Can Aquifer Quality at Complex Remediation Sites be Restored?

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Background/Objectives. Early in the history of the remediation industry, it was recognized that groundwater restoration at large complex sites was a technically challenging goal. With the discovery of dense non-aqueous phase liquids, this challenge was further underlined. Even with decades of advances in remediation technologies, restoration to a condition allowing for unlimited use and unrestricted exposure remains a significant technical and institutional challenge. Several factors contribute to the remaining challenges, including difficulties in characterizing contaminant distribution in complex hydrogeological settings, remedial technologies that do not meet design and performance criteria, delays between the discovery of the problem and increasingly stringent groundwater compliance concentrations. Despite the emergence of advanced characterization tools and more targeted in situ remediation technologies that are improving our ability to manage groundwater restoration, it is widely recognized that restoration at many complex sites may not be achieved in the next 50 to 100 years (NRC, 2013).

Approach/Activities. In order to protect human health and the environment at many large sites (both operating manufacturing sites and superfund sites) large and costly groundwater containment systems were built to prevent further migration of contaminated groundwater. Containment systems continue to be the preferred remedial technology for large complex contaminated groundwater sites, despite recognition that pump and treat is not a sustainable remedial technology. In the meantime, innovative site characterization methods for locating contaminants in the non-aqueous, aqueous, sorbed phases are being combined with advanced visualization tools to inform the selection and design of remediation technologies. In the early stages following a release remediation may focus on the recovery of free phase DNAPL, whereas at later stages the remediation needs to address less accessible residual DNAPL and dissolved plumes that are present in the transport zones (higher permeability) and storage zones (lower permeability). More surgical and targeted NAPL remediation technologies, including innovative thermal methods, are starting to show promise in removal of NAPL to the extent practical. Dissolved phase that was once considered to be locked up in low permeability strata, due to diffusion process, is now treated using novel delivery of reagent via electrokinetic methods. While these emerging remediation technologies promise significant mass reduction, there are still serious limitations to site closure when the remedial goal is to meet drinking water standard levels in groundwater.

Results/Lessons Learned. Advances in the state of the practice will be discussed in the context of restoration to a condition allowing for unlimited use and unrestricted exposure. The presentation will discuss transactional business drivers for a range of remedial alternatives at a complex site that is characterized by extensive groundwater contamination, heterogeneous contaminant distribution, multiple source zones, complex recalcitrant contaminants, and extended timeframes since releases occurred.