Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

A Rigorous Demonstration of Permeability Enhancement Technology for In Situ Remediation at Three Low Permeability Sites

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Background/Objectives. Effective amendment delivery at low-permeability sites remains one of the most challenging obstacles in the remediation industry. Permeability enhancement technology (i.e., environmental fracturing) has been shown capable of improving amendment delivery and treatment effectiveness at many sites where conventional injection techniques are ineffective. However, limited guidance is available for proper design and implementation. ESTCP project ER-201430 was funded to compare commercially available permeability enhancement technologies at three sites with differing lithologies, contaminant profiles, and remedial objectives, and to provide written guidance for future applications. In addition, advanced monitoring techniques pertinent to the permeability enhancement technology were evaluated. This presentation will compare and contrast the results at the three sites, and provide recommendations for application of the various techniques.

Approach/Activities. Three DoD sites with challenging lithologies were selected for demonstration of the permeability enhancement technology. Site contamination had previously been addressed using conventional injection techniques such as in-well or direct-push injection with limited success. A comparison of the hydraulic and pneumatic approach to permeability enhancement technologies was performed at one of the sites with a silty clay and weathered shale lithology, whereas two different hydraulic permeability enhancement techniques were performed at the other two sites with a weathered sandstone/siltstone and glacial till lithology. A variety of advanced monitoring techniques including tiltmeter, electrical resistivity tomography (ERT), and electrical conductivity (EC) logging were performed. In addition, conventional soil and groundwater sampling techniques were performed to aid validation and confirmation of aforementioned monitoring tools.

Results/Lessons Learned. This presentation provides details regarding the application of the permeability enhancement technology at three low-permeability sites. Injected amendments were observed more than 20 ft from the injection points, while conventional injections in the same media were ineffective for distributing amendments. Groundwater sampling, confirmation soil borings, EC, and ERT results will be presented. For the hydraulic fracturing technique, amendment injections were effectively mapped with tiltmeters, and three-dimensional visualization will be shown. A variety of design considerations, including selection of the proper enhancement technique for different geologic conditions, amendment injection methodology, emplacement volume, and appropriate tools for real-time monitoring will be discussed.