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Remedial Action Plan for Expanded Bioventing System Facility 6454

Vandenberg Air Force Base
California

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

30 CES/CEVCR
Vandenberg Air Force Base
California

May 1996

PARSONS
ENGINEERING SCIENCE, INC.

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DRAFT FINAL REMEDIAL ACTION PLAN
FOR EXPANDED BIOVENTING SYSTEM
FACILITY 6454
VANDENBERG AFB, CALIFORNIA

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

BROOKS AFB, TEXAS

AND

30 CES/CEVCR

VANDENBERG AFB, CALIFORNIA

MAY1996

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.

LA JOLLA, CALIFORNIA

022/726876/5.WW6

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CRWQCB	California Regional Water Quality Control Board
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
CO_2	Carbon dioxide
ISR	*In situ* respiration test
Kb	Biodegradation rate
Ko	Oxygen utilization rate
mg/kg	Milligrams per kilogram
MP	Monitoring point
O_2	Oxygen
O&M	Operation and Maintenance
Parsons ES	Parsons Engineering Science, Inc.
ppmv	Parts per million, volume per volume
PID	Photoionization detector
PVC	Polyvinyl chloride
RAP	Remedial Action Plan
scfm	Standard cubic feet per minute
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons
TVH	Total volatile hydrocarbons
USBR	United States Bureau of Reclamation
VW	Vent well

SECTION 1
INTRODUCTION

This draft remedial action plan (RAP) presents the scope for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at Site 6454 at Vandenberg Air Force Base (AFB), California. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, 0017. The primary objectives of the system upgrade are to:

- Supply oxygen throughout the contaminated soil volume;
- Continue *in situ* remediation of fuel-contaminated soils by stimulation with oxygen-rich soil gas; and
- Sustain *in situ* biodegradation until fuel-contaminated soils are remediated to regulatory-approved standards.

A one-year bioventing pilot test was performed at this site to determine if *in situ* bioventing would be a feasible cleanup technology for the JP-4 and diesel contaminated soils within the unsaturated zone in the source area. The radius of oxygen influence during the pilot test was approximately 40 feet around the air injection vent well (VW), at a 60 standard cubic foot per minute (scfm) air injection flow rate. Following the one-year pilot test, soil and soil gas samples were collected. Soil gas sampling results indicated that soil gas concentrations of total volatile hydrocarbons (TVH) and benzene, toluene, ethylbenzene, and total xylenes (BTEX) compounds increased in some locations and decreased in others. However, soil samples collected from the VW after one year of bioventing indicated a two order of magnitude decrease (to non-detected levels) of BTEX. A two order of magnitude decrease in total petroleum hydrocarbons (TPH) as gasoline was also detected in a soil sample from the VW. Total recoverable petroleum hydrocarbons (TRPH), TPH, and BTEX concentrations in two soil samples collected from monitoring points MPA and MPB were near or below detection limits during initial and one year sampling. The success of bioventing at this site supports the recommendation of an expanded bioventing system as the most economical approach of remediating the remaining fuel-contaminated soils.

Pilot test data have been used to design the expanded remediation system. The expanded system will employ four VWs (one installed during the initial pilot test and three additional VWs) to provide oxygen throughout the remaining fuel-contaminated soils area.

This document is divided into eight sections including this introduction. Section 2 discusses site background. Section 3 provides the results of the one-year pilot test conducted at Site 6454. Section 4 provides the proposed scope of work to be performed at Site 6454 and identifies the areas to be influenced by the system upgrade. Procedures for handling investigation-derived waste are described in Section 5, and Base support requirements are listed in Section 6. Section 7 provides key points of contact at Vandenberg AFB, AFCEE, and Parsons ES. Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in Appendix A.

SECTION 2
SITE BACKGROUND

2.1 SITE LOCATION AND HISTORY

Site 6454 is located between New Mexico Avenue and a railroad spur, approximately 300 feet southwest of the intersection of 13th Street and New Mexico Avenue (Figure 2.1). Four underground storage tanks and associated piping were located between the railroad spur and New Mexico Avenue. The facility was reported to be a transfer point for both diesel and JP-4. In 1986, a search was made for the tanks but none were found. Therefore, the tanks are assumed to be removed prior to that time. Presently, the site is an unpaved open field.

In 1993, the United States Bureau of Reclamation (USBR), drilled and sampled 20 soil boreholes in an attempt to characterize site contamination. Soil contamination, as characterized by the USBR is believed to be from both diesel and JP-4. Based on the results of this 1993 investigation, AFCEE funded a bioventing pilot test at this site. A long-term bioventing pilot test, which included drilling and installing a VW and three multi-depth soil vapor monitoring points (MPs) was conducted by Parsons ES between February 1994 and May 1995. To further characterize site contamination, 10 additional boreholes were drilled and sampled by the USBR in 1995.

2.2 SITE GEOLOGY

Site 6454 is located on the Burton Mesa, a relatively flat area consisting of alluvial sediments. The sediments of the Burton Mesa lie unconformably on the Monterey Shale. Figure 2.2 is geologic cross-section A-A' (traced on Figure 2.1) of the pilot test area at Site 6454 constructed using data from the bioventing pilot test VW and the three MPs. Silty sand and clayey sand appear to be the dominant soil type at the site. In most of the boreholes, silty sand was encountered from the surface to about 5 feet below ground surface (bgs). From 5 feet to approximately 70 feet bgs silty sand and clayey sand are the predominant soil types with numerous and apparently isolated lenses of clay and silt. These lenses, occasionally up to 10 feet in thickness, rarely correlate between boreholes.

The Monterey Shale was encountered at approximately 73 feet bgs in the deeper boreholes drilled at the site. Groundwater was not encountered at the site during any previous drilling activities.

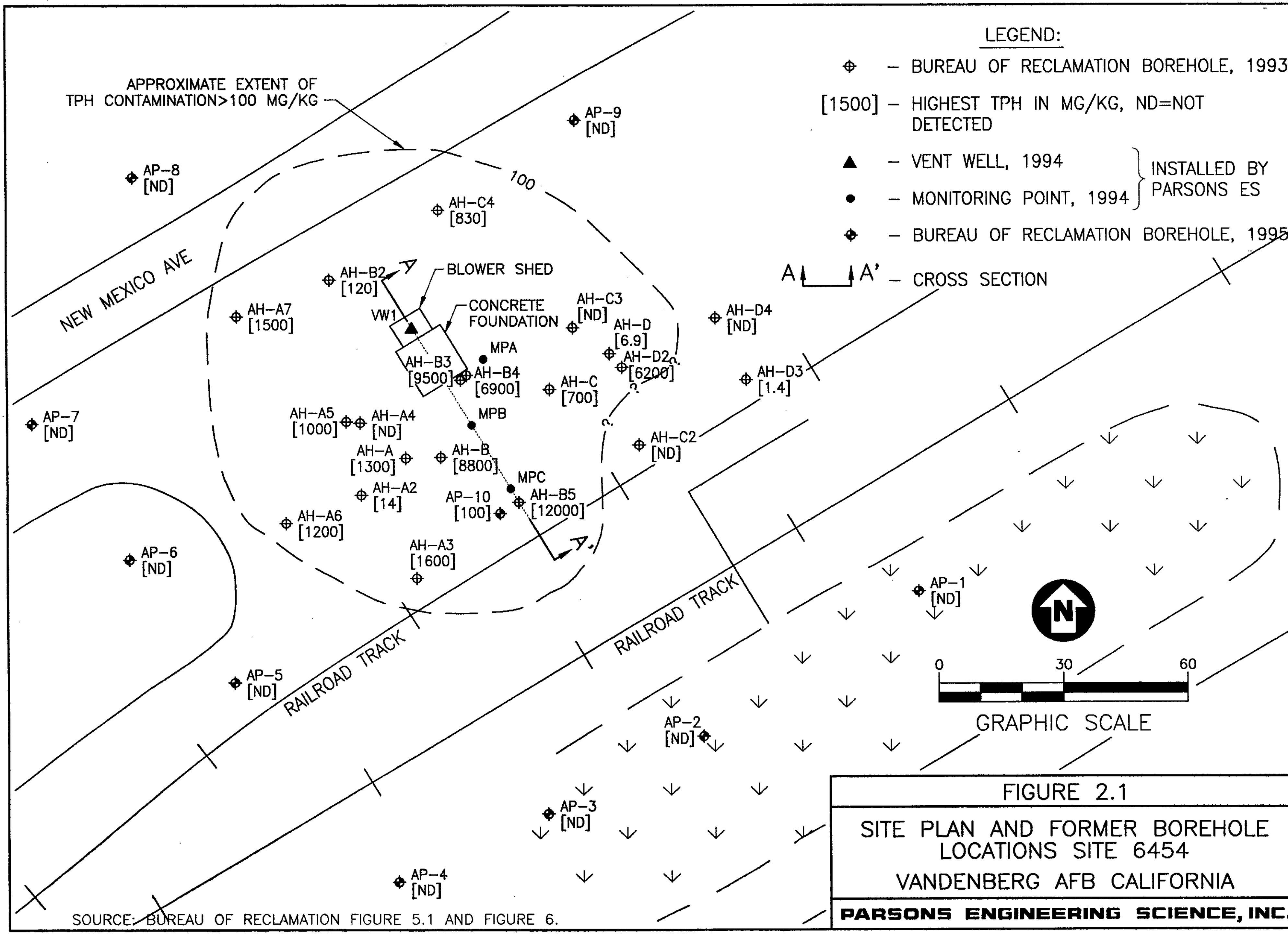
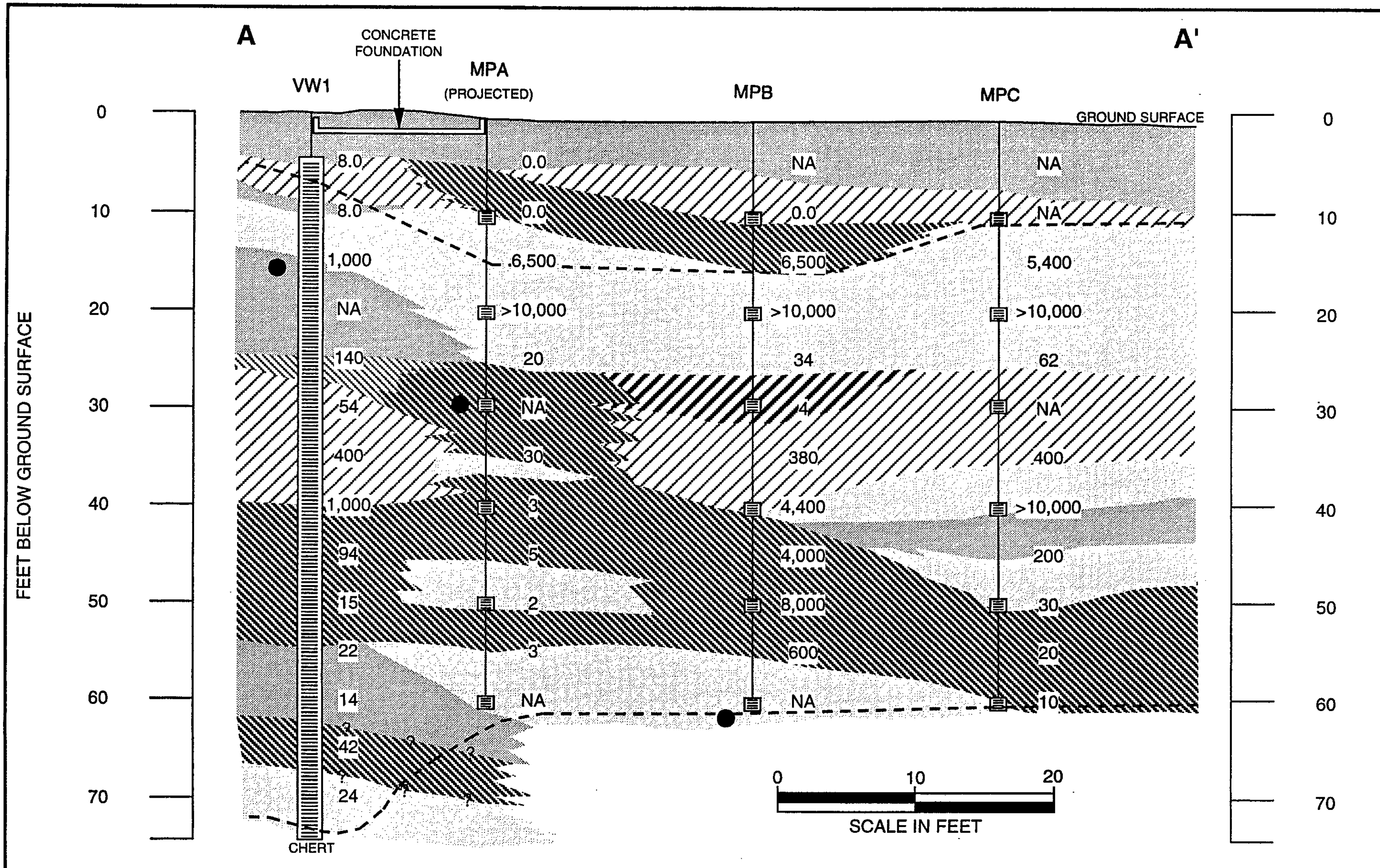


FIGURE 2.1

SITE PLAN AND FORMER BOREHOLE LOCATIONS SITE 6454

VANDENBERG AFB CALIFORNIA

PARSONS ENGINEERING SCIENCE, INC.



LEGEND

SAND		CLAY		VW SCREENED INTERVAL	
SILTY SAND		FATTY CLAY	8.0	TVH READINGS IN PPM	
CLAYEY SAND		SOIL SAMPLE	- - -	APPROXIMATE EXTENT OF SOIL CONTAMINATION	
SANDY CLAY AND CLAY		MP SCREENED INTERVAL	NA	NOT ANALYZED	

R1154-001/JED

FIGURE 2-2

GEOLOGIC CROSS-SECTION A-A'
SITE 6454 FORMER FUEL TRANSFER FACILITY

VANDENBERG AFB, CALIFORNIA

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2.3 SITE CONTAMINATION

2.3.1 U.S. Bureau of Reclamation Study - 1993

Twenty boreholes were drilled and sampled by the USBR in 1993. Borehole locations are shown on Figure 2.1. Soil samples were collected at approximate 5-foot intervals during the investigation and were analyzed for TPH by EPA Method 8015 modified for JP-4 or diesel. Selected samples were analyzed for BTEX by EPA Method 8020. Table 2.1 summarizes the analytical results for samples with greater than 100 mg/kg TPH diesel or JP-4.

The highest diesel contamination concentration, 12,000 mg/kg, was found in borehole AH-B5 at 72.5 feet bgs. Analytical results from a sample at 49.5 feet bgs in AH-B and 20 feet bgs in AH-B3-B4 were 8,800 and 9,500 mg/kg, respectively. TPH-diesel concentrations exceeding 100 mg/kg were detected near 70 feet bgs in boreholes AH-A3, AH-A7, AH-B, AH-B4, and AH-B5. In addition to the previously mentioned boreholes, AH-A, AH-A5, AH-A6, AH-B2, AH-B3, AH-C, AH-C4, and AH-D2 had at least one soil sample with TPH-diesel concentrations exceeding 100 mg/kg. Samples from the remaining boreholes had analytical results below 100 mg/kg TPH as diesel and are not included in Table 2.1.

Ten soil samples were analyzed for BTEX. Maximum detected concentrations of BTEX compounds were 15.0 mg/kg, 93.0 mg/kg, 864.0 mg/kg, and 140 mg/kg, respectively (see Table 2.1).

2.3.2 Bioventing Pilot Test System Installation - 1994

During bioventing pilot test system installation in February, 1994 by Parsons ES, evidence of contamination was found to be areally extensive and relatively homogeneous throughout the four drilling locations. This verified the results of the USBR 1993 investigation. Field evidence of contamination (i.e. a strong hydrocarbon odor and/or elevated hydrocarbon analyzer head space readings) was found in the VW from approximately 5 to 74 feet bgs, in MPA and MPB from approximately 15 to 62 feet bgs, and from approximately 10 to 62 feet bgs in MPC. VW and MP locations are shown on Figure 2.1. Field headspace measurements, using a GasTech® Tracetechtor® hydrocarbon meter, indicated volatile hydrocarbon concentrations in the VW ranging from 8 to 1,000 parts per million volume per volume (ppmv). Volatile hydrocarbon field measurements ranged from 2 to > 10,000 ppmv in MPA, MPB, and MPC.

The bioventing pilot test scope of work allowed for the analysis of three soil and three soil gas samples for TPH by EPA Method 418.1 and BTEX by EPA Method 8020. Analytical results are shown on Table 2.2. Soil gas analytical results, especially TVH, in two of the three samples, were relatively high. However, soil sample analytical results were relatively low. The soil sample results appear to contradict field observations.

Table 2.1

Summary of U.S. Bureau of Reclamation Analytical Data - 1993
For Samples with Greater Than 100 Mg/Kg TPH*
Site 6454 Vandenberg Air Force Base, California

Borehole ID	Depth Interval (feet bgs)	TPH (as Diesel) mg/kg	Benzene mg/kg	Toluene mg/kg	Ethyl benzene mg/kg	Xylenes mg/kg
AH-A	4.5 - 4.75	1300	NA	NA	NA	NA
AH-A3	20.25 -20.5	1400	NA	NA	NA	NA
	49.75 - 50.5	300	NA	NA	NA	NA
	54.5 - 54.75	470	NA	NA	NA	NA
	59.75 - 60.0	190	NA	NA	NA	NA
	64.9 - 65.3	300	NA	NA	NA	NA
	69.75 - 70.0	850	NA	NA	NA	NA
	71.35 - 71.6	1600	NA	NA	NA	NA
AH-A5	39.75 - 40.0	210	NA	NA	NA	NA
	49.75 - 50.0	1000	NA	NA	NA	NA
AH-A6	15.75 - 16.0	1200	NA	NA	NA	NA
	19.5 - 19.75	1100	NA	NA	NA	NA
	27.25 - 27.5	650	0.3	0.95	1.1	2.6
AH-A7	17.0 - 17.25	1300	NA	NA	NA	NA
	19.75 - 20.0	530	NA	NA	NA	NA
	20.75 - 21.0	760	NA	NA	NA	NA
	24.75 - 25.0	680	NA	NA	NA	NA
	29.5 - 29.75	1500	0.44	9.2	2.6	83.0
	29.75 - 30.0	1200	1.6	12.0	8.4	100
	34.75 - 35.0	660	NA	NA	NA	NA
	39.75 - 40.0	470	NA	NA	NA	NA
	44.25 - 44.5	520	NA	NA	NA	NA
	49.25 - 49.5	580	NA	NA	NA	NA

Table 2.1 (Continued)

Summary of U.S. Bureau of Reclamation Analytical Data - 1993 For Samples with Greater Than 100 Mg/Kg TPH* Site 6454 Vandenberg Air Force Base, California

Borehole ID	Depth Interval (feet bgs)	TPH (as Diesel) mg/kg	Benzene mg/kg	Toluene mg/kg	Ethyl benzene mg/kg	Xylenes mg/kg
AH-A7 (Continued)	54.75 - 55.0	1500	NA	NA	NA	NA
	56.25 - 56.5	1200	NA	NA	NA	NA
	64.75 - 65.0	680	NA	NA	NA	NA
	68.75 - 69.0	720	NA	NA	NA	NA
AH-B	17.25 - 17.5	1400	0.06	0.43	0.17	1.1
	22.25 - 22.5	150	NA	NA	NA	NA
	29.5 - 29.75	6000	NA	NA	NA	NA
	34.5 - 34.75	7400	NA	NA	NA	NA
	39.5 - 39.75	2900	NA	NA	NA	NA
	44.25 - 44.5	800	NA	NA	NA	NA
	49.5 - 49.75	8800	0.3	4.8	3.1	15.0
	49.75 - 50.0	1200	2.2	1.8	1.3	5.6
	54.3 - 54.55	600	NA	NA	NA	NA
	59.5 - 59.75	4500	NA	NA	NA	NA
	64.5 - 64.75	150	NA	NA	NA	NA
AH-B2	8.9 - 9.15	120	NA	NA	NA	NA
AH-B3	14.75 - 15.0	1300	0.38	0.434	0.441	1.7
	19.75 - 20.0	9500	NA	NA	NA	NA
	39.75 - 40.0	2000	NA	NA	NA	NA
	44.75 - 45.0	3500	NA	NA	NA	NA
	49.75 - 50.0	4100	NA	NA	NA	NA
AH-B4	59.75 - 60.0	1100	NA	NA	NA	NA
	64.75 - 65.0	5600	0.62	7.3	12	50
	69.75 - 70.0	6900	NA	NA	NA	NA
	71.0 - 71.25	6000	NA	NA	NA	NA

Table 2.1 (Continued)

Summary of U.S. Bureau of Reclamation Analytical Data - 1993
For Samples with Greater Than 100 Mg/Kg TPH*
Site 6454 Vandenberg Air Force Base, California

Borehole ID	Depth Interval (feet bgs)	TPH (as Diesel) mg/kg	Benzene mg/kg	Toluene mg/kg	Ethyl benzene mg/kg	Xylenes mg/kg
AH-B5	22.25 - 22.5	1500	NA	NA	NA	NA
	23.5 - 23.75	1300	NA	NA	NA	NA
	23.75 - 24.0	3700	NA	NA	NA	NA
	34.75 - 35.0	4500	15.0	93.0	864	140
	59.75 - 60.0	3000	NA	NA	NA	NA
	65.0 - 65.25	3200	7.0	22.0	21.0	42.0
	72.5 - 72.75	12000	NA	NA	NA	NA
AH-C	19.5 - 19.75	700	NA	NA	NA	NA
AH-C4	4.3 - 4.55	830	NA	NA	NA	NA
	6.25 - 6.5	430	NA	NA	NA	NA
	9.75 - 10.0	230	NA	NA	NA	NA
	15.25 - 15.5	650	NA	NA	NA	NA
	19.75 - 20.0	220	NA	NA	NA	NA
AH-D2	4.75 - 5.0	6200	NA	NA	NA	NA

* For analytical results greater than 100 mg/kg TPH for JP-4 or diesel.
NA = Not Analyzed

Table 2.2

Initial Soil and Soil Gas Laboratory Analytical Results
Site 6454, Former Fuel Transfer Facility
Vandenberg AFB, California

Analyte (Units)[a]	Sample Location - Depth (Feet Below Ground Surface)		
Soil Gas Hydrocarbons	MPB-20	MPC-10	MPC-60
TVH[b] (ppmv)	190,000	7,200	120,000
Benzene (ppmv)	280	9.2	33
Toluene (ppmv)	300	19	39
Ethylbenzene (ppmv)	33	11	5.0
Xylenes (ppmv)	74	20	5.9
Soil Hydrocarbons	VW1-15	MPA-30	MPB-62
TRPH[c] (mg/kg)	960	ND (1.2)	ND (1.2)
Gasoline[d] (mg/kg)	13	ND (5.6)	ND (5.6)
Benzene (mg/kg)	1.2	0.067	0.048
Toluene (mg/kg)	6	0.028	0.062
Ethylbenzene (mg/kg)	5.5	0.0036	0.007
Xylenes (mg/kg)	19	0.021	0.036

[a] ppmv = parts per million, volume per volume; mg/kg = milligrams per kilogram.
[b] TVH = total volatile hydrocarbons.
[c] TRPH = total recoverable petroleum hydrocarbons by EPA 418.1.
[d] Based on chromatography obtained in EPA 8020 analysis.
ND = non-detect. Detection limits are in parentheses.

2.3.3 U.S. Bureau of Reclamation Study - 1995

The USBR drilled and sampled 10 additional boreholes, AP-1 through AP-10, between April and August, 1995. The location of these boreholes are shown on Figure 2.1. Soil samples were analyzed by EPA Method 8015 by extraction (fingerprint). Selected samples were analyzed by EPA Methods 8010, 8020, 8240, and 8270. Results showed that only AP-10 (100 mg/kg) indicated a value for TPH. All other samples were non-detect at a method detection limit (MDL) of 1 mg/kg for TPH. Individual BTEX constituents ranged from 9 to 43 ug/kg, 16 to 114 ug/kg, and 190 to 9300 ug/kg in boreholes AP-2, AP-8 and AP-10, respectively.

SECTION 3
BIOVENTING PILOT TEST RESULTS

A bioventing pilot test was performed at Site 6454 from March 1994 to May 1995 by Parsons ES under the AFCEE Bioventing Pilot Test Initiative, using procedures given in the *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing,* (the protocol document) by Hinchee et al, 1992. The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil depth;
- Determine the rate at which indigenous microorganisms will degrade fuel when stimulated by oxygen-rich soil gas at this site; and
- Evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated below regulatory-approved standards.

Because bioventing has been demonstrated to be a feasible technology for this site, the pilot test data were used to design a full-scale remediation system (Section 4) to remediate the soils at the site and to assure that contaminant levels throughout the site are remediated below regulatory-approved standards.

3.1 PILOT TEST CONFIGURATION

One VW (VW1), three MPs (MPA, MPB, MPC), and one blower unit were installed at the site in March 1994 (Figure 2.1). The air injection VW was installed following procedures described in the AFCEE bioventing protocol document (Hinchee et al., 1992). The VW was located in an area where former site characterization boreholes had encountered elevated hydrocarbon levels. The MPs were located 20, 32, and 50 feet from the VW. MP screens were installed at 10, 20, 30, 40, 50, and 60 feet bgs. A geologic cross-section through the VW and MPs is shown on Figure 2.2.

A 1-horsepower Gast® regenerative blower unit (model R4) was used for both the initial air permeability test and the extended pilot test. The blower is currently injecting air at a flow rate of approximately 60 scfm. The unit is powered by a 208-volt, single phase, 60-amp power line, approximately eighteen (18) inches bgs, running from the blower shed to an adjacent power box located approximately 120 feet east of the site. After blower installation and start-up, Parsons ES provided an operation and maintenance (O&M) manual, including maintenance instructions, equipment specifications, and monitoring forms to Base personnel.

3.2 INITIAL SOIL GAS CHEMISTRY

Prior to air injection, the VW and MPs were purged and sampled. Initial oxygen, carbon dioxide, and TVH concentrations were measured using portable gas analyzers. Also, soil gas samples collected from MPB-20, MPC-10, and MPC-60 were sent for laboratory analysis for BTEX and TVH by EPA Method TO-3. Table 3.1 summarizes the initial soil gas chemistry at the site. Soil gas analytical results are presented in Table 2.2.

Field readings in all but the VW and the 10-foot depths in MPB and MPC had depressed oxygen concentrations ranging from 7.5 to 0.0 percent. Nine of these 16 points had oxygen concentrations of 0.0 percent. It is suspected that the higher oxygen concentrations of 19.5, 14.0, and 16.0 percent found at VW1, MPB-10, and MPC-10 respectively are due to diffusion of oxygen from the surface. Since there appears to be a small amount of fuel contamination at these shallow depths, there is minimal biological fuel consumption which could lead to elevated concentrations of oxygen in the soil.

Carbon dioxide, a by-product of aerobic fuel biodegradation, was detected in elevated concentrations of up to 16 percent. Elevated TVH concentrations of over 20,000 ppmv were detected at most MPs. Elevated TVH and carbon dioxide along with depleted oxygen are strong indicators of naturally occurring aerobic biodegradation of site hydrocarbon contamination.

3.3 *IN SITU* BIODEGRADATION RATES

Initial, 6-month and 12-month *in situ* respiration tests and initial and one-year soil sampling events were completed as part of the bioventing pilot test. Table 3.2 shows the estimated fuel degradation rates in milligrams of TRPH per kilogram of soil per year at MPA, MPB, and MPC locations, based on the initial, 6-month and one-year respiration tests. Degradation rates ranged from 30 to 760 mg/kg/year and remained relatively constant throughout the year long test. These consistent rates indicate biodegradable fuel residuals still remain at the site.

3.4 AIR PERMEABILITY/OXYGEN INFLUENCE

Air permeability/radius of oxygen influence tests were performed at Site 6454 to determine the pressure response in the formation induced by pressurizing the VW and to determine the volume of subsurface soils that could be oxygenated from air injection into a single VW. The depth and radius of oxygen influence in the subsurface resulting from air injection into the VW is the primary design parameter for extended bioventing systems. The pilot test data determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration.

An air permeability test was conducted at the site according to the protocol document procedures. Air was injected into the VW for three hours at a rate of 60 scfm. At this flow rate, pressure gradually increased at all three MPs. The dynamic method of determining air permeability is coded in the Hyperventilate® model that was used to calculate soil gas permeability values. These values ranged from 3 darcys for clayey sand to 319 darcys for sand at the site. A minimum radius of pressure influence of 50 feet was

Table 3.1

Initial Soil Gas Chemistry
Site 6454
Vandenberg Air Force Base, California

Sample Location	Depth (feet bgs)	O_2 (percent)	CO_2 (percent)	TVPH Field (ppmv)[a]	TVPH Lab (ppmv)[b]
VW1	4 - 75	19.5	0.2	80	NA
MPA-10	10	5.5	0.1	>20,000	NA
MPA-20	20	5.0	0.08	>20,000	NA
MPA-30	30	0.0	1.9	>20,000	NA
MPA-40	40	0.0	4.8	16,400	NA
MPA-50	50	0.0	7.5	>20,000	NA
MPA-60	60	0.0	11.0	>20,000	NA
MPB-10	10	14.0	0.05	4,000	NA
MPB-20	20	5.0	3.5	>20,000	190,000
MPB-30	30	3.5	10.0	>20,000	NA
MPB-40	40	4.0	0.05	>20,000	NA
MPB-50	50	0.0	4.4	>20,000	NA
MPB-60	60	0.0	9.0	>20,000	NA
MPC-10	10	16.0	0.9	580	7,200
MPC-20	20	2.5	14.5	2,000	NA
MPC-30	30	0.0	16.0	>20,000	NA
MPC-40	40	0.0	15.5	>20,000	NA
MPC-50	50	7.5	7.5	>20,000	NA
MPC-60	60	0.0	4.0	>20,000	120,000

a = Total hydrocarbon analyzer field screen results.
b = Laboratory results referenced to Jet Fuel (Molecular Weight = 156)
NA = Not Analyzed

Table 3.2
Site 6454
Respiration and Degradation Rates
Vandenberg AFB, California

Location-Depth (feet below ground surface)	Initial			6-Month [b/]			1-Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-10	0.00068	70	16.2	0.00084	93	20.8	0.0018	220	16.1
MPA-40	0.0021	490	NS [c/]	NC [d/]	NC	NS	NC	NC	NS
MPA-60	NS	NS	18.7	NC	NC	19.5	NS	NS	19.0
MPB-10	NS	NS	NS	0.0036	400	NS	0.0037	450	NS
MPB-20	0.00040	50	NS	0.00065	78	NS	0.00094	100	NS
MPB-50	0.0019	490	NS	NC	NC	NS	0.0034	760	NS
MPC-20	NS	NS	NS	0.0012	150	NS	NS	NS	NS
MPC-30	0.0014	130	NS	NC	NC	NS	0.00079	30	NS
MPC-40	NS	NS	NS	NC	NC	NS	0.0064	640	NS
MPC-50	NS	NS	NS	NC	NC	NS	.0022	490	NS
MPC-60	0.0021	540	NS	NC	NC	NS	0.00052	120	NS
VW1	NS	NS	NS	NC	NC	NS	0.0026	360	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Assumes moisture content of the soil is average of initial and final moistures.
[c/] NS = Not sampled.
[d/] NC = Not calculated. Oxygen concentrations failed to show significant reduction during testing.

observed at all depths except the 10-foot depths at MPB and MPC, and the 30-foot depth at MPB. These depths correspond to clay intervals (see Figure 2.2).

At an initial air injection rate of 60 scfm and an average pressure of 20 inches of water, the oxygen influence was monitored at all depth intervals of the three MPs. Initial, 20-hour, 22-day, 3-month, and 6-month oxygen readings are summarized in Table 3.3. The air injection flow rate of 60 scfm for 20 hours produced an increase in soil gas oxygen levels at a radius of approximately 50 feet from the VW. Extended monitoring at 3 and 6-months indicated a gradual decrease in oxygen concentration at the 40, 50, and 60-foot depths in MPB and MPC. One possible explanation is the development of preferential air flow from the top of the VW screen at 4 feet bgs to the ground surface instead of out into the formation. In fact, shortly after completion of one-year testing, air was observed escaping at the ground surface near the VW. This short circuit will be corrected during installation of the full-scale system. Though initial testing indicated a radius of oxygen influence of over 50 feet, a more conservative estimate of approximately 40 feet has been assumed for the placement of additional VWs for the full-scale bioventing system.

Weekly system checks consisting of pressure, vacuum, and temperature gage reading and inlet air filter inspection were conducted by Vandenberg AFB personnel. These weekly checks ensured consistent system operation and performance.

3.5 ONE-YEAR SOIL AND SOIL GAS SAMPLING RESULTS

Year end soil gas samples were collected from the same MPs as were originally sampled. Initial and year end-soil gas sample results are shown on Table 3.4. TVH concentrations decreased an order of magnitude at the 60-foot depth interval of MPC, and dropped by 47 percent at the 20-foot depth interval of MPB. The increase in the soil gas TVH concentration at MPC-10 is due to the outward displacement of volatile hydrocarbons caused by injection of air at the VW. Changes in BTEX concentrations ranged from an order of magnitude decrease to an order of magnitude increase. The apparent BTEX increases at some sampling locations are due to displacement of volatile hydrocarbons in the subsurface caused by air infection at the VW.

Initial and year-end soil sample results are also shown in Table 3.4. TRPH and TPH (gasoline) results were non-detect in MPA-30 and MPB-62 for both the initial and one year samples. TRPH concentrations remained steady for VW-15 between the initial and one year samples. However, TPH (gasoline) results at VW-15 showed a two orders of magnitude drop between the initial and one year samples. BTEX results at VW-15 also decreased two orders of magnitude over the year long test.

3.6 POTENTIAL AIR EMISSIONS

Air emissions during pilot testing were expected to be minimal. Site 6454 is a vacant lot with no habitable structures or sensitive environmental receptors. Site contamination consists primarily of compounds with low volatility (diesel and JP-4). During the first day of air injection for the pilot test, air in the breathing zone and at the VW and MP well heads was monitored using a photoionization detector (PID). The PID

Table 3.3

Influence Of Air Injection Vent Well On Monitoring Point Oxygen Levels
Site 6454
Vandenberg Air Force Base, California

Sample Location	Depth (feet bgs)	Distance from VW (feet)	Initial O_2 (percent)	20-Hour O_2 (percent)	22-Day O_2 (percent)	3-Month O_2 (percent)	6-Month O_2 (percent)
MPA-10	10	20	5.5	14.5	12.1	9.0	15.5
MPA-20	20	20	5.0	12.3	4.3	8.0	12.5
MPA-30	30	20	0.0	9.5	5.5	1.0	3.3
MPA-40	40	20	0.0	0.0	6.5	11.5	9.0
MPA-50	50	20	0.0	3.0	5.9	15.0	9.0
MPA-60	60	20	0.0	0.0	1.7	13.0	5.0
MPB-10	10	32	14.0	13.3	16.5	18.5	15.0
MPB-20	20	32	5.0	15.5	16.1	17.5	17.0
MPB-30	30	32	3.5	9.3	NA	water	water
MPB-40	40	32	4.0	6.5	5.5	2.0	4.2
MPB-50	50	32	0.0	4.8	0.75	3.0	0.5
MPB-60	60	32	0.0	0.0	0.5	12.5	0.5
MPC-10	10	50	16.0	9.2	3.0	2.5	2.5
MPC-20	20	50	2.5	9.9	10.0	3.5	8.2
MPC-30	30	50	0.0	11.5	9.0	4.5	8.5
MPC-40	40	50	0.0	8.8	6.5	0.5	3.0
MPC-50	50	50	7.5	9.2	9.0	0.5	0.5
MPC-60	60	50	0.0	5.0	8.0	0.5	0.4

NA = Not Analyzed

Table 3.4
Site 6454
Initial and 1-Year Soil and Soil Gas Analytical Results
Vandenberg AFB, California

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)					
	MPB-20		MPC-10		MPC-60	
Soil Gas Hydrocarbons	Initial [b]	1-Year [c]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	190,000	100,000	7,200	28,000	120,000	12,000
Benzene (ppmv)	280	370	9.2	25	33	74
Toluene (ppmv)	300	210	19	< 2.2	39	41
Ethylbenzene (ppmv)	33	54	11	38	5.0	23
Xylenes (ppmv)	74	110	20	35	5.9	52
	VW1-15		MPA-30		MPB-62	
Soil Hydrocarbons	Initial [d]	1-Year [e]	Initial	1-Year	Initial	1-Year
TPH (gasoline) 100	960	< 5	< 1.2	< 5	< 1.2	< 5
TRPH (mg/kg)	13 [f]	14.2	< 5.6	< 9.98	< 5.6	< 10
Benzene (mg/kg) .1	1.2	< 0.050	0.067	< 0.050	0.048	< 0.050
Toluene (mg/kg) 10	6	< 0.050	0.028	< 0.050	0.062	< 0.050
Ethylbenzene (mg/kg) 68	5.5	< 0.050	0.0036	< 0.050	0.007	< 0.050
Xylenes (mg/kg) 175	19	< 0.130	0.021	< 0.130	0.036	< 0.130
Moisture (%)	14.0	12.9	12.7	15.3	12.7	13.0

[a] TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TPH (gasoline)=total petroleum hydrocarbons as gasoline;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

[b] Initial soil gas samples collected on Febuary 28, 1994.

[c] Final soil gas samples collected on March 6,1995. Blower system was shut down approximately 30 days prior to soil gas sampling to allow soil gas to come to equilibrium with soils.

[d] Initial soil samples collected on February 22-24,1994.

[e] Final soil samples collected on May 22, 1995.

[f] Initial TRPH is corrected from Interim Test Results.

was calibrated with 100 ppm isobutylene. Volatile hydrocarbons were not detected in the breathing zone or at the VW or MP well heads.

Additional evidence supporting low potential for air emissions was collected at a bioventing pilot test located at the Base Exchange Service Station. This site is approximately 1 mile from Site 6454. Soils at the site are more porous than at Site 6454. The pilot test was conducted in gasoline contaminated soil. Gasoline is significantly more volatile than diesel or JP-4. Part of the test included extracting gasoline vapors from wells located in the spill area and re-injecting into 6-foot deep bioventing trenches partially surrounding the site. Surface emissions were monitored by collecting weekly flux samples. No emissions above regulatory limits were detected.

3.7 RECOMMENDATION FOR FULL-SCALE BIOVENTING

Based on the positive results of the bioventing pilot test, AFCEE has provided funding for the design and installation of an expanded bioventing system that will remediate remaining contaminated soils associated with Site 6454. AFCEE has retained Parsons ES to continue bioventing services at Vandenberg AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results, available analytical data, and soil sampling, Parsons ES has prepared a conceptual full-scale upgrade design that will employ the existing VW and three additional VWs. The short circuiting problem at the existing VW will be corrected by replacing the exiting 4-foot surface seal with a 15-foot surface seal. Two additional MPs will be installed to ensure oxygen is being delivered to contaminated soils. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system and is included in Appendix A of this RAP.

SECTION 4
EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the remaining soil contamination present at Site 6454. Based upon the evaluation of the pilot test data, three additional air injection VWs along with the existing pilot-scale VW will be used to provide oxygen to all remaining oxygen-depleted, contaminated soils at the site. Two additional MPs will also be installed to ensure that oxygen is being delivered to contaminated soils. System design details are provided in Appendix A.

4.1 OBJECTIVES

Following its implementation, the primary objectives of the expanded bioventing system will be to:

- Optimize the system to fully influence the contaminated area;
- Reduce the existing contaminant levels to below acceptable regulatory cleanup criteria. Vandenberg AFB has negotiated levels with CRWQCB of 0.1 mg/kg benzene, 10 mg/kg toluene, 68 mg/kg ethylbenzene, 175 mg/kg total xylenes, and 100 mg/kg TPH-diesel for this site (USBR, 1994);
- Monitor the system to ensure continuous operation; and
- Provide the most cost-effective remediation alternative for this site.

4.2 BASIS OF DESIGN

Site investigation data, pilot test data, and experience at other bioventing sites provide the main elements of the basis of design. The expanded bioventing system was designed to provide oxygen to areas of significant soil contamination. Pilot test data, such as operating pressure and radius of oxygen influence, and the availability of electric power were considered during design development. These data were considered in the spacing of VWs and sizing of a full-scale blower system. In addition to the pilot test data from these sites, experience at other sites with similar soil types was considered in design development. The significant design parameters and considerations are as follow:

- A radius of oxygen influence of approximately 40 feet was used for the spacing of VWs.
- An air injection pressure of 15 inches of water was assumed in sizing the full-scale bioventing blower. This is consistent with pressures observed during the extended pilot test.
- An air injection flow rate of 50 scfm per VW was assumed based on experience at this site and the limited electric supply available to power the blower.

The full-scale bioventing system will require the replacement of the existing blower used for the pilot test at Site 6454 with a larger blower that will supply the pilot test VW (VW1) and one of the three additional VWs. Air flow into the VWs will be alternated so that sufficient oxygen is delivered throughout the contaminated zone. The blower was sized assuming air flow to a total of two wells at a given time would be provided by this blower. A blower of sufficient size to inject air into all four wells would require three phase electric power, which is not available at this site without major additional costs.

The locations of the two additional MPs were selected such that they would provide information as to the extent of contamination, would be useful in evaluating the magnitude of contaminant reduction through soil gas sampling, and would provide important oxygen influence data. The proposed MPs will be located just outside of the design radius of oxygen influence to verify that design radius is achieved.

4.3 SYSTEM DESIGN

The proposed upgrade to the pilot-scale bioventing system will incorporate the existing VW and the addition of three new VWs (VW2, VW3, and VW4). The additional VWs will be installed to ensure proper oxygen influence throughout the area of soil contamination. Two new MPs (MPD and MPE) will also be constructed to monitor soil gas at the site. Existing and proposed VW and MP locations and the VW's estimated radius of influence are shown in Figure 4.1. The new VWs will be 4 inches in diameter and will be screened with 0.040-inch slot from 15 to 70 feet bgs. The two new MPs will have depth specific screen intervals at 10, 20, 30, 40, 50, and 60 feet bgs. VW and MP design, trenchline configuration, and other design detail are included in the design package provided in Appendix A.

Air will be delivered from the blower to the VWs via 2-inch diameter Schedule 80 PVC piping. The air injection piping will be installed approximately 18-inches bgs. All four VWs will be connected via a manifold to a single 1.5-horsepower (R4P) regenerative blower installed at the same location as the current blower. A separate (manual) flow control valve and air velocity port will be included in the lines connecting each VW in order to adjust and monitor air flow at each location. The blower and valving will be housed in a locked weatherproof enclosure for protection from the elements and for security purposes. The blower will be powered by the existing 208-volt, single-phase, 60-amp power line

Based on data collected from the pilot test, a maximum injection rate of 50 scfm and an air injection pressure of 15 inches of water at VW1 and one other VW will supply oxygen to remaining contaminated soils and sustain *in situ* fuel biodegradation. During monthly site inspections, the manual flow control valves will be adjusted to alternate flow between VW2, VW3, and VW4, with preference to VW3. (During the first month of operation, flow will be through VW1 and VW3, followed by VW1 and VW2, then VW1 and VW3, then VW1 and VW4). The radius of oxygen influence around each VW should extend approximately 40 feet. These assumptions are based on data collected during the pilot test.

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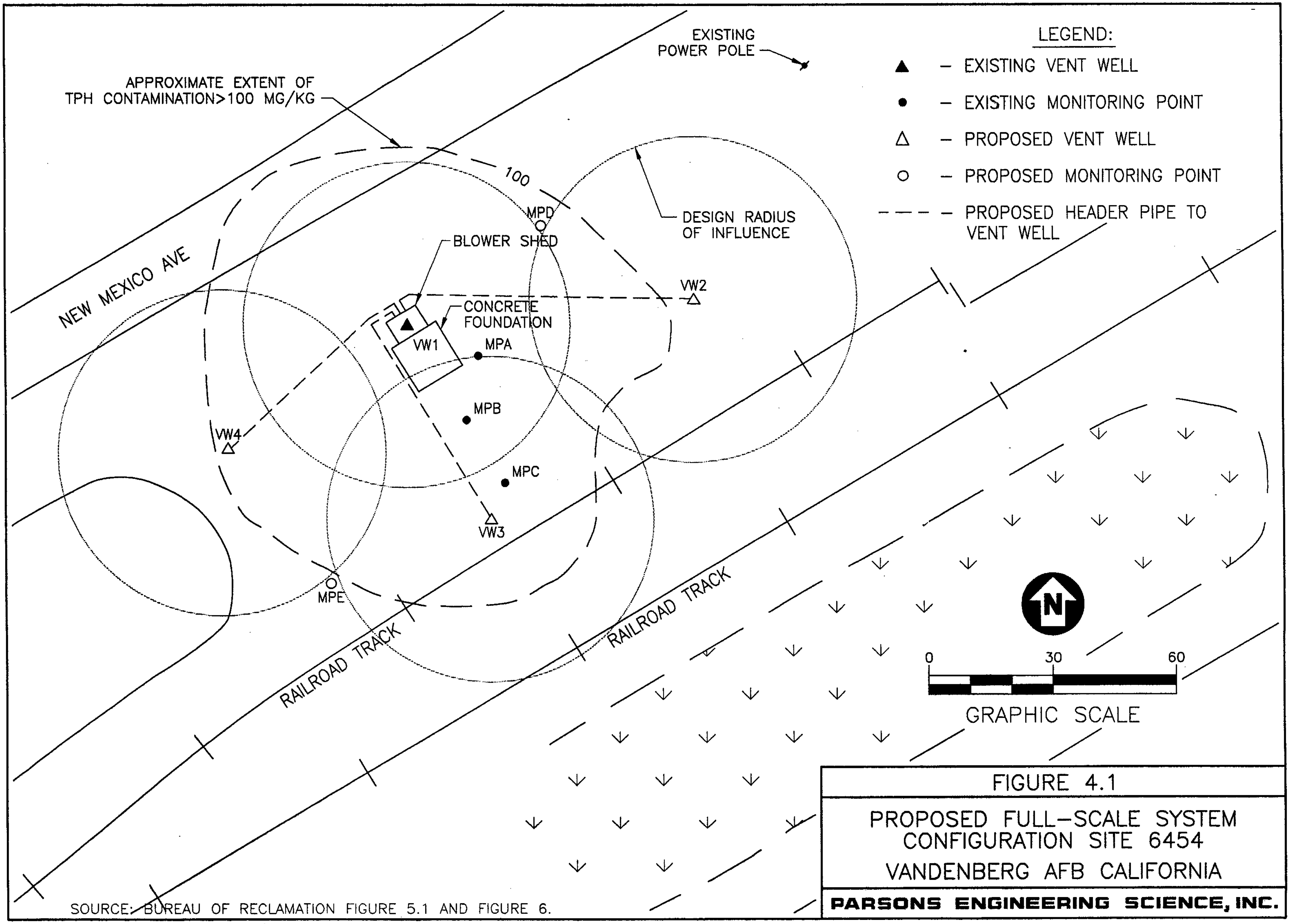

FIGURE 4.1

PROPOSED FULL-SCALE SYSTEM CONFIGURATION SITE 6454

VANDENBERG AFB CALIFORNIA

PARSONS ENGINEERING SCIENCE, INC.

4.4 SOIL AND SOIL GAS SAMPLING

Soil samples will be collected from all boreholes advanced during drilling activities for installation of the full-scale bioventing system components. Samples will be collected at 5-foot intervals, and will be screened in the field using a GasTech® Tracetechtor® hydrocarbon meter. Five soil samples will be sent to the analytical laboratory for analysis of BTEX by Method SW8020 and TRPH by Method SW8015 modified. The sample with the highest TVH concentration from each borehole, based on field screening, will be selected for laboratory analysis.

Soil gas sampling will be conducted at all MPs and VWs prior to system startup to establish baseline oxygen, carbon dioxide, and TVH levels using field instruments. In addition, soil gas samples from ten locations will be forwarded to an analytical laboratory for analysis of TVH (jet fuel) and BTEX by Method TO-3. The locations of these samples will be determined based on the field screening results. However, VWs will not be selected for analytical soil gas sampling as they are not representative of typical soils in the treatment zone. The ten samples exhibiting the highest TVH concentrations based on field instrument readings will be sent for laboratory analysis.

4.5 SYSTEM OPTIMIZATION

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each of the two VWs until soil gas oxygen concentrations at all MPs within a 40-foot radius of the VWs reach a minimum concentration of approximately 5 percent. Oxygen levels in excess of 5 percent at the outer MPs may indicate that the volume of air passing through the soil exceeds the biological oxygen utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection.

Emissions are not expected during full-scale system operation. During initial air injection, accumulated vapors will move slowly outward from the air injection points and will biodegrade as they move horizontally through the soil. If some upward movement of injected air does occur, it will be highest during the first day of air injection for the full-scale system when the initial soil gas volume is displaced. Parsons ES personnel will monitor air at the VWs, MPs, and breathing zone hourly for the initial 8 hours during the first day of testing. A PID will be used to detect any emissions exceeding ambient conditions. Any sustained readings in excess of 10 ppmv will require an immediate reduction in air injection rates.

Following startup and optimization of the bioventing system, Parsons ES personnel will return to the site after one month of system operation to ensure that adequate oxygen influence has been achieved. In the event sufficient oxygen influence is not achieved (at least 5 percent oxygen at a majority of the MP depths) the blower piping system may be modified. System modification would include re-piping the centrally located VW1 to the blower intake. Extracted soil gas from VW1 will flow through a knockout drum to remove excess moisture, then mixed with sufficient ambient air to increase the oxygen concentration to approximately 15 to 20 percent. The extracted soil gas/ambient air mixture will be injected into VW3, and either VW2 or VW4. The flow between VW3 and VW2, and VW3 and VW4 would be alternated monthly. If made, these modifications will be described on the as-built drawings and in the O&M manual.

4.6 SYSTEM OPERATION

Following system installation, an O&M plan and as-built system drawings will be prepared. O&M requirements for the proposed bioventing system are minimal. The regenerative blowers are virtually maintenance-free. The only recurring maintenance required is a monthly check of the air filter, which is generally replaced when a pressure difference (from initial pressure) of 10 to 15 inches of water across the inlet filter is reached. The time period between filter changes is dependent on site conditions, and is typically every 3 to 6 months. The O&M manual will further detail operation requirements.

Monitoring of the bioventing system will include system checks of blower operation, including outlet pressures, inlet vacuum, and exhaust temperature every two weeks. Monitoring will also include the monthly air flow adjustments previously described. These system checks will be the responsibility of Vandenberg AFB personnel.

4.7 EXTENDED TESTING

System performance monitoring by Parsons ES under Option 1 of the Extended Bioventing Project will include *in situ* respiration testing during a site visit after 1 year of full-scale system operation. Soil gas samples will also be collected from the same ten MPs sampled during full-scale system installation and reanalyzed for BTEX and TVH using Method TO-3. No soil sampling will be performed under Option 1 of the Extended Bioventing Project.

Prior to performing the 1-year respiration tests and soil gas sampling, the blowers will be turned off for 30 days to allow soil gas to equilibrate so that 1-year data can be compared to initial soil gas data. Air will be injected into VWs or MPs for 20 hours using 1 scfm blowers. Oxygen uptake will be monitored in the MPs for approximately 72 hours to measure the rate at which oxygen decreases in the soil gas. These data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower oxygen utilization rates result. The use of oxygen utilization and soil gas chemistry as indicators of remaining contaminant concentration decreases the likelihood of premature closure soil sampling events.

System monitoring and *in situ* respiration test data will be analyzed to determine the progress of soil remediation. Estimates of contaminant reduction and time remaining to complete soil remediation will be based on the data collected during the respiration tests (oxygen utilization rates), quantitative estimates of the long-term biodegradation rates, and decreases in soil gas concentrations. If soil gas data indicate that the soils have been sufficiently remediated, closure sampling may be recommended.

4.8 PROJECT SCHEDULE

Following review and approval of the system upgrade RAP by AFCEE/ERT, Vandenberg AFB, the California Department of Toxic Substance Control (DTSC), and the California Regional Water Quality Control Board (CRWQCB), field work will begin. The following schedule for the upgrade is contingent upon timely approval of this RAP:

Event	Start Date	End Date	Duration (working days)
Submit Draft RAP and Design Package to AFCEE/ERT and Vandenberg AFB	NA	23 February 1996	NA
AFCEE/ERT and Vandenberg AFB Review Period	23 February 1996	16 April 1996	35 days
Respond to Comments on Draft	17 April 1996	3 May 1996	13 days
Submit Draft Final RAP and Design Package to AFCEE/ERT, Vandenberg AFB, DTSC, and CRWQCB	NA	3 May 1996	NA
Draft Final Review Period	6 May 1996	6 June 1996	25 days
Respond to comments on Draft Final RAP	10 June 1996	14 June 1996	5 days
Submit Final RAP and Design Package to AFCEE/ERT, Vandenberg AFB, DTSC, and CRWQCB	NA	14 June 1996	NA
Submit Work Permit (digging permit) Request	NA	10 June 1996	NA
Construction of Expanded System/System Startup	24 June 1996	3 July 1996	10 days
Complete Construction Drawings/O&M Manual	8 July 1996	9 August 1996	30 days

SECTION 5
HANDLING OF INVESTIGATION-DERIVED WASTES

All soil cuttings generated during the drilling program will be containerized in Department of Transportation (DOT) approved 55-gallon drums at the site. Drums will be labeled with the borehole ID, depth interval, date, base point of contact, and highest field screening result. Following completion of drilling activities, Parsons ES personnel will provide all field screening and analytical results to the Vandenberg AFB waste handling subcontractor. The drums will be transported by the Parsons ES drilling subcontractor to a site on base as specified by the base point of contact or will be removed from the site by a Vandenberg AFB waste handling subcontractor. It is anticipated that approximately 150 cubic feet of soil cuttings (20 drums) will be generated during installation of the full-scale bioventing system.

Decontamination of augers and sampling equipment will be performed at a portable decontamination trailer supplied by the Parsons ES drilling subcontractor. Decontamination water will be placed in properly labeled DOT approved 55-gallon drums and transported as described above.

SECTION 6
BASE SUPPORT REQUIREMENTS

The following support from Vandenberg AFB is needed prior to the arrival of the drillers and the Parsons ES team:

- Assistance in obtaining a Base digging permit.
- Assistance in obtaining any air permits (if required).
- Provide a copy of the Base waste management plan.
- Provide any documentation required to obtain gate passes and security badges for drilling personnel and two Parsons ES employees. If required by the Base, vehicle passes will be needed for two Parsons ES vehicles, one drill rig, and two drilling support trucks. These passes must be valid for the expected duration of drilling operations (about 1 week) and the full-scale system installation and startup (about 3 weeks).
- A potable water supply for well construction and decontamination activities.

During full-scale bioventing, Base personnel will be required to check the blower systems once every two weeks to ensure that they are operating properly, record air injection pressures and temperatures, and replace air filters, as needed. Base personnel will also be required to re-direct air flow monthly as previously described. Parsons ES will provide a maintenance procedures manual and a brief training session.

- If a blower stops working, notify Mr. John Jackson of Parsons ES - Pasadena at (818) 585-6207, Mr. John Ratz of Parsons ES - Denver at (303) 831-8100, or Capt. Ed Marchand of AFCEE at (210) 536-4364.
- Arrange site access for a Parsons ES technician to conduct respiration testing and soil gas sampling approximately 1 year after full-scale system installation and start up.

SECTION 7
KEY POINTS OF CONTACT

Base Point of Contact
Mr. Jack Yamauchi
30 CES/CEVCR
Environmental Restoration Section
806 13th Street, Suite 116
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Parsons ES Southern California Regional Manager
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Parsons ES Project Manager
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Fax: (303) 831-8208

SECTION 8
REFERENCES

Engineering Science, Inc. 1994. Bioventing Pilot Test Workplan Addendum for Site 6454, Former Fuel Transfer Facility, Vandenberg Air Force Base, California. Prepared for U.S. Air Force Center for Environmental Excellence. June.

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APPENDIX A

DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM
FACILITY 6454
VANDENBERG AFB, CALIFORNIA

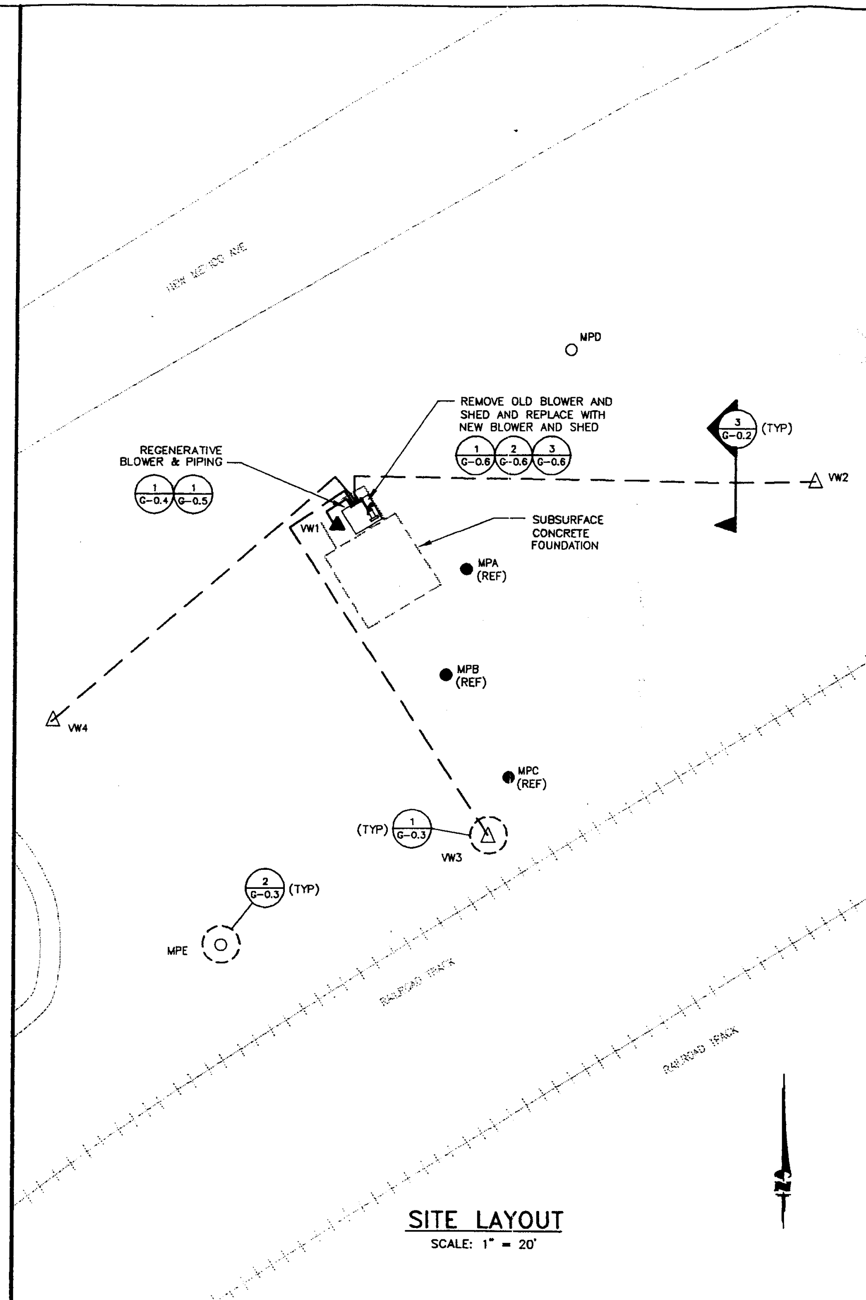
PREPARED FOR

AFCEE

FEBRUARY 1996

DRAWING INDEX

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAILS
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL



SITE LAYOUT

SCALE: 1" = 20'

Job No. 726876.22142				
Designed RAF				
Drawn				
Checked	2/22/96			
Reviewed	2/22/96			
Approved	2/22/96			
Reg No	A	2/22/96	65% DESIGN	
Date	Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
FACILITY 6454
VANDENBERG AFB, CALIFORNIA

TITLE SHEET AND SITE LAYOUT

DRAWING NO G-0.1 REV A

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ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK
WWF	WELDED WIRE FABRIC

SYMBOLS

MPA ●	EXISTING BIOVENTING MONITORING POINT
VW1 ▲	EXISTING VENT WELL
MPD ○	PROPOSED BIOVENTING MONITORING POINT
VW2 △	PROPOSED VENT WELL
— — —	PROPOSED HEADER PIPE TO VENT WELL
+++++++	RAILROAD TRACK

SECTION DESIGNATION — SECTION NAME
(A/X) **SECTION CUT**
SCALE: NTS
DRAWING OF ORIGIN — SCALE

DETAIL NO — DETAIL NAME
(1/X) **DETAIL DESCRIPTION**
SCALE: NTS
DRAWING OF ORIGIN — SCALE

MATERIAL LEGEND

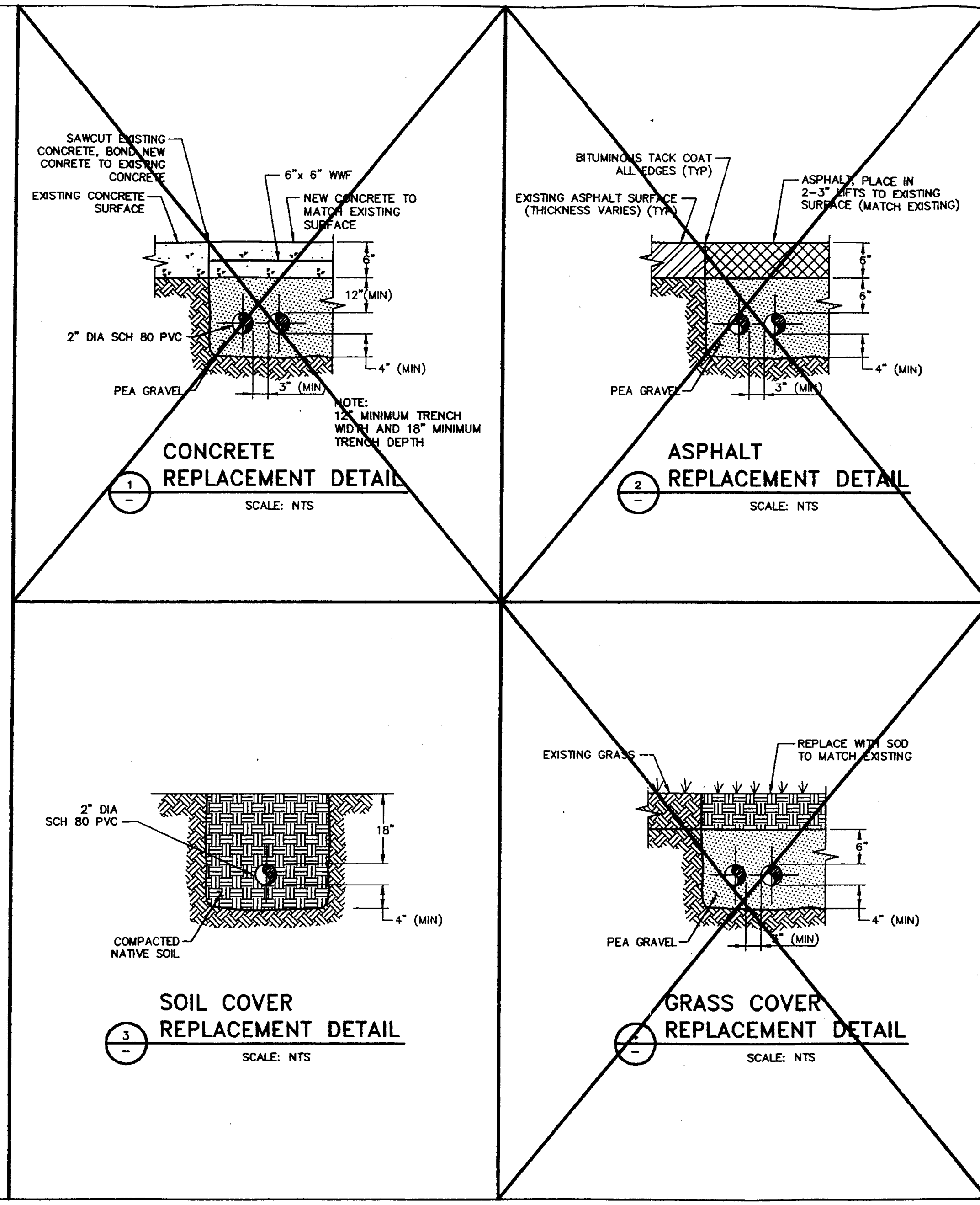
- ASPHALT
- BENTONITE
- BENTONITE/CEMENT GROUT
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



Job No. 726876.22142				
Designed RAF				
Drawn				
Checked	2/22/96			
Reviewed	2/22/96			
Approved	2/22/96			
Reg No	A	2/22/96	65% DESIGN	
Date	Rev	Date	Description	By

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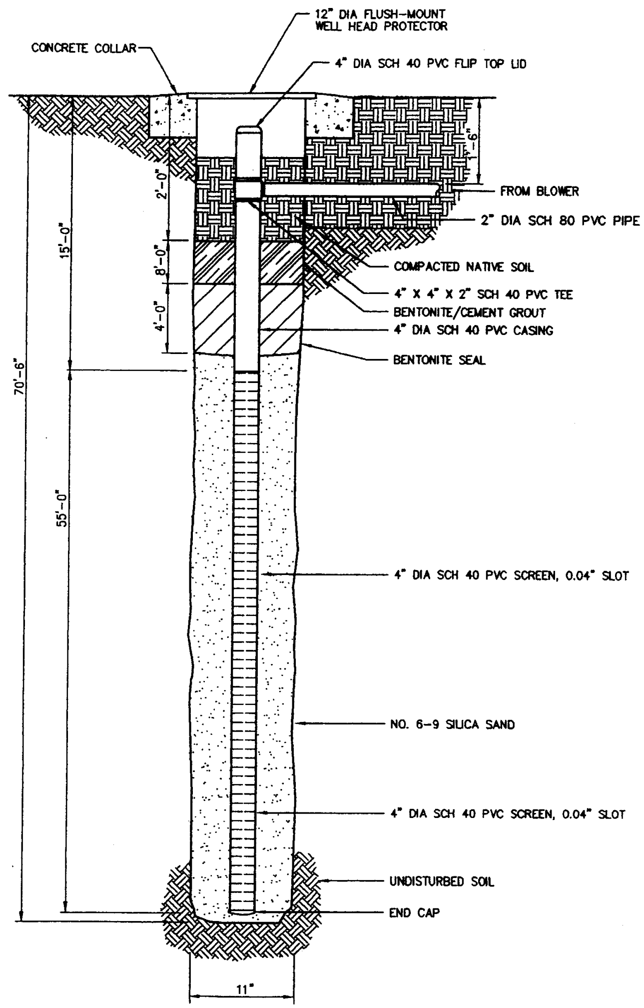
EXPANDED BIOVENTING SYSTEM
FACILITY 6454
VANDENBERG AFB, CALIFORNIA

LEGEND AND STANDARD TRENCH DETAILS

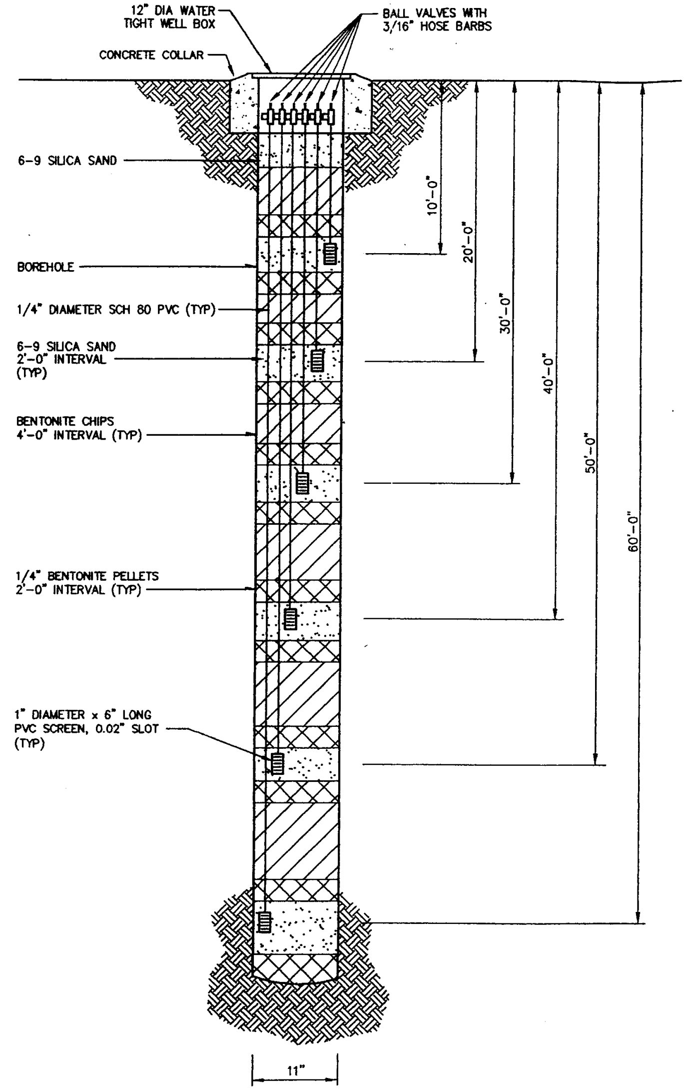
DRAWING NO G-0.2 REV A

K:\AFCEE\726876\VANDEN\96DN0107, 02/22/96 at 10:50



1 VENT WELL (VW) DETAIL

SCALE: NTS



2 MONITORING POINT (MP) DETAIL

SCALE: NTS

Job No.	726876.22142
Designed	RAF
Drawn	
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Reviewed	2/22/96
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Date	

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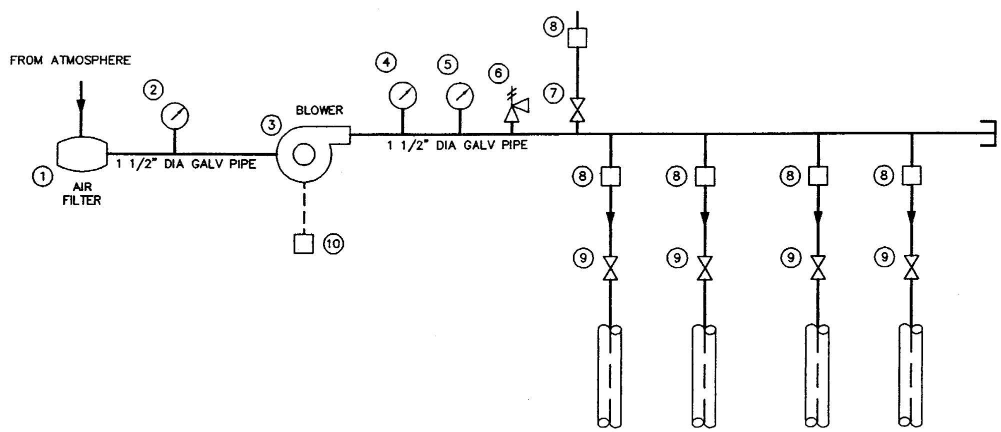
VENT WELL AND MONITORING POINT STANDARD DETAILS

DRAWING NO G-0.3 REV A

K:\AFCEE\726876\VANDEN\96DN0108, 02/22/96 at 11:00



LEGEND

1. INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
2. VACUUM GAUGE – GAST®, 2 5/8" DIA., 0-60" H_2O, 1/4" NPT, LM (PART NO. AJ497)
3. BLOWER – GAST® 1.5HP R4P115N-50, 95 CFM AT 25" H_2O PRESSURE
4. TEMPERATURE GAUGE – ASHCROFT, 0-250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)
5. PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0-100" H_2O, 1/4" NPT, CBM (Part No. 9851879)
6. AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 50" H_2O PRESSURE
7. MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
8. FLOW MEASURING PORT FITTED WITH PLUG (1/4"x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. STARTER

1/– BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Rev	Date	Description	By
B	4/26/96	90% DESIGN	
A	2/29/96	65% DESIGN	

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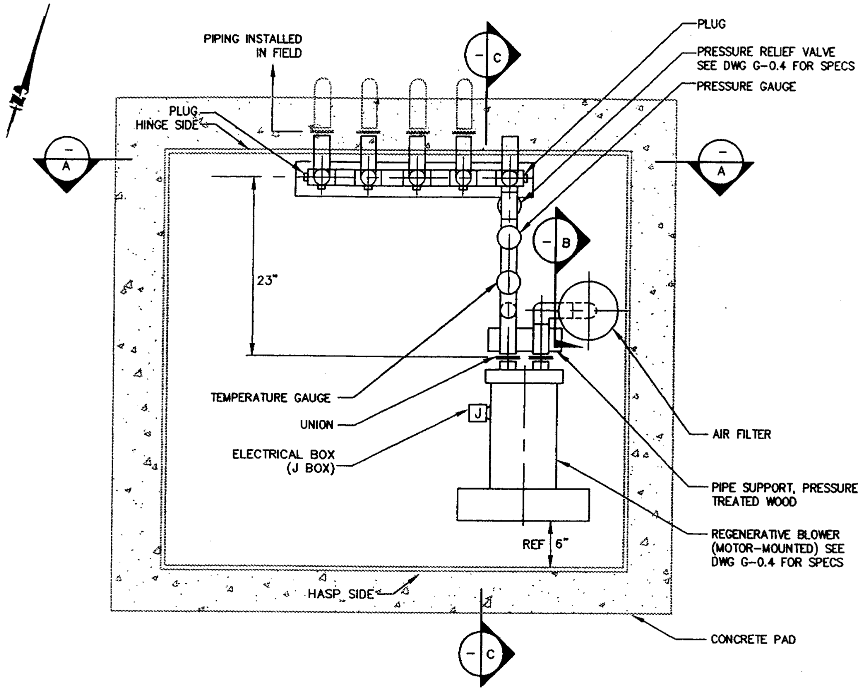
BLOWER P & ID

DRAWING NO G-0.4 REV B

K: \AFCEE\726876\VANDEN\96DN0109, 04/26/96 at 14:21

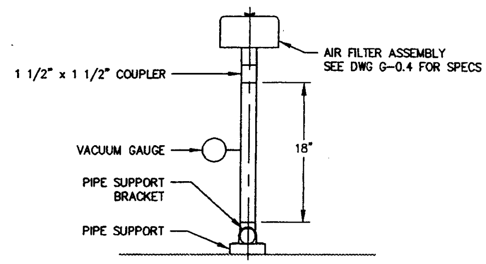


BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"

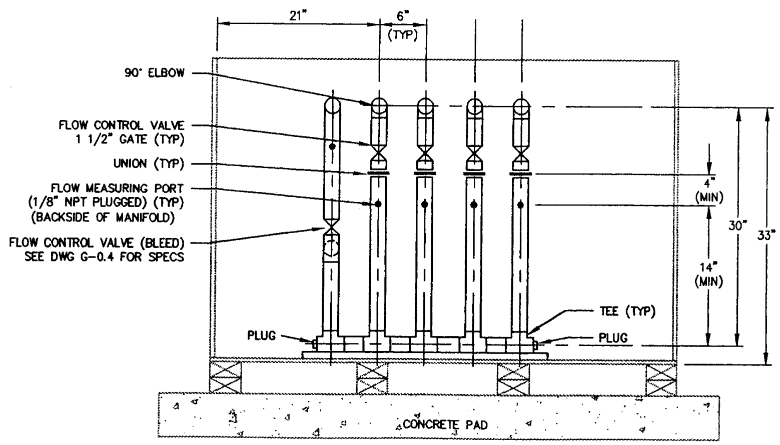
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS



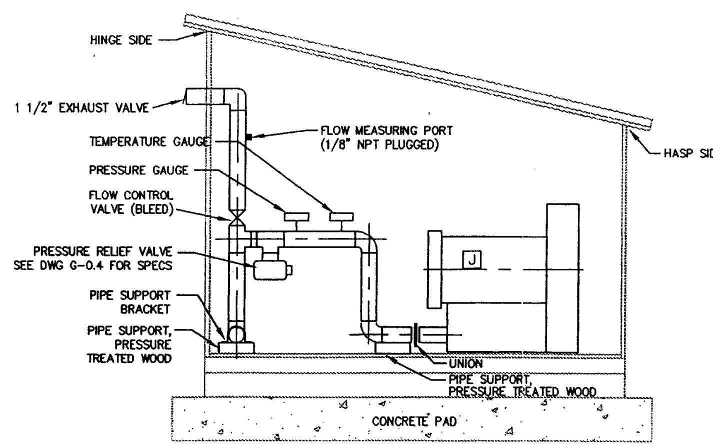
BLOWER INLET PIPING SECTION

3/4" = 1'-0"



MANIFOLD DETAIL SECTION

3/4" = 1'-0"



BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

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B	4/26/96	90% DESIGN	
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BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.5 | REV B

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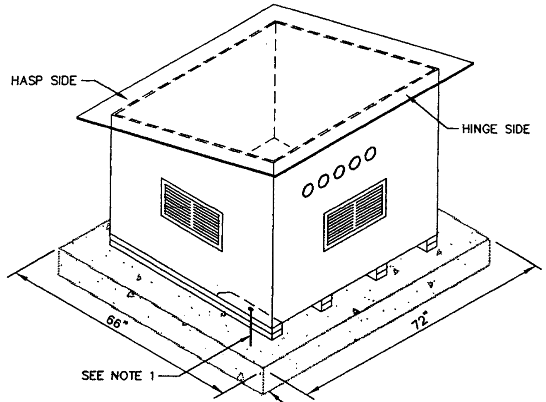
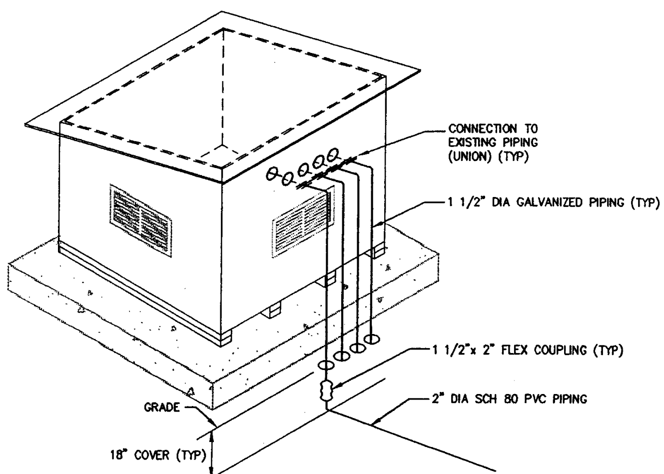


NOTES:

1. FIELD SECURE BLOWER SHED TO CONCRETE PAD AT 4 LOCATIONS BY THRU BOLTING. USE 3/8"x 6" LONG ST STL WEDGE ANCHOR BOLTS

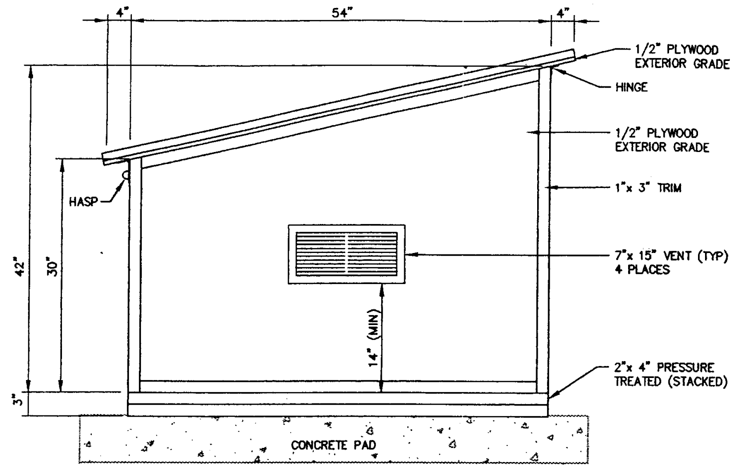
(1/–) BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

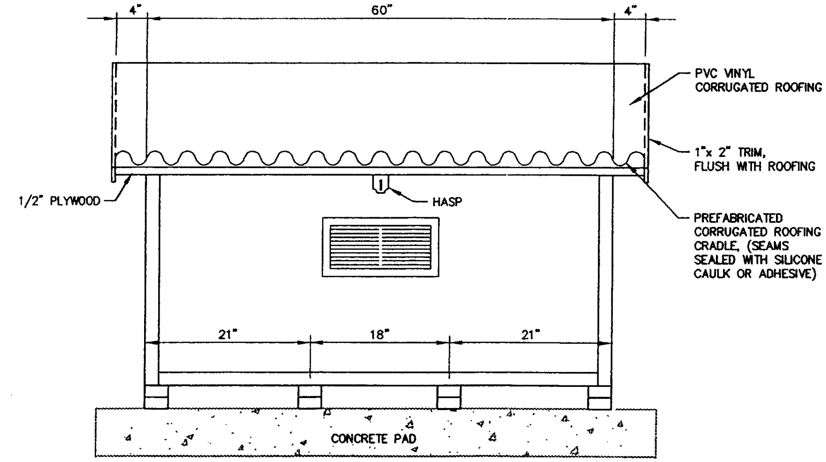


(2/–) TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:

1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

(3/–) BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

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BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.6 | REV B