





# Evaluation of the Role of *Dehalococcoides* Organisms in the Natural Attenuation of Chlorinated Ethylenes in Ground Water

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## Notice

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## Foreword

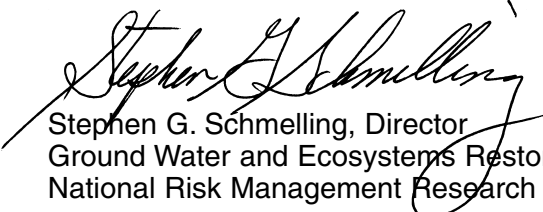
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Chlorinated solvents such as tetrachloroethylene and trichloroethylene are an important category of contaminants in ground water at hazardous waste sites. Frequently, these compounds are subject to natural anaerobic biodegradation in ground water. During anaerobic biodegradation they undergo a sequential biological reductive dechlorination to produce *cis*-dichloroethylene, then vinyl chloride, and finally ethylene or ethane. Although *cis*-dichloroethylene is less hazardous than trichloroethylene or tetrachloroethylene, vinyl chloride is more hazardous. In contrast, ethylene or ethane is not hazardous to humans. If the biological reductive dechlorination is complete, with ethylene or ethane as the final product, then monitored natural attenuation can be used a remedy for the ground water contamination.

In recent years, bacteria that can dechlorinate dichloroethylene to ethylene or ethane have been isolated and characterized. All the strains that can dechlorinate vinyl chloride to ethylene or ethane belong to the genus *Dehalococcoides*. A biochemical assay for DNA specific to the genus *Dehalococcoides* is commercially available. This report provides technical recommendations on the interpretation of the biochemical assay and on the contribution of bacteria in the *Dehalococcoides* group to monitored natural attenuation of chlorinated solvents in ground water.



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## Abstract

At most hazardous waste sites where monitored natural attenuation (MNA) of chlorinated solvents in ground water is successful as a remedy, the chlorinated solvents are biologically degraded to harmless end products such as ethylene or ethane. Many organisms can degrade chlorinated solvents such as tetrachloroethylene or trichloroethylene, to dichloroethylene and vinyl chloride. This contributes little to risk reduction because vinyl chloride is more toxic and more carcinogenic than tetrachloroethylene or trichloroethylene. The only organisms known to degrade dichloroethylenes and vinyl chloride to ethylene or ethane are members of the *Dehalococcoides* group. As a result, these organisms have a critical role in the evaluation of MNA at chlorinated solvent sites. In recent years, biochemical assays for the presence of DNA from the organisms have become commercially available. These assays are based on the polymerase chain reaction (PCR) for the amplification of DNA extracted from ground water. They are very sensitive and can be very specific.

This report is designed for technical staff in the EPA Regions and in state agencies that require information on the contribution of *Dehalococcoides* bacteria to MNA of chlorinated solvents, and information on the proper application and interpretation of the assays in an evaluation of MNA. This report includes sections on the role of biotransformation in evaluation of MNA of chlorinated solvents, the ecology of microorganisms that transform chlorinated solvents, tools to assay microorganisms that transform chlorinated solvents, the relationship between *Dehalococcoides* DNA in ground water and rates of natural attenuation at field scale, the relationship between geochemical parameters and the occurrence of *Dehalococcoides* DNA in ground water, and the relationship *Dehalococcoides* DNA in ground water and behavior of chlorinated solvents in laboratory treatability studies or microcosm studies done with water from the plume.