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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

28 Nov 94

MEMORANDUM FOR OC-ALC/EMR
ATTN: Mr. Jeffrey Bradley

FROM: HQ AFCEE/ERT
8001 Arnold Drive
Brooks AFB TX 78235-5357

SUBJECT: Completion of One-Year Bioventing Test, POL Storage Area C

The Air Force Center for Environmental Excellence (AFCEE) one-year bioventing test and evaluation project at the POL Storage Area has been completed. Figure 1 provides general site information and Table 1 provides a summary of initial, six-month, and one-year fuel biodegradation rates measured at several monitoring points. Biodegradation rates have gradually decreased over the one-year pilot test. These decreases are best explained by the reduction of contaminant levels as the bioventing continued. Table 2 provides a summary of initial and final soil and soil gas sampling results for total recoverable petroleum hydrocarbons (TRPH) and benzene, toluene, ethyl benzene, and xylenes (BTEX). Based on results from your site and 109 other sites currently under operation, bioventing is cost-effectively remediating fuel contamination in a reasonable time frame. We recommend its application throughout the POL storage area and at other sites on your installation using the criteria in the AFCEE Test Plan and Technical Protocol for a Field Treatability Test for Bioventing, May 1992, including Addendum One, February 1994.

The objective of the one-year sampling effort was not to collect the large number of samples required for statistical significance. It was conducted to give a qualitative indication of changes in contaminant mass. Soil gas samples are somewhat similar to composite samples in that they are collected over a wider area. Thus, they provide a good indication of changes in soil gas profiles and volatile contaminant concentrations (see Addendum One to Test Plan and Technical Protocol for a Field Treatability Test for Bioventing - Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential, February 1994). Soil samples, on the other hand, are discrete point samples subject to large variabilities over small distances/soil types. Given this variability, coupled with known sampling and analytical variabilities, a large number of samples would have to be collected to conclusively determine "real" changes in soil contamination. Because of the limited number of samples, these results should not be viewed as conclusive indicators of bioventing progress or evidence of the success or failure of this technology. In situ respiration tests are considered to be better indicators of hydrocarbon remediation than limited soil sampling.

Sampling results indicate that a reduction in BTEX has taken place in the soils within the treatment radius of the pilot vent well. All measurements indicate that fuel biodegradation is progressing at a significant rate. AFCEE recommends that the bioventing pilot system continue to operate while planning for an expansion of the system for full-scale remediation. AFCEE/ERT can provide technical coordination, contractual support, and possibly funding for expansion to a full-scale bioventing system. Please contact Jerry Hansen, DSN 240-4353, COM 210-536-4353, to discuss technical and contractual options for full-scale expansion.

Data from your base and many others indicate that BTEX compounds are preferentially biodegraded over TRPH. Since BTEX compounds represent the most toxic and mobile fuel constituents, a BTEX standard is a risk-based standard. Oklahoma has provisions for site specific cleanup levels and has BTEX cleanup levels. We recommend that you try to use a BTEX standard for determining cleanup requirements. Attachment 3 summarizes the BTEX/TRPH issue and the report entitled "Use of Risk-based Standards for Cleanup of Petroleum Contaminated Soil," June 94, which was recently sent under separate cover ("tool box") will assist you in negotiating for a BTEX cleanup standard.

In general, quantitative destruction of BTEX will occur over a one- to two-year bioventing period. Soil gas surveys and respiration tests can be used as BTEX destruction indicators. If a non-risk-based/TRPH cleanup is chosen, the pilot and full-scale systems should be operated until respiration rates approach background rates. We recommend that confirmatory soil sampling be conducted four to six months after background respiration rates are approached.

Because this is a streamlined test and evaluation project, our contract does not provide for additional reports to the base on pilot study results. The interim results report dated Dec 92 contains as-builts and initial data. This letter summarizes all data collected and provides next step recommendations. AFCEE is no longer responsible for the operation, maintenance, or monitoring of the POL storage area bioventing system. We are initiating a contract to extend monitoring at some sites beyond the initial one-year test. Monitoring will continue soil gas and respiration tests to document hydrocarbon degradation, and will also include the collection of sufficient final soil samples to statistically demonstrate site cleanup. If you are interested, please call us.

The blower and accessories are now base property and should continue to be used on this or other bioventing sites. Although current equipment is explosion proof, under no circumstances should it be used for soil vapor extraction unless appropriate explosion-proof wiring is provided. If the base does not want to keep the blower or if you have further questions, please contact us.

On behalf of the AFCEE/ERT staff, I would like to thank you for your support of this bioventing test and evaluation project. The information gained from each site will be invaluable in evaluating this technology and will promote its successful application on other DOD, government, and private sites. I have attached a customer satisfaction survey. Please take a few minutes to fill it out and tell us how we did. We look forward to hearing from you.

ROSS N. MILLER, Lt Col, USAF, BSC
Chief, Technology Transfer Division

Attachments:
1. Storage Area C Data
2. Addendum One
3. "Using Risk-based Standards will Shorten Cleanup Time at Petroleum Contaminated Sites"
4. Survey

cc: AFCEE/ERD (Mr. McMindes)
HQ AFMC/CEVR

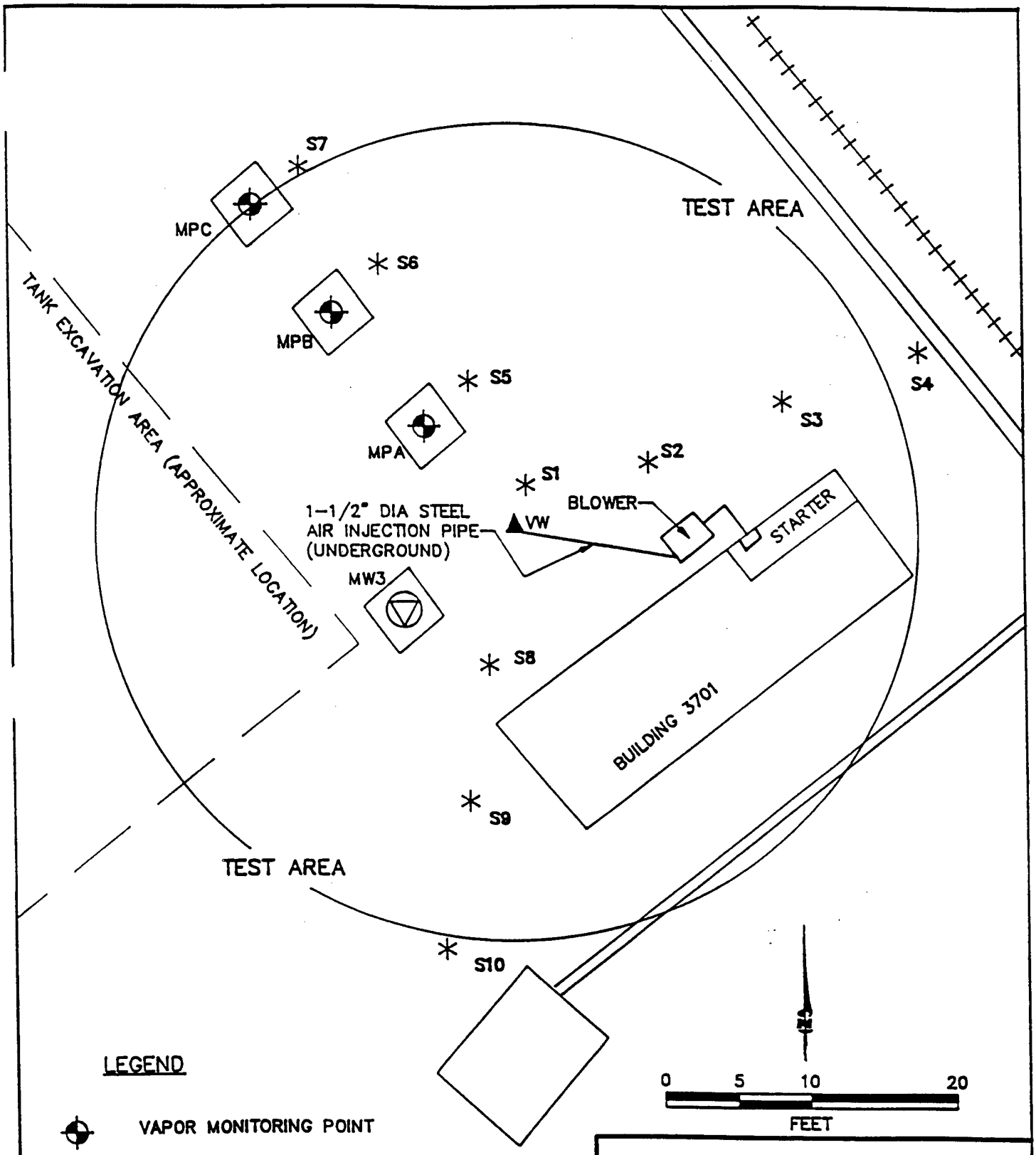

FIGURE 1

AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS POL STORAGE AREA C

TINKER AFB, OKLAHOMA

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

26816-01, 12/23/92 at 15:23

TABLE 1
POL AREA 3
RESPIRATION AND DEGRADATION RATES
TINKER AFB, OKLAHOMA

Location–Depth	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–5	0.0053	900	17.3	0.0020	320	15.1	0.00088	120	9.5
MPA–10	NS[c/]	NS	NS	NS	NS	NS	0.00013	30	NS
MPA–15	0.0021	420	20.1	0.000065	13	18.6	0.000093	19	16.2
MPB–5	NS	NS	NS	NS	NS	NS	0.00099	170	NS
MPB–10	0.0026	610	NS	0.00056	130	NS	0.0011	260	NS
MPB–15	0.0024	480	NS	0.00014	28	NS	0.00064	130	NS
MPC–5	NS	NS	NS	NS	NS	NS	0.0017	250	NS
MPC–10	0.0031	720	NS	0.00055	130	NS	0.0017	400	NS
MPC–15	0.0025	500	NS	0.00043	87	NS	0.0011	220	NS

[a/] Milligrams hydrocarbons per kilogram soil per year
[b/] Moisture content an average of initial and final readings.
[c/] NS = Not Sampled.
REV01/6/8/94

TABL
POL AREA 3
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
TINKER AFB, OKLAHOMA

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)					
	VW		MPA-5		MPC-10	MPC-15
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	940	2.4	3,500	34	30,000	530
Benzene (ppmv)	<0.21	0.003	100	<0.002	59	0.049
Toluene (ppmv)	6.3	<0.002	120	0.052	180	<0.025
Ethylbenzene (ppmv)	1.1	0.005	17	0.071	15	2.1
Xylenes (ppmv)	3.2	0.017	55	0.23	51	2.9

	VW-5		MPA-5		MPB-5	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,100	<5.5	5800	<5.8	5	<5.6
Benzene (mg/kg)	<2.7	<0.0006	4.3	0.003	<0.0006	<0.0006
Toluene (mg/kg)	120	0.0016	15	<0.0029	<0.0008	0.0013
Ethylbenzene (mg/kg)	140	<0.0006	19	0.014	<0.0005	<0.0006
Xylenes (mg/kg)	130	<0.0008	120	0.11	<0.001	<0.0008
Moisture (% by wt.)	9.6	8.7	10.7	13.1	7.8	11.3

[a/] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram; TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; $CaCO_3$=calcium carbonate; TKN=total Kjeldahl nitrogen.

[b/] Initial soil gas samples collected on November 14, 1992.

[c/] 1-Year soil gas samples collected on January 29, 1994.

[d/] Initial soil samples collected on November 11 and 12, 1993.

[e/] 1-Year soil samples collected on January 27, 1994.

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