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Simultaneous optimization of dense non-aqueous phase liquid (DNAPL) source and contaminant plume remediation

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Abstract

A framework is developed for simultaneous, optimal design of groundwater contaminant source removal and plume remediation strategies. The framework allows for varying degrees of effort and cost to be dedicated to source removal versus plume remediation. We have accounted for the presence of physical heterogeneity in the DNAPL source, since source heterogeneity controls mass release into the plume and the efficiency of source removal efforts. We considered high and low estimates of capital and operating costs for chemical flushing removal of the source, since these are expected to vary form site to site. Using the lower chemical flushing cost estimates, it is found that the optimal allocation of funds to source removal or plume remediation is sensitive to the degree of heterogeneity in the source. When the time elapsed between the source release and the implementation of remediation was varied, it was found that, except for the longest elapsed time (50,000 days), a combination of partial source removal and plume remediation was most efficient. When first-order, dissolved contaminant degradation was allowed, source removal was found to be unnecessary for the cases where the degradation rate exceeded intermediate values of the first-order rate constant. Finally, it was found that source removal became more necessary as the degree of aquifer heterogeneity increased.

Keywords: Optimization; DNAPL; Remediation; Transport

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