

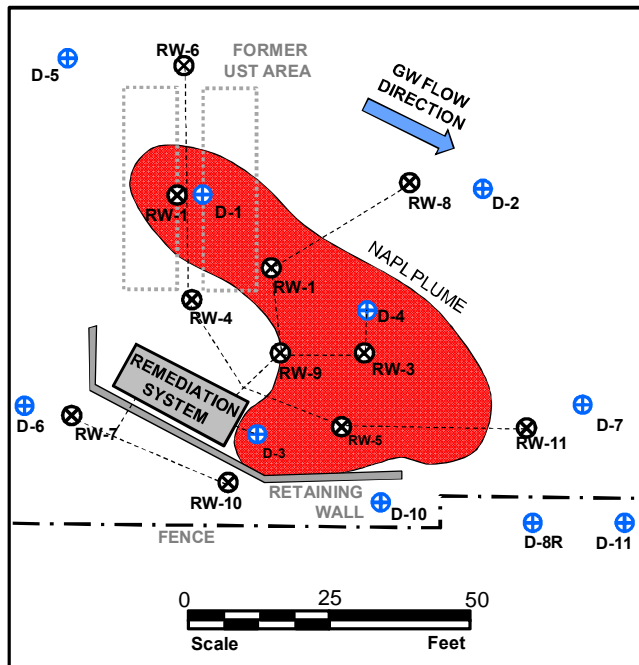
SURFACTANT-ENHANCED LNAPL RECOVERY PETROSOLV™ SURFACTANT

- Type of Project:** Full-scale
- Contaminants Treated:** Light non-aqueous phase liquid (LNAPL) . gasoline & diesel fuel
- Concentration:** NAPL layer ranging from 0.1 to 1.0 feet in thickness
- Technology Applied:** Dual-phase Extraction and GW Recirculation supplemented with Surfactant Flushing
- Geology:** Sandy SILT (SM)
- Treatment Interval:** GW and smear zone at 20-25 feet bgs
- Average % Reduction:** 90%
- Timeframe:** Current 24-month remediation period, ongoing system operation.
- Project Reference:** Available on request.

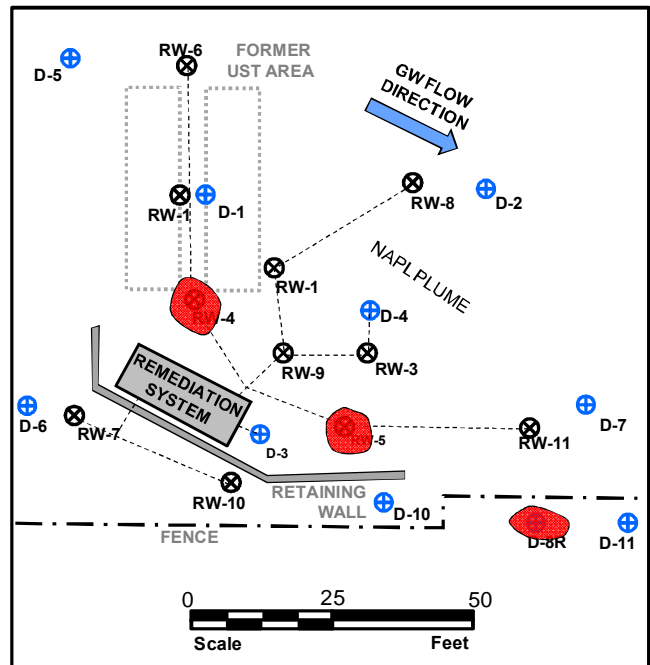
SITE SUMMARY: During site characterization activities following UST removal in 1989, free product (NAPL) was observed in site monitoring wells at this truck maintenance and fueling facility in Georgia. After 6 years of pump-and-treat remediation, additional NAPL delineation was performed, along with ten Enhanced Fluid Recovery (EFR) events. A more aggressive dual-phase remediation system, consisting of Total Fluids Recovery (TFR), Vapor Extraction (VE), GW injection, and Surfactant Injection (INJ), began operation in January 2008. The system includes 11 recovery wells that are used for vapor extraction, GW extraction, and/or GW injection. Injection and extraction is alternated regularly to adjust the fluid capture zone and ensure effective treatment of smear-zone soils.

The initial NAPL plume thickness **varied from 0.1 to 1.0 feet in thickness**. After 18 months of system operation, only 3 wells contained measurable free product, at thicknesses **ranging from 0.01 to 0.08 ft**. The remediation system has operated for 2 years, recovering 500 equiv. gallons of NAPL.

HISTORIC NAPL PLUME



CURRENT NAPL PLUME



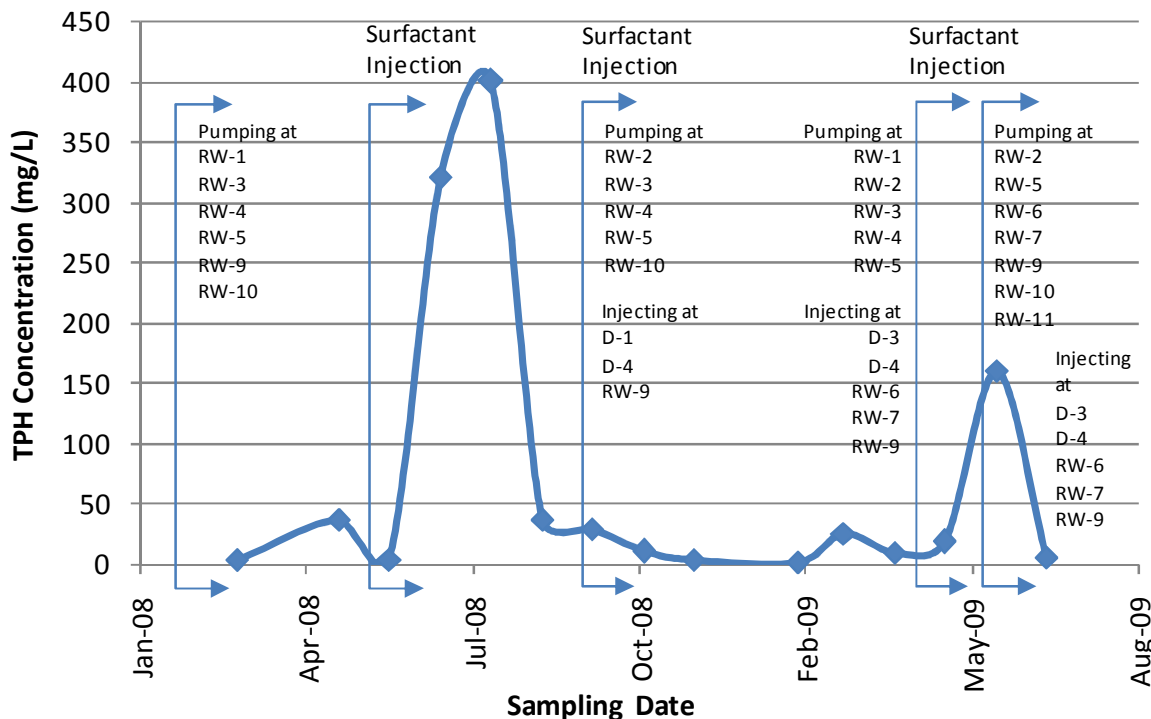
CASE STUDY

TYPE: Surfactant-Enhanced NAPL Recovery
COMPONENTS: Bio-Surfactant & Nutrients

VAPOR EXTRACTION (VE) SYSTEM OPERATION: Based on influent/effluent vapor analytical results, 173 equivalent gallons of NAPL has been removed via vapor-phase concentrations.

TOTAL FLUIDS RECOVERY (TFR) SYSTEM OPERATION: The TFR system extracted and treated over 1,000,000 gallons of groundwater; of this, 950,000 gallons were re-injected to enhance mobilization of trapped NAPL. At various times during remediation, remediation wells were switched from injection to extraction in order to induce specific GW flow directions and NAPL capture zones. Based on influent/effluent analytical results, the TFR system has removed 256 equivalent gallons of NAPL via dissolved-phase concentrations, and 34 gallons of NAPL from the oil-water separator.

SURFACTANT INJECTION (INJ) SYSTEM OPERATION: The INJ system performed pulsed injection of surfactant into the subsurface to enhance mobilization of weathered, trapped, adsorbed NAPL. As a result of intermittent surfactant application, dissolved TPH concentrations have increased dramatically, and are subsequently captured and treated by the TFR system. As a result, the surfactant solution is responsible for a significant portion of the NAPL that is recovered by the TFR system. The following graph illustrates the effectiveness of this process.



BIOREMEDIATION SYSTEM OPERATION: In addition to surfactant injection, over 2,000 pounds of nutrients and secondary electron acceptors (nitrate/sulfate) were injected into the subsurface. These electron acceptors supported degradation of over 36 equivalent gallons of NAPL.

RESULTS: NAPL has been completely removed in 8 site wells, and only three wells contain any measurable free product, at thicknesses ranging from 0.01 to 0.08 ft. The upcoming sampling event (at 24 months after system start-up) will determine whether the system can be shut down.

COST: Approx. 275 gallons of PetroSolvi and 2,000 lbs. of CBN nutrients were used for the project, at a total cost of \$17,000, incl. shipping. Consultant labor/equipment/O&M costs were not available.