# Techniques for Evaluating the In Situ Injection Process

***Theresa Sorrells*** (tree@alpineremediation.com) (Alpine Remediation, Golden, CO)

**Background/Objectives.** A natural gas liquids (NGL) pipeline release resulted in subsurface hydrocarbon contamination in an agricultural field in Kansas. While the majority of the plume consisted of dissolved phase hydrocarbons, phase separated hydrocarbons (PSH) were present in the area of the rupture.

The lithology at the site consists of a sandy clay transitioning to sand at approximately 15 feet below ground surface (bgs). The groundwater table fluctuates and can be found anywhere from 15 to 20 feet bgs.

Alpine Remediation, Inc. (Alpine) was contracted to perform an in situ injection of Remediation Product's BOS 200® within both the PSH and dissolved phase plumes.

**Approach/Activities.** Most in situ injection plans are focused on evaluating whether the chosen product is effective and little thought is given to the physical injection process. At this site, there was already confidence in the chosen product, but Alpine wanted to ensure that the injections were as successful as possible by focusing on how the product was installed. To do this, Alpine spent the first week of the project conducting pump tests and sampling to get a better idea of the radius of influence (ROI) of the injections and the effect that changes to the injection process could change it.

The basic procedure consisted of performing a test injection, evaluating the ROI by sampling the groundwater in various locations within the estimated ROI, and then soil sampling to confirm the results of the groundwater sampling. Once the basic procedure was complete, if the confirmed ROI did not match the estimated ROI, one change was made to the injection procedure and the process was started again until the confirmed ROI and the estimated ROI matched. Among the changes that were made, were exit velocity, slurry volume, pumping rate, and grid spacing. The exit velocity of the injectate was increased by changing both the size & number of holes on the injection tip. The slurry volume was increased to decrease the viscosity. The pumping rate was doubled by bringing a second diaphragm pump in line with the original pump and finally, the grid spacing was decreased to bring the confirmed ROI in line with the estimated ROI.

This procedure was repeated as the injection team moved across the plume and adjustments were made as necessary.

**Results/Lessons Learned.** In order to perform a successful injection, Alpine changed the pumping rate, injection tool, slurry volume, and the grid spacing at the beginning of the project. As the injections proceeded closer to the source area, the monitoring procedure indicated that another change was needed and the grid spacing was decreased for a second time. Thanks to both the investigation into the injection process and the continued monitoring of the process, the installation proved to be successful.