REDUCTIVE DECHLORINATION OF SOLVENTS IN GROUNDWATER USING CONTROLLED RELEASE CARBON WITH ZVI

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ABSTRACT:

Adventus Remediation Technologies Inc. (Adventus) has developed a combination of controlled-release solid carbon and zero valent iron (ZVI) particles to yield a highly effective material for stimulating the reductive dechlorination of otherwise persistent organic solvents present in groundwater. The materials are known as EHC™ and can be employed as fill material for permeable reactive barriers or injected into groundwater and contaminant source zones in a variety of ways. Following placement of EHC into the subsurface environment, indigenous heterotrophic bacteria consume the organic component of EHC (processed fibrous organic material) and consume dissolved oxygen thereby reducing the redox potential in groundwater. In addition, these bacteria ferment carbon and release a variety of volatile fatty acids (acetic, propionic, butyric) into the groundwater plume which serve as electron donors for other bacteria, including dehalogenators and halorespiring species. Finally, the small ZVI particles (i.e., between 10 and 100 μm) provide substantial reactive surface area that stimulates direct chemical dechlorination and an additional drop in the redox potential of the groundwater. These physical, chemical, and biological processes combine to create a strongly reducing (e.g., -600 mV Eh) environment that stimulates both chemical and microbiological dechlorination of solvents in groundwater.

Groundwater beneath an active grain storage facility in south central Kansas is impacted by carbon tetrachloride (CT) which was used as a silo fumigant. Chloroform (CF) - a recognized anaerobic biodegradation product of CT - is also present. There is limited evidence for the presence of other CT catabolites such as dichloromethane (DCM) or chloromethane (CM). Significant soil impacts were not observed for any constituent. Remedial engineering and design efforts considered the use of ZVI or EHC™ to support in situ source management (ISSM) and enhanced passive remediation (EPR) for treatment of the groundwater plume. Two conceptualized groundwater remedies (i.e., PRB and source area treatment) using ZVI or EHC were subsequently compared for full-scale field demonstration of their ability to effectively manage a plume of CT and related compounds. Cost factors for EHC, applied at dosages shown to be effective and long lasting, are substantially (i.e., 50%) lower than materials currently being employed for enhancement of in situ reductive dechlorination of solvents. A ZVI PRB (100% iron with dimensions 61 m long x 10 cm wide x 3 m deep) represents a cost-effective approach for managing the VOC plume, if natural attenuation processes are allowed to manage the lowered concentration of CT metabolites. The use of EHC at 2% mass seems more appropriate for source area treatment to affect source removal/flux reduction and accelerate site remediation and closure. Full-scale implementation of the combined approaches is scheduled for spring of 2004.