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Laboratory Bench-Scale Testing in Support of Monitored Natural Attenuation

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Background/Objectives. Monitored natural attenuation (MNA) can be an effective and low cost approach for remediation of chlorinated volatile organic compound (cVOCs) and metals. MNA includes physical, chemical and biological processes that reduce contaminant mass or concentration in soil or groundwater. The most common MNA mechanisms at sites contaminated with cVOCs are anaerobic biodegradation and abiotic/chemical reduction, whereas adsorption, precipitation and biodegradation are important processes for the attenuation of metals. Biodegradation involves key bacteria that are capable of degrading cVOCs to non-toxic end products or to create reduced species to precipitate metals as sulfides. Abiotic degradation is mediated by naturally occurring reduced iron and sulfur minerals, and although often unrecognized, is now considered a key process in natural attenuation of cVOCs and metals.

Approach/Activities. In situ remediation approaches are often evaluated with laboratory treatability studies prior to field implementation. These bench-scale tests provide proof of concept information for enhanced remediation approaches and are used to select and optimize amendment strategies. Bench-scale testing for MNA approaches excludes the addition of biostimulation amendments. This testing involves constructing microcosms or columns with site materials and comparing these to sterile controls where biotic activity is inhibited. The sterile controls provide information on the abiotic processes alone, whereas the non-amended systems allow assessment of both abiotic and biotic processes, which often occur at the same time and can be complimentary or synergistic. Several additional analytical parameters can be beneficial in assessing MNA processes including acid digestion, X-ray diffraction (XRD), scanning electron microscopy (SEM) coupled with energy dispersive X-ray (SEM/EDX), sequential extraction procedure, bioavailable iron, acid volatile sulfides and microbial characterization using next generation sequencing (NGS). Isotherm batch tests and evaluation of sorption kinetics including flow-through column break through tests can also be beneficial to evaluate the attenuation capacity of aquifer matrices for dissolved metals attenuation.

Results/Lessons Learned. Bench-scale treatability studies were conducted to evaluate MNA as a remedial option. In one study MNA was compared to the addition of electron donor, sulfate and iron to evaluate biogeochemical transformation processes in the degradation of cVOCs. SEM/EDX was used to identify the formation and proportion of iron sulfides in the different treatments. In another study the analyses listed above were used to elucidate the degradation mechanisms observed where chlorinated ethenes were completely degraded without a corresponding increase in ethene. The detailed parameter testing plan and data will be presented and lessons learned discussed, in the context of USEPA's tiered approach to MNA evaluation for organic and inorganic compounds at field sites. At the time of abstract preparation several other studies are planned and results from these studies will be also presented.