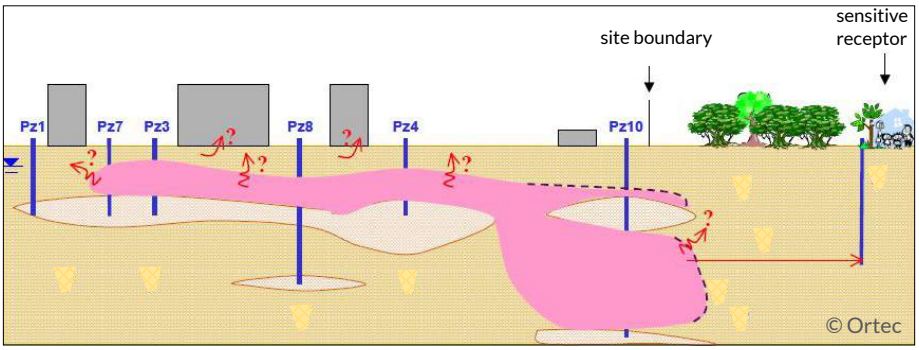
In Situ Bioremediation at a French Airport in Southwest France:
Successful standalone treatment of a large plume with difficult site conditions

Introduction

The process of Enhanced Reductive Dechlorination (ERD) for the biological degradation of chlorinated compounds, is now a widely used and proven in situ remediation approach. Nevertheless, ERD is often used only as a 'polishing step' of the plume, rather than a stand-alone primary remediation technology.
In our experience, the potential of ERD is much more powerful than a final stage to address residual dissolved phase contamination. In many cases, it is the only viable remediation option available when site conditions are difficult, as was the case at this an active industrial site located at an airport in the Southwest of France.

Challenging Site Conditions

- Restricted access; the contamination was located on the sites of 2 different companies active in the aviation industry (manufacturing airplane parts).
- Heterogeneous geology with very different permeabilities; gravelly clay overlying sandy gravel.
- Seasonal fluctuations in the groundwater table.
- Wide contaminant distribution; the contamination spread along the permeable bedding of a sewage system located in the gravelly clay. From here, the contamination seeped into the sandy gravel layer. This resulted in a very long plume with the potential to cross the site border approx. 700 m downgradient of the source (see section below).
- There was a wide range in contaminant concentrations on this site; Relatively high PCE concentrations in the source area (up to 14,000 µg/l), with very low dissolved phase concentrations further away from the sewage system.



Remediation Details

Site Type:
Active Manufacturing Site

Project Driver:
Regulatory requirement

Remediation Approach:
Enhanced Reductive Dechlorination

Technology:
3-D Microemulsion®

Geology	
X	Gravel
X	Sand
	Silt
X	Clay

Medium	
X	Groundwater
	Saturated Soil
	Vadose Zone

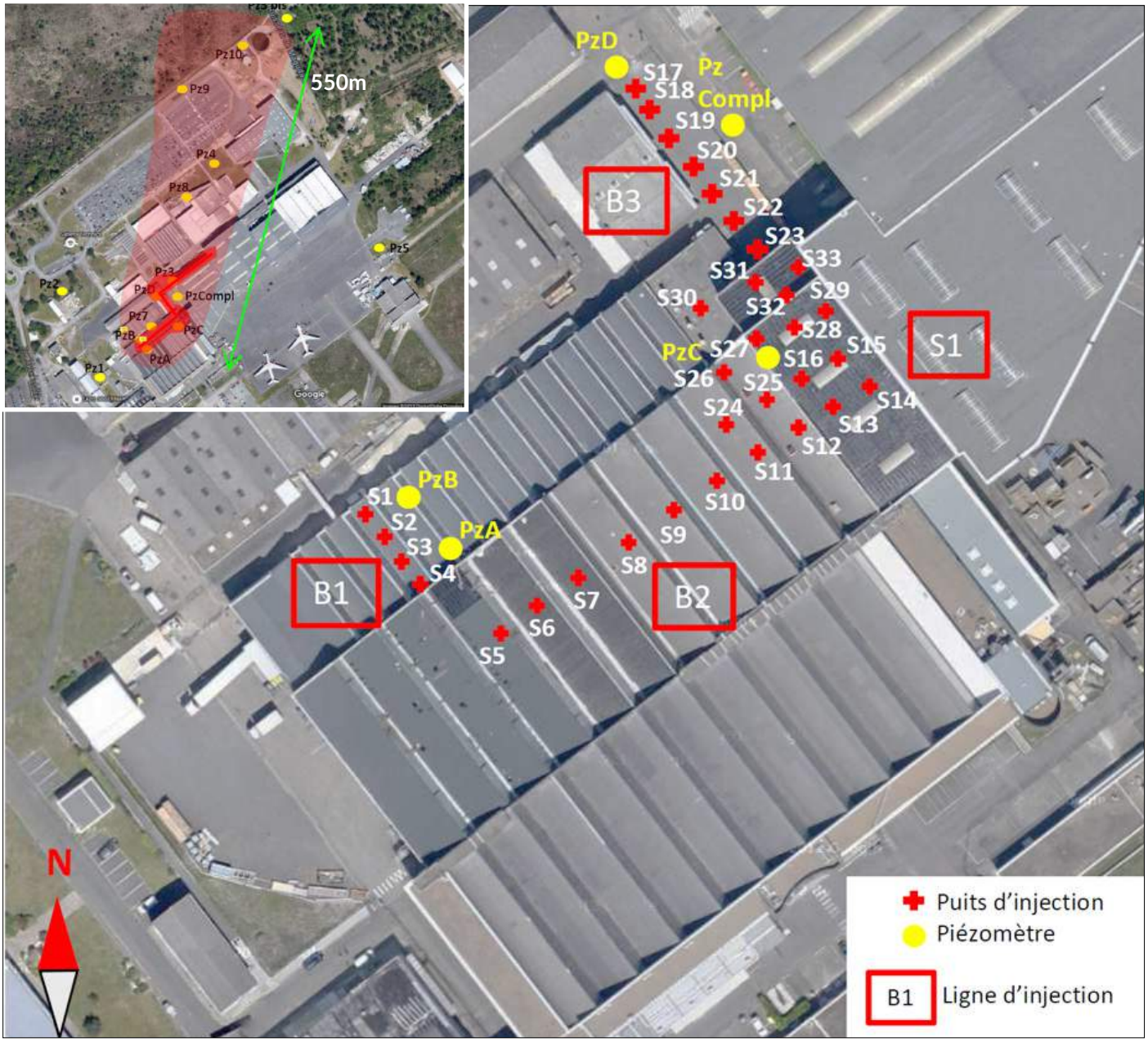
COC	
	Petro HCs
	Petro LNAPL
X	Chlorinated VOCs
	Metals

COC Concentration Levels:
up to 14,000 µg/l

No. of Injection points:
70

Injection formation:
grid (in source zone) and barrier (downgradient)

Remediation cost:
€200 - 230k approx.



Remediation Method/Application

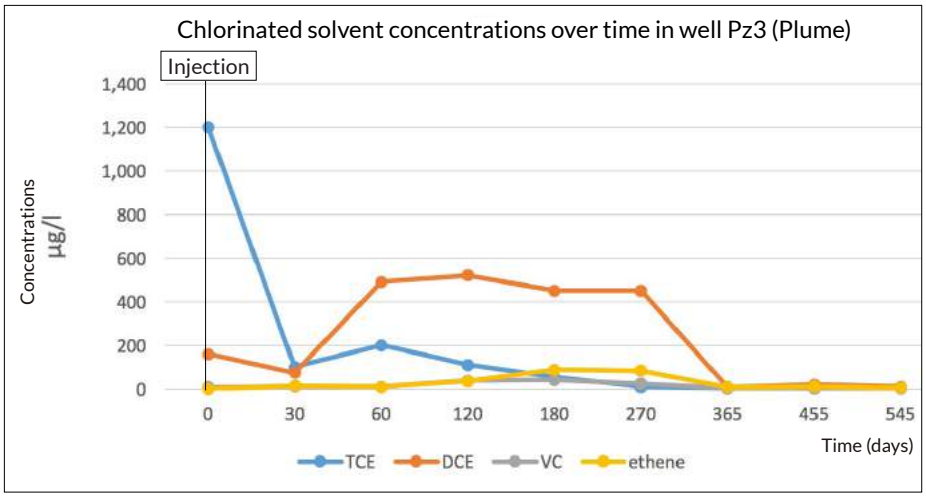
After a successful pilot test, full-scale application using a single injection of REGENESIS' controlled-release electron donor 3-D Microemulsion (3DMe) into 70 injection points. 'Top-down' direct-push injections were used to provide a targeted vertical distribution of the electron donor.

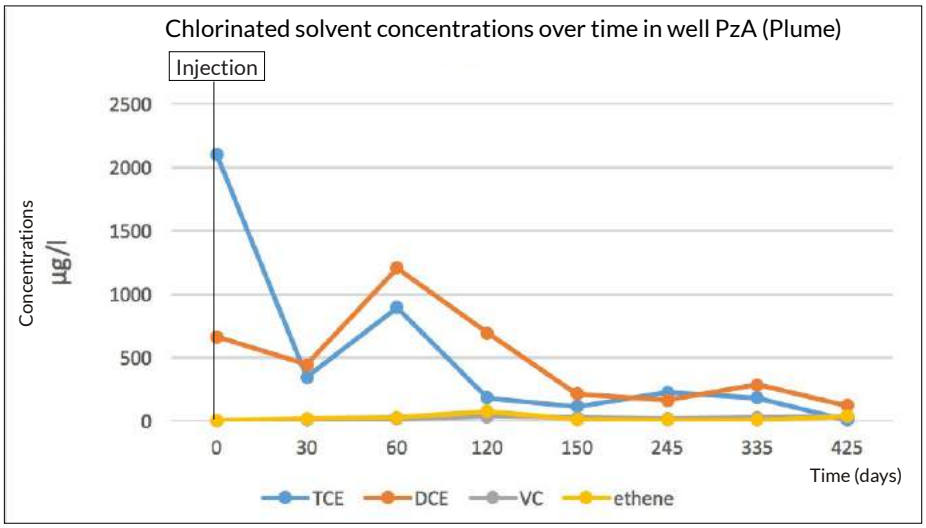
The injection work was carried out in 3 weeks total, spread over 2 campaigns:

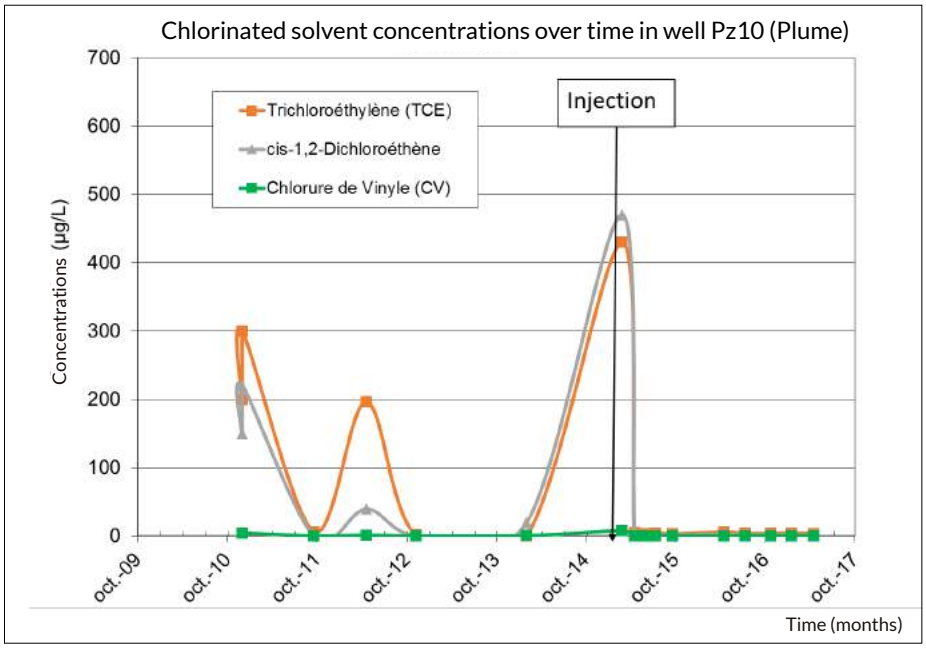
- The downgradient product barrier was installed in spring.
- The injection points in the source zone were located inside buildings with ongoing activity. These injections were carried out during the summer holiday period, to minimise disturbance of commercial activity.

Full Scale Results - Downgradient Barrier

In the downgradient plume area, an excellent reduction of the parent compound TCE can be observed: for example the areas around Pz3, PzA and well Pz10 shown in the graphs below. The graphs show the sequential formation and degradation of the daughter products DCE and VC, which then decrease showing that full reductive dechlorination is occurring.

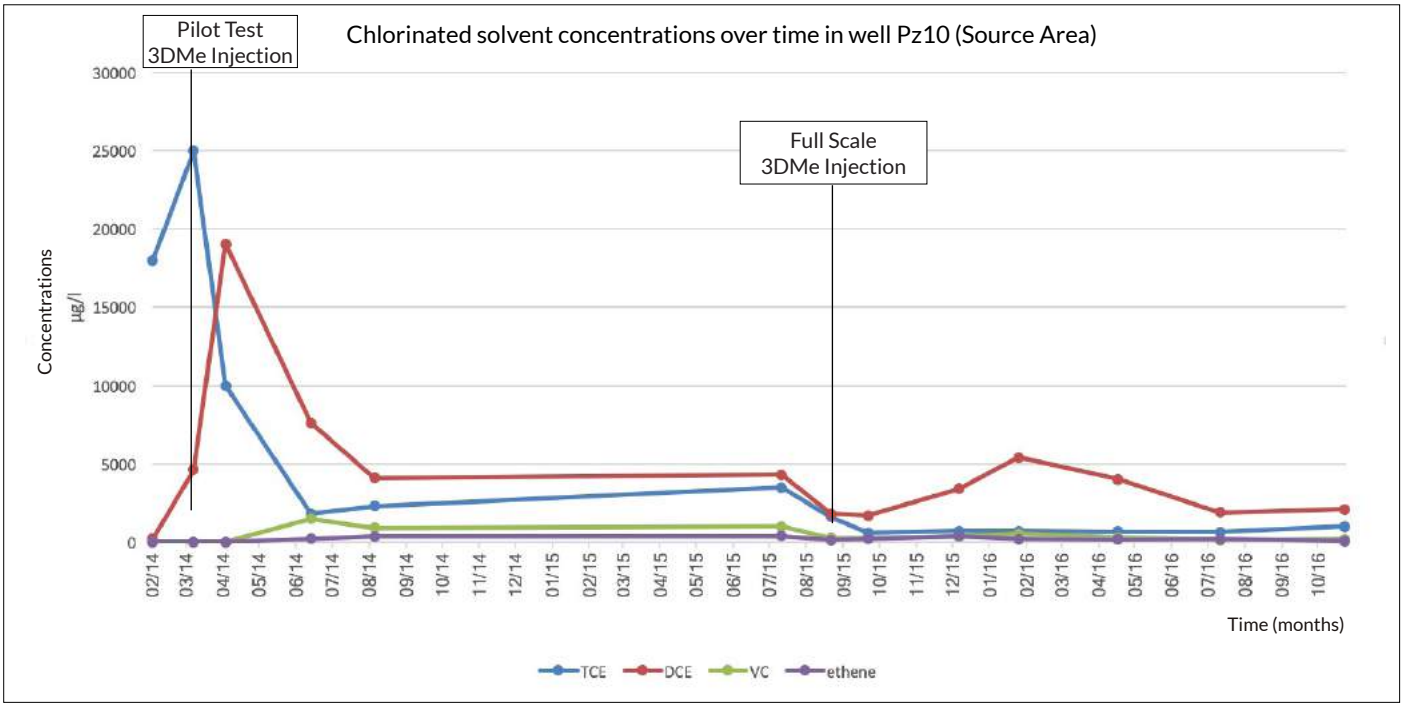






Results - Source Area

In the Source Area, rapid degradation can be observed in the first months after the pilot test, followed by a slight fluctuation of concentrations at lower level until the full scale application was completed.Following the full scale injection, TCE is rapidly reduced and maintained at a low concentrations. The daughter product DCE can be observed increasing and following the degradation of TCE in the mobile porosity. The DCE concentration presently remains slightly elevated, but not increasing. As full ERD is occurring, this suggests an influx of parent compound that is being rapidly degraded (TCE breaks down more quickly than cis-1,2DCE). It is thought that this is occurring through back-diffusion of residual dissolved phase contamination in the over-lying clay (immobile porosity). Due to the longevity of the treatment provided by the 3DMe (4-5 years), the residual mass diffusing out of the immobile porosity will continue to be treated until it is completely depleted.



Conclusions

- With a longevity of minimum 4 – 5 years, 3DMe was selected to remediate the site from a single application;
  - This removes the requirement for further application on this busy factory site:
  - This allows the contamination within the overlying clay layer to be addressed, avoiding a rebound due to back-diffusion.
- The ability of 3Dme to self-distribute over a wide radius of influence from each injection location, allowed the number of points to be minimised. This reduced the cost and onsite programme for the treatment.
- The treatment has clearly achieved mass reduction of the contamination in the downgradient plume and the source. This has reduced the risk to the site and offsite receptors.
- The treatment is ongoing, targeting the residual contamination in the overlying clay and avoiding rebound in concentrations
- Ideal conditions for ERD were rapidly created and have been maintained since through the controlled release of electron donor over a wide area. This has lead to full reductive dechlorination occurring, ensuring that all chlorinated parent and daughter compounds are degraded.

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