

## Soil Mixing with Steam and Zero Valent Iron Remediation Performance Monitoring Results at Wilson Corner, Kennedy Space Center, Florida

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The National Aeronautics and Space Administration (NASA), Kennedy Space Center (KSC), Remediation Program implemented a groundwater interim measure between September 2014 and February 2015, to remediate a trichloroethene (TCE) groundwater source area at the Wilson Corners site. The groundwater plume is associated with the release of chlorinated solvents (specifically TCE) from historic precision cleaning and laboratory operations. A summary of the groundwater interim measure using soil mixing with steam and zero valent iron (also referred to as large diameter auger [LDA]) was presented at the 2015 Florida Remediation Conference. The objective of this presentation is to provide performance monitoring results.

The Interim Measure was designed to remediate an area of 0.33 acres from the surface to 58 feet below land surface (ft bgs) where TCE concentrations were greater than 3,000 micrograms per liter ( $\mu\text{g/L}$ ). Within the planned treatment area footprint there was an area of  $\sim 0.028$  acres where historic TCE results were 100,000  $\mu\text{g/L}$  or higher. The maximum TCE concentration observed prior to treatment was 290,000 ( $\mu\text{g/L}$ ). The maximum TCE concentration observed during treatment was 4,582 parts per million vapor from the effluent vapor stream. The objective of the Interim Measure was to reduce TCE concentrations to less than Florida Department of Environmental Protection (FDEP) Natural Attenuation Default Concentrations (NADCs). The Interim Measure met this objective through the treatment of 308 cells for a total treatment volume of 24,535 cubic yards. Real-time adjustments of treatment protocol, enabled by on-site gas chromatographs providing data for TCE, its daughter products and Freon 113, was an important tool in ensuring all targeted source material was treated.

Performance monitoring events occurred nine and 18 months following treatment. To allow flexibility groundwater samples were collected using a direct push technology (DPT) drilling rig. For the first performance monitoring event, a total of 168 groundwater samples were collected from 25 locations, at depths ranging from 7 to 62 ft bgs. During the first event groundwater temperatures ranged from 80 to 118 degrees Fahrenheit ( $^{\circ}\text{F}$ ), with an average temperature of 98.2  $^{\circ}\text{F}$ . Samples with temperatures above 98  $^{\circ}\text{F}$  were cooled prior to analysis by passing the water through a coil of stainless steel tubing immersed in an ice bath before filling the sample container. For the second performance monitoring event, a total of 74 samples were collected from 15 locations.

Eighteen months post-treatment, concentrations of TCE and cis, 1-2, dichloroethene (cDCE) concentrations remain below FDEP NADCs within the treatment area; meeting the Interim Measure objective. Vinyl chloride (VC) concentrations are greater than NADCs in two monitoring wells (maximum 400  $\mu\text{g/L}$ ). These sampling locations are down-gradient of an untreated area, and may be representative of the surrounding groundwater plume infiltrating into the treatment area. Performance monitoring results overall demonstrate a 99.94% reduction of the target volatile organic compounds and 99.99% reduction in TCE mass within the area treated.