FINAL

SITE-SPECIFIC WORK PLAN FOR THE PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION AT VANDENBERG AFB, CALIFORNIA

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Prepared for:

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

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LIST OF ACRONYMS AND ABBREVIATIONS

1STRAD	First Strategic Aerospace Division
ABRES	Advanced Ballistic Reentry System
AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
AFSPC	Air Force Space Command
ANOVA	analysis of variance
BGMP	Basewide Groundwater Monitoring Program
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
BXSS	Base Exchange Service Station
COC	chemical of concern
DCA	dichloroethane
DCE	dichloroethene
DoD	Department of Defense
DSITMS	Direct Sampling Ion-Trap Mass Spectrometry
GIS	Geographical information system
GSA	General Services Administration
HASP	Health and Safety Plan
ICBMs	intercontinental ballistic missiles
IRP	Installation Restoration Program
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
msl	mean sea level
MTBE	Methyl tert-butyl ether
Parsons	Parsons Engineering Science, Inc.
PDBS	passive diffusion bag sampler
RPD	relative percent difference
SAC	Strategic Air Command
SAMTO	Space and Missile Test Organization
SLC	Space Launch Complex
SVOC	semivolatile organic compound
TCE	trichloroethene
TCFM	trichlorofluromethane
TO	task order
TPH-D	total petroleum hydrocarbons, as diesel
TPH-G	total petroleum hydrocarbons, as gasoline
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	volatile organic compound
WSMC	Western Space and Missile Center

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) to demonstrate the use of passive diffusion bag samplers (PDBSs) in existing groundwater monitoring programs at selected Air Force Base Conversion Agency (AFBCA) installations. The site of the PDBS demonstration outlined in this work plan is Vandenberg Air Force Base (AFB), California. 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 Vandenberg 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 or using Micropurge dedicated pumps) during the previously scheduled August 2001 Basewide Groundwater Monitoring Program (BGMP) event with results obtained using the PDBS method.

Vertical contaminant profiles will be developed by placing 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 BGMP 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 Vandenberg AFB PDBS 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 in mid- to late-July 2001 to provide adequate equilibration time before the incumbent environmental contractor for Vandenberg AFB, Tetra Tech, begins the scheduled BGMP sampling event scheduled to begin on August 6, 2001. The PDBSs will be retrieved immediately prior to the conventional BGMP sampling at the selected locations to ensure temporal comparability of the analytical results obtained using the two methods. The PDBSs will be in place for a minimum of 14 days, which fulfills the 14-day minimum equilibration time period specified in the AFBCA 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 Vandenberg AFB site description is presented in Section 2. Section 3 presents the scope of the PDBS investigation at Vandenberg 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 a site-specific addendum to the Project Health and Safety Plan (HASP) (Parsons, 2001). Appendix B provides detailed site access instructions.

2.0 SITE DESCRIPTION

2.1 Location and Description of Vandenberg Air Force Base

Vandenberg AFB is a 98,000-acre, 154-square mile installation located along 35 miles of undeveloped Central California coast. It is often described as a national park setting and includes one of the largest undeveloped areas left in the state. The Base is located 55 miles northwest of Santa Barbara, California; its nearest neighbors are the cities of Lompoc, located 6 miles to the southeast, and Santa Maria, 5 miles to the northeast.

Prior to becoming a military base, the Vandenberg AFB property was zoned for ranching and agricultural uses. The first military installation was Camp Cooke Army Base. The War Department established an artillery training facility on 90,000 acres around Burton Mesa in March 1941. From February 1942 until the end of World War II, armored and infantry divisions were trained at Camp Cooke. A prisoner of war camp was also established. In 1945, a maximum-security army disciplinary barracks was constructed to house military prisoners. After Camp Cooke was deactivated in June 1946, most of the Base was leased for agriculture and grazing. The camp was briefly reactivated during the Korean Conflict, but deactivated again in 1953.

In 1956, the DoD chose Camp Cooke to be the first U.S. Air Force missile base. In June 1957, North Camp Cooke was transferred to the Air Force and re-designated Cooke Air Force Base. The southern portion was assigned to the Navy and re-designated Point Arguello Naval Missile Facility. In October 1958, Cooke Air Force Base was re-designated Vandenberg Air Force Base in honor of General Hoyt Vandenberg, the second

Air Force Chief of Staff. The Defense Reorganization Act of 1964 transferred the Point Arguello Naval Missile Facility to the Air Force.

The first missile was launched from Vandenberg AFB in December 1958. Over 1,600 intercontinental ballistic missiles (ICBMs) and polar-orbiting satellites have since been launched, including more than 50 types of missiles and rockets. Vandenberg AFB is presently the only U.S. military installation that launches ICBMs and satellites.

From 1958 until 1991, Vandenberg AFB operated as a missile test base and aerospace center under control of the Strategic Air Command (SAC). The host organization under SAC was the First Strategic Aerospace Division (1STRAD). Under 1STRAD, the major tenants were the Space and Missile Test Organization (SAMTO) and its subordinate, the Western Space and Missile Center (WSMC), which conducted range operations. Major range operations are currently the responsibility of the Air Force Space Command (AFSPC), which now operates Vandenberg AFB.

Potential contamination at Vandenberg AFB has been investigated under the Installation Restoration Program (IRP) since 1985. The BGMP addresses wells at 17 IRP Sites located throughout the Base as illustrated on Figure 2.1. Table 2.1 provides a BGMP summary listing each IRP site, chemicals of concern (COCs), and a discussion on whether or not the site will be included in the PBDS demonstration.

2.2 Geology and Hydrogeology

The geomorphology of Vandenberg AFB varies significantly, ranging from the high elevations of the rugged Santa Ynez Mountains in South Vandenberg to the broad, low-lying, generally flat Burton Mesa and San Antonio Terrace in North Vandenberg. The complete geology is discussed in the Remedial Investigation/Feasibility Study Work Plan for Operable Units 1, 2, 3B, 4, and 5 (Jacobs, 1993). The Base is located within two separate structural provinces. South Vandenberg is located within the Santa Ynez Mountain uplift, which is part of the Transverse Ranges (Dibblee, 1982). North Vandenberg is located within the Santa Maria Basin. Major faults that cross the Base include the Santa Ynez River Fault, the Baseline-Purisima Hills-Lompoc Oil Field-Lion's Head Fault, the Honda Fault, and the Hosgri Fault Zone. Most sites are underlain by unconsolidated material (interbedded layers of clay, silt, and sand) that overlies the Monterey Formation (composed of clayey shales, silicious shales, and limestones).

Vandenberg AFB encompasses parts of at least two major groundwater basins (Santa Ynez River basin and the San Antonio Creek basin) and the Lompoc Terrace and Cañada Honda subbasins of the Santa Ynez River Basin.

Hydrogeological characteristics for sites included in the PDBS demonstration that may affect the groundwater sampling results are discussed below.

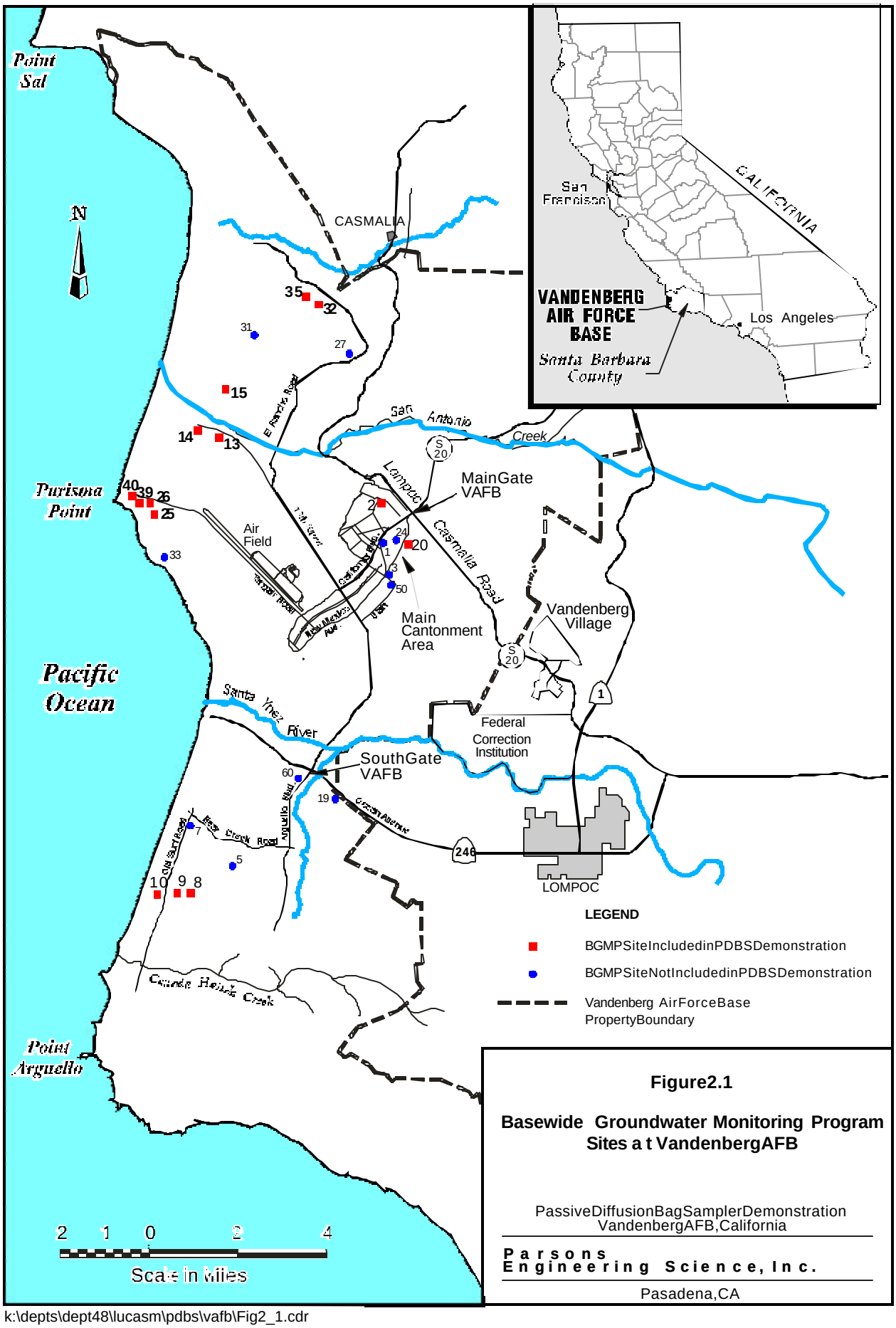

Figure2.1

Basewide Groundwater Monitoring Program Sites a t VandenbergAFB

PassiveDiffusionBagSamplerDemonstration
VandenbergAFB,California

Parsons Engineering Science, Inc.

Pasadena,CA

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TABLE 2.1
BASEWIDE GROUNDWATER MONITORING PROGRAM SITE SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
VANDENBERG AFB, CALIFORNIA

Site ID	Name	Chemicals of Concern	Discussion for Inclusion in PBDS Demonstration
Site 1	Base Exchange Service Station (BXSS)	Active Base Service Station; gasolene-related contaminant plume apparently migrating toward the north-northwest; COCs include TPH-G and BTEX.	Not included. Sampled on a Semi-Annual Basis; next scheduled sampling is Fall 2001.
Site 2	Old Base Service Station	Base Service Station from 1941 to 1981; COCs include fuel hydrocarbons, VOCs, SVOCs, and selected inorganic compounds.	Included. Benzene was detected during the Winter 2001 in one well above the CA primary MCL of 1 µg/L; VOCs not detected in other wells.
Site 3	Old Railroad Pumping Station	Former fuel transfer station near railroad siding; six aboveground tanks removed 1961; COCs include chlorinated VOCs, TPH-D, and PAHs.	Not included. Perched groundwater occurs sporatically; a continuous piezometric surface is not present.
Sites 5/7 Cluster	Space Launch Complex (SLC) 3 East/Bear Creek Pond	Aboveground gantry launch complex and pond located downstream/downgradient.	Not included. Separate investigation and not yet included in BGMP.
Sites 8/9/10 Cluster	SLC 4 East/SLC 4 West/Spring Canyon Pond	Aboveground gantry launch complex and pond located downstream/downgradient; COCs include clorinated VOCs and metals.	Included. TCE exceeds Federal MCL of 5 µg/L.
Sites 13/14 Cluster	ABRES-A Launch Complex/ABRES-A Lake	Aboveground launch complex and lake located downstream/downgradient; COCs include clorinated VOCs and metals.	Included. cis-1,2-DCE exceeds CA primary MCL of 6 µg/L; vinyl chloride exceeds Federal MCL of 2 µg/L.
Site 15	ABRES-B Launch Complex	Aboveground launch complex and lake located downstream/downgradient; COCs include clorinated VOCs and metals.	Included. Per request of Base point of contact.
Site 19	NASA Building 836	Missile support building; COCs include chlorinated VOCs, BTEX, and TPH-D.	Not included. Sampled on an Annual Basis; next scheduled sampling is Fall 2001.
Site 20	Area 1 (UST Area), Areas 2&3 (Landfill 1 & Drum Disposal Site 1)	UST Area was used to store diesel fuel from 1942 to 1946 and gasolene from 1951 to 1953; tanks were removed in 1993. Landfill 1 was the active municipal waste landfill from 1942 to 1957. The Drum Disposal Site reportedly received drums of waste petroleum oils, lubricants, and unexploded ordinence.	Area 1 wells included. Areas 2&3 wells not sampled for VOCs and not included. At Area 1, Benzene exceeds CA primary MCL of 1 µg/L; 1,2-DCA exceeds Federal MCL of 5 µg/L.
Site 24	Entomology Wash Rack	This site includes an area used for mixing pesicides and washing equipment, and old fuel island, and a military tank maintenance pad.	Not included. Separate investigation and not yet included in BGMP.
Sites 25/26/39/40 Cluster	SLC 2 East/SLC 2 West/SLC 1 East/SLC 1 West	The SLCs were originally constructed in 1958 for launching Thor missiles. SCL 2 West has been converted to an aboveground gantry launcher and is currently used for Delta rockets, with SLC 2 East being used for missile support. COCs include chlorinated VOCs (TCE), perchlorate, and metals.	Included. TCE exceeds Federal MCL of 5 µg/L.
Site 27	Exploded Missile Silo	This site was constructed as a training facility and was destroyed by an in-silo explosion during a simulated launch. COCs include metals and VOCs (TCE and TCFM).	Not included. Only low levels of TCFM (below regulatory standards) detected in Winter 2001 sampling.
Site 31	Missile Launcher 576-C	This "coffin-type" missile laucher was used from July to September 1963 to launch Atlas missiles; COCs present in site groundwater include VOCs, metals, and pesticides.	Not Included. All wells currently being sampled have dedicated pumps.
Sites 32/35 Cluster	Missile Silo 576-D/Missile Silo 576-G	These "silo-lift" facilities were used for Atlas launches; COCs include chlorinated solvents and metals.	Included. TCE exceeds Federal MCL of 5 µg/L.
Site 33	Missile Silo 576-E	These "silo-lift" facility was used for Atlas launches; COCs include chlorinated solvents and metals.	Not Included. All wells currently being sampled where VOCs were dected have dedicated pumps.
Site 50	Bionetics Building	This site was used for metal plating and parts cleaning operations	Not included. Separate investigation and not yet included in BGMP.
Site 60	South Base General Services Administration (GSA) Service Station	This was a diesel and gasoline fueling facility and the USTs were removed in 1995.	Not Included. Only MTBE detected in Winter 2001 sampling event.

Notes:

SLC = Space Launch Complex
ABRES = Advanced Ballistic Reentry System
COC = chemical of concern
MCL = Maximum Contaminant Level
µg/L = microgaims per liter
UST = underground storage tank
VOC = volatile organic compound
SVOC = semi-volatile organic compound
1,2-DCA = dichloroethane
BGMP = Basewide Groundwater Monitoring Program
BTEX = benzene, toluene, ethylbenzene, xylenes
cis-1,2-DCE = cis-1,2-dichloroethene
MTBE - Methyl tert-butyl ether
TCE = trichloroethene
TCFM = trichlorofluormethane
TPH-D/G = total petroleumhydrocarbons - gasolene/diesel

Site 2

Located on Burton Mesa; groundwater encountered in discontinuous lenses in unconsolidated sediments overlying Monterey Formation Bedrock. Groundwater depths typically range from 20 to 25 feet below ground surface (bgs). Based on measurements collected in December 1999, HydroGeologic estimated that groundwater beneath the site flows to the south along a very shallow gradient (HydroGeologic, 2000). Groundwater level measurements collected in March 2001 showed groundwater flow to the east along a very shallow gradient, suggesting that groundwater flow is variable over time, possibly influenced by seasonal rainfall (Tetra Tech, 2001).

Sites 8/ 9/10

Sites 8, 9, and 10 are located on the southern margin of the Lompoc Terrace sub-basin of the Santa Ynez River basin. Groundwater is present in the unconsolidated material immediately above the contact with Sisquoc Formation bedrock. Groundwater elevation ranges from approximately 423 feet above mean sea level (msl) in 8-MW-2 to 64 feet above msl in 8-MW-13 (Tetra Tech, 2001).

Sites 13/14

Sites 13 and 14 are located on the drainage divide between the Santa Ynez River groundwater basin to the south and the San Antonio Creek basin to the north. Groundwater flows northwest at a hydraulic gradient of 0.01 feet per foot (Tetra Tech, 2001). Depth to groundwater beneath the site ranges from 47 to 83 feet bgs.

Site 15

Site 15 is located to the north of the San Antonio Creek, in the San Antonio Creek basin. Groundwater flows south-southwest and groundwater depths typically range from 11 to 29 feet bgs.

Site 20, Area 1

Site 20, Area 1 is located in the North Santa Ynez River groundwater basin, with groundwater flow towards the northeast. Groundwater is encountered in discontinuous lenses in unconsolidated sediments overlying dark brown, hard, thinly bedded claystone bedrock. Groundwater depths typically range from 25 to 35 feet bgs.

Sites 25/26/39/40

Sites 25, 26, 39, and 40 are located north of the Santa Ynez River groundwater basin and southwest of the San Antonio Creek. Groundwater is encountered in the shallow unconsolidated material at depths ranging from 8 ft bgs on the east side of the cluster to 83 feet bgs on the west side (Tetra Tech, 2001). Groundwater levels indicate a northwest groundwater flow, but may be influenced by the underlying bedrock structure (i.e. undulations in the dune sand/bedrock contact and possible fracture zones) (Jacobs, 1993).

Sites 32/35

Sites 32 and 35 are located between the San Antonio Creek basin and Shuman Canyon and not located in either basin. Groundwater flows southwest following bedrock topography. Groundwater is unconfined and the depth ranges from 50 ft bgs on the east side of the sites to spring discharge in the southwest area (Tetra Tech, 2001).

2.3 Chemicals of Concern

Due to the size of Vandenberg AFB and the large, undeveloped areas, COCs found in groundwater are highly variable across the Base and tend to be located around individual IRP sites or clusters of sites. The BGMP addresses wells at 17 IRP Sites located across the Base primarily contaminated with fuel hydrocarbons, VOCs, semi-volatile organic compounds (SVOCs), and metals (Tetra Tech, 2000a). Table 2.1 provides a summary of the contaminants found at each BGMP site.

2.4 Current Basewide Groundwater Monitoring Program

The current BGMP is being performed to meet regulatory requirements at 17 IRP sites at Vandenberg AFB. These sites are being monitored to assess potential migration of contaminant plumes. Sampling events are performed quarterly (approximately 171 wells are included in the Summer 2001 event). The Base monitoring wells are sampled in accordance with the *Final Basewide Groundwater Monitoring Program Work Plan* (Tetra Tech, 2000a), the *Final Basewide Sampling and Analysis Plan* (Tetra Tech 2000b), and the *Final Basewide Groundwater Monitoring Program Health and Safety Addendum* (Tetra Tech, 2000c).

3.0 SCOPE OF PDBS DEMONSTRATION

An estimated total of 177 PDBSs will be installed in 56 monitoring wells at Vandenberg AFB as part of this project. The 56 primary monitoring wells located at seven IRP sites have been chosen based on the presence of VOCs in groundwater. The monitoring wells that will be sampled during this PDBS demonstration are summarized on Table 3.1, and their locations are shown on Figures 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6.

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 Tetra Tech BGMP scheduled to begin in August 2001. Monitoring wells were selected based primarily on VOC concentrations detected during previous sampling events, on the presence/absence of a dedicated pump, and the hydrogeologic conditions at each site. The selected wells are those that have had detectable concentrations of VOCs and do not contain dedicated pumps.

TABLE 3.1
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
VANDENBERG AFB, CALIFORNIA

Well Number	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft Below TOC)[b/]	Approximate Water Level Range (ft below TOC)	July 2001 Water Level (ft below TOC)	Number of PDBSs Deployed	Main COCs and Winter 2001 Contaminant Concentration (mg/L)[b/]	Comments/Sampling Rationale
Site 2								
2-MW-8	35.0	4" PVC	25.0 - 35.0	20.9 - 20.9	20.69	3	Benzene 4.4; ethylbenzene 10; m,p-Xylenes 42; o-Xylenes 14; toluene 11	Benzene exceeds CA primary MCL of 1 µg/L
Sites 8/9/10								
8-MW-4	107.5	4" PVC	96.1 - 106.1	102.4 - 102.4	101.08	1	TCE: 660; cis-1,2-DCE: 7.1	TCE exceeds Federal MCL of 5 µg/L
8-MW-5	108.0	4" PVC	87.0 - 107.0	86.5 - 86.8	86.36	6	TCE: ND; cis-1,2-DCE: ND	Baseline uncontaminated well
8-MW-6	161.5	4" PVC	141.5 - 161.0	142.8 - 143.4	142.51	6	TCE: 230; cis-1,2-DCE: 56; trans-1,2-DCE 1.8J	TCE exceeds Federal MCL of 5 µg/L
8-MW-7	151.0	4" PVC	135.0 - 145.0	139.8 - 140.2	139.66	1	TCE: 160	TCE exceeds Federal MCL of 5 µg/L
8-MW-8	123.0	4" PVC	102.5 - 122.5	110.3 - 110.3	109.76	4	TCE: 100	TCE exceeds Federal MCL of 5 µg/L
8-MW-9	137.5	4" PVC	72.0 - 82.0	75.8 - 75.8	75.14	2	TCE: 41	TCE exceeds Federal MCL of 5 µg/L
8-MW-10	107.0	4" PVC	65.0 - 80.0	68.0 - 68.2	66.80	4	TCE: 15; cis-1,2-DCE: 0.62J	TCE exceeds Federal MCL of 5 µg/L
8-MW-11	142.0	4" PVC	117.0 - 127.0	110.8 - 162.9	110.72	3	TCE: 130	TCE exceeds Federal MCL of 5 µg/L
8-MW-13	137.5	4" PVC	127.1 - 137.1	132.4 - 132.5	132.12	1	TCE: 170	TCE exceeds Federal MCL of 5 µg/L
9-MW-1	28.0	4" SS	12.1 - 22.1	10.0 - 14.6	10.27	3	TCE 1.7; cis-1,2-DCE: 17; vinyl chloride 2.8	cis-1,2-DCE exceeds CA primary MCL of 6 µg/L; vinyl chloride exceeds Federal MCL of 2 µg/L
9-MW-2	39.0	4" SS	15.8 - 26.8	6.1 - 18.8	13.42	3	cis-1,2-DCE: 1.8	Detectable concentrations of VOCs
9-MW-3	141.5	4" PVC	131.2 - 141.2	132.4 - 132.6	132.20	2	TCE: 99; cis-1,2-DCE: 2.3	TCE exceeds Federal MCL of 5 µg/L
9-MW-4	118.0	4" PVC	98.0 - 118.0	101.2 - 101.5	100.58	5	TCE: 2900	TCE exceeds Federal MCL of 5 µg/L
9-MW-5	201.0	4" PVC	181.0 - 201.0	189.4 - 189.6	189.36	3	TCE: 1,600; cis-1,2-DCE: 7.6J; 1,1-DCE 7.5J	TCE exceeds Federal MCL of 5 µg/L
9-MW-6	191.2	4" PVC	181.2 - 191.2	181.9 - 182.3	182.23	3	TCE: 130; cis-1,2-DCE: 7.1	TCE exceeds Federal MCL of 5 µg/L
9-MW-7	187.0	4" PVC	167.0 - 187.0	112.8 - 172.6	172.93	4	TCE: 620; cis-1,2-DCE: 3.5J; 1,1-DCE 2.5J	TCE exceeds Federal MCL of 5 µg/L
9-MW-8	151.5	4" PVC	141.0 - 151.0	142.8 - 142.8	142.22	2	TCE: 7.6	TCE exceeds Federal MCL of 5 µg/L
9-MW-9	153.5	4" PVC	143.5 - 153.5	149.0 - 149.1	148.80	1	TCE: 14	TCE exceeds Federal MCL of 5 µg/L
9-MW-10	185.0	4" PVC	165.4 - 184.6	174.2 - 174.3	173.81	3	TCE: 200; cis-1,2-DCE: 40; trans-1,2-DCE 1.0	TCE exceeds Federal MCL of 5 µg/L
9-MW-11	282.0	4" PVC	247.0 - 282.5	162.9 163.2	162.18	11	TCE: 1.5	Detectable concentrations of VOCs
9-MW-12	185.0	4" PVC	169.5 - 184.5	175.1 - 175.7	174.99	3	TCE: 150; cis-1,2-DCE: 25; trans-1,2-DCE 0.95J	TCE exceeds Federal MCL of 5 µg/L
9-MW-13	185.0	4" PVC	164.5 - 184.5	175.4 - 175.7	175.90	2	TCE: 200; cis-1,2-DCE: 6.1; 1,1-DCE 0.6J	TCE exceeds Federal MCL of 5 µg/L
9-MW-15	93.7	6" PVC	NA	85.4 - 85.4	84.97	2	TCE: 180; 1,1-DCE 2.7; chloroform 0.63J	TCE exceeds Federal MCL of 5 µg/L
9-MW-17	113.9	5" PVC	NA	101.7 - 101.7	101.00	4	TCE 3000; 1,1,1-TCA 3.3; 1,1-DCE 18; chloroform 21; PCE 0.71J	TCE exceeds Federal MCL of 5 µg/L
9-MW-18	118.3	5" PVC	NA	111.1 - 111.1	110.74	2	TCE 12,000; 1,1,1-TCA 1.2; 1,1-DCE 7.6; chloroform 12; PCE 1.1; trans-1,2-DCE 0.81J	TCE exceeds Federal MCL of 5 µg/L
9-MW-19	120.6	4" PVC	NA	107.8 - 107.8	107.31	4	TCE 11,000; 1,1,1-TCA 1.3; 1,1-DCE 7.1; chloroform 12; PCE 0.98J; trans-1,2-DCE 0.82J	TCE exceeds Federal MCL of 5 µg/L
10-MW-2	169.0	4" PVC	149.0 - 169.0	150.3 - 150.6	149.70	6	TCE: 6.1; cis-1,2-DCE: 1.3	TCE exceeds Federal MCL of 5 µg/L
10-MW-3	161.5	4" PVC	141.9 - 161.9	141.1 - 141.1	140.29	6	TCE: 0.7J	Detectable concentrations of VOCs
10-MW-4	65.0	4" PVC	55.0 - 65.0	25.7 - 25.7	26.98	3	TCE: 0.93J	Detectable concentrations of VOCs

TABLE 3.1 (Continued)
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
VANDENBERG AFB, CALIFORNIA

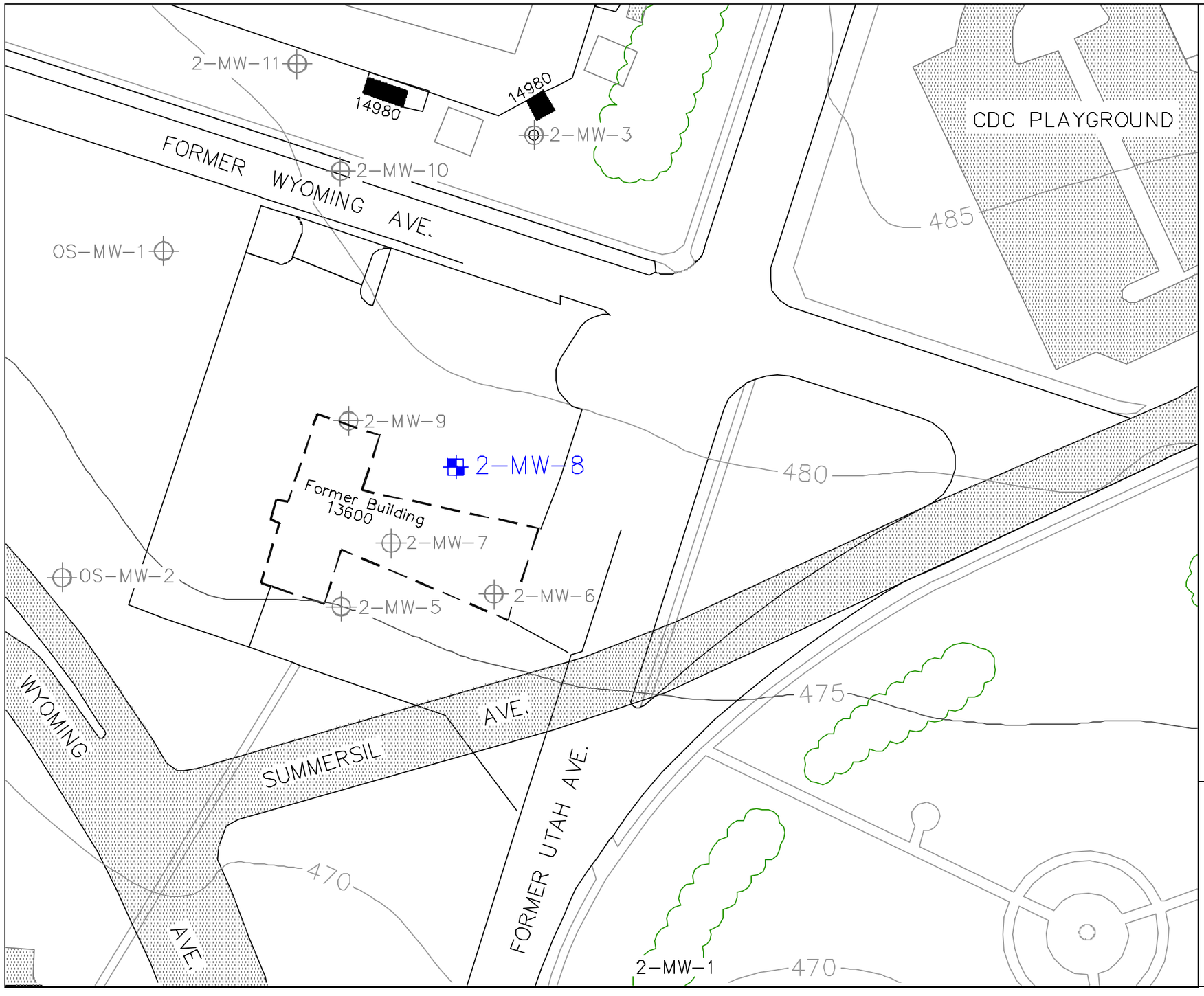
Well Number	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft Below TOC)[b/]	Approximate Water Level Range (ft below TOC)	July 2001 Water Level (ft below TOC)	Number of PDBSs Deployed	Main COCs and Winter 2001 Contaminant Concentration (mg/L)[b/]	Comments/Sampling Rationale
Sites 13/14								
14-MW-3	147.5	4" PVC	137.5 - 147.5	62.4 - 86.9	70.24	3	cis-1,2-DCE: 310; 1,1-DCE 1.2; trans-1,2-DCE 8.5; vinyl chloride 20	cis-1,2-DCE exceeds CA primary MCL of 6 µg/L; vinyl chloride exceeds Federal MCL of 2 µg/L
14-MW-4	111.8	4" PVC	101.8 - 111.8	61.9 - 68.1	63.24	3	cis-1,2-DCE: 4.7; vinyl chloride 0.70J	Detectable concentrations of VOCs
14-MW-6	110.0	4" PVC	100.0 - 110.0	59.6 - 64.4	62.40	3	cis-1,2-DCE: 4.2; acetone 4.0J; carbon disulfide 0.53J	Detectable concentrations of VOCs
14-MW-7	90.5	4" PVC	80.0 - 90.0	63.8 - 63.8	61.85	3	cis-1,2-DCE: 12	cis-1,2-DCE exceeds CA primary MCL of 6 µg/L
Site 15								
15-MW-10	39.0	4" PVC	14.0 - 39.0		13.82	8	TCE: 5,600; DCE 10	
Site 20, Area 1								
11669-MW-2	43.0	4" PVC	22.5 - 42.5	21.9 - 22.3	23.20	6	1,2-DCA 19	1,2-DCA exceeds Federal MCL of 5 µg/L
11669-MW-3	55.0	4" PVC	34.0 - 54.0	35.8 - 35.8	35.92	6	TCE ND; benzene ND	Baseline uncontaminated well
11669-MW-4	46.5	4" PVC	31.5 - 46.5	33.2 - 33.2	33.76	4	benzene 1.4	Benzene exceeds CA primary MCL of 1 µg/L
11669-MW-5	33.3	4" PVC	17.3 - 32.3	26.9 - 26.9	27.60	1	1,2-DCA 180; benzene 1800; ethylbenzene 38; m,p-Xylenes 300; o-Xylenes 78; toluene 120	Benzene exceeds CA primary MCL of 1 µg/L; 1,2-DCA exceeds Federal MCL of 5 µg/L
Sites 25/26/39/40								
25-MW-1	39.0	4" SS	16.2 - 36.7	17.8 - 33.9	31.86	1	TCE: 1.7	Detectable concentrations of VOCs
25-MW-2	54.0	4" SS	8.1 - 18.4	8.4 - 11.9	10.20	3	TCE: 31; cis-1,2-DCE: 4.6	TCE exceeds Federal MCL of 5 µg/L
25-MW-6	17.0	4" PVC	8.6 - 18.6	10.6 - 13.0	12.59	1	TCE: 2.4	Detectable concentrations of VOCs
25-MW-7	12.0	4" PVC	7.9 - 12.9	4.3 - 11.4	8.08	1	TCE: 16; cis-1,2-DCE: 12	TCE exceeds Federal MCL of 5 µg/L
25-MW-9	40.0	4" PVC	25.0 - 40.0	31.2 - 31.9	30.80	2	TCE: 5	TCE at Federal MCL of 5 µg/L
26-MW-2	29.0	4" SS	16.3 - 26.7	20.9 - 24.0	21.40	2	TCE: 3.8	Detectable concentrations of VOCs
26-MW-3	13.0	4" PVC	9.7 - 14.7	6.2 - 10.5	10.20	1	TCE: 0.74J	Detectable concentrations of VOCs
26-MW-4	30.0	4" PVC	21.9 - 31.9	26.1 - 29.0	28.60	1	TCE: 19; cis-1,2-DCE: 1.2	TCE exceeds Federal MCL of 5 µg/L
26-MW-5	52.4	4" PVC	42.4 - 52.4	37.0 - 37.6	36.63	3	TCE: 4.4	Detectable concentrations of VOCs
39-MW-1	78.3	4" SS	62.5 - 78.0	67.3 - 67.6	66.79	3	TCE: 6.2	TCE exceeds Federal MCL of 5 µg/L
39-MW-2	79.3	4" SS	63.5 - 79.0	71.2 - 71.4	70.59	2	TCE: 25	TCE exceeds Federal MCL of 5 µg/L
39-MW-4	80.9	4" PVC	65.0 - 80.0	74.2 - 75.7	73.43	2	TCE: 80	TCE exceeds Federal MCL of 5 µg/L
39-MW-5	45.1	4" PVC	30.0 - 45.1	35.8 - 37.3	35.73	3	TCE: 16	TCE exceeds Federal MCL of 5 µg/L
39-MW-6	43.7	4" PVC	28.7 - 43.7	37.9 - 39.5	37.28	2	TCE: 11	TCE exceeds Federal MCL of 5 µg/L
40-MW-4	95.0	4" PVC	75.3 - 95.3	79.3 - 84.0	81.32	4	TCE: 20	TCE exceeds Federal MCL of 5 µg/L
Sites 32/35								
32-MW-2	29.0	4" SS	14.3 - 24.5	12.4 - 18.4	15.40	3	TCE: 13	TCE exceeds Federal MCL of 5 µg/L
35-MW-6	46.0	4" PVC	36.2 - 46.2	15.5 - 19.2	18.38	3	TCE: 0.60J	Detectable concentrations of VOCs

Notes:

TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; TCFM = Trichlorofluoromethane; 1,2-DCA = 1,1-Dichloroethane; 1,2-DCE = 1,1-Dichloroethene

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

[b/] TOC = top of casing; mg/L = micrograms per liter; COCs = chemicals of concern.



N

LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

50 0 50

Scale in Feet

Figure 3.1

Proposed PDBS Wells
Site 2
Old Service Station

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

PARSONS
ENGINEERING SCIENCE, INC.

Pasadena, CA

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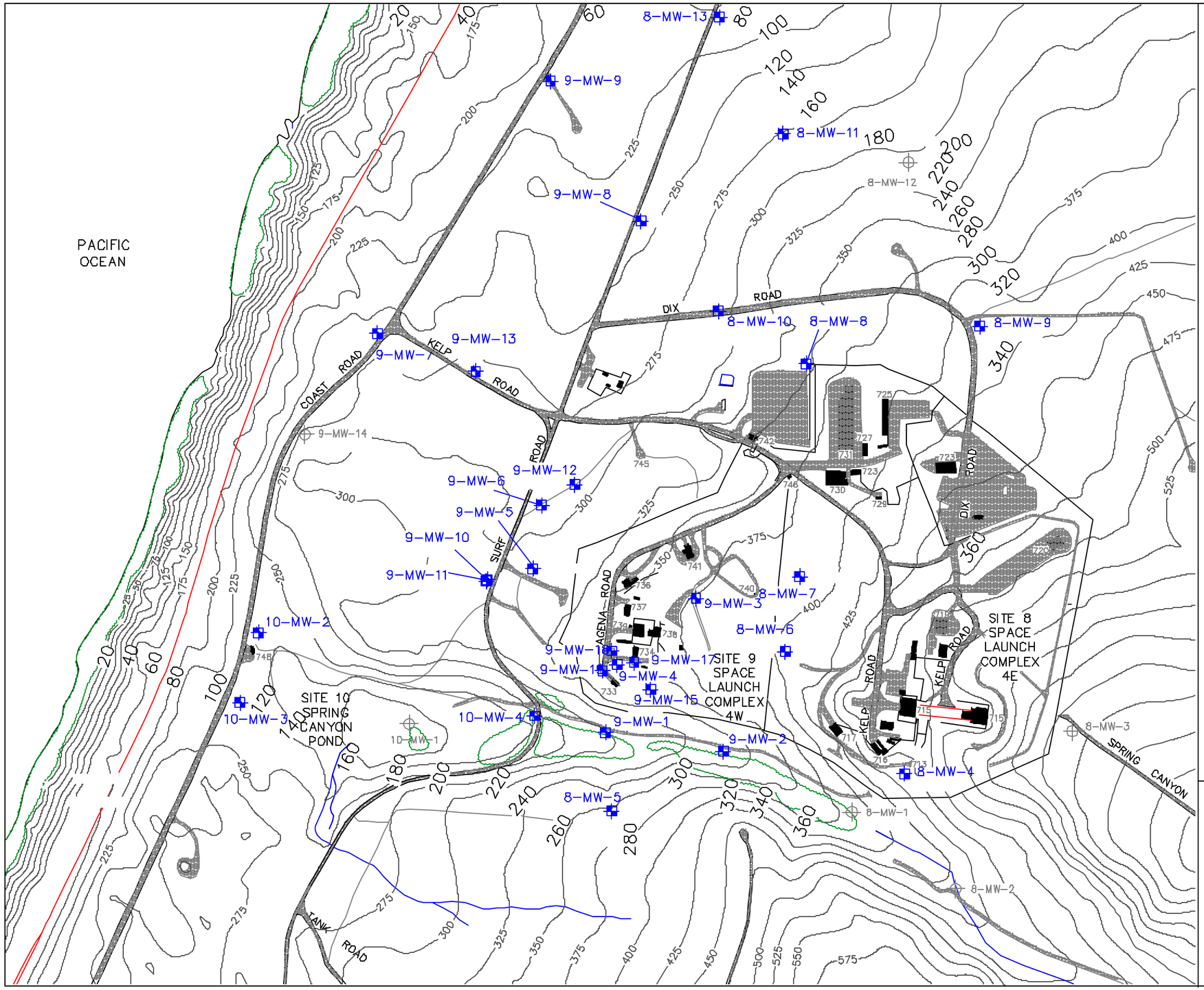

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LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

600 0 600

Scale in Feet

Figure 3.2

Proposed PDBS Wells
Sites 8, 9, and 10
SLC-4E, SLC-4W, and Spring Canyon Pond

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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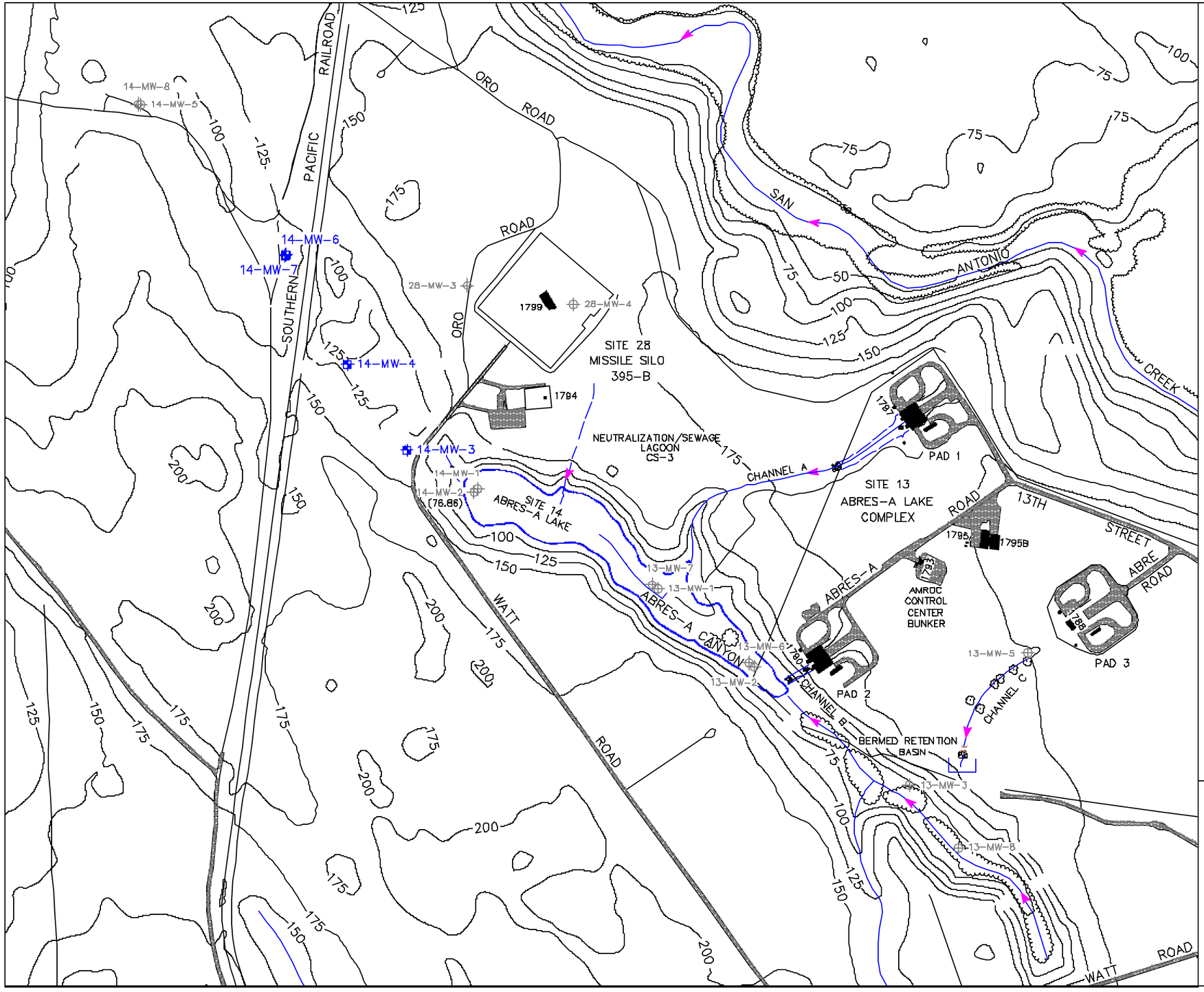

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LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

600 0 600

Scale in Feet

Figure 3.3

Proposed PDBS Wells
Sites 13 and 14
ABRES-A and ABRES-A Lake

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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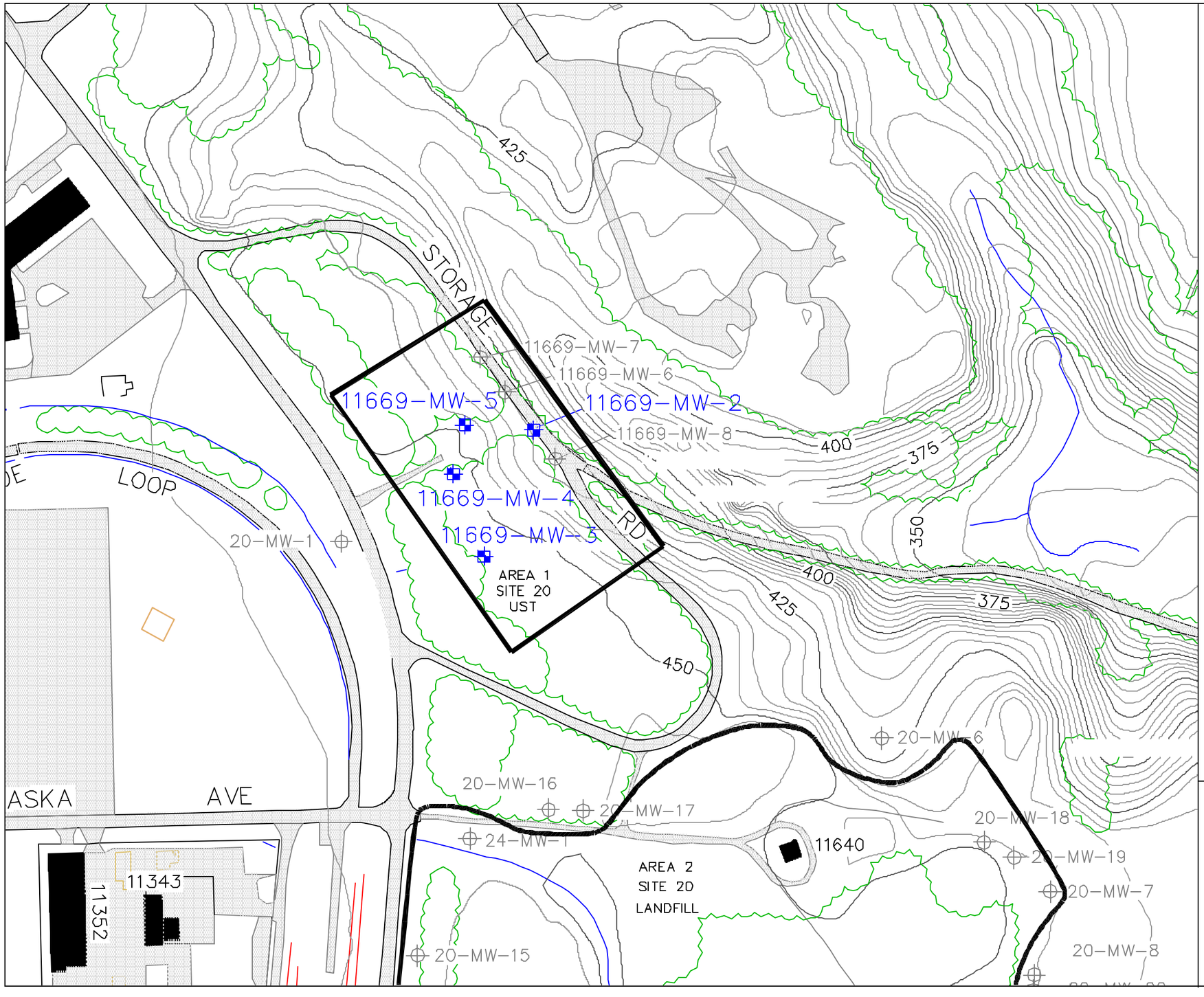

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LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

200 0 200

Scale in Feet

Figure 3.4

Proposed PDBS Wells
Site20, Area 1
UST Area

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

PARSONS
ENGINEERING SCIENCE, INC.
Pasadena, CA

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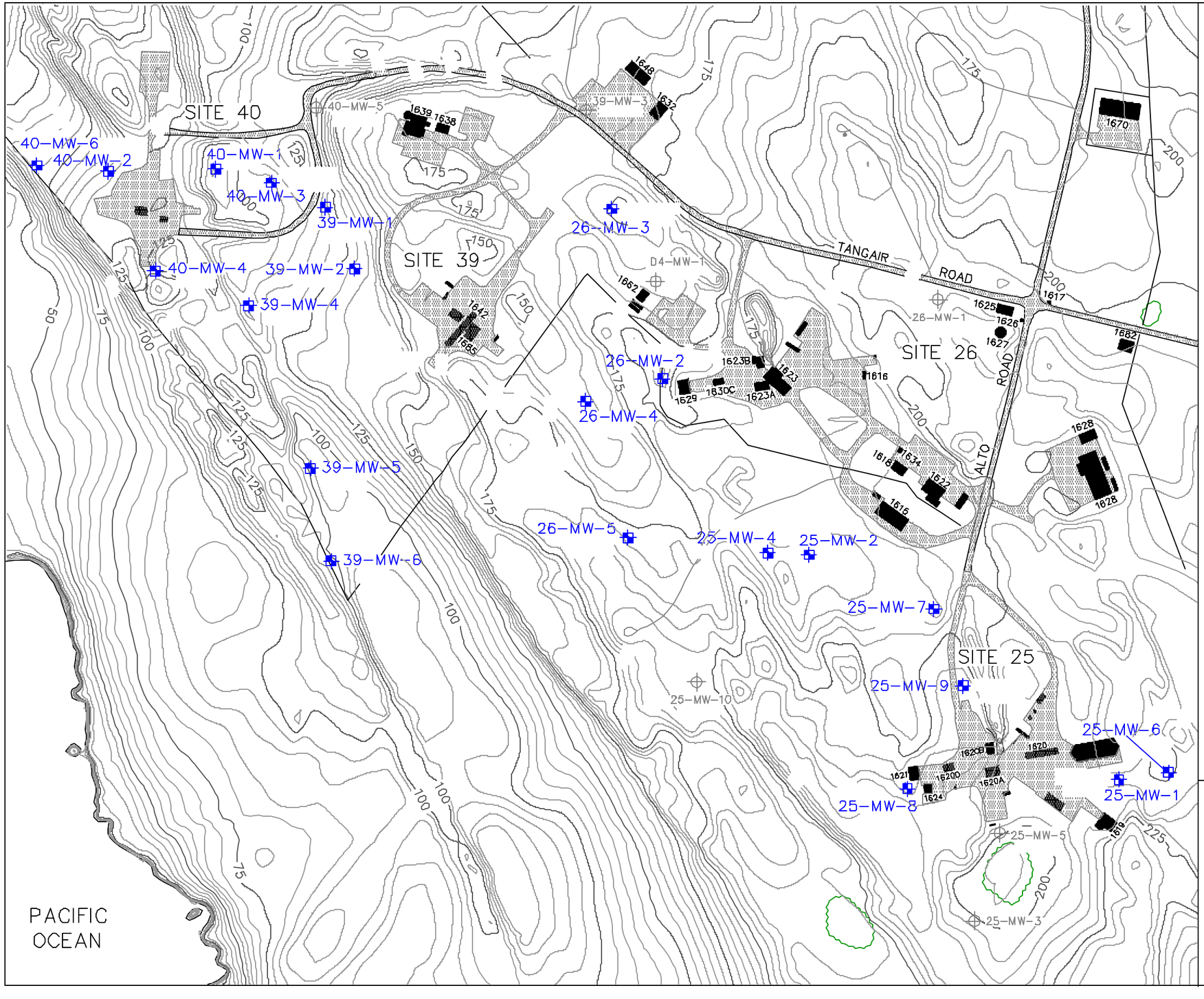

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LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

200 0 200

Scale in Feet

Figure 3.5

Proposed PDBS Wells
Sites 25, 26, 39, and 40
SLC-2E, SLC-2W, SLC-1E and SLC-1W

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

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ENGINEERING SCIENCE, INC.

Pasadena, CA

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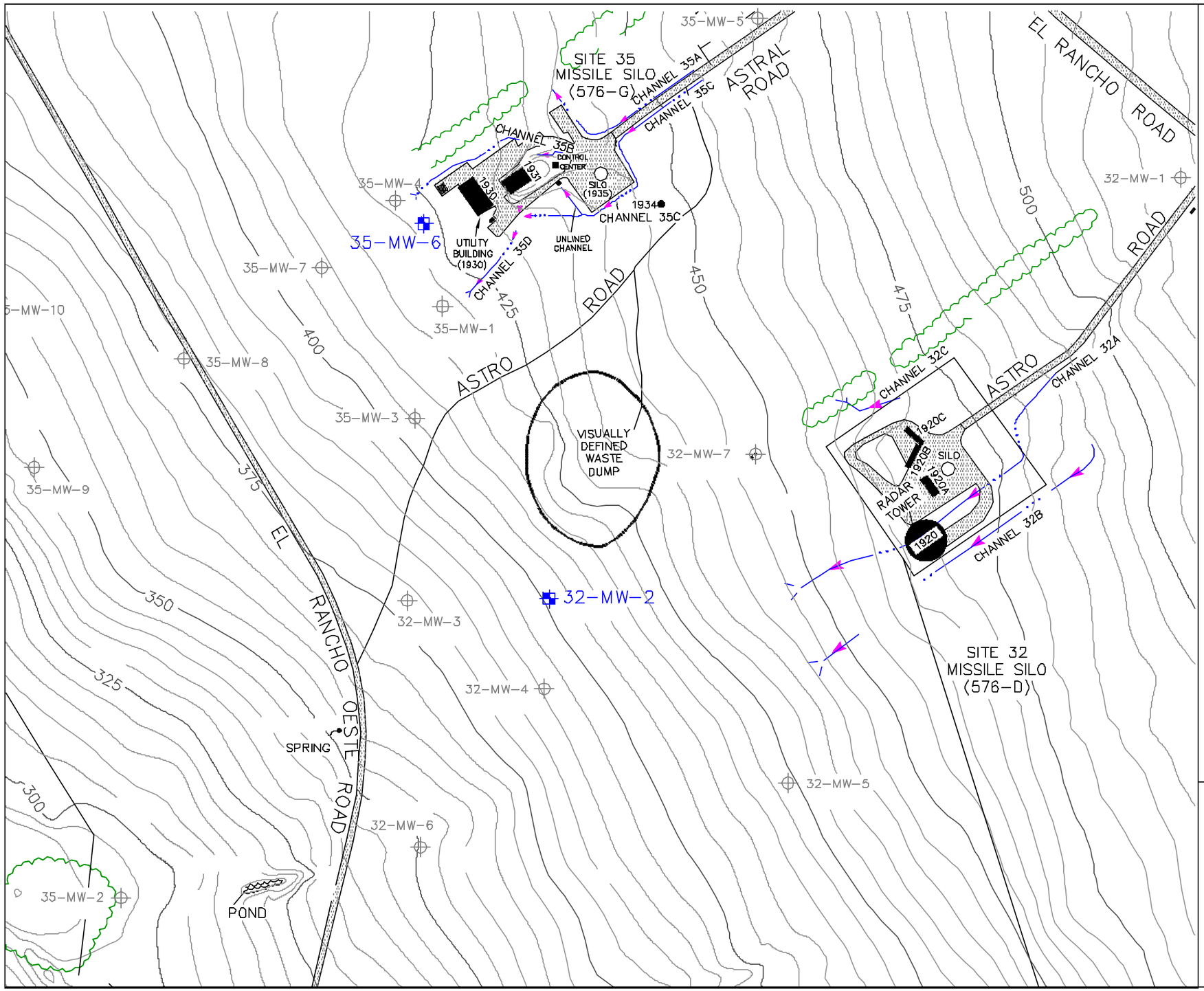

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LEGEND

MW-180 Groundwater Monitoring Well (Included in Passive Diffusion Bag Sampling Demonstration)

MW-195 Groundwater Monitoring Well (Not included in Passive Diffusion Bag Sampling Demonstration)

SOURCE: Tetra Tech, Inc.

300 0 300

Scale in Feet

Figure 3.6

Proposed PDBS Wells
Sites 32 and 35
Missile Silos 576-D and 576-G

Passive Diffusion Bag Sampler Demonstration
Vandenberg AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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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 PDBSs will be collected prior to the August 2001 Tetra Tech sampling event. Analysis of the vertical profiling samples is discussed in Section 3.1.2.

Sample aliquots from PDBSs installed in the 56 existing wells targeted for sampling will be shipped to Pace Analytical Services, Inc., Minneapolis, Minnesota for VOC analysis using US Environmental Protection Agency (USEPA) Method 8260B. This is the same laboratory that will be used by Tetra Tech 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.

3.1.2 Contaminant Profiling

Per the project work plan (Parsons, 2001), contaminant profiling within the screened intervals of the BGMP 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 Vandenberg AFB because recently reported VOC concentrations in most of the monitoring wells are below the minimum quantitation limits of the field test kits.

Therefore, a high-level field screening via direct-sampling ion-trap mass spectrometer (DSMS) (Tri-Corder Environmental, Inc.) will be used in the field to screen groundwater samples at Vandenberg AFB. All samples will be analyzed in the field, and the highest sample from each of the 56 wells will be shipped to Pace Analytical Services for VOC analysis (EPA Method 8260B).

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 PDBSs are higher than concentrations in samples collected using the conventional method, it is probable that the concentrations from the PDBSs are more representative of ambient groundwater chemistry conditions than are the conventional-sampling data (Vroblesky, 2001). 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, 2001).

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 56 monitoring wells at this installation will be evaluated as part of this task. Parsons will coordinate with Vandenberg 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 Vandenberg AFB.

4.0 PROJECT ORGANIZATION

Addresses and telephone numbers of the Vandenberg AFB 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
Ms. Mary Lucas	Parsons ES Site Manager	100 West Walnut Pasadena, California 91124	(626) 440-6032 email: mary.lucas@parsons.com	(626) 440-6200
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

Name	Title	Address	Phone/Email	Fax
Mr. Andrew Edwards	Vandenberg AFB Point of Contact	Vandenberg AFB, CA 93437	(805) 605-8684 email: andrew.edwards@vandenberg.af.mil	
Mr. Pablo Martinez	Vandenberg AFB Point of Contact	Vandenberg AFB, CA 93437	(805) 605-3121 email: pablo.martinez@vandenberg.af.mil	
Mr. Mike McElligott	Vandenberg AFB Point of Contact	Vandenberg AFB, CA 93437	(805) 606-3919 email: michael.mcelligott@vandenberg.af.mil	
Mr. Rafael Vazquez	AFCEE/ERT		(210) 536-1431 email: rafael.vazquez@ hqafcee.brooks.af.mil	
Mr. Joe Ebert	AFCEE/ERT		(210) 536-6478 email: joseph.ebert@ hqafcee.brooks.af.mil	
Ms. Audrey Schoellman	AFCEE/ERD		(210) 536-2394 email: audrey.schoellman@ hqafcee.brooks.af.mil	
Mr. James Elliot	Tetra Tech Point of Contact	4213 State Street Suite 100 Santa Barbara, CA 93110	(805) 681-3100 email: james.elliot@tetratech.com	
Mr. Kevin McNamara	Tetra Tech Point of Contact	4213 State Street Suite 100 Santa Barbara, CA 93110	(805) 681-3100 email: kevin.mcnamera@tetratech.com	
Ms. Andrea Nemitz	Pace Analytical Services, Inc.	1700 Elm St., Suite 200 Minneapolis, MN 55414	(612) 607-6378 main: (612) 607-1700	(612) 607-6444

5.0 SCHEDULE

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

- Submittal of the Draft Vandenberg AFB PDBS Work Plan to commenting parties: July 6, 2001
- Receipt of Draft Vandenberg AFB PDBS Work Plan Comments: July 20, 2001
- Submittal of the Final Vandenberg AFB PDBS Work Plan to commenting parties: September 7, 2001

- Install PDBS samplers in 56 monitoring wells at Vandenberg AFB: July 23-25, 2001
- Remove PDBS samplers from 56 monitoring wells at Vandenberg AFB: August 13-16, 2001
- Preparation of the Draft Vandenberg AFB PDBS Report: October 1 – First Quarter 2002.

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 Earth Tech 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.

7.0 REFERENCES

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HydroGeologic, Inc., 2000. *Supplemental Remedial Investigation Report, Site 2 – Old Base Service Station, Draft.* Prepared for the Air Force Center for Environmental Excellence ((AFCEE). May.

Jacobs Engineering Group, Inc. (Jacobs), 1993. *Remedial Investigation/Feasibility Study Work Plan for Operable Units 1, 2, 3B, 4, and 5, Vandenberg AFB, California.* 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), 2001. *Work Plan for the Air Force Environmental Directorate Passive Diffusion Sampler Demonstration*. April.

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Tetra Tech, 2000b. *Final Basewide Groundwater Monitoring Program Sampling and Analysis Plan.* December.

Tetra Tech, 2000c. *Final Basewide Groundwater Monitoring Program Health and Safety Plan.* December.

Tetra Tech, 2001. *Basewide Groundwater Monitoring Program Reports, Winter 2001, IRP Sites 2, 3, 8/9/10, 13/14, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 33, and 60, Vandenberg AFB, California.* 31 May.

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

VANDENBERG AIR FORCE BASE CALIFORNIA

JULY 2001

Prepared by

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

Reviewed and Approved By:

	Name	Date
Project Manager	Linda B. Murray	7-13-01
Office Health and Safety Representative	JBlakemore for Timothy L. Mustard	07.13.01

1.0 INTRODUCTION

This addendum modifies the existing program health and safety plan entitled *Program Health and Safety Plan (HASP) 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 Vandenberg Air Force Base (AFB) in California. 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 *Site-Specific Work Plan for the Passive Diffusion Bag Sampler Demonstration, Vandenberg AFB, California* (Parsons, 2001).

4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the PDBS demonstration activities at Vandenberg 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
Ms. Mary Lucas	Site Manager
Mr. Randy Brand	Site Health and Safety Officer
Mr. Mike Zabaneh	Vandenberg AFB Site Contact (AFBCA)

5.0 HAZARD EVALUATION

5.1 Chemical Hazards

The primary contaminants of concern at the various sites are the chlorinated solvents trichloroethene (TCE), perchloroethene (PCE), 1,2-dichloroethane (1,2-DCA), 1,1-dichlorethene (1,1-DCE), *cis*-1,2-dichloroethene (1,2-DCE), *trans*-1,2-DCE, 1,1,1-trichloroethane (1,1,1-TCA), vinyl chloride, chloroform, acetone, carbon disulfide, and the

volatile hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). Health hazard qualities for these 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 Vandenberg 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.

The weather is typically 100°+ and humid. Heat Stress is a critical issue in July.

Venomous spiders and snakes are present in this area. Well covers are a favorite hiding place for black widows. More rattlesnakes have been observed than usual this year.

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 Contact: Andrew Edwards	(805) 605-8684
Fire Department	911/cell 734-4117
Police Department	911/cell 606-3911
Ambulance	911/cell 734-4117
Poison Control Center	(800) 876-4766
Medical Emergency (off-base facility)	
Nearest Hospital	Lompoc District Hospital
Address	508 E Hickory Ave, Lompoc, CA 93436
Telephone Number	911 or (805)-737-3300

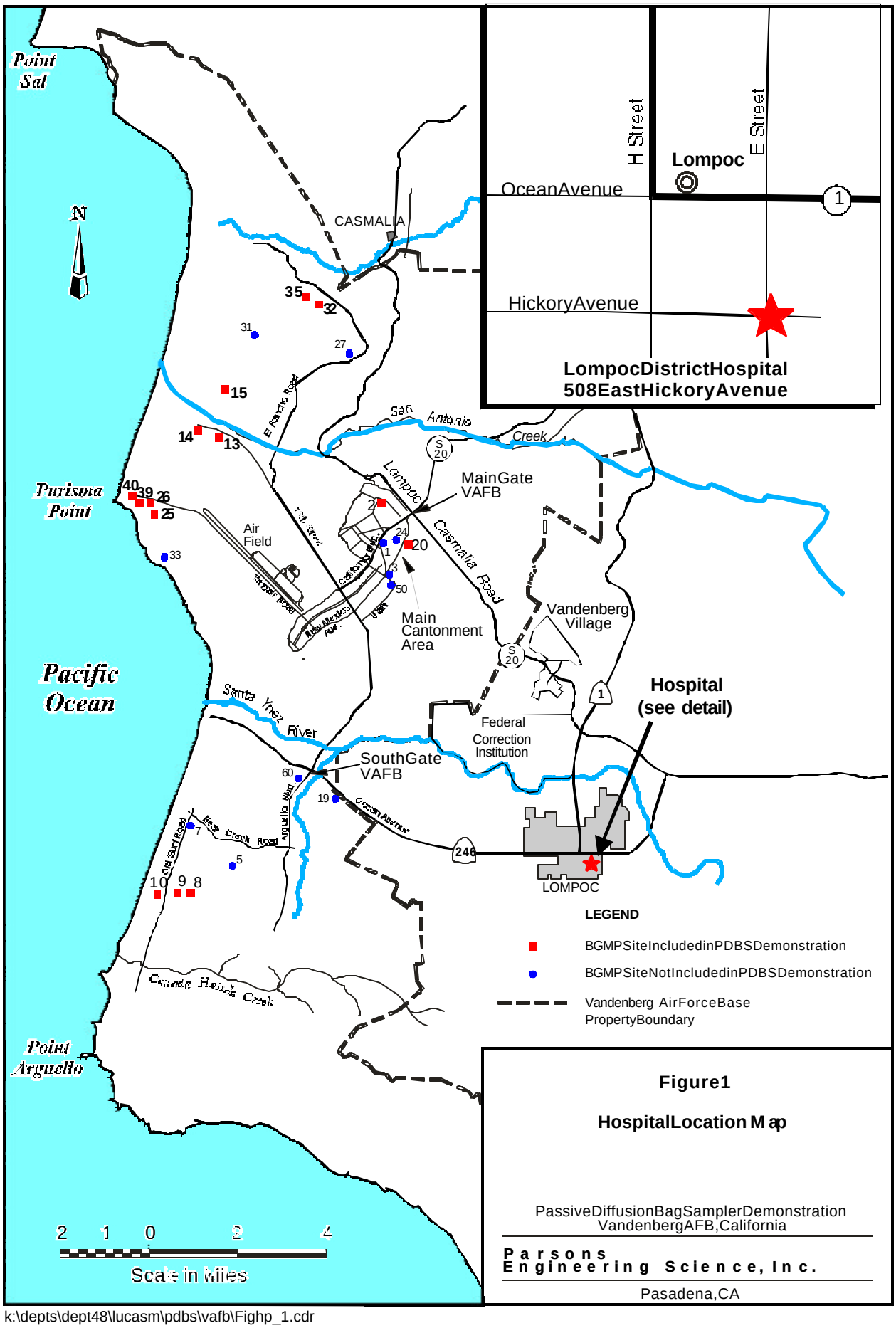

Figure1

HospitalLocation Map

PassiveDiffusionBagSamplerDemonstration
VandenbergAFB,California

Parsons Engineering Science, Inc.

Pasadena,CA

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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)
Mary Lucas Site Manager	(626) 440-6032 (Work) (562) 692-3037 (Home)
Randy Brand Site Health and Safety Officer	(626) 440- 6114 (Work) (909) 734-4905 (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 Vandenberg 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 are no Dräger® tubes for 1,2-DCA, or 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

If vinyl chloride, 1,2-DCA, 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 the above compounds do not exist, the following will be used to check for the additional contaminants of concern.

A reading of 2 ppm above background in the worker-breathing zone will require the use of Dräger® tubes or the equivalent to determine if chloroform is present. Level B protection must

also be used if concentrations of chloroform meet or exceed 2 ppm above background in the worker-breathing zone.

A sustained air monitoring reading in the worker breathing zone greater than or equal to 4 ppm above background for 30 seconds or longer as indicated by the photoionization detector will require the use of a Dräger® tube or the equivalent to determine if carbon disulfide is present at a concentration greater to or equal to the permissible exposure limit (PEL) of 4 ppm.

A reading of 5 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 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 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.

If the PID indicates concentrations at or above 50 ppm above background in the worker-breathing zone, the screening process must be repeated with 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 11.7 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 11.5V.

Table 5.1 Health Hazard and Properties of Chemicals 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
Acetone	750	500	2,500 (LEL) [f/]	100	9.69	Colorless liquid with mint-like odor. Irritates nose, eyes, and throat. Causes headaches, dizziness, central nervous system (CNS) depression, and dermatitis.
Benzene	1 (29 CFR 1910.1028) [g/]	10	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.
Carbon Disulfide	4 (skin) [h]	10 (skin)	500	0.0011-7.7	10.08	Colorless to faint-yellow liquid with sweet ether or foul (reagent grade) odor. Irritating to eyes, skin, and mucous membranes on contact. Causes dizziness, headaches, poor sleep, fatigue, nervousness, low-weight, psychosis, nervous system degeneration, Parkinson-like syndrome, ocular changes, heart disease, gastritis, dermatitis, eye and skin burns, liver and kidney damage, and reproductive effects. Mutagen and experimental teratogen.
Chloroform (Trichloromethane)	2	10	500	205 [i/]	11.42	Colorless, heavy liquid with pleasant odor. Irritates eyes and skin. Anaesthetic. Causes dizziness, mental dullness, nausea, confusion, headache, fatigue, anesthesia, and enlarged liver. Also attacks kidneys and heart. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
1,2-Dichloroethane (DCA) (Ethylene Dichloride, EDC	1	10	50	100	11.05	Colorless liquid with a pleasant, chloroform-like odor. Strong narcotic. Irritates eyes. Causes corneal opaqueness, nausea, CNS depression, vomiting, dermatitis, and damage to liver, kidneys, and cardiovascular system. In animals, causes cancer of the forestomach, mammary gland, and circulatory system. Mutagen, experimental teratogen, and carcinogen.
1,1-Dichloroethene (DCE) (Vinylidene Chloride)	1	5	3000	NA [j/]	11.06	Colorless liquid or gas (>89°F) with a mild, sweet, chloroform-like odor. Irritates eyes, skin, and throat. Causes dizziness, headaches, nausea,

Table 5.1 Health Hazard and Properties of Chemicals 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
						shortness of breath, liver and kidney dysfunctions, and lung inflammation. Mutagen and carcinogen.
1,2-Dichloroethene (DCE) (cis- and trans-isomers)	200	200	1,000	0.085-500	9.65	Colorless liquid (usually a mixture of cis- and trans- isomers), with a slightly acrid, chloroform-like odor. Irritates eyes and respiratory system. CNS depressant. Cis- isomer is a mutagen.
Ethylbenzene	100	100	800	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.
Methyl Chloroform (TCA) (1,1,1-Trichloroethane)	350	350	700	20-500	11.00	Colorless liquid with a mild, chloroform-like odor. Irritates eyes and skin. Causes headaches, exhaustion, CNS depression, poor equilibrium, dermatitis, liver damage, cardiac arrhythmia, hallucinations or distorted perceptions, motor activity changes, aggression, diarrhea, and nausea or vomiting. Mutagen, experimental teratogen, and questionable carcinogen.
Tetrachloroethene (PCE) (Perchlorethylene)	25 [k/]	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 [i/]	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.
Trichloroethene (TCE)	50	50	1000	21.4-400	9.45	Clear, colorless or blue liquid with chloroform-like odor. Irritates skin and eyes. Causes fatigue, giddiness, headaches, vertigo, visual

Table 5.1 Health Hazard and Properties of Chemicals 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
						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.
Vinyl Chloride	1 (29 CFR 1910.1017) [g]	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 [i/]	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), *2001 TLVs ®and BEIs®*.

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.

f/ 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).*

g/ Refer to expanded rules for this compound.

h/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.
i/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.
j/ NA = Not available.
k/ NIOSH recommends reducing exposure to the lowest feasible concentration, and limiting the number of workers exposed.

APPENDIX B

SITE ACCESS INSTRUCTIONS

Mary-

I've been asked to help you with some site access issues at VAFB. The first thing you'll need is a base pass, which you can get at the visitors center at the main gate entrance. You will need to have someone at the IRP office vouch you on, either verbally or with a letter, make sure to find out before you show up. Make sure that it is valid for both North and South Base. Also, make sure to bring your car registration and insurance so they can put the info. on your pass.

Site 2

All wells on site are flush mounted and semi-difficult to find. To make matters worse, there was a mis-communication between certain groups on base, and a new T-ball field was built over 5 wells, burying them 3 feet under (2-MW-5 through 2-MW-9). You will need to call Christie from Youth Sports at 805-606-9374 to make sure that no baseball games are scheduled for that day. We have been able to find these wells every quarter due to the fact that every time we dig them up we disturb the grass and/or dirt in the area, and when we return to look for them again, we search for anomalies in density and contour and have been able to relocate them. Let me stress, it takes a long time to deal with these wells. Once you think you know where they are, you then have to dig with a shovel. You may not get it on the first try, and you may spend hours/days looking for these wells. These wells are very difficult to deal with. Last quarter, we were unable to sample 2-MW-8 because we couldn't find it. We spent a day and a half looking for it, and were unable to find it. You must also leave the wells looking liking the grounds were never touched. The grounds keepers are very sensitive to this issue. Also, I just wanted to mention that this site only has one "hot" well (2-MW-8). Due to the minimal diversity of contaminant concentrations and the extremely difficult well access, I wasn't sure if this would be the best place for your study.

Site 8/9/10

First you need to call Sgt. Frost (Env. Coordinator for SLC 4) at 805-605-3397 and let him know what you plan on doing, and where you plan on working. He will ultimately communicate with the security and police, to let them know you'll be in the area. Also, you'll need to check in every day with SLC 4 Operations at 805-605-4465 to see if there are any hazardous operations occurring during the time you plan on working. You'll need to tell them where you plan on working, and for how long. If you plan on doing any work on the wells inside the perimeter fence, then you'll need to hire a Security Escort. You can call Segura Security in Santa Maria, CA at 805-349-0550 to setup an appointment. Call as early as possible, as they have limited staff that have access to SLC 4. All wells are accessible with a 4 wheel drive truck.

Site 20 Area 1

This site has no access issues. You do not need to call anyone. All wells are easily accessible.

Site 13/14

You do not need to call anyone, and this site is only accessible with a 4 wheel drive truck. All wells can be reached by driving up to them, expect for 13-MW-3. There is a trail that leads down the canyon to 13-MW-3 and 13-MW-8, but you cannot drive directly to 13-MW-3. Do be careful while driving to 14-MW-3 and 14-MW-4, as they are located on soft dune sand. It is very easy to get stuck, but I've been able to drive to them every time.

Site 25/26/39/40

While working at sites 39 and 40 you must call the HAIR (high accuracy instrumentation radar) facility (805-605-0727) to find out when they are transmitting. You cannot work on this site while they are transmitting due to the dangerous R.F. Radiation that the instrument radiates. This site is only accessible with 4 wheel drive trucks. While at 25 and 26, you must contact Jerry Schute or Charlie Brooks Jr. at the SLC 2 Operations center (805-606-6340 X2211). You must call prior to work, to make sure there are no haz. ops. during that day of work. You will also need to check in with in person, to let them know where you'll be. You will need to talk to Jerry Schute to see if you need to get ELSA (safety breathing apparatus) trained, depending on how much work you'll be doing on the SLC. Sites 25 and 26 will also need a 4 wheel drive to reach most of the wells.

Site 32/35

You do not need to call anyone. There are no access issues except make sure you close the cow fences. You can carefully drive around the site in a 2 wheel drive truck....but 4 wheel drive is highly recommended.

If you have any more questions or concerns, please let me know,

Ryan

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