STANDARD OPERATING PROCEDURE

Twelve

AIR PERMEABILITY TEST

Modified from
Groundwater Pollution Control Program Guideline #5
Minimum Design Requirements and Common Accepted Engineering Practices:
Soil Vapor Extraction and Bioventing Systems
Wyoming Department of Environmental Quality
Water Quality Division
June 1998

TABLE OF CONTENTS

1.0 OVERVIEW – AIR PERMEABILITY TEST

Air permeability tests directly measure many pertinent site characteristics and potential geologic heterogeneities as an inherent part of the test procedure. An air permeability test is generally conducted for no longer than one day, although for larger sites long term testing may be recommended. The tests need to be conducted for a long enough period of time to reach equilibrium conditions. Tests should be conducted under conditions that are typical at the site. For example, a test could produce misleading results if conducted during or shortly after a rainstorm.

A successful air permeability test should:

1) Estimate full-scale system operating air flow rate and vacuum
2) Estimate initial VOC removal rates.
3) Determine subsurface vacuum distribution to evaluate air flow patterns and zone of influence
4) Acquire data needed for computer modeling, if applicable.

A typical test will include a minimum of one extraction well, several observation wells and/or monitoring points and the hookup of the extraction well to the vacuum equipment. Upon startup of the vacuum pump, several field measurements are taken at the extraction well(s) and monitoring points. Guidelines regarding standard practices for the design and implementation of air permeability tests are presented below. Adherence to these guidelines should improve overall quality of the test data obtained. Miscellaneous components of testing operations are included since they might be required, depending on site-specific conditions. Monitoring and reporting requirements are also discussed.

2.0 AIR PERMEABILITY TEST DESIGN RECOMMENDATIONS

Air Extraction Wells:
Existing groundwater monitoring wells are typically used as air extraction wells. Selection of appropriate wells is crucial to obtaining representative data from pilot tests. The following standards apply:

- The extraction well(s) should generally be located near the center of the most contaminated zone or 'hot spot' in order to ensure that data collected during testing is representative of start-up conditions.
- The extraction well(s) should not be placed in the vicinity of man-made air flow conduits, such as sewer or utility lines.
- Only wells with known construction details should be used. Older wells without adequate completion information should be avoided.
- Well construction should ensure that short-circuiting of air flow is unlikely to occur across the seal and surface grout. If the screened interval is near to the soil surface, short-circuiting is likely to occur.
- The top of the screened interval must be placed above the seasonally high water table to avoid submergence. The expected rise in the water table due to the maximum operating vacuum must also be considered.
- If the elevation of the top of the well screen is not adequate, groundwater would need to be pumped during the pilot test and subsequent full-scale operation to prevent submergence of the well screen. Installing new wells screened a significant distance above the water table may be warranted.
- The bottom of the screened interval must lie below the seasonal low water table for all wells. In areas of groundwater contamination, the well(s) shall be utilized for both monitoring and

air extraction; therefore, the bottom of the screened interval must lie at least 10 feet below the seasonal low water table to obtain representative groundwater samples.

Vacuum Monitoring Wells and Probes:
Vacuum monitoring is typically conducted from the existing groundwater monitoring well network. Existing groundwater monitoring wells may not be sufficiently close to one another to adequately measure the vacuum distribution; therefore, temporary vacuum monitoring probes or permanent monitoring points may need to be installed.

The following standards apply:

- Existing monitoring wells should have grout seals and surface caps in good condition to prevent air leakage which might hinder measurement of small vacuum pressures.
- The radial distribution and minimum number of vacuum monitoring points required (including both wells and probes) will depend upon subsurface conditions. For a relatively homogeneous site, a minimum of three vacuum monitoring points are required. Heterogeneous sites should be monitored with a greater number of vacuum points, especially close to the extraction well.
- At least one monitoring well or point is required close to the extraction well and at least one monitoring point is required near the expected zone of influence. A third monitoring point is required within the zone of influence.
- For relatively homogeneous subsurface conditions, vacuum should be measured in wells and probes at nearly the same depth as the unsaturated screened interval of the extraction well(s).
- For highly heterogeneous subsurface conditions, or when three dimensional computer modeling is planned (i.e., significant vertical pressure gradients exist), vacuum should be measured at various depths.

3.0 STANDARD AIR PERMEABILITY TEST PROCEDURES

- The pilot test must be performed long enough to evacuate a minimum of 1.5 - 2 pore volumes of air in order to gather sufficient and representative data. This typically can be accomplished within 8 to 12 hours of test operation. The tests need to be conducted for a long enough period of time for the measured vacuums and extracted VOC concentrations to reach equilibrium conditions.
- Document the first representative sample of the extracted VOC vapors only after air in the vicinity of the extraction well(s), monitoring wells or probes has been purged. Initial extracted VOC concentrations observed are not indicative of equilibrium conditions (i.e., especially with the presence of free product) and tend to be higher than during system operation.
- Extraction well vacuum should be stepped (i.e., more than one vacuum should be applied at the test well). Sufficient steps should be performed in order to adequately establish the relationship between vacuum, air flow rates and the VOC mass removal rate. The highest vacuum step applied should be at the maximum capabilities of the air pump or blower used (without submerging the screened interval). Lower vacuum step tests should also be performed, because results from operating at the vacuum extremes helps to determine the vacuum required to obtain optimum mass removal rates.
- Changes in barometric pressure should be monitored at the beginning and end of each vacuum step (especially on windy days), in order to determine baseline shifts in apparent vacuum.
- Extraction well vacuum must be held constant at each step until vacuum measurements in all monitoring points have stabilized and reached equilibrium.

- Vacuum monitoring readings should be taken at wells and/or probes at nominal 15 minute intervals through each vacuum step. Air flow rates should be measured at the extraction well frequently throughout each vacuum step in order to document any increase or decrease in flow.
- Blowers/vacuum pumps need to have explosion proof motors, starters, and electrical systems.

4.0 PERMEABILITY TEST MONITORING

- Measure the background vapor VOC headspace readings in the extraction well prior to the pilot scale test. Background methane (CH_4) can also be measured prior to the test to help evaluate anaerobic degradation conditions.
- Measure the flow rate of extraction and VOC of extracted vapors at the extraction wellhead. One air sample must be taken for laboratory analysis. Measurements need to be taken upstream of any air dilution valves. If multiple extraction wells are tested concurrently, the flow rate and VOC concentrations need to measured at the manifold (i.e., prior to blower) to evaluate pipe head losses and total emissions.
- The temperature of the extracted air should be measured concurrently with flow rate measurements during testing.
- Measure vacuum influence in the surrounding soil probes and/or monitoring wells.
- If biodegradation potential is to be evaluated to optimize for bioventing, samples taken from soil vapor monitoring points (both wells and/or probes) should be measured for O_2 and CO_2 prior to inducing air flow and immediately after completion of the permeability test.

5.0 MISCELLANEOUS COMPONENTS OF AIR PERMEABILITY TESTS

- Muffler: need for a muffler depends on the size of equipment used during testing and the potential for public nuisance conditions.
- Off-gas treatment: the Air Quality Program might require off-gas treatment during pilot tests, depending on anticipated emissions during testing. Contact the Air Quality Program at 605-773-3151 prior to performing tests.
- Water trap and/or particulate filter: may be needed.

6.0 REPORTING AIR PERMEABILITY TEST RESULTS

- A site map drawn to scale indicating: Locations of air extraction well(s) and vacuum measuring points. Paved areas, buildings, and structures that may act as surface seals or infiltration barriers. Buried utility trenches or other subsurface structures that may act as zones of increased permeability.
- Descriptions of field equipment and procedures used during testing.
- Table of operating flow rates at different vacuum steps, vacuum measured at monitoring points and duration of each vacuum step applied. Barometric pressure readings should also be tabulated. Times of readings should be included.
- Plot of soil vapor vacuum vs. horizontal distance from the extraction well to determine the zone of influence. Graph should be plotted on semi-log paper with vacuum as the log scale (y-axis). A linear regression analysis should be performed on the data.
- Table of VOC levels in extracted vapors (measured prior to any off-gas treatment system), temperature of extracted vapor, and time of each reading. Average VOC mass removal rates for the test must be calculated from extraction concentrations and flow rates for each vacuum step.
- Table of O_2, CO_2, and CH_4 measurements (when bioventing is considered), taken prior to and after conducting the air permeability test.

- Sampling methods and procedures.
- Boring logs and 'as-built' construction diagrams for air extraction well(s) and vacuum monitoring wells/points.