Impacts of DNAPL Source Zone Treatment: Experimental and Modeling Assessment of Benefits of Partial Source Removal

Background:

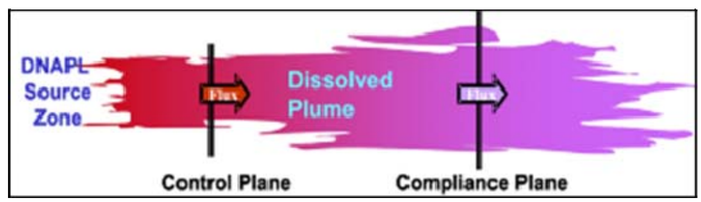
At the nearly 17,000 sites on Department of Defense installations potentially requiring environmental cleanup, there is a need for innovative source-zone treatment technologies that offer cost-effective risk reduction. Unfortunately, there is currently no consensus in the academic, technical and regulatory communities on the ecological or environmental impacts of dense non-aqueous phase liquid (DNAPL) source-zone treatment. The cost of source-zone treatment is high, and the anticipated benefits need to be understood before significant resources are committed to source-zone removal. Since it is not economically practical to remove all DNAPL mass from most source zones, the focus of this project is on the likely benefits from partial DNAPL mass removal using some aggressive in-situ technology (e.g., alcohol or surfactant flushing; steam flooding; air sparging; chemical oxidation).

Objective:

The primary objective of this project is to develop a scientifically defensible approach for assessing the long-term environmental impacts (i.e., benefits) of DNAPL removal from source zones. The fundamental premise is that contaminant flux from the source should be used as the basis for evaluating the effectiveness of remediation.

Process/Technology Description:

An integrated approach, comprised of laboratory experiments, field observations and numerical simulations, will be used. To evaluate the functional relationships between DNAPL mass reduction, contaminant mass flux and plume behavior, data from selected DNAPL source-zone remediation field tests will be used to demonstrate the ability of selected numerical simulators to realistically forecast the performance of remedial activities. Codes such as T2VOC and UTCHEM will be used to simulate remediation processes during steam, surfactant, or cosolvent flooding and to predict the temporal and spatial distribution of contaminant flux leaving the source zone. Laboratory studies will be conducted to supplement existing field data and to further assess the relationship between mass removal and resultant contaminant flux for a broad range of hydrogeological conditions. Contaminant flux distributions will be used as input to dissolved-plume models to forecast the natural or enhanced attenuation expected within the plume. Plume transport simulations will be carried out using codes that simulate aqueous-phase transport explicitly coupled with important geochemical and biological reactions. Currently, there is no numerical code that is capable of modeling fully coupled enhanced DNAPL remediation by thermal and chemical flooding methods with biogeochemical reactions that occur in dissolved aqueous phase DNAPL components. Coupling these two types of modeling approaches at the DNAPL source-zone/ dissolved-plume interface is a new approach that is computationally efficientbras and that incorporates the dominant physical, chemical and biological features in each region.



Hypothetical DNAPL Source and Dissolved Plume.

Expected Benefits:

This project will develop sufficient understanding of the linkage between source-zone remediation and its impacts on dissolved plume behavior to permit optimization of the remedial process by balancing mass removal with plume attenuation. The experimental data and modeling analyses will provide a basis for developing appropriate flux-based remediation endpoints at DNAPL sites and will help in the design of cost-effective remediation technologies. Thus, project results will facilitate more comprehensive risk assessments and provide a scientific basis for developing regulatory and policy guidelines for DNAPL source-zone remediation. (Anticipated Project Completion – 2008)

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