Diversified Horizontal Injection Methods Effectively Deliver Amendments for Large Plume Coverage or Precise Target Areas

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Background/Objectives. This presentation describes three horizontal injection case studies demonstrating how diversified injection strategies customized to individual sites' treatment areas resulted in bioremediation of subsurface impact of petroleum and chlorinated solvents in various geological settings.

Site 1: A major redevelopment project of a brownfield site faced significant environmental challenges due a chlorinated solvent plume which extended over 3 acres. The contamination was due to a former dry-cleaner operating on the property for over 60 years prior.

Site 2: Industrial process wastewater leaking from a drain line at a manufacturing facility contributed to perchlorate concentrations in the groundwater ranging from 10 to 500 mg/L. The contaminate plume migrated down-gradient to a river, threatening surface water quality. An injection barrier was needed to cut off migration and treat the source area.

Site 3: Leaking USTs originally installed in the 1980s resulted in a petroleum plume beneath active an chemical manufacturing facility. Surface obstructions including warehouses, ASTs, loading racks, and high traffic areas prevented vertical injection points. An alternative injection strategy was needed to access the plume.

Approach/Activities.
Site 1: Ten single-entry horizontal injection wells approximately 400 feet in length were installed beneath the future building sites while active redevelopment construction activities were being conducted. The property owner specified a strict completion deadline for the installation horizontal wells. In addition, five horizontal soil vapor extraction wells were installed beneath the former dry-cleaner for vadose remediation for the source area. The horizontal injection system delivered over one million gallons of potassium permanganate solution within a 26-day period for expedited remediation.

Site 2: Pilot testing of vertical injection wells demonstrated success of a soluble carbon source and bio-culture amendment for treating the perchlorate in groundwater. Two horizontal injection wells installed beneath a parking lot and building injected the amendment to facilitate anoxic biodegradation of the perchlorate. The remediation method used gravity feed injection so that a permanent remediation compound and injection pumps were not necessary.

Site 3: Three horizontal injection wells were installed beneath the facility's infrastructure to provide delivery of hydrogen peroxide and ferrous sulphate solution into the petroleum impacted groundwater. The target zones required compound curved bore paths to access the plume.

Results/Lessons Learned.
Site 1: The remediation system and horizontal wells facilitated injection of 1.4 million gallons of KMNO4 over two major injection events to treat the 1,600 feet long plume. TCE concentrations were reduced from 12 mg/L to non-detect. The Maryland Department of the Environment describes the project as a major success through the Land Restoration Program.

Site 2: The horizontal injection achieved 98 percent reduction of perchlorate mass within a 3-year period, with NFA status from the Massachusetts DEP. The site was recognized by Massachusetts DEP with a Greener Cleanup Leadership Award. The horizontal injection strategy saved the responsible party over $5 million and at least five years of additional O&M compared to continuing with pump and treat.

Site 3: Initial injection successfully influenced the groundwater by creating groundwater mounding of 16 inches and temperature increases observed at nearby groundwater monitoring wells. After only six months of operation, an estimated 36% of the mass in the target zone has been remediated.