Biopiles for Site Remediation

An Online Continuing Education Course for Engineers

Course Number: EN-2008

Credit: 2 Hours / 2 PDH / 2 CPD

Biopiles for Site Remediation

Overview

Biopiles, also known as biocells, bioheaps, biomounds, and compost piles, are used to reduce concentrations of petroleum constituents in excavated soils through the use of biodegradation. This technology involves heaping contaminated soils into piles (or “cells”) and stimulating aerobic microbial activity within the soils through the aeration and/or addition of minerals, nutrients, and moisture. The enhanced microbial activity results in degradation of adsorbed petroleum-product constituents through microbial respiration. Biopiles are similar to landfarms in that they are both above-ground, engineered systems that use oxygen, generally from air, to stimulate the growth and reproduction of aerobic bacteria which, in turn, degrade the petroleum constituents adsorbed to soil. While landfarms are aerated by tilling or plowing, biopiles are aerated most often by forcing air to move by injection or extraction through slotted or perforated piping placed throughout the pile. A typical biopile cell is shown in Exhibit 1.

Biopiles, like landfarms, have been proven effective in reducing concentrations of nearly all the constituents of petroleum products typically found at underground storage tank (UST) sites. Lighter (more volatile) petroleum products (e.g., gasoline) tend to be removed by evaporation during aeration processes (i.e., air injection, air extraction, or pile turning) and, to a lesser extent, degraded by microbial respiration. Depending upon your state's regulations for air emissions of volatile organic compounds (VOCs), you may need to control the VOC emissions. Control involves capturing the vapors before they are emitted to the atmosphere, passing them through an appropriate treatment process, and then venting them to the atmosphere. The mid-range hydrocarbon products (e.g., diesel fuel, kerosene) contain lower percentages of lighter (more volatile) constituents than does gasoline. Biodegradation of these petroleum products is more significant than evaporation. Heavier (non-volatile) petroleum products (e.g., heating oil, lubricating oils) do not evaporate during biopile aeration; the dominant mechanism that breaks down these petroleum products is biodegradation. However, higher molecular weight petroleum constituents such as those found in heating and lubricating oils, and, to a lesser extent, in diesel fuel and kerosene, require a longer period of time to degrade than do the constituents in gasoline. A summary of the advantages and disadvantages of biopiles is shown in Exhibit 2.

Exhibit 1
Typical Biopile System

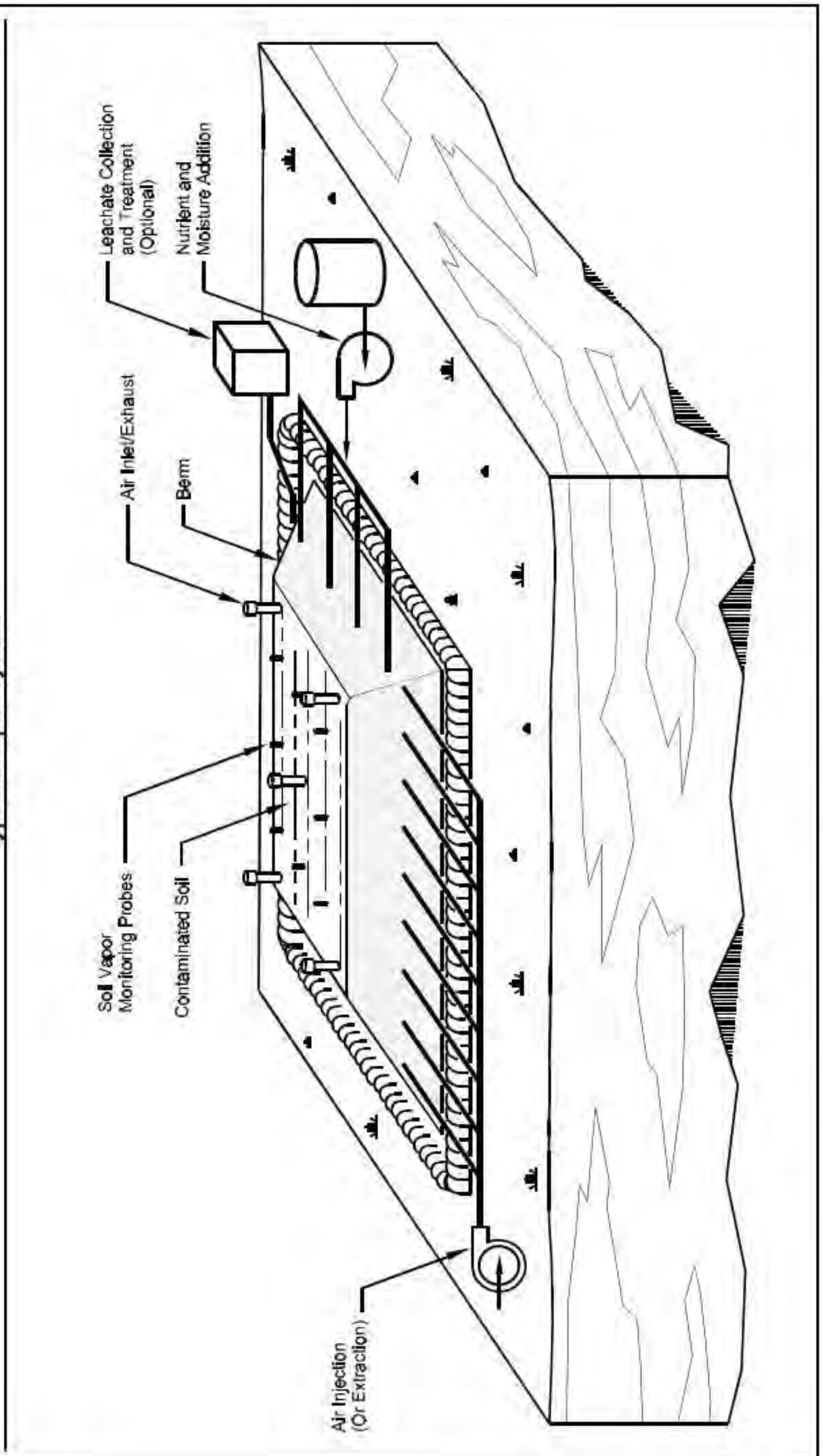


Exhibit 2
Advantages And Disadvantages Of Biopiles

Advantages

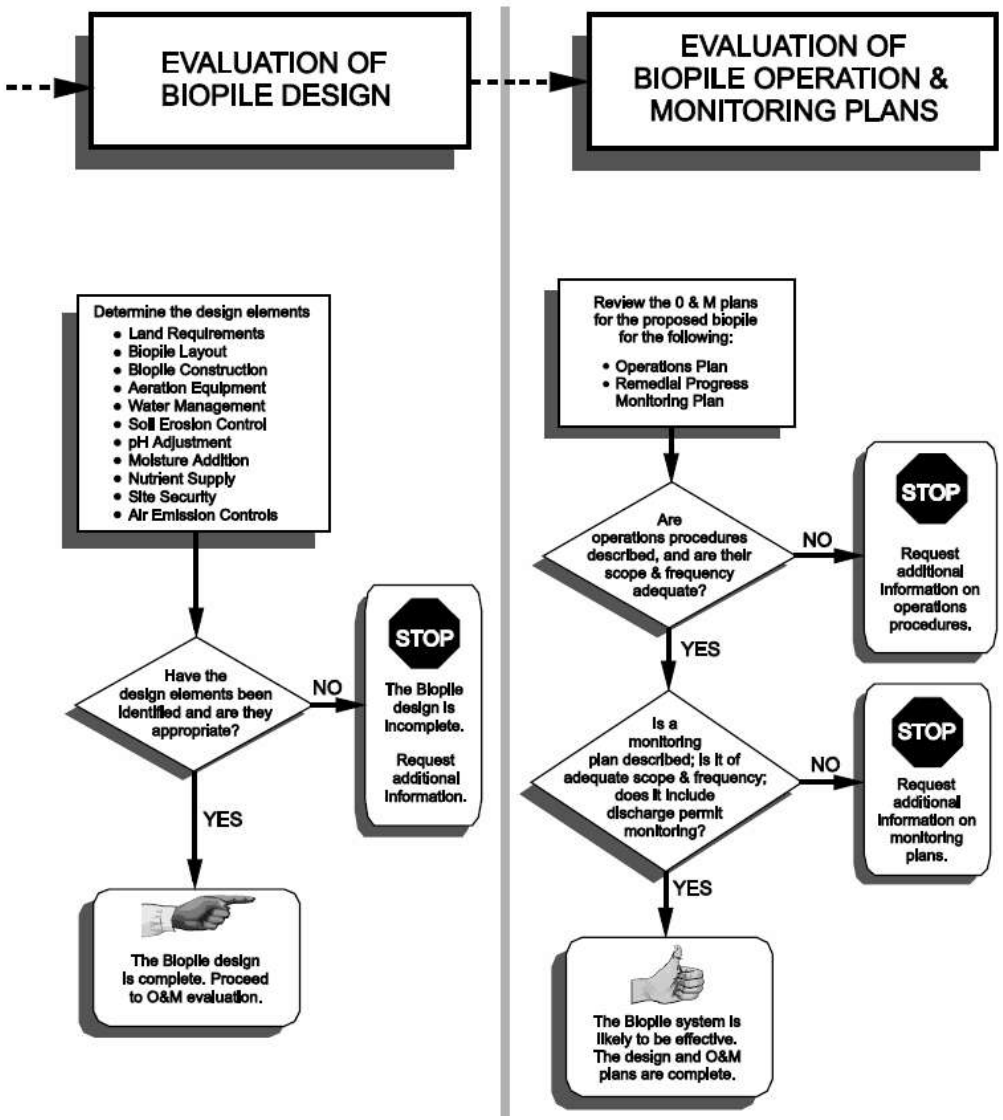
- Relatively simple to design and implement.
- Short treatment times: usually 6 months to 2 years under optimal conditions.
- Cost competitive: $30-90/ton of contaminated soil.
- Effective on organic constituents with slow biodegradation rates.
- Requires less land area than landfarms.
- Can be designed to be a closed system; vapor emissions can be controlled.
- Can be engineered to be potentially effective for any combination of site conditions and petroleum products.

Disadvantages

- Concentration reductions > 95% and constituent concentrations < 0.1 ppm are very difficult to achieve.
- May not be effective for high constituent concentrations (> 50,000 ppm total petroleum hydrocarbons).
- Presence of significant heavy metal concentrations (> 2,500 ppm) may inhibit microbial growth.
- Volatile constituents tend to evaporate rather than biodegrade during treatment.
- Requires a large land area for treatment, although less than landfarming.
- Vapor generation during aeration may require treatment prior to discharge.
- May require bottom liner if leaching from the biopile is a concern.

This course will assist you in evaluating a corrective action plan (CAP) that proposes biopiles as a remedy for petroleum-contaminated soil. The evaluation guidance is presented in the three steps described below. The evaluation process, summarized in a flow diagram shown in Exhibit 3, will serve as a roadmap for the decisions you will make during your evaluation. A checklist has been provided at the end of this course for you to use as a tool for evaluating the completeness of the CAP and for focusing on areas where additional information may be needed. Because a biopile system can be engineered to be potentially effective for any combination of site conditions and petroleum products, the evaluation process for this technology does not include initial screening. The evaluation process can be divided into the following steps.

- Step 1: An evaluation of biopile effectiveness, in which you can identify the soil, constituent, and climatic factors that contribute to the effectiveness of biopiles and compare them to acceptable operating ranges. To complete the evaluation, you will need to compare these properties to ranges in which biopiles are effective.



- Step 2: An evaluation of the biopile system design will allow you to determine if the rationale for the design has been appropriately defined, whether the necessary design components have been specified, and whether the construction designs are consistent with standard practice.

- Step 3: An evaluation of the operation and monitoring plans, which are critical to the effectiveness of biopiles, will allow you to determine whether start-up and long-term system operation and monitoring plans are of sufficient scope.

Evaluation of Biopile Effectiveness

The effectiveness of a biopile system ... which are listed in Exhibit 4. The parameters ar... s, constituent characteristics, and climatic condi...

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

Close this window and click "Add to cart" on the product page.

Exhibit 4
Parameters Used ...

Soil Charact...	Climatic Conditions
Microbial population	...nbient temperature
Soil pH	...infall
Moisture content	...nd
Soil temperature	
Nutrient concentration	
Soil texture	

The following paragrap... include: why it is important; how it can be determin... is. During your evaluation, remember that because a biopile is ... treatment technique, most parameters (except climatic conditions) can be controlled during the design and operation of the biopile. Therefore, during your evaluation, identify those parameters that fall outside the effective ranges provided and verify that the system design and proposed operating specifications compensate for any site conditions that are less than optimal.