PlumeStop™ Pilot Study: Former Dry Cleaner – Marina, CA, USA

Rapid solvent treatment to non-detect – Degradation lines of evidence

Approach

A beta-test pilot evaluation of PlumeStop™ performance was conduced on chlorinated solvent groundwater contamination at a former dry cleaner site. PlumeStop was applied in conjunction with the slow-release electron donor, HRC® and the microbial bioaugmentation dechlorinator inoculum, BDI® for the treatment of residual PCE (550 µg/L). The test was conducted around a single well. Conditions prior to the test were aerobic (ORP +254 mV; DO 44%). Multiple parameters were monitored from groundwater samples to explore lines or evidence of solvent fate / degradation.

Results

Post-treatment solvent concentrations in groundwater were reduced by over 99% to non-detect (<5µg/L) by the first sampling round (19 days). Microbial quantitative array data revealed marked increases in reductive dechlorinator species from baseline conditions in the months following reagent application (several hundred percent or more). (Baseline taken as immediately post-inoculation for species included in BDI). Moreover, functional enzymes for dechlorination of PCE through to ethene similarly increased over the same period (i.e. including specific genes for the degradation of TCE, DCE and vinyl chloride). Through this time, groundwater concentrations of PCE and daughter products remained below detection limits (>15 months post treatment).

Remediation Details

Site Type:
Former Dry Cleaner

Project Driver:
Remediation Product Beta Test R&D

Remediation Approach:
Sorption-enhanced In Situ Anaerobic Bioremediation

Technologies:
PlumeStop™, HRC®, BDI®

Geology	
	Bedrock
	Gravel
X	Sand
	Silt
	Clay

Medium	
X	Groundwater
	Saturated Soil
	Vadose Zone

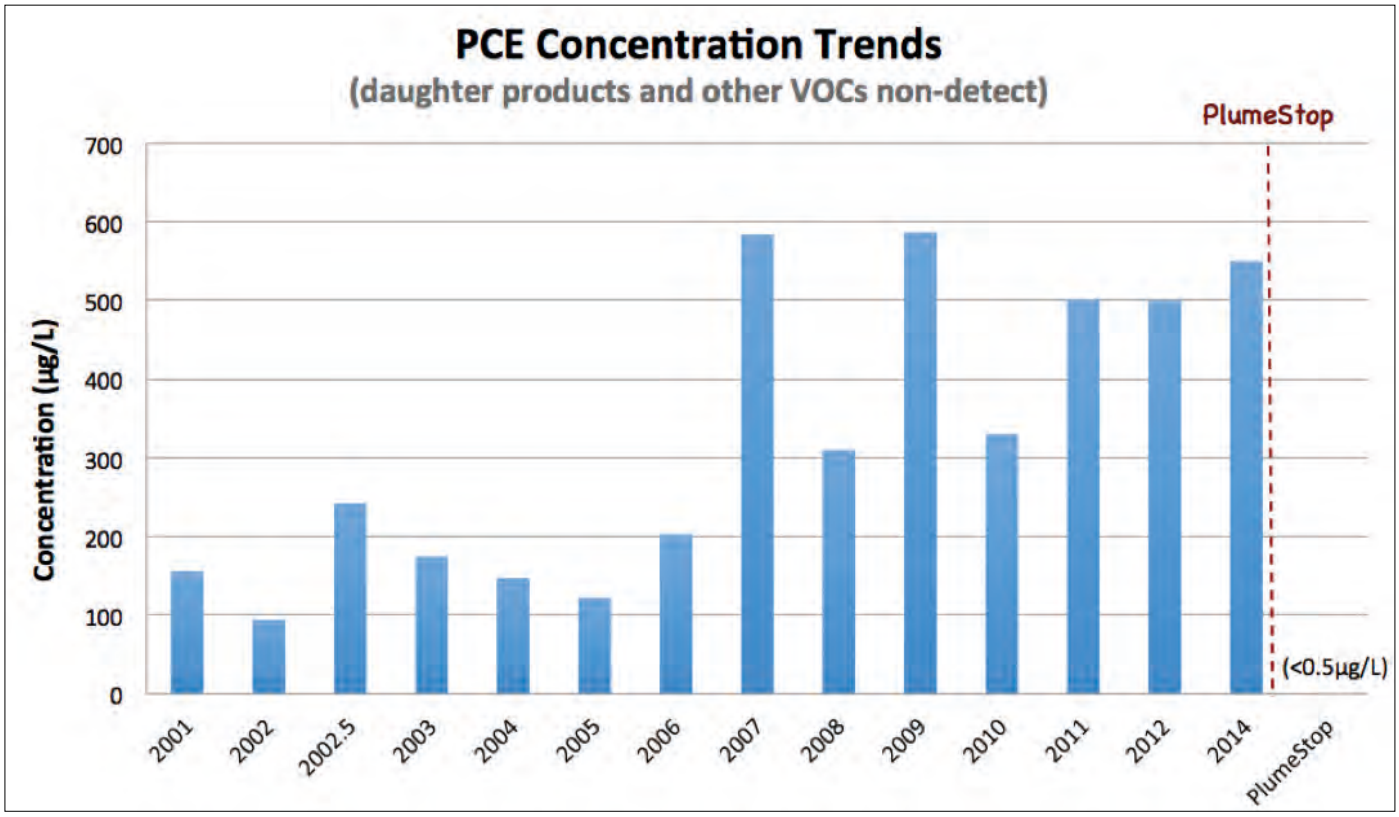
COC	
	Petro HCs
	Petro LNAPL
X	Chlorinated VOCs
	Metals

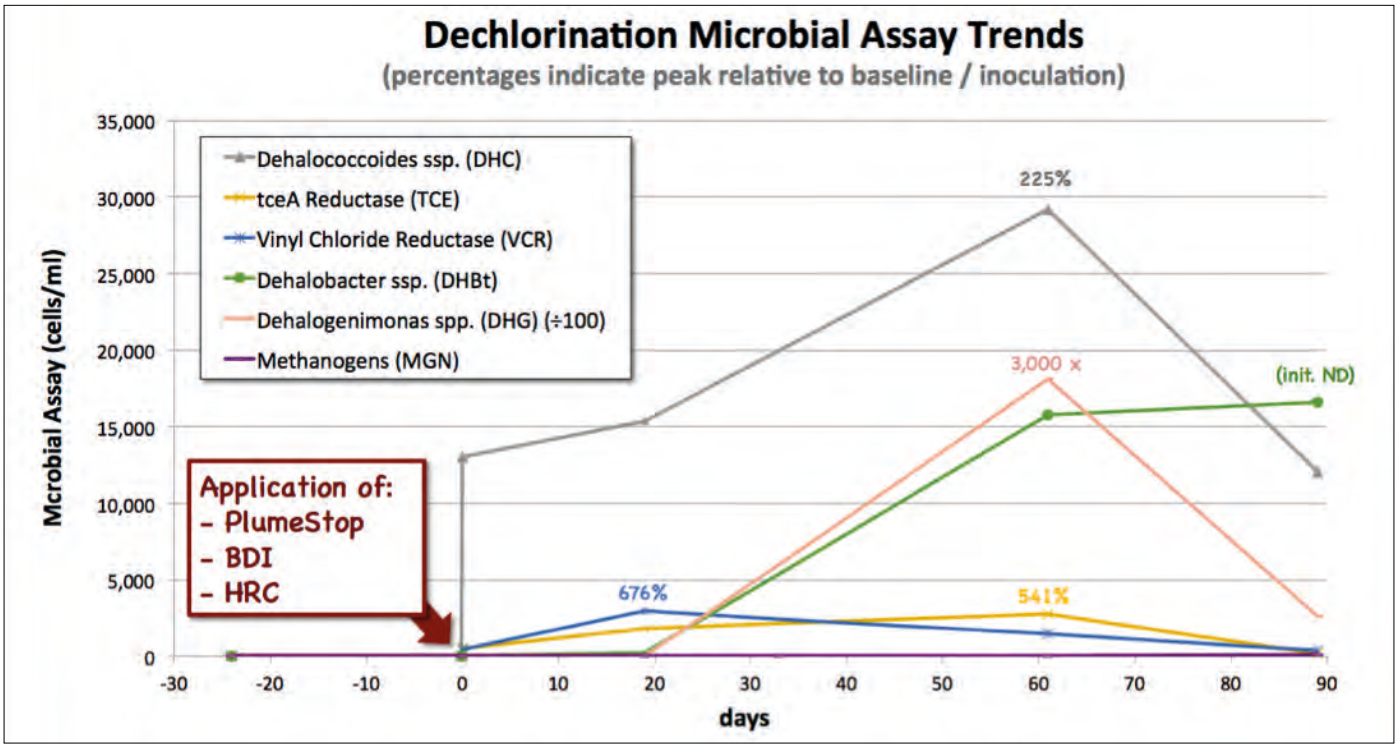
COC Concentration Levels:
550 µg/L PCE

Treatment Depth:
2.5 – 7.5 m

Treatment Area:
6 x 5 m

Injection points and grid:
10 points, 1.5 m grid





Electron donor status and redox potential post-application quickly stabilised at near-optimal conditions (150mV +/- 30 mV), with rapid decreases in competing electron acceptors observed within the first sampling intervals, albeit with some interplay with available iron, possibly reflecting an electron-shuttle dynamic with iron naturally present within the formation. The redox remained below methanogen activity thresholds – methanogen numbers did not share the trends observed in dehalorespirers, and in fact were detected above quantitation thresholds (2 – 30 cells /ml) in one sampling event only, at significantly lower cell counts than Dehalococcoides (94 vs. 12,200 cells/ml).

Analyte		baseline (-24 days)	19 days	33 days	61 days	89 days
PCE	(µg/L)	550	<5	<5	<0.5	<0.5
Dissolved Oxygen	(%)	44.5	6.5	5.1	n/a	0.5
RedOx (ORP)	(mV)	254	-177	-157	n/a	-117
Nitrate (as N)	(mg/L)	6.6	5.1	3.0	0.7	3.0
Dissolved Iron	(mg/L)	0.77	0.56	5.1	6.5	4.0
Sulphate	(mg/L)	42	83	41	18	25
Alkalinity	(mg/L)	62	250	260	170	130
Carbon Dioxide	(mg/L)	11	11	9.0	36	15
Methane	(mg/L)	<0.001	0.0072	0.0011	0.12	0.16
Lactic Acid	(mg/L)	0.036 J	65	120	260	100
Pyruvic Acid	(mg/L)	0.15 U	15 U	1.5 U	8.3	1.5 U
Acetic Acid	(mg/L)	0.035 J	27	36	120	74
Propionic Acid	(mg/L)	0.028 J	18	57	130	130
Butyric Acid	(mg/L)	0.05 U	4.5 J	28	140	76

Discussion

The continued expansion and proliferation of an active dechlorinating microflora in the months following inoculation are indicative of solvent biodegradation through this time. That no solvent was present above detection limits in groundwater through the same period would indicate the degradation to be proceeding ostensibly from the sorbed-phase (i.e. PlumeStop/water interface). This would be consistent with the PlumeStop bio-matrix hypothesis. It is also of note that the dechlorinator numbers and activity peaked at approximately sixty days and declined thereafter. Although the data set is limited, this trend would be consistent with the presumed depletion of the solvent through degradation, the starting concentration having been only 550 µg/L.

Conclusion

These data provide lines of evidence for post-sorption degradation of the target solvents on the PlumeStop, and would further indicate that methanogenic conditions are not necessary for complete reductive dechlorination activity through to ethene. Moreover, all data were obtainable from groundwater samples presenting a straightforward means of performance tracking via wells using the lines of evidence approach.

What's Special

- Depletion of groundwater solvent concentrations to non-detect within 19 days
- All Contaminants of Concern (PCE and daughter products) are remaining below detection limits 15 months post application (and counting)
- Multiple lines of evidence for post-sorption solvent degradation
- All data obtainable from groundwater samples alone
- No generation of methane / competition from methanogens

For more information or to discuss your project, please contact:

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