The Benefit/Cost Analysis was performed in 2003

JTRP / INDOT RESEARCH PROGRAM

Research Pays Off

Bioremediation Treatability Studies— SPR 2008

Leaking underground storage tanks are widespread throughout United States. It is estimated that there are 1.4 million underground gasoline storage tanks in the United States, with as many as 75,000 to 100,000 that may be leaking. In Indiana alone, more that 3,500 of the 15,000 registered underground tank facilities have reported leaks. Conventional remediation methods often involve pump-and-treat schemes for contaminated water, and excavation and burial of contaminated soil in hazardous waste landfills. These methods increase risk of exposure to pollutants for workers and local residents. Furthermore, these methods merely involve the transfer of pollutants from one environmental compartment to another, and are rather costly.

Bioremediation (including landfarming) is another method available for the restoration of contaminated sites. Advantages of bioremediation include competitive cost, pollutant destruction, and minimal environmental disturbance. By biodegrading organic pollutants on site, exposure to pollutants is minimized and costs are reduced. Bioremediation can potentially be an effective, low-cost, and terminal solution for remediation of sites contaminated with organic pollutants. The goal of bioremediation is to accelerate the biodegradation rates of naturally occurring microorganisms that utilize organic pollutants as a food source.

The overall objective of this study was to determine whether bioremediation is a feasible treatment option for contaminated INDOT soils. This has been accomplished by characterizing the type and level of contamination; characterizing the presence of indigenous pollutant degrading microorganisms; and by determining the extent to which oxygen and nutrients are required to promote biodegradation.

Research Findings and Implementation

All INDOT soils studied under this study had three things in common. First, a thriving heterotrophic population existed. Second, bacteria capable of degrading benzoate (a toluene surrogate) were present in all soils. Finally, toluene biodegradation in all soils indicated indigenous populations with the catabolic capabilities to remediate petroleum hydrocarbons. This study provides some evidence that physical, rather than microbial, parameters control biological processes in soil.

Landfarming has been used successfully to treat petroleum contaminated soils and may be applicable to soils with low hydraulic conductivities. Landfarming is a desirable treatment option when in-situ treatment is not possible, for example, when contaminated materials are encountered during construction projects. Several landfarming methods exist, however, each method avoids the use of landfills for soil disposal. Treatment processes range from the use of traditional farm equipment to till and aerate contaminated soil to constructed biotreatment reactors. Composting is one of the most economical and effective landfarming methods used for treating petroleum contaminated soils.

Based on the above findings, the study recommends that steps be taken to increase utilization of bioremediation for the remediation of petroleum contaminated soils and groundwater. Contractors implementing bioremediation must be certain that their design is justified by sound science and engineering principles. However, there are no currently existing “design codes” or “standard practices” for the design, implementation or monitoring of bioremediation projects. Development of “standard practices” for bioremediation will reduce uncertainties when dealing with contractors and setting performance criteria and were developed in this project. Developing techniques for expanding bioremediation application to low permeability soils will result in additional cost savings for INDOT site remediation.

Potential Benefits

A total of 20 projects were considered to evaluate benefits of this study. A comparison of cost was made with the conventional landfill method. The cost for landfill is ranging from $30,000 to 50,000. An average cost of $40,000 was used for the evaluation. It is estimated that 90% of the cost for the conventional method of landfill is for digging and haulage of material. The estimated cost for landfarming is $15/cubic meter. Therefore, a similar cost estimation for the bioremediation (landfarming) method revealed a cost of $12,213 on the analyzed projects. This results in a savings of $27,787 per project when subtracted from the $40,000 average cost of landfill method.

Cost of Research $100,488

Estimated Economic Value of the Study

Number of Sites [1]	Savings Per Site [2]	Total Savings [3] = [1] x [2]	Benefit/Cost Ratio [4] = [3] / $100,488
20	$27,787*	$555,740	5.53

[*] = $40,000 conventional method cost - $12,213 landfarming method cost

Assumptions

- That INDOT will use this method on 20 sites identified by the Environmental, Planning, and Engineering Division as a result of the study.
- That the average cost of landfill (dig and haul) method is $ 40,000. Ben Lawrence of Environment, Planning, and Engineering Division supplied this information.
- Professor L. Nies provided cost information on Land Farming.

References

- Nies, L.,"Field Implementation of Bioremediation at Indiana Department of Transportation Facilities" Joint Transportation Research Project FHWA/IN/ JTRP-99/13 Final Report, August 2000.
- Nies, L. and Mesarch, M.,"Bioremediation Treatability Studies for Soils Containing Herbicides, Chemicals, and Petroleum Products" Joint Transportation Research Project FHWA/IN/ JHRP-95/13 Final Report, September 16, 1996.