Remediation of DNAPL-Impacted Sites Using Enhanced In Situ Bioremediation: Experience-Based Remediation Using Virtual Data Set

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Background/Objectives. The development of a conceptual site model (CSM) is an essential step in the selection, design and optimization of a remediation approach. Following CSM development, remediation approaches are typically evaluated on the basis of overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction of toxicity, mobility or volume, short-term effectiveness, implementability and cost. However, for remediation efforts directed at dense, non-aqueous phase liquid (DNAPL) source zones, one prerequisite for success is accurate delineation of the spatial extent of DNAPL in three dimensions. Regardless of how well the remediation effort is designed and implemented, failure is likely to result if the three-dimensional extent of DNAPL has not been accurately delineated.

Approach/Activities. The SERDP DIVER (Data Information Value to Evaluate Remediation) project has developed three virtual data sets (VSDs), which represent hypothetical DNAPL-impacted sites of varying complexity. Virtual site conditions were established using high-resolution numerical simulation of trichloroethylene (TCE) DNAPL migration in heterogeneous porous media and associated dissolution to generate dissolved phase VOC plumes. Four decision maker (DM) teams, made up of senior practitioners in the consulting industry, were provided with Phase I reports containing detailed site history and the results of preliminary site investigation. Each team then conducted a virtual investigation of each of the three VSDs, using post-processing algorithms designed to simulate a variety of investigation tools. Based on their developed CSMs, each DM team submitted an enhanced in-situ biodegradation (EISB) design that was implemented using the numerical model DNAPL3D-RX. Elements of the designs that were implemented included injection well location, frequency of lactate injection, lactate concentration and injection rate. Remediation goals provided to the DM teams included a specified percentage of DNAPL mass reduction, total VOC mass discharge reduction and TCE concentration reduction.

Results/Lessons Learned. The biodegradation reaction mechanisms and kinetics simulated by DNAPL3D-RX were identical for all VSDs and for all DM teams. Therefore, the ability of the various DM teams to achieve the required remediation goals was dependent only on their submitted EISB designs, which were based on their submitted CSMs. Details will be provided regarding the ability of the DM teams to achieve the remediation goals, and the degree to which the achievement of these goals was dependent on the accuracy of their CSMs and elements of their EISB remediation designs.