DEPARTMENT OF AGRICULTURE

http://www.mda.state.mn.us/pesticide-fertilizer/spills-cleanup

Bioremediation Treatability Study Fact Sheet

Guidance Document 17

Bioremediation is defined as the use of microorganisms to remove or reduce contaminants in order to effectively remediate a contaminated site. Some requirements for effective bioremediation are: contaminant degrading microorganisms, moisture, nutrients, and appropriate pH. There are two types of bioremediation: in-situ (in place treatment of contaminants) and ex-situ (removal and treatment of contaminated soil and/or water). Hydraulic injection and oxygen controlling systems are often used in in-situ bioremediation. Some methods used in ex-situ bioremediation include: activated sludge processes, fixed film processes, stabilization ponds, land farming, and composting.

Before bioremediation can be used on an agricultural chemical site, a treatability study must be performed. Exceptions to this treatability requirement can be made for proposals that include a list of references which demonstrate the effectiveness of bioremediation of the same contaminants with comparable concentrations and conditions. The purpose of the treatability study is to evaluate the effectiveness of the bioremediation proposal to remove or reduce contaminants at a particular site. Each proposal must carefully define the treatability study goals, experimental design, sampling and analysis plan, and data interpretation standards. The following general procedures apply to the design and application of a bioremediation treatability study. The final requirements for each treatability study will be site specific.

The Goals of the treatability study are to determine:

1. if biodegradation is occurring, and that reductions in contaminant concentrations are not due solely to volatilization, adsorption, photo degradation and/or leaching of contaminants from the soil;
2. the effectiveness of the bioremediation design to significantly reduce contaminant concentrations during a six to eight-week study, as compared to a control;
3. design information required for the next level of remedy screening should the treatability study be successful; and
4. if the bioremediation design will meet site cleanup goals in a timely and cost-effective manner when compared to other options.

Treatability Study Proposal

The experimental design section of the treatability study proposal should:

- include information or propose appropriate testing of any required nutrient sources, solutions or additives to prove that they do not contain hazardous substances, pollutants or contaminants within the meaning of Minnesota Statutes §115B.02, Subds. 8 and 9;
- be contained and treated in such a way as to prevent the migration of contaminants. If leachate is generated, the study must provide for the proper collection, testing and treatment of leachate.
- comply with appropriate federal, state and local regulations; and
- provide for accurate and detailed monitoring and record keeping of the experiment including experiment conditions, dates and volumes of added bioremediation solutions (solutions containing biological organisms) and moisture, as well as mixing and sampling activities.

The sampling and analysis section of the treatability study proposal should:

- provide for the collection of an adequate number of samples to provide a statistically valid analysis for the volume of soil to be treated;
- describe composite sampling procedures;
- analyze a matrix spike in approximately 10 percent of the samples; and
- analyze for all detected contaminants and, where appropriate, their breakdown products.

Experimental Design

The following design may not be appropriate for all bioremediation treatability studies. Bioremediation treatability studies should be site specific.

1. Collect a representative sample of the contaminated soil to be used in the study and separate it from the rest of the contaminated soil.
2. Mix this soil thoroughly and divide it into three equal portions (Fig. 1). The soil may need to be sieved or crushed to homogenize it. Two of the soil subportions will be treated as controls in the study.

    a. The first control should consist of microbially inhibited soil + any moisture used in the study.

    This control will measure the impact of non-biological degradation processes. Microbial inhibition should follow established procedures and have minimal impact on the soil structure and contaminants (for methods see Chapter 3, Methods of Soil Analysis Part 2-Microbiological and Biochemical Properties, Soil Science Society of America, 1994).

    b. The second control should consist of soil + any moisture or nutrients used in the study.

    c. The third soil portion should consist of soil + any moisture or nutrients used in the study + bioremediation solutions (such as added microorganisms).

3. Each of the three soil portions should be divided into three subsamples for a total of nine soil portions. Three will form the first control, three will form the second control and three will be treated with moisture, nutrients and the bioremediation solutions.

4. Soil sampling should be initiated on day 0. Sampling should continue with one sampling event per week or five sampling events, whichever is more. Sampling intervals which will demonstrate a statistically valid trend in contaminant concentrations over time should be selected for the study. Composite soil sampling should be completed in each of the nine soil portions and a total of nine soil samples should be analyzed during each sampling event (see Figure 1 for example).

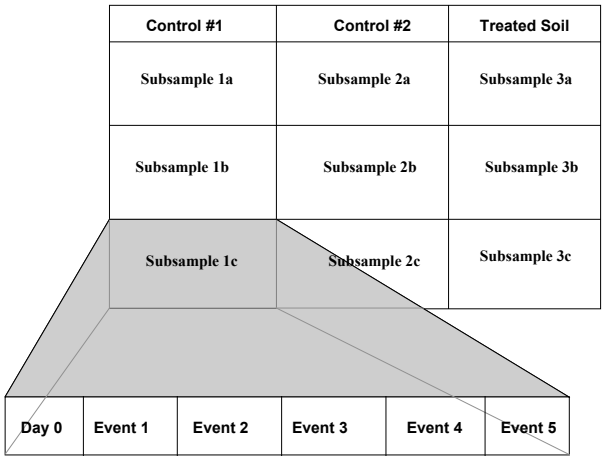

Figure 1

Data Interpretation

Data interpretation should:

- calculate the arithmetic mean contaminant concentration(s) in soil in both controls and treated groups at each sampling event, and
- use analysis of variance methods at the 80 percent confidence level to compare the control and treated mean values at each sampling interval to determine if there is a statistically significant difference between the treated and untreated soil mean concentrations.

If the treatability test is successful, the design should be evaluated, and necessary alterations should be made to bring the design up to pilot or full-scale remediation, if appropriate. The pilot or full-scale design should follow procedures for a corrective action plan

described in the Minnesota Department of Agriculture (MDA) guidance document GD10 Agricultural Chemical Incident Remedial Investigation Report and Corrective Action Plan. In addition, the full-scale costs of the bioremediation method should be compared to other remediation options to determine feasibility for field application.