Lessons Learned over 20 Years of Designing and Implementing Enhanced In Situ Bioremediation Remedies

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Background/Objectives. Over the last 20 years, enhanced in situ bioremediation (EISB) has become a mainstream remediation technology for treating chlorinated solvents in soil, bedrock, and groundwater. This is largely due to its efficacy at treating many chlorinated compounds over a wide range of concentrations and soil types in a highly sustainable and cost-effective manner. Although EISB is now widely applied by most consultants, there remain a number of common pitfalls that beset many projects that are largely avoidable at this point in time.

Approach/Activities. This presentation will draw on the author's experience in designing and implementing more than a dozen pilot and full-scale EISB systems to highlight a number of valuable lessons learned over that period. Some of the lessons learned and best practices summarized in this presentation were developed through participation in the Remedial Technology Development Forum (RTDF) Bioremediation group, which was active from 1995-2010. Others were derived from personal experience in the laboratory and in the field. Although the direct application of this talk will be EISB remedies, the presentation will stress the importance of employing a systematic and disciplined approach that is applicable to all remediation designs, with emphasis on developing the most efficient and cost-effective remedial solutions.

Results/Lessons Learned. Topics discussed will include the value of performing economic analyses prior to remedial design, the value (and tradeoffs) of site characterization in support of remedial design, the value and purpose of laboratory treatability studies and field pilot programs, the placement of amendments in low permeability soils, perspectives on amendment loading, and compatibility of EISB with other remedies. A key question that every client should be able to ask of its consultant from the onset of the design process is "How much will this remedy cost?" It is critical for consultants to do their homework up front and have a ready answer to this question. This may establish the need for additional site characterization to refine the design and reduce uncertainty around the full-scale cost, although this information comes with a price tag related to the characterization program. If an EISB remedy is chosen, laboratory treatability studies are usually the best way to confirm the biology will work as anticipated, while field pilot studies should focus primarily on amendment distribution. Although low permeability soils are not typically amenable for injection of soluble electron donors, emplacement of solid donors is possible and can be highly effective. In this case it is critical to be able to measure the distribution of the amendment in the subsurface. There is a good deal of discussion today related to amendment loading as it affects secondary groundwater impacts, particularly methane generation. However, concern over secondary impacts must be balanced against inherent uncertainties in the injection process to avoid underperformance of the remedy. Finally, treatment train remedial approaches have become more popular in recent years. EISB is often employed as part of this treatment train, sometimes after some other treatment step. While microbial communities in the subsurface are remarkably robust and will survive many treatments, chemical residuals left behind in the soil are more problematic and can negatively impact the subsequent EISB process for years.