TechData Sheet
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Advanced Fuel Hydrocarbon Remediation National Test Location

PHYTOREMEDIATION

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Petroleum contamination of soil is a serious problem throughout the United States. Bioremediation of petroleum in soil using soil microorganisms has proven effective; however, the biodegradation rate of more recalcitrant and potentially toxic petroleum contaminants is rapid at first but declines quickly. Vegetation may play an important role in the biodegradation of toxic organic chemicals in soil. The beneficial effects of vegetation on the biodegradation of petroleum contaminants are two-fold: ***organic contaminants*** may be taken up by the plant and metabolized, and/or the ***soil microorganisms*** associated with the plant root system accelerate biodegradation of the absorbed or entrapped contaminants. In the contaminated soil, studies have indicated the roots of perennial grasses may be more effective at stimulating rhizosphere microorganisms. Fibrous roots offer more root surface area for microbial colonization than other rooting systems. Using vegetation on hazardous waste sites is an economic, effective, low maintenance approach to waste remediation and stabilization. Using plants for remediation is especially well suited for soils contaminated by organic chemicals to depths less than 6 feet.

Phytoremediation Demonstration at Port Hueneme

Petroleum contaminated soil located at the Naval Construction Battalion Center (NCBC), Port Hueneme, California will be treated using phytoremediation. The contaminated soil will be thoroughly characterized for chemical properties, physical properties, and initial contaminant concentrations. A variety of plant species, warm and cool season grasses, and legumes (e.g., clovers) suitable to the local area will be used on the study area. Contaminant concentration and soil toxicity will be assessed over time to evaluate the efficiency and applicability of this remediation method.

Advantages of Phytoremediation

Phytoremediation has several advantages over traditional remediation approaches including:

- Minimal site disturbance
- Less expensive
- Reduced volume of waste products

Using plants to remediate soluble organics or heavy metal contaminated soil has become more popular throughout the United States. Field trials indicate that both soil and ground water can be successfully treated using perennial grasses and trees.

Phytoremediation Project

A large containment area (60 feet x 100 feet) was constructed for the phytoremediation plots (see Figure 1). Concrete K-rails and a 30-mil water and petroleum resistant liner was used as a containment cell for the petroleum contaminated soil. The bottom of the containment area was filled with 2 to 4 inches of sand. The sand aids drainage and collection of leachate samples. Twenty-four inches of soil was placed in the contaminant cell. A surface irrigation system was installed to provide water to the plants.

Figure 1. Phytoremediation plots.

Different vegetation regimes will be evaluated for their remediation potential. The study area was divided into 12 distinct plots (three treatments with four replicates) in a randomized design. There are two treatments based on plant species selection. Plant species were chosen based on initial germination studies and consultation with local horticultural experts. One treatment contains a mixture of rapidly growing perennial grasses and a broad leaf clover (see Figure 2). The second vegetated treatment consists of native California grasses. Unvegetated plots will be used as controls.

Figure 2. Grasses and clover used in phytoremediation.

Each treatment will be replicated four times. Fertilizer and irrigation will be used as needed. Samples of soil and leachate will be taken every 3 months. Also, soil solution samplers (vacuum pore water samplers) will be installed in the study area to assess the movement of contaminants by leaching. Soil microbial activity will be assessed by field respiratory measurements, including oxygen and carbon dioxide concentrations, at various depths in the plots. Volatile petroleum emissions from the soil surface will be evaluated using an organic vapor analyzer. This will address air pollution control concerns and support a petroleum removal mass balance analysis.

Improvement in soil, surface water runoff, and ground water health will be measured by the reduction in petrol contamination toxicity in the test soil communities. Four standard environmental toxicity risk assessment tests are being conducted periodically. Toxicity of soil and leachate samples will be evaluated using microorganisms (Microtox method), shrimp, earthworm, and seed germination assays. An increase in the survival rate of a given test would indicate a reduction in contaminant toxicity.

Plant growth assessments will look at the four-way interaction between contaminants, soil, microbial communities, and plant roots. Plant biomass will be assessed at least twice a year and plant tissue will be tested for target contaminants. Above-ground plant biomass will be assessed at least twice a year, and plant tissue will be tested for uptake of contaminants. The analysis will focus on determining the ratio of root biomass per kilogram of soil and root surface area per kilogram of soil. Presumably, increasing root surface area will increase the interaction of roots, hydrocarbon degrading rhizosphere microorganisms, and soil resulting in a better assessment of the impact of plant growth on contaminant dissipation.

In summary, phytoremediation of petroleum contaminated soil involves plant selection, plant population, irrigation, and site monitoring. Results obtained from this field study will contribute to the overall database on phytoremediation and evaluation of acceptable remediation endpoints.

For more information on **phytoremediation**, contact:

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