MEMORANDUM FOR  66 SPTG/CEV
ATTN: Mr. Robert Spelfogel
120 Grenier Street
Hanscom AFB, MA 01731-1910

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

SUBJECT: Completion of One Year Bioventing Test, Buildings 1639 and 1812

The Air Force Center for Environmental Excellence (AFCEE) one-year bioventing test and evaluation projects at Buildings 1639 and 1812 have been completed. For each site, Figure 1 provides general site information and Table 1 provides a summary of initial, six-month, and one-year fuel respiration and degradation rates measured at several monitoring points. Overall, for Building 1639, biodegradation rates have decreased over the one-year pilot test. These decreases are best explained by the reduction of contaminant levels as the bioventing continued. For Building 1812, the oxygen levels at monitoring point MPA seem to naturally remain elevated. It is possible that this monitoring point is in relatively uncontaminated soil and the vent well is in a relatively contaminated area. Table 2 provides a summary of initial and final soil and soil gas analytical results for total recoverable petroleum hydrocarbons (TRPH) and benzene, toluene, ethyl benzene, and xylenes (BTEX). Based on results from your sites and 123 other sites currently under operation, bioventing is cost-effectively remediating fuel contamination in a reasonable time frame. We recommend its application 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. These are found in the “Tool Box” recently sent to your base.

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 show relative reductions in TRPH and BTEX concentrations. 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.

The soil analytical results for Building 1639 are not conclusive. Both the initial and one-year soil analysis for this site indicate low contamination levels. However, one-year point soil gas analytical results for Building 1639 indicate overall decreasing TVH and BTEX in the soils within the treatment radius of the pilot vent well. The one-year point respiration tests indicate some degradation is occurring at Building 1639. We recommend that the system continue to operate until respiration tests indicate background respiration rates for clean soils. Additional respiration testing and system expansion to cover the entire site can be contracted through AFCEE. Please contact Jerry Hansen, AFCEE/ERT, DSN 240-4353, COM 210-536-4353, to discuss technical and contractual options for full-scale expansion.

The soil analytical results for Building 1812 indicate TRPH contamination remains at the vent well. However, BTEX levels have been reduced to a low level at the vent well. It appears that the contamination at this site may be localized near the vent well. This conclusion is based on the naturally elevated oxygen levels at monitoring point MPA. The state of Massachusetts has site specific cleanup standards. The Building 1812 site appears to be at contaminant levels below the state requirements. We have on contract the ability to do site closure soil sampling for the Building 1812 site. We will be contacting you to schedule the closure sampling.

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. We strongly encourage its use over an arbitrary TPH standard. Within the AFCEE Risk-based Petroleum Hydrocarbon “Tool Box,” the reported entitled "Use of Risk-based Standards for Cleanup of Petroleum Contaminated Soil," summarizes the BTEX/TPH issue and 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 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 bioventing systems. We are initiating a contract to extend monitoring at some sites beyond the initial one-year test. Monitoring
will include soil gas and respiration tests to document hydrocarbon degradation, but may 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 the 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 these bioventing test and evaluation projects. 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, LtCol, USAF, BSC
Chief, Technology Transfer Division

Attachments:
1. Building 1639 Data
2. Building 1812 Data
3. Survey

cc: AFCEE/ERD (Mr. Saulnier)
    HQ AFMC/CEV
    Engineering Science
<table>
<thead>
<tr>
<th>Location – Depth</th>
<th>Initial (October 1992)</th>
<th>6 – Month (June 1993)</th>
<th>1 – Year (March 1994)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$K_0$ (% O₂/min)</td>
<td>Degradation Rate (mg/kg/year)$^{c,d}$</td>
<td>Soil Temperature (°C)</td>
</tr>
<tr>
<td>MPA – 2.5</td>
<td>NS$^e$</td>
<td>NS</td>
<td>18.6</td>
</tr>
<tr>
<td>MPA – 5</td>
<td>0.023</td>
<td>9800</td>
<td>19.7</td>
</tr>
<tr>
<td>MPB – 2.5</td>
<td>0.0070</td>
<td>2900</td>
<td>NS</td>
</tr>
<tr>
<td>MPB – 5</td>
<td>0.0097</td>
<td>4000</td>
<td>NS</td>
</tr>
<tr>
<td>MPC – 6</td>
<td>0.012</td>
<td>4700</td>
<td>NS</td>
</tr>
</tbody>
</table>

$^a$ Initial testing and calculations were performed by Battelle.
$^b$ 1-Year respiration test was performed approximately 30 days after blower system was shut off.
$^c$ Milligrams of hydrocarbons per kilogram of soil per year.
$^d$ Assumes moisture content of the soil is average of initial and final moitures.
$^e$ NS = Not Sampled.
$^f$ Thermocouple leads were destroyed by ice in well head.
$^g$ Respiration test was not performed at this point due to water in monitoring points.
$^h$ Respiration test was not performed at this point due to initial oxygen concentration in point being 0.0 percent.
### TABLE 2
**BUILDING 1639**
**INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS**
**HANSCOM AFB, MASSACHUSETTS**

<table>
<thead>
<tr>
<th>Analyte (Units)²⁄</th>
<th>Soil Gas Hydrocarbons</th>
<th>Sample Location − Depth (feet below ground surface)</th>
<th>MPA−2.5</th>
<th>MPA−5</th>
<th>MPB−2.5</th>
<th>MPB−5</th>
<th>MPC−3.5</th>
<th>MPC−6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial²⁄</td>
<td>1−Year²⁄</td>
<td>Initial</td>
<td>1−Year</td>
<td>Initial</td>
<td>1−Year</td>
<td>Initial</td>
</tr>
<tr>
<td>TVH (ppmv)</td>
<td></td>
<td>5600</td>
<td>130</td>
<td>19000</td>
<td>16</td>
<td>2700</td>
<td>59</td>
<td>3200</td>
</tr>
<tr>
<td>Benzene (ppmv)</td>
<td></td>
<td>5.2</td>
<td>0.21</td>
<td>27</td>
<td>&lt;0.002</td>
<td>2.8</td>
<td>0.32</td>
<td>2.4</td>
</tr>
<tr>
<td>Toluene (ppmv)</td>
<td></td>
<td>4.2</td>
<td>&lt;0.002</td>
<td>35</td>
<td>&lt;0.002</td>
<td>1.3</td>
<td>1.7</td>
<td>0.84</td>
</tr>
<tr>
<td>Ethylbenzene (ppmv)</td>
<td></td>
<td>1.1</td>
<td>0.035</td>
<td>10</td>
<td>0.006</td>
<td>0.84</td>
<td>0.11</td>
<td>0.42</td>
</tr>
<tr>
<td>Xylenes (ppmv)</td>
<td></td>
<td>2.9</td>
<td>0.058</td>
<td>30</td>
<td>0.011</td>
<td>1.9</td>
<td>2.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analyte (Units)</th>
<th>Soil Hydrocarbons</th>
<th>VW (4−4.5)</th>
<th>Initial²⁄</th>
<th>1−Year²⁄</th>
<th>VW (4.5−5)</th>
<th>Initial</th>
<th>1−Year</th>
<th>MPA (3−4)</th>
<th>Initial</th>
<th>1−Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Initial²⁄</td>
<td>1−Year²⁄</td>
<td></td>
<td>Initial</td>
<td>1−Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

²⁄Initial soil gas samples collected on 10/12/92.
³⁄1−Year soil gas samples collected on 3/8/94.
⁴⁄Initial soil samples collected on 10/2/92.
⁵⁄1−Year soil samples collected on 3/23/94.

---

Final\Hanscom\ha1639−2.wk1 7/8/94
BUILDING 1812

LEGEND

▲ INJECTION VENT WELL
● VAPOR MONITORING POINT
● SOIL GAS SURVEY POINT

FIGURE 1

BUILDING 1812
AS-BUILT SITE PLAN

HANSCOM AFB, MASSACHUSETTS
ENGINEERING-SCIENCE, INC.
Denver, Colorado
<table>
<thead>
<tr>
<th>Location – Depth</th>
<th>Initial (Oct. 1992)_\textsuperscript{a}</th>
<th>6-Month (June 1993)</th>
<th>1-Year (March 1994)_\textsuperscript{d}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$K_0$ (% O\textsubscript{2}/min)</td>
<td>Degradation Rate (mg/kg/year)_\textsuperscript{b}</td>
<td>Soil Temperature (°C)</td>
</tr>
<tr>
<td>MPA – 2.5</td>
<td>NS\textsuperscript{e}</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>MPA – 5</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Initial testing was not performed by Battelle due to high oxygen concentrations.

\textsuperscript{b} Milligrams of hydrocarbons per kilogram of soil per year.

\textsuperscript{c} Assumes moisture content of the soil is average of initial and final moistures.

\textsuperscript{d} 1-Year testing was not performed at this site due to atmospheric oxygen concentrations in soil gas 30 days after blower system was shut down.

\textsuperscript{e} NS = Not Sampled.
TABLE 2
BUILDING 1812
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HANSCOM AFB, MASSACHUSETTS

<table>
<thead>
<tr>
<th>Analyte (Units)</th>
<th>Sample Location – Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(feet below ground surface)</td>
</tr>
<tr>
<td>Soil Gas Hydrocarbons</td>
<td>NO SOIL GAS DATA COLLECTED&lt;sup&gt;b/&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil Hydrocarbons</th>
<th>VW (3–3.5)</th>
<th>VW (3.5–4.5)&lt;sup&gt;c/&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial&lt;sup&gt;d/&lt;/sup&gt;</td>
<td>1-Year&lt;sup&gt;d/&lt;/sup&gt;</td>
</tr>
<tr>
<td>TRPH (mg/kg)</td>
<td>12</td>
<td>658</td>
</tr>
<tr>
<td>Benzene (mg/kg)</td>
<td>&lt;0.062</td>
<td>&lt;0.0006</td>
</tr>
<tr>
<td>Toluene (mg/kg)</td>
<td>&lt;0.072</td>
<td>0.0013</td>
</tr>
<tr>
<td>Ethylbenzene (mg/kg)</td>
<td>&lt;0.052</td>
<td>&lt;0.0006</td>
</tr>
<tr>
<td>Xylenes (mg/kg)</td>
<td>&lt;0.093</td>
<td>0.001</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>3.2</td>
<td>5.7</td>
</tr>
</tbody>
</table>

<sup>a/</sup> TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.
<sup>b/</sup> No soil gas samples were collected from this site.
<sup>c/</sup> Initial soil sample taken from 3.5–4 feet bgs, 1-year soil sample taken from 4–4.5 feet bgs.
<sup>d/</sup> Initial soil samples collected on 10/3/92.
<sup>e/</sup> 1-Year soil samples collected on 3/23/94.
DEFENSE TECHNICAL INFORMATION CENTER
REQUEST FOR SCIENTIFIC AND TECHNICAL REPORTS

Title
AFCEE Collection

1. Report Availability (Please check one box)
☑ This report is available. Complete sections 2a - 2f.
☐ This report is not available. Complete section 3.

2a. Number of Copies Forwarded
1 each

2b. Forwarding Date
July 2020

2c. Distribution Statement (Please check ONE box)

☑ DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.
☐ DISTRIBUTION STATEMENT B: Distribution authorized to U.S. Government Agencies only.
☐ DISTRIBUTION STATEMENT C: Distribution authorized to U.S. Government Agencies and their contractors.
☐ DISTRIBUTION STATEMENT D: Distribution authorized to U.S. Department of Defense (DoD) and U.S. DoD contractors only.
☐ DISTRIBUTION STATEMENT E: Distribution authorized to U.S. Department of Defense (DoD) components only.
☐ DISTRIBUTION STATEMENT F: Further dissemination only as directed by the controlling DoD office indicated below or by higher authority.
☐ DISTRIBUTION STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals or enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25, Withholding of Unclassified Technical Data from Public Disclosure, 6 Nov 84.

2d. Reason For the Above Distribution Statement (in accordance with DoD Directive 5230.24)

☑ This report is NOT forwarded for the following reasons. (Please check appropriate box)
☐ It was previously forwarded to DTIC on _______________ (date) and the AD number is _______________.
☐ It will be published at a later date. Enter approximate date if known. _______________.
☐ In accordance with the provisions of DoD Directive 3200.12, the requested document is not supplied because:

2e. Controlling Office
HQ AFCEE

2f. Date of Distribution Statement Determination
15 Nov 2000

3. This report is NOT forwarded for the following reasons. (Please check appropriate box)

☐ It was previously forwarded to DTIC on _______________ (date) and the AD number is _______________.
☐ It will be published at a later date. Enter approximate date if known. _______________.
☐ In accordance with the provisions of DoD Directive 3200.12, the requested document is not supplied because:

Print or Type Name
Laura Peña

Signature

Telephone
210-530-1431

AQ Number M01-03-0544

TOTAL P. 02