

Injectable PRB provides rapid remediation of chlorinated plume allowing redevelopment within months



CASE STUDY

Stringent regulatory targets achieved in short timescale, despite challenging site conditions



INTRODUCTION

A former silver frames manufacturing facility in an urban area in Central Italy was undergoing redevelopment comprising complete demolition of the existing industrial buildings and construction of residential buildings.

Historical industrial activities had caused **chlorinated solvent contamination** in the subsurface. Although only moderate concentrations were detected in the source areas, the permeable geology formation and high groundwater seepage velocity (>200 meters/year) had formed an elongated plume extending beyond the downgradient site boundary.



Artist's impression of residential development

The construction company had a **strict deadline** for the remediation to be completed, as their intention was to sell the new residential properties with the remediation site closure already obtained; allowing maximization of the return on investment.

Therefore, the selection of the remediation strategy needed to focus on a rapid and effective solution that would **avoid the long-term installation of active pumping equipment onsite** and would provide **minimal interference with the ongoing construction activities**.

Environmental company **CECAM** completed the site investigation and determined that there was no human-health risk for the future residential users of the area, and so the remediation should focus on protection of the offsite environment.

It was decided that an **in situ injectable permeable reactive barrier (iPRB)**, located along the site downgradient boundary, would be the optimal solution to prevent offsite migration and protect sensitive environmental receptors. This solution was approved by local authorities, in substitution of a previously approved pump & treat remediation plant envisaged by the former owner, as the new solution avoids having equipment onsite with contaminated water being brought to the surface in a residential area for decades.

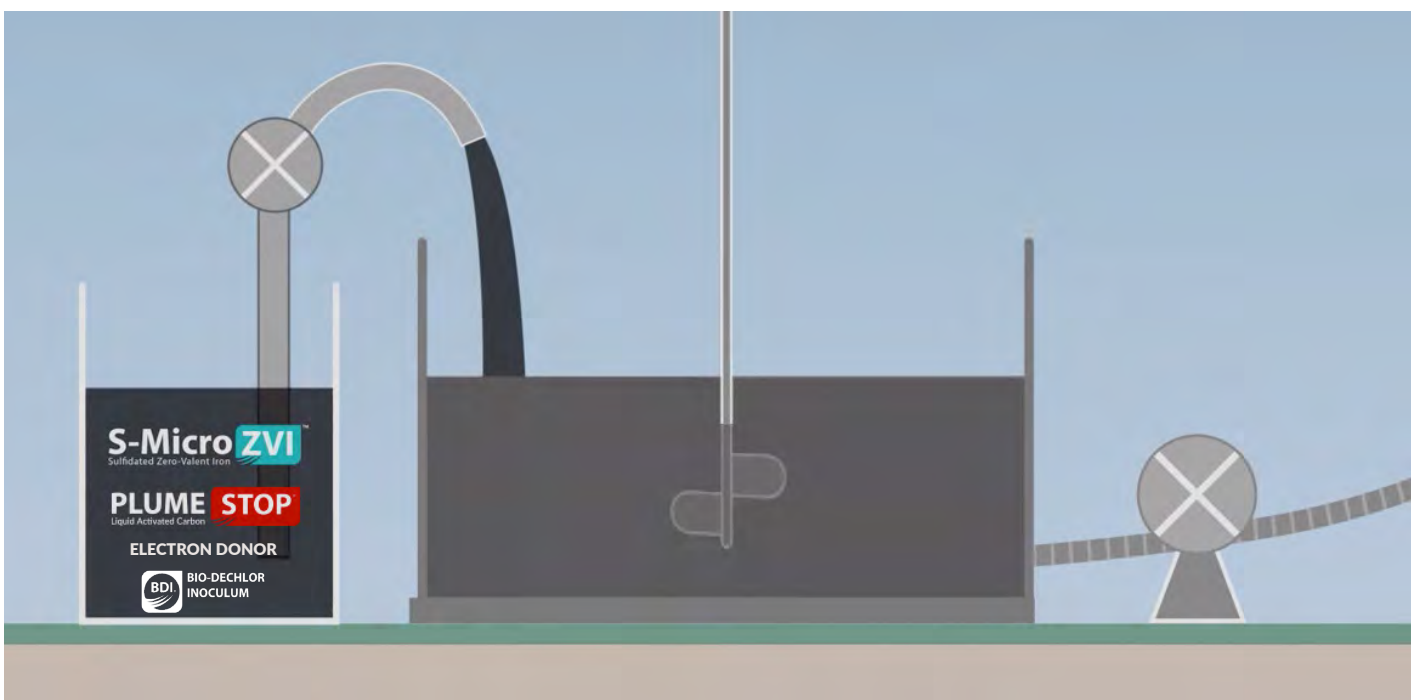
REMEDIATION TECHNOLOGIES: A COMBINED APPROACH

The technologies used comprised three liquid reagents that would be co-injected: a colloidal activated carbon, a colloidal sulfidated zero-valent iron (ZVI) and an organic long term release electron donor, as well as additional bioaugmentation using a specific dechlorinating microbial consortia. These technologies would provide a combination of in situ sorption, chemical reduction and biological degradation of chlorinated compounds. Due to the synergy between these physical, chemical and biological processes, the treatment optimized the remediation efficiency in terms both of timing and minimization of daughter product production.

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The design comprised a combined-approach iPRB installed along the downgradient property boundary combining **PlumeStop**® and **S-MicroZVI**® to remove the parent compound chlorinated solvents from the groundwater and then destroy them using a powerful ISCR technology.

The addition of enhanced reductive dechlorination was completed through biostimulation and bioaugmentation using controlled release electron donor and the **BDI Plus**® microbial consortium. This was used to rapidly degrade low levels of daughter products (DCE and VC) that may be produced in the treatment and that already existed in the plume due to the ongoing natural attenuation of the PCE and TCE parent compounds.





APPLICATION

Design Verification Testing (DVT) was completed prior to the iPRB installation to obtain detailed information on contaminant flux zone location and optimum injection approach. This allowed confirmation of the exact iPRB location and composition, as well as allowing a greater understanding of the treatment effect and longevity, allowing REGENESIS to offer **a guaranteed solution to the client.**

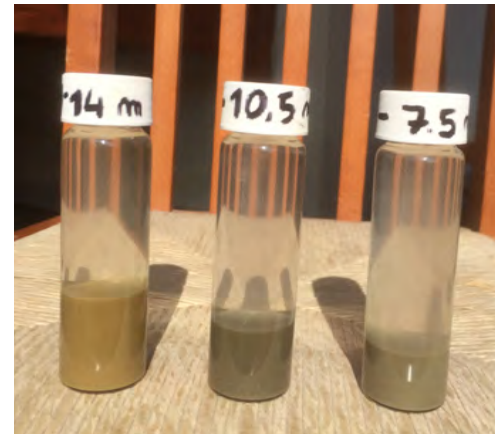
REGENESIS Remediation Services then completed the full-scale application of a 25m long iPRB along the site boundary, over a vertical thickness of 8 meters, intercepting the shallower portion of the superficial contaminated aquifer from 6 to 14m BGL.

The works were completed using direct push technology (DPT) injection, with all products co-applied in the same injection event. The DPT injection used only temporary equipment with a small site footprint and required no fixed installation nor treatment plant on site.

Over the length of the barrier, 13 direct push injection points were completed with a spacing of 2m between points, into which 4000L of the substrates were injected at low pressure.

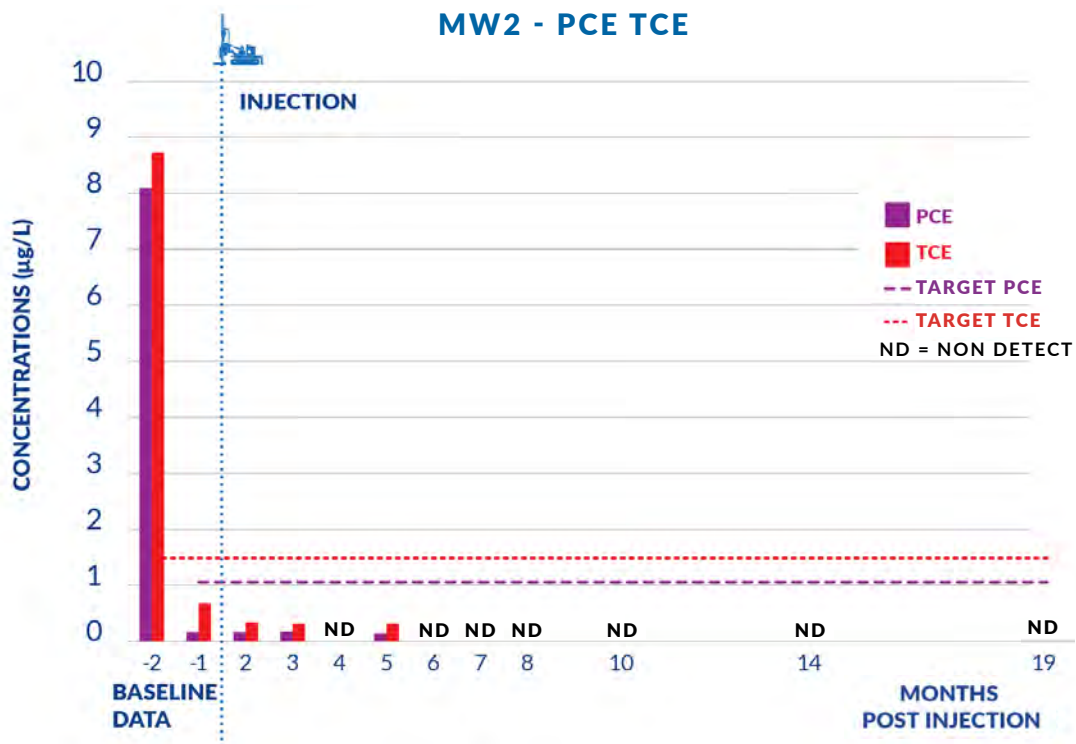
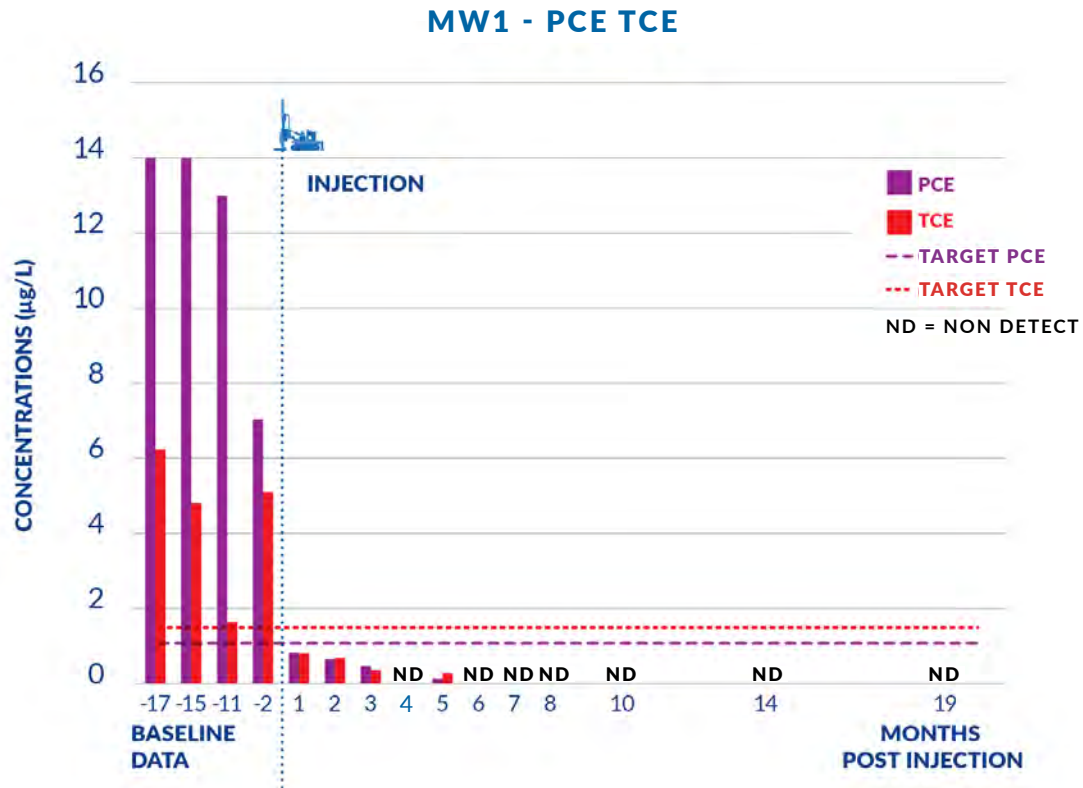
Confirmation of product emplacement sampling was completed throughout the injection works in order to ensure good distribution of the reagents. This sampling allowed real-time adjustments to volume and spacing, to establish a continuous and effective treatment zone along the site boundary.

Only a few meters away, while injections works were being carried out, excavation and construction of an underground car park was being completed.



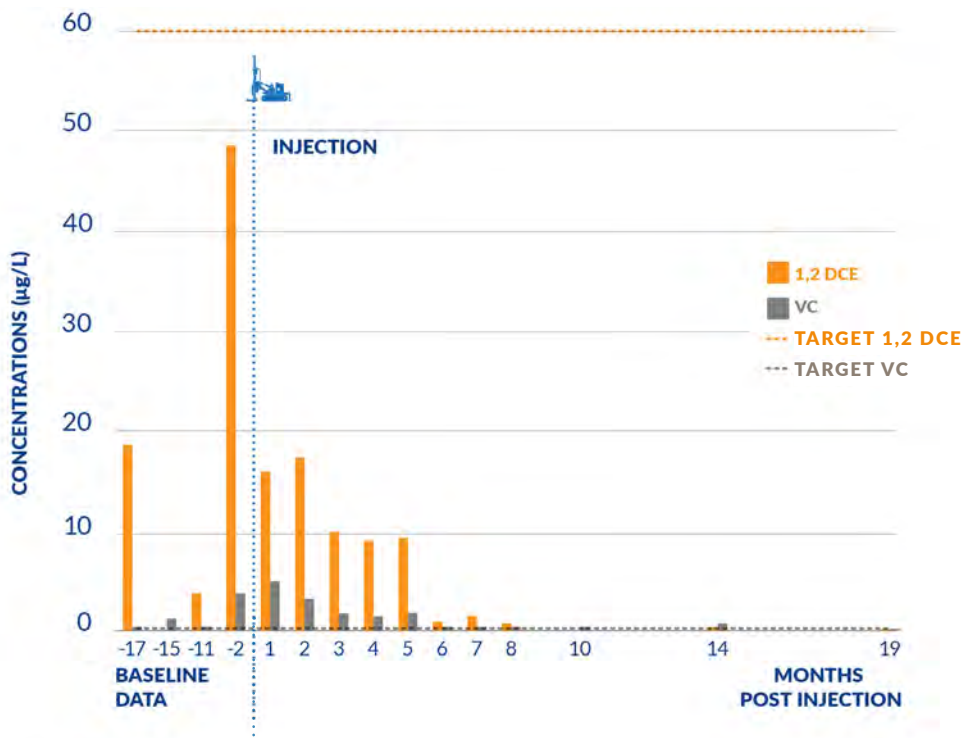
RESULTS

Post application monitoring performed by CECAM showed a rapid reduction of PCE and TCE and immediate achievement of the stringent remediation targets in the first monitoring campaign.

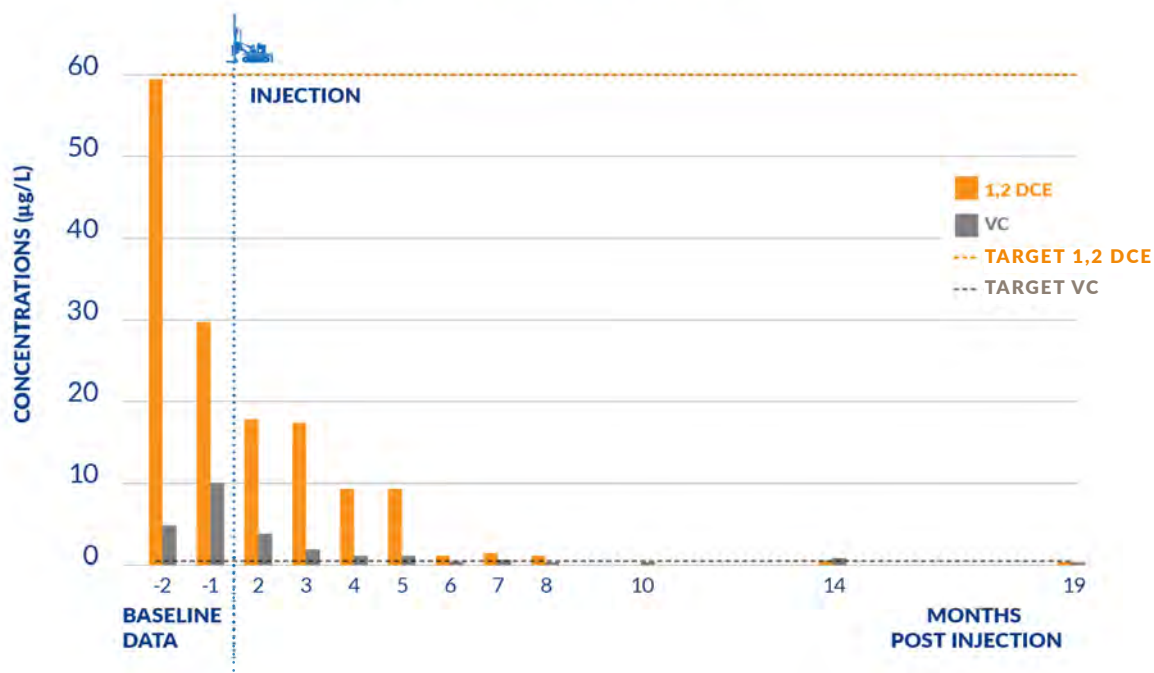


Targets for the daughter products (cis-1,2 DCE and VC) have been reached in only a few months (<0.5 µg/L for VC). No build-up of daughter products were observed, due to the use of PlumeStop (sorption) and S-MicroZVI (ISCR).

MW1 - DAUGHTER PRODUCTS



MW2 - DAUGHTER PRODUCTS

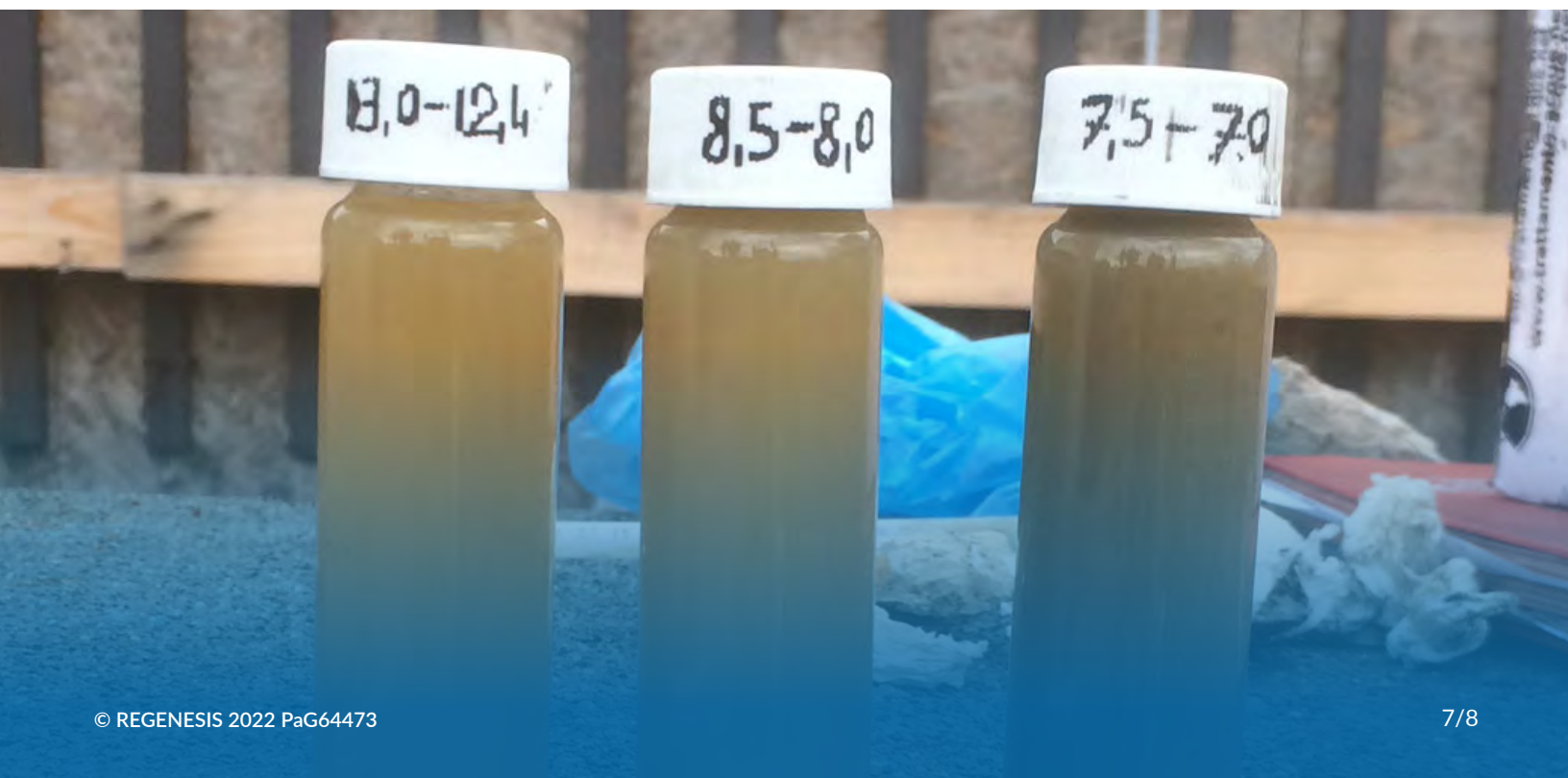


CONCLUSIONS

Post-compliance validation monitoring, performed through the two Points of Compliance (POC) located 3m downgradient of the iPRB, confirmed reduced and stable concentrations below the remedial targets were maintained over time for 2 years post application, with no rebound nor fluctuation of data observed.

This allowed formal site closure to be achieved on time, within the scheduled construction programme. The redeveloper was therefore able to release to the market the newly constructed residential properties in parallel to the remediation activities taking place. REGENESIS provided a guarantee of performance in order to give the developer certainty of time and budget.

Remediation targets and the client's economic requirements were achieved on time and within budget under a guaranteed contract. This was achieved by developing an excellent understanding of the contaminant flux zones, building into the design a synergy of remedial approaches, use of highly effective wide-distribution substrates, accurate low-pressure injection into the flux zones, emplacement verification and adjustment to provide a rapid and long-term solution for the client.



CLIENT QUOTE

“REGENESIS has been supportive throughout all the steps, starting before our remediation design with the remedial investigation activities. Their input was crucial to identify how to best design the treatment and resulted in a very straightforward project for my client, meeting goals in a timely manner, without any surprises.”

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ABOUT THE CONSULTANT

CECAM has been active for over 25 years in Tuscany and throughout Italy, offering environmental consultancy services, including the design and implementation of subsurface remediation projects, for contaminated soil and groundwater.

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