUMBUS AFB, MISSISSIPPI

Site	Contaminant Group	Contaminant	Well Number	Concentration (mg/L)
LF-06				
	VOCs	Vinyl Chloride	W-18	6.19
		Vinyl Chloride	W-21	9.04
		Vinyl Chloride	W-22	3.87
		Vinyl Chloride	W-81	4.92
		Trichloroethene	W-21	13
	Metals	Lead	W-81	0.0197 mg/L
ST-13				
	VOCs	Benzene	W-35	15.6
		Tetrachloroethene	W-84	6.03
SS-25				
	VOCs	Trichloroethene	W-8	6.63
		Trichloroethene	W-10	9.33
SS-26				
	VOCs	1,2,4-Trimethylbenzene	W-13	82.8
		Naphthalene	W-13	24.7
SS-28				
	VOCs	1,1-Dichloroethene	W-87	12.2
		Tetrachloroethene	W-47	9.4
		Trichloroethene	W-86	15.8
		Trichloroethene	W-87	44.3
		Vinyl Chloride	W-87	2.34
Boundary Wells				
	none			

Notes:
VOCs = Volatile Organic Compounds

meeting data quality objectives and quality assurance requirements. The LTMO TM provides the basis and rationale for the current LTM SAP.

Analytical parameters, number of wells sampled, and sampling frequency have been modified from the previous 1997 LTM SAP. One additional site monitoring well has been installed and will be sampled as part of the ongoing LTM program at Spill Site SS-28. The current LTM program will continue through the fall 2002 sampling event. After that sampling event, the program will be reassessed to potentially further modify the number of wells sampled, analytical parameters included, and sampling frequency.

Monitoring wells that are sampled currently at Columbus AFB as part of the LTM program are located within eight sites where contaminants have been historically detected, and along the Base boundary. Sampling events are performed semiannually. A total of 44 Base monitoring wells were sampled in November 2000 in accordance with the October 2000 LTM SAP (CH2M Hill, 2000), and a total of 56 monitoring wells will be sampled in May 2001. The monitoring wells sampled in November 2000 are a subset of the monitoring wells to be sampled in May 2001.

Five new groundwater monitoring wells will be installed at the Fire Training Area in May 2001. These wells will be sampled by CH2M Hill immediately following their installation.

3.0 SCOPE OF PDBS DEMONSTRATION

An estimated total of 58 passive diffusion samplers will be installed in 19 monitoring wells at Columbus AFB as part of this project. An additional 6 alternate monitoring wells have been designated for sampling in the event that one or more of the primary monitoring wells cannot be sampled. Seventeen of the 19 primary monitoring wells to be sampled are located at six IRP sites where contaminants have historically been detected in groundwater, and an additional 2 wells are located near the Columbus AFB boundary. The monitoring wells that will be sampled during this PDBS demonstration are summarized on Table 3.1, and their locations are shown on Figure 2.2.

3.1 Diffusion Sampling

3.1.1 Field Activities

Monitoring wells selected for VOC sampling using the PDBS technique (Table 3.1) were chosen from the list of monitoring wells targeted for sampling by CH2M Hill during the LTM sampling event scheduled to begin in May 2001. Monitoring wells were selected based primarily on VOC concentrations detected during previous sampling events, as indicated below. Selected wells include:

- All 12 LTM wells at which VOC concentrations exceeded regulatory limits for during the November 2000 sampling event;
- 4 wells contained at which VOCs were detected below regulatory limits during the November 2000 LTM sampling event; and
- The 3 new wells that will be installed at the Fire Training Area in May 2001.

TABLE 3.1
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
COLUMBUS AFB, MISSISSIPPI

Well Number	Primary/Alternate (P/A)	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft Below TOC)[b/]	Dominant Lithology of Screened Interval	Approximate Water Level Range (ft below TOC)	Aquifer Unit	Dedicated Pump yes/no (Y/N)	Estimated Number of PDBSs	Main COCs and Nov. 2000 Contaminant Concentration (mg/L)[b/]	Comments/Sampling Rationale
Site: LF-06											
W-18[c/]	P	33.27	2	21-31	Silty Sand	14.58 - 19.00	Surficial	N	3	VC: 6.19	Nov 2000 VC exceeds regulatory limit
W-21[c/]	P	31.70	2	18-28	Well Graded Sand and Gravel	4.47 - 12.08	Surficial	N	3	TCE: 13, VC: 9.04	Nov 2000 VC exceeds regulatory limit
W-22[c/]	P	25.05	2	11.5-21.5	Well Graded Sand and Gravel	6.61 - 13.98	Surficial	N	3	VC: 3.87	Nov 2000 VC exceeds regulatory limit
W-81	P	27.48	2	17-27	Well Graded Gravel and Sand	14.09 - 16.80	Surficial	N	3	VC: 4.92	Nov 2000 VC exceeds regulatory limit
Site: LF-12											
W-25[c/]	A	26.00	2	13-23	Sand and Gravel	9.89 - 15.68	Surficial	N	3	TCE: 1.6, cis-1,2-DCE: 3.2	TCE and cis-1,2-DCE concentrations
Site: ST-13											
W-35	P	18.50	2	3.5-18.5	5ft-10ft: Sand 10ft-16ft: Sand and Gravel 16ft-18ft: Clayey Sand	8.19 - 10.50	Surficial	N	3	Benzene 15.6	Nov 2000 Benzene exceeds regulatory limit
W-49	P	16.24	4	8-18	Silty Sand and Gravel	5.02 - 7.40	Surficial	N	3		Historic detections--see Appendix D, target for field duplicates and MS/MSD sets.
W-84	P	22.00	2	5-20	9 ft-11 ft : Silty Sand 15ft-17 ft: Clayey Sand	9.46 - 11.98	Surficial	N	3	Benzene 4.4, PCE 6.03	Nov 2000 PCE exceeds regulatory limit
Site: SS-25											
W-8[c/]	P	33.38	2	20.7-30.7	Sandy Gravel	3.31 - 10.28	Surficial	N	3	1,1-DCA: 2.16, 1,1-DCE: 7, cis-1,2-DCE:1.56, TCE: 6.63	Nov 2000 TCE exceeds regulatory limit
W-9[c/]	A	34.31	2	22-32	Poorly Graded Sand with Silt	3.01 - 10.45	Surficial	N	3	1,1-DCA: 0.7, TCE: 3.39	Historic TCE detections
W-10[c/]	P	34.48	2	24-34	Poorly Graded Sand	3.10 - 10.60	Surficial	N	3	cis-1,2-DCE: 2.4, TCE: 9.33	Nov 2000 TCE exceeds regulatory limit
Shallow and Deep Well Pairs at SS-26											
W-13[c/]	P	30.00	2	6-16	8ft-10ft: Silty Sand 10ft-14ft: Sand and Gravel 14ft-20ft Sand	9.98 - 12.94	Surficial	N	1	1,2,4-TMB: 82.8, 1,3,5-TMB: 4.52, benzene: 0.91, Ethylbenzene: 27.4, Isopropylbenzene: 15.2, Xylenes: 96.6	Nov 2000 Naphthalene and 1,2,4-Trimethylbenzene exceed regulatory limits
DW-16[c/]	P	184.00	4	105-115		14.73 - 19.91	Eutaw	N	3	dichloropropane	Historic detections of dichloropropane, target 1 interval for field duplicate and MS/MSD set.
			4	130-140		-	Eutaw	N	3		
DW-43[c/]	A	150.00	4	135-145	Clayey Sand	12.86 - 18.18	Eutaw	N	3	Toluene: 0.7	Historic detections of toluene.
Shallow and Deep Well Pairs at SS-28											
W-47[c/]	P	22.96	2	7-17	Silty Sand and Gravel	5.59 - 7.48	Surficial	N	3	cis-1,2-DCE: 1.61, PCE: 9.37, TCE: 1.51	Nov 2000 PCE exceeds regulatory limit
W-86	P	47.00	2	35-45	Silty Fine Sand to Silty Clay	4.97 - 7.30	Surficial	N	3	cis-1,2-DCE: 1.37, TCE: 15.5	Nov 2000 TCE exceeds regulatory limit
DW-86	A	72.00	2	60-70	Silty Clay	7.70 - 11.35	Eutaw	N	3	ND[d/]	Clean well
W-87	P	42.00	2	30-40	31ft-35t: Gravel 36ft-42ft: Silty Sand	9.42 - 12.66	Surficial	N	3	1,1-TCA: 8.82, 1,1-DCA: 6.31, 1,1-DCE: 12.2, Benzene, 0.55, TCE: 44.3, VC: 2.34	Nov 2000 1,1-DCE, VC, and TCE exceed regulatory limits
DW-87	A	74.00	2	62-72	Silty Clay	14.16 - 17.85	Eutaw	N	3	ND	Clean well
Boundary Wells											
W-82	P	30.00	2	15-25	Well Graded Gravel with Sand	4.98 - 13.50	Surficial	N	3	1,1-DCE: 3.65, 1,1,1-TCA: 0.94	Detections of 1,1,1-TCA and 1,1-DCE
DW-85	P	84.00	2	72-82	72ft-74ft: Clayey Sand 78ft-80ft: Silty Clay	18.09 - 22.77	Eutaw	N	3	1,1,1-TCA: 1.6	Historic detections of 1,1,1-TCA
W-89	A	23.00	2	11-21	Well Graded Gravel	7.42 - 10.46	Surficial	N	3	1,1,1-TCA: 0.27, Chloroform: 0.47	Historic and current detections of 1,1,1-TCA and Chloroform
Fire Training Area											
W-105	P	TBD[e/]	2	TBD	TBD	TBD	Surficial	N	3	BTEX	Geoprobe data in this area indicate that there will be substantial BTEX concentrations in groundwater. Target W-107 for field duplicates.
W-106	P	TBD	2	TBD	TBD	TBD	Surficial	N	3	BTEX	
W-107	P	TBD	2	TBD	TBD	TBD	Surficial	N	3	BTEX	

Notes:
VC= Vinyl Chloride; TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; PCE = Tetrachloroethene;
1,1-DCA = 1,1-Dichloroethane; 1,1-DCE = 1,1-Dichloroethene; 1,2,4-TMB = 1,2,4-Trimethylbenzene; 1,1,1-TCA = 1,1,1-Trichloroethane.

[a/] ft = feet; in = inches.

[b/] TOC = top of casing; µg/L = micrograms per liter.

[c/] Well completion is a stickup.

[d/] ND = not detected.

e/ TBD = to be determined.

PDBSs deployed during this investigation will be installed and retrieved in general accordance with the diffusion sampler installation and recovery standard operating procedures presented in Appendix B of the AFILEV PDBS Project Work Plan (Parsons, 2001). PDBSs will be installed throughout the screened interval of each well (i.e., 1 PDBS per 3 feet of saturated screen) to obtain a vertical profile of contaminant concentrations. The PDBS samples will be collected prior to the May-June 2001 CH2M Hill sampling event except for the three new fire training area wells. PDBSs will be installed in the three new wells immediately following CH2M Hill's sampling of these same wells on May 10-11. Analysis of the vertical profiling samples is discussed in Section 3.1.2.

Sample aliquots from PDBSs installed in the 16 existing wells targeted for sampling will be shipped to PEL Laboratory, Inc. in Tampa, Florida for VOC analysis using US Environmental Protection Agency (USEPA) Method 8260B. PDBS samples from the three new wells installed in the Fire Training Area will be shipped to Kemron Environmental Services in Marietta, Ohio for VOC analysis using USEPA Method 8260B. These are the same laboratories that will be used by CH2M Hill during their conventional sampling of the same wells. Field quality control samples will be collected at the following frequencies:

- 10 percent field duplicates;
- 5 percent matrix spikes and matrix spike duplicates;
- 1 pre-installation equipment blank; and
- Approximately 3 trip blanks.

The LTM SAP for Columbus AFB (CH2M Hill, 2000) will be adopted as the site-specific addendum to the PDBS SAP, as appropriate.

3.1.2 Contaminant Profiling

Per the project work plan (Parsons, 2001), contaminant profiling within the screened intervals of the LTM wells was intended to be conducted using field-screening methods, with only the sample exhibiting the greatest VOC concentrations based on the field analysis method being submitted for laboratory analysis. However, the field-screening test kits specified in the AFILEV PDBS Project Work Plan (Parsons, 2001) are not appropriate for use at Columbus AFB for two primary reasons:

- Recently reported VOC concentrations in all but four monitoring wells at Columbus are below the minimum quantitation limits of the field test kits; and
- Vinyl chloride (VC) is a primary COPC at Columbus AFB, and the field test kits are relatively inefficient at detecting and quantifying concentrations of VC.

Therefore, the field test kits will not be used to screen groundwater samples at Columbus AFB. Rather, sample aliquots will be collected from all PDBSs to be installed in the 19 monitoring wells and shipped to PEL Laboratories for VOC analysis. Thus,

vertical profiling of VOC concentrations within each well will be completed using fixed-based laboratory analyses rather than field-screening methods.

3.1.3 Analytical Results Comparison/Evaluation

Analytical results for groundwater samples collected using the PDBSs and using conventional techniques will be compared, and the results will be evaluated. Typically, if maximum concentrations from the PDBS are higher than concentrations in samples collected using the conventional method, it is probable that the concentrations from the PDBS are more representative of ambient groundwater chemistry conditions than are the conventional-sampling data (Vroblesky, 2000). If, however, the conventional method produces VOC results that are higher by a predetermined amount than the concentrations reported for the PDBS, then the PDBS may not adequately represent local ambient groundwater conditions. In this case, the difference may be due to a variety of factors, including hydraulic and chemical heterogeneity within the saturated screened interval of the well, vertical flow of groundwater within the well, and/or the relative permeability of the well screen with respect to the surrounding aquifer matrix (Vroblesky and Campbell, 2000).

Considering the above guidance, if the maximum analytical result obtained using the PDBS is greater than or equal to the conventional sampling result, it will indicate that the PDBS method is appropriate for use in that particular well and no further comparison of results will be performed. However, if the maximum PDBS result is less than the conventional sampling result, further comparison of the two sets of results will be undertaken. In this instance, analytical results for samples collected using the diffusion samplers will be compared to results from the conventional sampling using relative-percent-difference (RPD), as defined by the following equation:

$$RPD = 100*[abs(D-C)]/[(D+C)/2]$$

Where:

abs = absolute value

D = diffusion sampler result

C = conventional sample result.

For this investigation, an RPD of less than 15 (McClellan AFB, 2000) will be considered to demonstrate good correlation between sample results. Calculated RPDs in excess of 15 will be reviewed individually in an attempt to determine the reason for the variance.

3.2 Monitoring Network Optimization Evaluation

A portion of the groundwater monitoring network at this installation will be evaluated using both qualitative assessments and a geographical information system (GIS)-based algorithm that performs statistically based temporal and spatial analyses of monitoring-well information. Locations and completion intervals of individual monitoring wells and sampling points will be examined, and the informational contribution of each well or

sampling point to the network will be weighed against the cost of monitoring at that point. Monitoring protocols and analytical methods also will be evaluated. Where warranted, recommendations will be developed for optimization of the portion of the monitoring network that is evaluated. Methods to be used in the evaluation will include, but are not limited to, qualitative hydrogeologic and hydrochemical analyses, application of statistical optimization techniques, and application of decision-logic structures.

A maximum of 30 monitoring wells at this installation will be evaluated as part of this task. Parsons will coordinate with Columbus AFB to determine which wells to include in the evaluation. The results of the evaluation will be included in the Site-Specific Diffusion Sampler Demonstration Report for Columbus Air Force Base.

4.0 PROJECT ORGANIZATION

Addresses and telephone numbers of the Columbus PDBS management team are as follows:

Name	Title	Address	Phone/Email	Fax
Dr. Javier Santillan	AFCEE COR	AFCEE/ERT 3207 North Road Brooks AFB, TX 78235-5363	(210) 536-5207 email: javier.santillan@hqafcee.brooks.af.mil	(210) 536-4330
Mr. Jack Sullivan	Parsons ES Program Manager	Parsons ES, Inc. 901 N.E. Loop 410 Suite 610 San Antonio, TX 78209	(210) 828-4900 email: jack.sullivan@parsons. com	(210) 828-9440
Ms. Linda Murray	Parsons ES TO/Project Manager	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1904 email: linda.murray@parsons.com	(303) 831-8208
Mr. Doug Downey	Parsons ES Technical Director for PDBS	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1915 email: doug.downey@parsons.com	(303) 831-8208
Mr. John Anthony	Parsons ES Technical Director for Statistics	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1910 email: john.anthony@parsons.com	(303) 831-8208
Mr. John Hicks	Parsons ES PDBS Task Manager	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1941 email: john.hicks@parsons.com	(303) 831-8208
Mr. John Tunks	Parsons ES PDBS Deputy Task Manager	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-8740 email: john.tunks@parsons.com	(303) 831-8208

Name	Title	Address	Phone/Email	Fax
	Manager			
Mr. Dan Griffiths	Parsons ES Site Manager	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1940 email: daniel.r.griffiths@parsons.com	(303) 831-8208
Mr. Bradley P. Varhol	PDBS Vendor	EON Product, Inc. P.O. Box 390246 Snellville, GA 30039	(800) 474-2490 web site: www.eonpro.com email: sales@eonpro.com	(770) 978-8661
Mr. Troy Stewart	Columbus AFB Point of Contact	14 CES/CEV 555 Simler Road, Suite 108 Columbus AFB, MS 39710-5010	(662) 434-7973 email: troy.stewart@columbus.af.mil	(662) 434-3973
Mr. Robert Carlisle	CH2M Hill Point of Contact	2567 Fairlane PO Box 230548 Montgomery, AL 36123.0548	Email: rcarlisl@ch2m.com	(334)271-1444
Mr. Kevin Dunham	PEL Laboratory Inc.	4420 Pendora Point Rd. Tampa, FL 33619	(813) 247-2805 Email: kdunham@pelab.com	(813) 248-1537
Ms. Teresa Davis	Kemron Environ-mental Services	109 Starlite Park Marietta, OH 45750	740-373-4071 email: tdavis@kemron-lab.com	(740) 373-4835
Columbus AFB Hotel	Magnolia Inn	179 F Street Columbus AFB, MS 39710	Reservations: (662) 434-2372 Lodging Manager 434-2373	(601) 434-2777

5.0 SCHEDULE

Work performed as part of this demonstration at Columbus AFB will be completed according to the schedule summarized below.

- Submittal of the Draft Columbus AFB PDBS Work Plan to commenting parties: May 2, 2001
- Receipt of Draft Columbus AFB PDBS Work Plan Comments: May 4, 2001
- Submittal of the Final Columbus AFB PDBS Work Plan to commenting parties: May 20, 2001
- Install PDBS samplers in 20 monitoring wells at Columbus AFB: May 9-11, 2001
- Remove PDBS samplers from 20 monitoring wells at Columbus AFB: May 29 - 31, 2001

- Preparation of the Draft Columbus AFB PDBS Report: July 12 - August 15, 2001.

6.0 REPORTING

The site-specific results report will provide a map and accompanying table identifying the location and depth for each PDBS sample collected. Analytical results collected as part of this study will be compared to conventional-sampling analytical results collected by CH2M Hill in a scientifically defensible manner using statistical analyses. The results of the statistical comparisons will be presented in a clear and logical manner in the results report. Statistical methods will include calculation of RPDs between PDBS and conventional sampling results, and possibly parametric or non-parametric analysis of variance (ANOVA) tests. The draft version of this report will be distributed according to the schedule presented in Section 5.

7.0 REFERENCES

Air Force Center for Environmental Excellence (AFCEE). 1997. *Long Term Monitoring Optimization Guide*. Version 1.1.

CH2M Hill. 1989. *Remedial Investigation Report, Columbus Air Force Base, Mississippi*. Prepared for Headquarters Air Training Command/DEEV, Randolph Air Force Base, Texas. December.

CH2M Hill. 1995. *Air Force Installation Restoration Program Site Inspection Report, Final, Columbus Air Force Base, Mississippi*. Prepared for Headquarters Air Education and Training Command/CEVR. June.

CH2M Hill. 2000. *Final Long Term Monitoring Program Sampling and Analysis Plan, Columbus Air Force Base, Mississippi*. October.

CH2M Hill. 2001. *November 2000 Long-Term Monitoring Report, Columbus AFB, Mississippi*. March.

McClellan AFB. 2000. *Final Passive Diffusion Membrane Samplers Technology Application Analysis Report.* National Environmental Technology Test Sites (NETTS). August.

Parsons Engineering Science, Inc. (Parsons). 1999. *Baseline Risk Assessments and Feasibility Studies for Installation Restoration Program Sites SS-28, ST-13, ST-24, SS-28, and SS-29, Columbus Air Force Base, Mississippi*. December.

Parsons. 2001. *Work Plan for the Air Force Environmental Directorate Passive Diffusion Sampler Demonstration*. April.

US Air Force (USAF). 1997. *Columbus Air Force Base, Comprehensive Plan, General Plan.* September 8.

USAF. 1998. *Draft Final Environmental Assessment, Military Family Housing Construction Project, Columbus Air Force Base, Mississippi*. April.

Vroblesky, D.A. 2001. *User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells.* US

Geological Survey Water-Resources Investigations Report 01-4060. Columbia, South Carolina.

APPENDIX A

HEALTH AND SAFETY PLAN ADDENDUM

ADDENDUM TO THE PROGRAM HEALTH AND SAFETY PLAN
FOR THE EVALUATION OF
PASSIVE DIFFUSION BAG SAMPLERS (PDBS)

AT

COLUMBUS AIR FORCE BASE
COLUMBUS, MISSISSIPPI

MAY 2001

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290

Reviewed and Approved By:

	Name	Date
Project Manager	_____	_____
Office Health and Safety Representative	_____	_____

1.0 INTRODUCTION

This addendum modifies the existing program health and safety plan entitled *Program Health and Safety Plan for the Evaluation of Passive Diffusion Bag Samplers (PDBSs)* (Parsons Engineering Science, Inc., [Parsons] 2001) for the evaluation of the use of PDBSs in existing groundwater monitoring programs at selected Department of Defense installations across the United States. This work is being performed under contract number F41624-00-D-8024 Task Order 0024, Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base.

This addendum to the program health and safety plan was prepared to address the upcoming tasks at Columbus Air Force Base (AFB) in Mississippi. Included or referenced in this addendum are the scope of services, site specific description and history, project team organization, hazard evaluation of physical hazards and of known or suspected chemicals, and emergency response information. All other applicable portions of the program health and safety plan remain in effect.

2.0 SCOPE OF SERVICES

Site activities will involve the placement of a water-filled diffusive membrane capsule in a well installation device at a specific depth in an existing groundwater monitoring well. The wells are located in various areas throughout the base. After a specified period of time, the water in the sampler is transferred to a sample container and submitted for laboratory analysis. No drilling or ground-intrusive activities are anticipated under the current scope of work.

3.0 SITE SPECIFIC DESCRIPTION HISTORY

The descriptions, history, and maps for the various sites are contained in the work plan entitled *Work Plan for a Passive Diffusion Bag Sampler Demonstration, Columbus Air Force Base, Mississippi* (Parsons, 2001).

4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the PDBS demonstration activities at Columbus AFB is identified in the program health and safety plan. The following personnel will also be involved in this project.

Ms. Linda Murray	Project Manager
Mr. John Hicks	Task Manager
Mr. Dan Griffiths	Site Manager
Mr. Dan Griffiths	Site Health and Safety Officer
Mr. Troy Stewart	Columbus AFB Site Contact

5.0 HAZARD EVALUATION

5.1 Chemical Hazards

The primary contaminants of concern at the various sites are chlorinated solvents and the volatile hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). Health hazard qualities for these and other compounds are presented in Table 5.1 at the end of this

addendum. If other contaminants are found to exist at the site, this addendum will be modified to include the necessary information that will then be communicated to the onsite personnel.

5.2 Physical Hazards

Potential physical hazards at Columbus AFB include hazards associated motor vehicles; slip, trip, and fall hazards; noise; and heat exposure. These hazards are discussed in the program health and safety plan.

5.3 Biological Hazards

An abundance of red fire ants has been observed at Columbus AFB, especially in the vicinity of the existing monitoring wells. Do not stand on, place equipment on or otherwise disturb the anthills. It is also advisable to place a four foot square piece of plywood where personnel need to stand. An insect repellent may be used if it does not interfere with the desired groundwater sampling analyses. Latex booties taped at the top or Tyvek® suits may also be used. Frequent self-checks for crawling ants should also be performed.

6.0 EMERGENCY RESPONSE PLAN

6.1 Emergency Contacts

In the event of any emergency situation or unplanned occurrence requiring assistance, the appropriate contacts should be made from the list below. A list of emergency contacts must be posted at the site.

Contingency Contacts	**Telephone Number**
Site/Medical Emergency	911
Columbus AFB Security	911
Site Contact: Troy Stewart	(662) 434-7973

Medical Emergency (on-base facility for minor care)

Base Clinic	Columbus AFB Clinic
Hours	0715-2000
Address	Independence Avenue and Harpe Boulevard
Telephone Number	911
Ambulance	911

Directions to the Base Hospital:

Directions to the hospital from each of the work sites will be discussed in daily tailgate meetings prior to the start of field activities.

Parsons ES Contacts	**Telephone Number**

Linda Murray Project Manager	(303) 831-8100 or 764-1904 (Work) (303) 279-9129 (Home)
John Hicks Task Manager	(303) 831-8100 or 764-1941 (Work) (303) 279-3698 (Home)
Tim Mustard, CIH Program Health and Safety Manager	(303) 831-8100 or 764-8810 (Work) (303) 450-9778 (Home)
Ed Grunwald, CIH Corporate Health and Safety Manager	(678) 969-2394 (Work) (404) 299-9970 (Home)
Judy Blakemore Assistant Program Health and Safety Manager	(303) 831-8100 or 764-8861 (Work) (303) 828-4028 (Home) (303) 817-9743 (Mobile)

7.0 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

The personal protection level prescribed for field activities at Columbus AFB is Occupational Safety and Health Administration (OSHA) Level D with a contingency for the use of OSHA Level C or B, as site conditions require. The flow chart presented in Figure 7.1 of the program health and safety plan and this addendum will be used to select respiratory protection with the following comments and additions.

While there is a Dräger® tube for vinyl chloride, there is no Dräger® tube for 1,1-DCE. Therefore the following will occur. If sustained air monitoring readings in the worker breathing zone indicate vapor concentrations greater than or equal to 1 part per million (ppm) above background for 30 seconds or longer, the field crew will be forced to evacuate and ventilate the area until readings are less than 1 ppm in the worker breathing zone. If ventilation is inadequate, air samples will be taken to confirm or deny the existence of the contaminants of concern and/or the crew will upgrade to Level B respiratory protection. These air samples will be sent to a lab to be analyzed by US Environmental Protection Agency (USEPA) Compendium Method TO-14 or the equivalent. Method TO-14 will also analyze for the other volatile contaminants of concern at the site as listed in Table 5.1 of this addendum, with the exception of naphthalene. If a sample is sent for TO-14 analysis, naphthalene results should also be requested, since there are no Dräger® tubes for naphthalene (permissible exposure limit [PEL] of 10 ppm).

If vinyl chloride and/or 1,1-DCE are found to exist in the worker-breathing zone at concentrations above 1 ppm above background, additional work must be performed in OSHA Level B personal protective equipment (PPE) due to the inadequate warning properties of the compounds. If other volatile compounds listed in Table 5.1 are present as indicated by the TO-14 analytical results, the following will be used to check for the additional compounds.

A reading of 5 part per million (ppm) above background in the worker breathing zone as indicated by the photoionization detector will require the use of a Dräger® tube or the equivalent to determine if benzene is present at a concentration greater than or equal to the PEL of 1 ppm. The flow chart presented in Figure 7.1 and appropriate text in the Program Health and Safety Plan (HASP) then will be used to select respiratory protection against volatile hydrocarbon constituents.

If sustained air-monitoring readings in the worker-breathing zone persist at or above 25 ppm, Dräger® tubes or the equivalent must be used to confirm or deny the presence of tetrachloroethene (PCE). Due to the inadequate warning properties of PCE, Level B protection must be used if concentrations of PCE exceed 25 ppm above background in the worker-breathing zone.

If PCE is not present, continue to monitor the air in the worker-breathing zone. If concentrations in the worker-breathing zone persist above 25 ppm above background as indicated by the PID, periodic use of the PCE Dräger® tubes must be used to confirm the absence of PCE.

USEPA Method TO-14 will indicate the presence of 1,2,4-trimethylbenzene (1,2,4-TMB), which has a PEL of 25 ppm. There are no Dräger® tubes for 1,2,4-TMB.

If the PID indicates concentrations at or above 50 ppm above background in the worker-breathing zone, the screening process must be repeated with trichloroethene (TCE) Dräger® tubes to confirm or deny the presence of TCE.

Section 7 of the Program HASP contains guidelines for selection of PPE. PPE will be required when handling contaminated samples and when working with potentially contaminated materials. See Page 7-4 of the HASP for PPE to be used.

8.0 FREQUENCY AND TYPES OF AIR MONITORING

A photoionization detector (PID) with an 10.2 electron volts (eV) (HNU®) or equivalent lamp will be used for air monitoring during this project since the ionization potentials of the contaminants of concern are below 10.2 eV.

Revised
02/14/96

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold [d/] (ppm)	Ionization Potential [e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	0.5 (skin) [g/]	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
1,1-Dichloroethene (DCE) (Vinylidene Chloride)	1	5	NA [h/]	NA	10.00	Colorless liquid or gas (>89°F) with a mild, sweet, chloroform-like odor. Irritates eyes, skin, and throat. Causes dizziness, headaches, nausea, shortness of breath, liver and kidney dysfunctions, and lung inflammation Mutagen and carcinogen.
Ethylbenzene	100	100	800 (10% LEL) [i/]	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Naphthalene	10	10	250	0.3	8.1	Colorless to brown solid (shipped as a molten liquid) with a mothball-like odor. Irritates eyes, skin, and bladder. Causes headaches, confusion, excitement, convulsions, coma, vague discomfort, nausea, vomiting, abdominal pain, profuse sweating, jaundice, hematoma, hemoglobin in the urine, renal shutdown, dermatitis, optic nerve disorders, and corneal and liver damage. Experimental teratogen and questionable carcinogen.
Perchlorethylene (Tetrachloroethene or PCE)	25 [j/]	25	150	5-50	9.32	Colorless liquid with a mild chloroform odor. Eye, nose, skin and throat irritant. Causes nausea, flushed face and neck, vertigo, dizziness, headaches, hallucinations, incoordination, drowsiness, coma, pulmonary changes, and skin redness. Cumulative liver, kidney, and CNS damage. In animals, causes liver tumors. Mutagen, experimental teratogen, and carcinogen.
Toluene	100	50 (skin)	500	0.2-40 [k/]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold [d/] (ppm)	Ionization Potential [e/] (eV)	Physical Description/Health Effects/Symptoms
Trichloroethene (TCE)	50	50	1,000	21.4-400	9.45	Clear, colorless or blue liquid with chloroform-like odor. Irritates skin and eyes. Causes fatigue, giddiness, headaches, vertigo, visual disturbances, tremors, nausea, vomiting, drowsiness, dermatitis, skin tingling, cardiac arrhythmia, and liver injury. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
1,2,4-Trimethylbenzene (Pseudocumene)	25	25	NA	0.027	8.27	Colorless liquid with a distinctive, aromatic odor. Irritates eyes, skin, nose, throat, and respiratory system. Causes bronchitis, hypochromic anemia, headaches, drowsiness, fatigue, dizziness, nausea, incoordination, vomiting, confusion, CNS depression, and chemical pneumonia.
Vinyl Chloride	1 (29 CFR 1910.1017) [f/]	5	NA	260	9.99	Colorless gas (liquid<7°F) with a pleasant odor at high concentrations. Severe irritant to skin, eyes, and mucous membranes. Causes weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or blue skin on the extremities, liver cancer, and frostbite (liquid). Also attacks lymphatic system. Mutagen, experimental teratogen, and carcinogen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 [k/]	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain, and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1997. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), *TVLs® and BEIs®* (Current Edition).

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1997.

d/ When a range is given, use the highest concentration.

e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards*, June 1997.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms

f/ Refer to expanded rules for this compound.

g/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.

h/ NA = Not available.

i/ Indicates that the IDLH value was based on 10% of the lower explosive limit for safety considerations, even though relevant toxicological data indicated that irreversible health effects or impairment of escape existed only at higher concentrations *(NIOSH Pocket Guide to Chemical Hazards, 1997)*.

j/ NIOSH recommends reducing exposure to the lowest feasible concentration, and limiting the number of workers exposed.

APPENDIX B

HISTORICAL SITE DOCUMENTATION

This information can be obtained by contacting
Mr. John Hicks
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290
(303) 831-8108

APPENDIX C

FIELD EQUIPMENT LIST

Status		PDBS Sampling Supplies Checklist
get from Troy on 5/9		well keys
Cooler	x	water level meter
Cooler		field book
Reserved	x	laptop computer with PDBS placement form template loaded and with car battery adapter
DRG	x	well completion info (TOC elev., total depth, screened interval, etc.)
Cooler	x	plastic sheeting
DRG		pencil, pen, sharpee
DRG		site map
DRG		phone list
DRG		cell phone
Cooler	x	tape measure (long >100 ft.)
Cooler	x	latex gloves
Cooler		clip board
Cooler		blank paper/notebook
On base		sample bottles
On base	x	diffusion samplers
Purchase in MS	x	DI/distilled water (if necessary)
Purchase in MS	x	zip-ties
DRG	x	weights
DRG		well caps with hangers/hooks
On base		cooler for samples
Purchase in MS		ice
Purchase in MS		trash bags
On base		COC forms
On base		COC seals
Cooler		FedEx Label (preprinted)
On base		address label for lab
Cooler		clear tape
Purchase in MS		packing/strapping tape
Cooler		ziplock bags (quart)
Purchase in MS		5-gallon buckets for temporary storage of decon water and excess PDBS water
Purchase in MS	x	polypropylene rope
Cooler		1st aid kit
Cooler		eye wash kit
DRG		rain gear
Purchase in MS		bug spray/repellant
Purchase in MS		sun lotion
DRG		hat
DRG		coveralls
DRG		hard hat
DRG		safety sunglasses
DRG		steel toed boots
DRG		ear muffs/plugs
DRG		work gloves
Cooler		small tool box with the following: vise grips, screwdrivers, wrenches (9/16, 1/2, 15/16), hammer, scissors/razor blade/pocket knife
Cooler		duct tape
Cooler	x	paper towels
DRG		references, etc.: work plan, HASP, existing data