Phytoremediation of Soil and Sediment Residues from Composting and Land Treatment Evaluations

U.S. EPA Test and Evaluation Facility Research Project

Project Objectives:

The objectives of this Work Assignment are to:

1. Design and prepare the U.S. EPA Test & Evaluation (T&E) Facility greenhouse to accommodate phytoremediation studies.

2. Develop experimental designs for phytoremediation studies, including selecting suitable plant species for evaluation during the studies.

3. Conduct treatability studies using soil and sediment residues generated from T&E Facility composting and land treatment evaluations.

Environmental Relevance:

Composting and land treatment of contaminated soil and sediments offer a publicly accepted, cost-effective method of environmental remediation. For some recalcitrant chemicals, composting and land treatment may require long time periods (years) to reach endpoints deemed protective of health and environment. After about 2 years, degradation of easily metabolized contaminants has run its course and further treatment may produce limited results. At this time, the compost pile or land treatment residues may be spread over land for a final curing stage. During the curing stage, weeds grow in the dispersed mixture since it offers a highly fertile growing environment for plants.

Phytoremediation appears to be a logical extension of composting and land treatment. The dismantled compost pile offers such a rich environment for plant growth that it is difficult to stop natural vegetation from moving in. Since phytoremediation has been demonstrated to offer an effective and inexpensive method of bioremediation, deliberate application of phytoremediation during the curing stage makes sense scientifically and logistically.

Phytoremediation involves the use of vegetation for the treatment of contaminated soil or sediments. It employs plants and their associated rhizospheric (the area immediately surrounding the roots) microorganisms to remove or degrade contaminants located in the contaminated matrix. There are 5 basic mechanisms associated with phytoremediation: phytotransformation, rhizosphere bioremediation (also known as plant-assisted bioremediation), phytostabilization, phytoextraction, and rhizofiltration. These mechanisms are based on the contaminant and plant selected. Treatment systems may use one or a combination of these mechanisms.

Plant species are selected for phytoremediation based on the matrix and contaminant characteristics. Various plants (trees, grasses, legumes, and aquatic plants) have been shown to be able to treat a wide variety of contaminants. These contaminants include polynuclear aromatic hydrocarbons (PAHs), chlorinated hydrocarbons, pesticides, metals, radionuclides, and explosives. Phytoremediation is best applied to sites with shallow contamination that is conducive to a hardy plant life.

Experimental Approach:

The phytoremediation studies are conducted in a 10 ft. by 24 ft. greenhouse, located within the T&E Facility. The greenhouse includes a computerized environmental control system composed of a high-pressure fogging system, exhaust fan, motorized windows, and a heater. A data logging system records the hourly temperature and relative humidity within the greenhouse.

Contaminated soil from the Calhoun Park manufactured gas plant (MGP) Superfund site in Charleston, South Carolina, and contaminated sediment from the New York Bay area were received at the T&E Facility for treatability evaluations. After conducting composting and land treatment treatability studies to reduce PAH concentrations, the treatment residues were ready for use in the phytoremediation evaluations. After conducting a number of germination studies and physical/chemical characterization of the study materials, tall fescue and crested wheatgrass were selected as the two plant species to be evaluated in the phytoremediation study.

Contaminated soil, contaminated sediment, and clean potting soil were placed separately into 15-cm diameter plastic pots. Twenty seeds were planted into each pot. The plants were watered and monitored daily. The date of initial germination and the percent of germination of each species in each matrix were noted at the end of three weeks.

During the sampling events, five replicates of each condition were sacrificially sampled and analyzed for PAHs. Contaminant reduction was evaluated for the different plant species versus control subjects (no plants) and versus different contaminant matrices.

EPA Contacts:

Dr. Carl L. Potter
U.S. Environmental Protection Agency
National Risk Management Research Laboratory
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
Phone: **(513) 569-7231**
Fax: **(513) 569-7105**
E-Mail: **potter.carl@epamail.epa.gov**

IT Contacts:

Donald A. Schupp, P.E.
IT Corporation
11499 Chester Road
Cincinnati, Ohio 45246
Phone: **(513) 569-7059**
Fax: **(513) 569-7707**
E-Mail: **schupp.donald@epamail.epa.gov**

E. Radha Krishnan, P.E.
IT Corporation
11499 Chester Road
Cincinnati, Ohio 45246
Phone: **(513) 569-7063**
Fax: **(513) 569-7707**
E-Mail: **krishnan.radha@epamail.epa.gov**