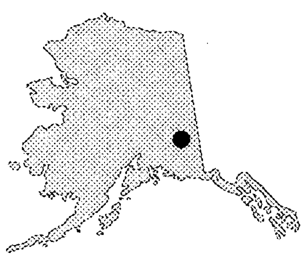
United States Environmental Protection Agency | Office of Research and Development Washington, DC 20460 | Office of Solid Waste and Emergency Response Washington, DC 20460

EPA/540/F-95/506B | September 1995

Bioremediation Field Initiative Site Profile:

Eielson Air Force Base Superfund Site

SITE FACTS



Location: Fairbanks, Alaska

Laboratories/Agencies: U.S. Air Force, U.S. EPA National Risk Management Research Laboratory (NRMRL), U.S. EPA Region 10

Media and Contaminants: JP-4 jet fuel in shallow unsaturated soil

Treatment: Bioventing with active and passive soil warming

Date of Initiative Selection: Spring 1991

Objective: To examine the use of soil-warming technologies to enhance the effectiveness of bioventing jet fuel-contaminated soil in a cold climate

Bioremediation Field Initiative Contact: Gregory Sayles, U.S. EPA NRMRL, 26 West Martin Luther King Drive, Cincinnati, OH 45268

Regional Contact: Mary Jane Nearman, U.S. EPA Region 10, 1200 Sixth Avenue, Seattle, WA 98101

Background

Eielson Air Force Base (AFB) in Fairbanks, Alaska, is one of about 4,300 Air Force sites contaminated with petroleum hydrocarbons in soil. In 1988, the U.S. Air Force initiated a study at Hill AFB to examine the potential of bioventing to remediate JP-4 jet fuel-contaminated soils. Promising results prompted a joint U.S. EPA and Air Force study at Hill AFB (see separate fact sheet, EPA/540/F-95/506C)) as well as Air Force studies at more than 125 sites across the United States. Based on early successes at warm-weather sites, the Air Force and the U.S. EPA National Risk Management Research Laboratory (NRMRL) became interested in using bioventing in cold climates. Because microbial degradation occurs slowly at low temperatures, they decided to study soil warming to enhance the effectiveness of bioventing at a cold-weather site—Eielson AFB.

Characterization

Prior to bioventing, the soil at the Eielson site consisted of sand and silt contaminated with JP-4 jet fuel from a depth of roughly 2 ft to the water table at 6 to 7 ft. Total petroleum hydrocarbon (TPH) levels ranged from 100 to 3,000 mg/kg. Although the site is not in the permafrost region, soil temperatures in winter drop to nearly 0°C. Researchers hypothesized that using soil warming to promote high-rate, year-round bioremediation at this site would cost less overall than sustaining low-rate bioremediation at ambient temperatures for an extended period.

Field Evaluation

In summer 1991, the Air Force and NRMRL began operating a bioventing system at Eielson, using a blower to inject air into the contaminated soil at a rate of 25 ft^3/min. To evaluate bioventing with and without soil warming, they constructed four 50-ft square test plots in the contaminated area (see Figure 1):

Warm water test plot. Ground water was pumped through an electric heater, heated to about 35°C, then pumped through soaker hoses buried 2 ft underground at a rate of 1 gpm. Insulation was placed over the ground to retain heat.

Heat tape test plot. Strips of heat tape were buried at a depth of 3 ft to warm the soil directly. The total heating rate was about 1 watt per square foot. Insulation was placed over the ground to retain heat.

Solar test plot. Insulation was placed over the ground during the winter months, then replaced with plastic mulch sheeting during the spring and summer months to capture solar heat and passively warm the soil.

Control test plot. The control test plot received no soil warming.

All four test plots contained air injection/extraction wells (distributed at 30-ft intervals to provide uniform aeration), thermocouples for monitoring soil temperature, and three-level soil gas monitoring points for monitoring oxygen delivery and for sampling soil gas during in situ respiration tests. During quarterly in situ respiration tests, the Air Force and NRMRL shut off air injection for several days and monitored soil gas oxygen and carbon dioxide levels; they used these measurements to calculate

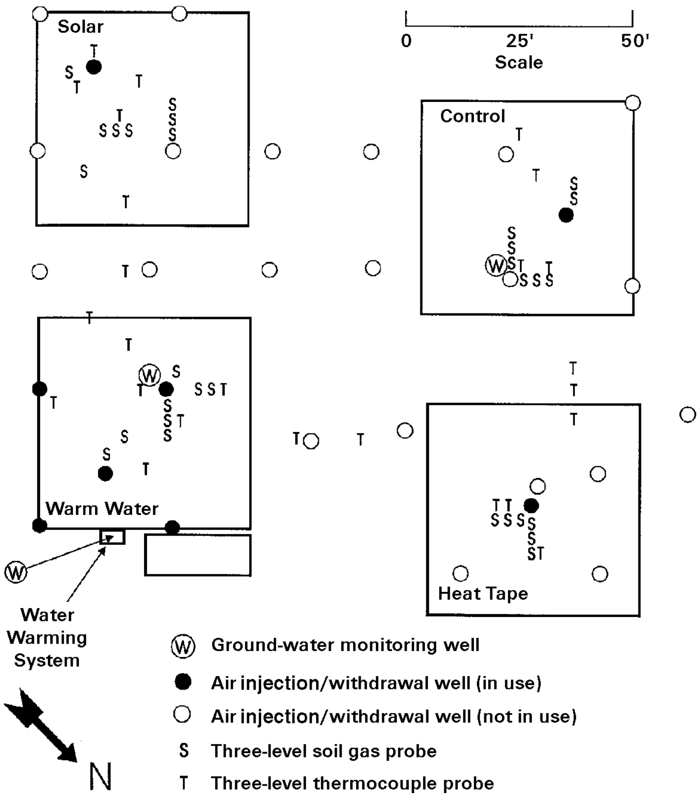


Figure 1. Schematic plan view of warm water, heat tape, solar, and control test plots.

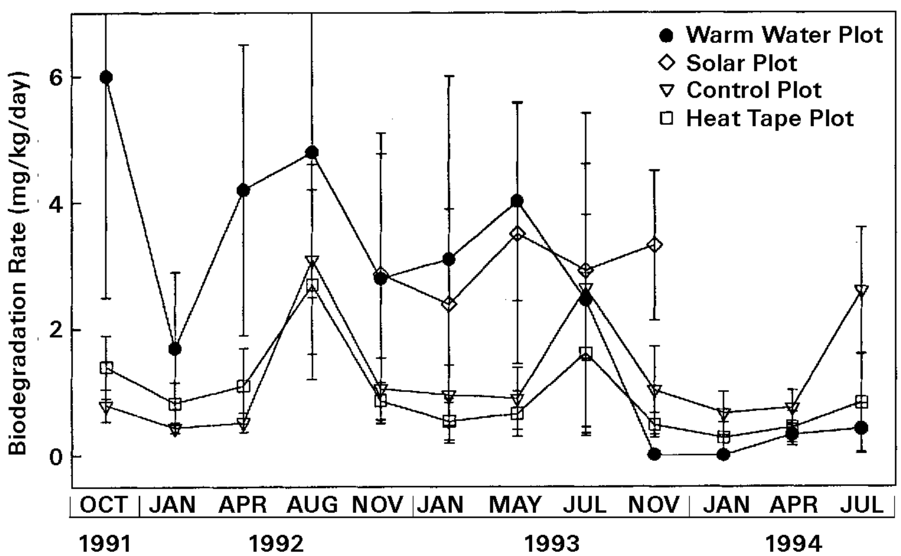


Figure 2. Average rate of biodegradation in warm water, heat tape, solar, and control test plots.

oxygen consumption and carbon dioxide production rates, which they used to estimate biodegradation rates.

With a couple of exceptions, the Air Force and NRMRL operated the bioventing and soil warming systems for 3 years, from summer 1991 to summer 1994. They terminated warm water circulation after 2 years, and they operated the heat tape test plot for 2 years (from summer 1992 to summer 1994).

Status

Since shutting down the bioventing system in summer 1994, the Air Force and NRMRL have been analyzing and publishing the results of their study. All three soil warming methods raised soil temperatures and stimulated biodegradation, but the warm water and heat tape methods resulted in high soil temperatures year-round and biodegradation rates two to three times higher than the rates found in the unheated control (see Figure 2). Petroleum hydrocarbon levels dropped dramatically. On average, TPH levels declined by 60 percent, and benzene, toluene, ethylbenzene, and xylene (BTEX) levels fell to nondetect.

Taking into account the time needed to achieve adequate remediation (based on average biodegradation rate), the Air Force and NRMRL determined that bioventing alone and bioventing with any of the three soil warming methods cost about the same—about $25/yd^3$. Thus, the decision to use soil warming can be based on factors other than cost (e.g., the desired timeframe for remediation). If soil warming is used, the researchers concluded that heat tape might be the most efficient of the three soil warming methods evaluated because it enhanced biodegradation without causing the moisture problems associated with warm water circulation.

The Bioremediation Field Initiative was established in 1990 to expand the nation's field experience in bioremediation technologies. The Initiative's objectives are to more fully document the performance of full-scale applications of bioremediation; provide technical assistance to regional and state site managers; and provide information on treatability studies, design, and operation of bioremediation projects. The Initiative has performed or currently is performing field evaluations of bioremediation at eight other hazardous waste sites: Libby Ground Water Superfund site, Libby, MT; Park City Pipeline, Park City, KS; Bendix Corporation / Allied Automotive Superfund site, St. Joseph, MI; West KL Avenue Landfill Superfund site, Kalamazoo, MI; Hill Air Force Base Superfund site, Salt Lake City, UT; Escambia Wood Preserving Site, Brookhaven, MS; Reilly Tar and Chemical Corporation Superfund site, St. Louis Park, MN; and Public Service Company, Denver, CO. To obtain profiles on these additional sites or to be added to the Initiative's mailing list, call 513-569-7562. For further information on the Bioremediation Field Initiative, contact Fran Kremer, Coordinator, Bioremediation Field Initiative, U.S. EPA, Office of Research and Development, 26 West Martin Luther King Drive, Cincinnati, OH 45268; or Michael Forlini, U.S. EPA, Technology Innovation Office, Office of Solid Waste and Emergency Response, 401 M Street, SW., Washington, DC 20460.