A Comparison of Substrate Delivery Methods for Accelerated Anaerobic Biodegradation of Chlorinated Solvents at Dover AFB, DE

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Several large chlorinated solvent plumes are present in the shallow water table aquifer at Dover Air Force Base (DAFB). As part of the overall Base remediation strategy, a number of solvent source areas and downgradient plumes are undergoing active treatment using accelerated anaerobic biodegradation (AAB) technology. This paper compares the effectiveness and efficiency of the various methods employed to distribute the substrates used to stimulate AAB.

Stimulation of microbial reductive dechlorination of solvents using carbon substrates (such as sodium lactate and emulsified vegetable oil [EVO], both of which are used at DAFB) is well documented. However, delivery of the substrates is dependent upon multiple, site-specific variables such as hydrogeologic characteristics, the size of the area to be treated, and site access.

Various delivery methods have been used to distribute substrates at DAFB:

1. direct push injection points
2. alternating injection/extraction wells ("push-pull") along transects that are perpendicular to the flow of groundwater
3. injection wells along transects
4. continuous recirculation from injection wells installed upgradient of extraction wells

Method 1 is a technique commonly used in small, discreet source areas. Each injection point has small radius of influence, thus many points are typically necessary to treat a small area. This is infeasible for many larger sites. Method 2 is an innovative approach for injecting substrates over relatively large areas. Groundwater is extracted, amended, and then reinjected via alternating extraction and injection wells forming small, cross-gradient recirculation cells to distribute the substrate. This technique has been applied to address large downgradient plumes where there are infrastructure constraints and relatively good hydraulic conductivity. Method 3 is a modification of the Method 2 design and typically used when injection rates are lower and limit the effectiveness of the push-pull effect. Method 4 creates a large-scale recirculation cell and is typically applied at source areas that are under buildings and inaccessible by other remedial technologies.

This paper explains the rationale for selecting substrate delivery methods for several sites at DAFB and evaluates the subsequent site monitoring data, including total organic carbon (TOC) levels and other aquifer geochemical parameters, to understand how to most efficiently and effectively implement AAB.