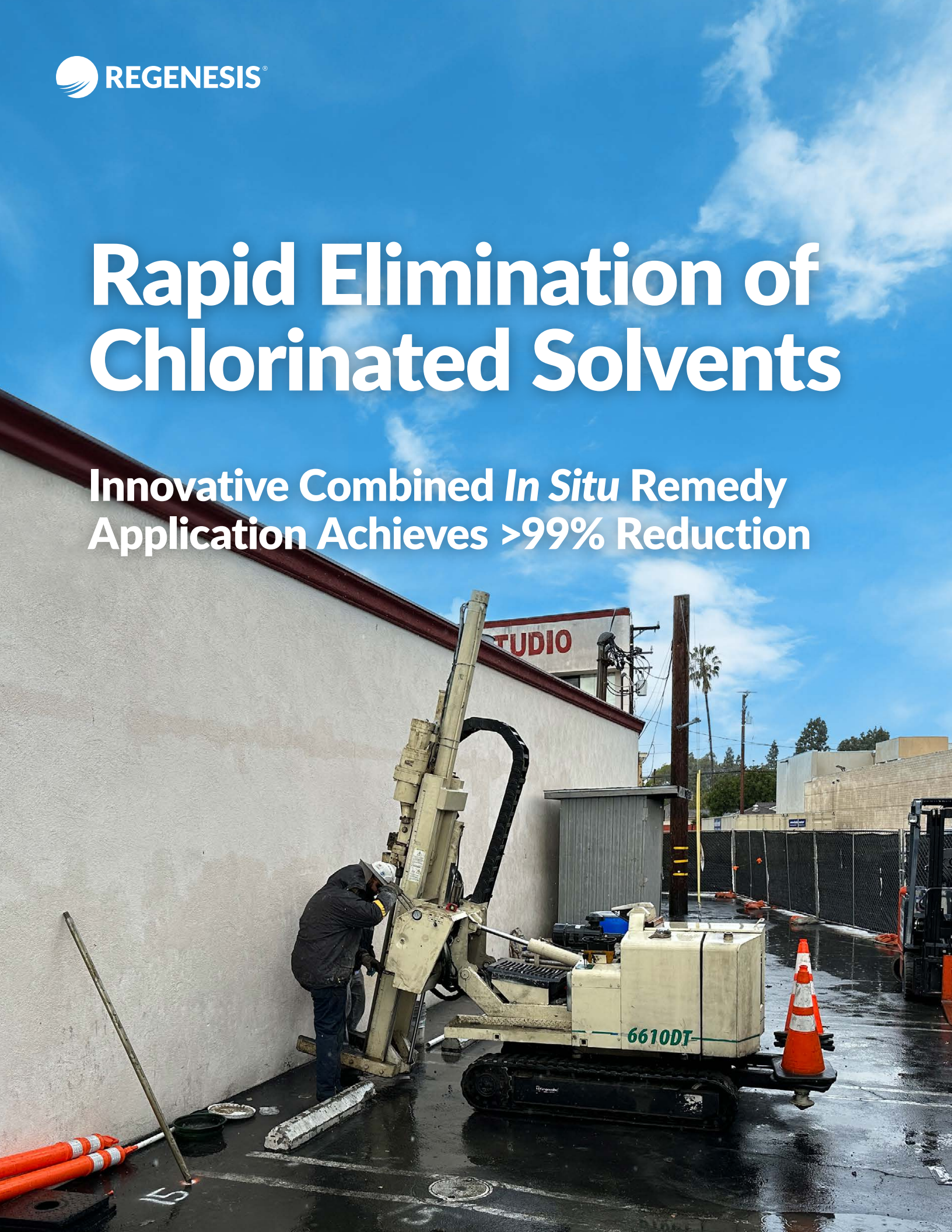
REGENESIS®

Rapid Elimination of Chlorinated Solvents

Innovative Combined *In Situ* Remedy Application Achieves >99% Reduction



Highlights

Site Type:
Commercial

Project Driver:
Offsite plume migration, vapor intrusion

Contaminants:
CVOCs, including PCE detected at up to 93,000 micrograms per liter (µg/L) and TCE up to 15,700 µg/L

Geology:
Layers of low-permeability silty clay and higher permeability silt/sand mixtures

Treatment:
Enhanced reductive dechlorination (ERD) and *in situ* chemical reduction (ISCR)

Technologies:
3-D Microemulsion, S-MicroZVI, BDI Plus

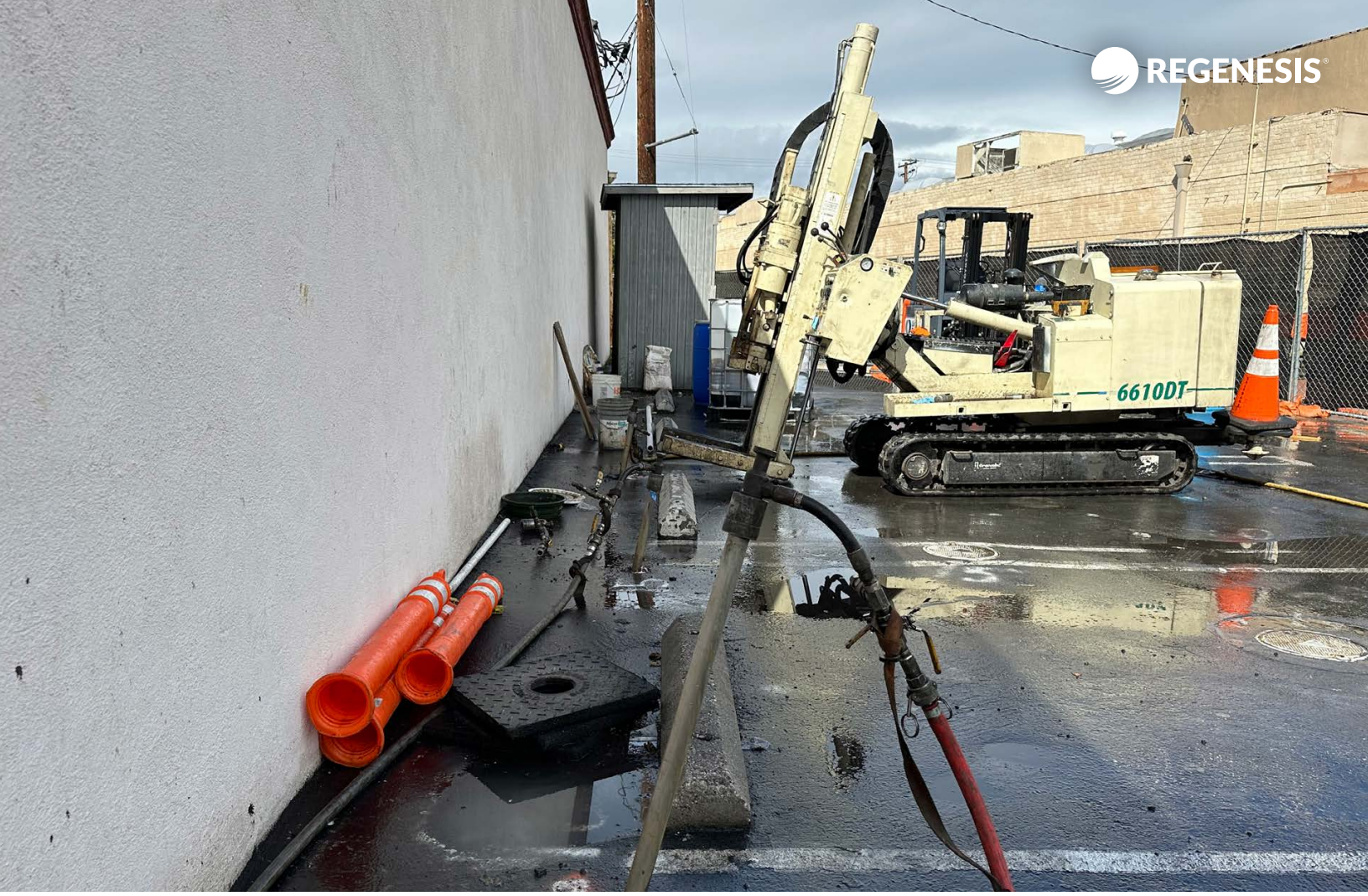
Quantity Injected:
16,600 gallons

Summary

In Southern California, a retail facility with an active food service tenant faced significant groundwater contamination from chlorinated solvents, primarily tetrachloroethylene (PCE) and trichloroethylene (TCE), resulting from a historical release at a former dry cleaners on-site, which also impacted adjacent properties. Despite previous remediation efforts, high contaminant concentrations persisted, feeding a contaminant plume. Using 3-D Microemulsion® (3DME), Sulfidated Micro-Scale Zero Valent Iron® (S-MZVI), and Bio Dechlor Inoculum Plus® (BDI Plus), the site achieved a greater than 99% reduction in CVOC concentrations and halted plume migration through biologically enhanced reductive dechlorination (ERD) and in situ chemical reduction (ISCR), meeting the site's performance goals.

Results

- **The site achieved a greater than 99% reduction in CVOC concentrations**



Background and Challenges

A historical dry cleaning solvent release impacted the subject property and adjacent sites resulting in groundwater contaminated with PCE and TCE. Previous remedial efforts to eliminate the CVOC contaminants included excavation, operating a soil vapor extraction (SVE) system and limited chemical injections. These efforts were designed to address the high concentrations and residual dense non-aqueous phase liquids (DNAPLs) in the source areas. While they successfully reduced contaminant mass, they were unable to achieve long-term remedial goals due to the inaccessibility of the impacted media, which were located beneath the building and other infrastructure.

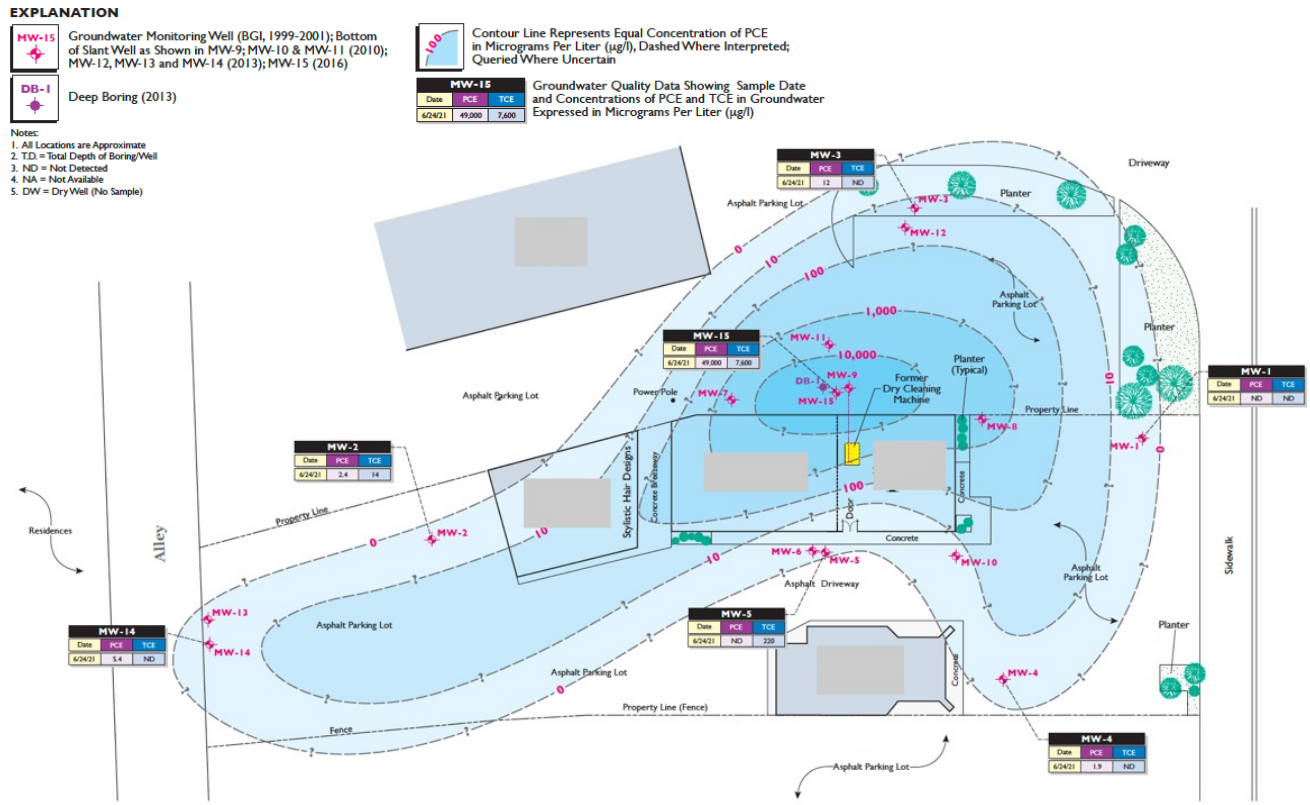
To chart the best remedial path forward, Bryant GeoEnvironmental, Inc. (Bryant), a highly experienced environmental consulting company headquartered in California, developed a conceptual site model (CSM) of the chlorinated solvent contamination incorporating historical data and a subsurface investigation, including direct-push groundwater sampling and MiHPT (Membrane Interface Probe High-Resolution Profiling). The contaminants were found at significant concentrations, and a defined groundwater plume had developed, extending from the source area.

The challenges were multifaceted with contaminants in both a high-permeability source area and a low-permeability soil unit, which was storing the contaminants and providing a continuous source of leaching. The source zone was characterized by high concentrations of CVOCs, with the plume extending downgradient into areas of lower permeability. The remediation efforts had to overcome the difficulty of treating these contaminants across varied soil and groundwater conditions.

Additionally, the site posed logistical challenges, with the contamination located within a densely developed urban area and confined spaces within the building that required precise planning for the placement of the injection points.

Figure 1 PCE Plume Extents

Site map showing extent of PCE plume in groundwater. Image provided by Bryant GeoEnvironmental.



Remedial Solution and Project Goals

Following a comprehensive review of available remedial technologies to treat the site, Bryant ultimately selected an *in situ* remediation solution to mitigate the VOC plume. This involved developing a comprehensive remediation strategy incorporating a combination of technologies designed to target the CVOCs in the source area and the downgradient plume, including:

3-D Microemulsion (3DME): A high-performance colloidal emulsion that distributes widely in the subsurface and facilitates the breakdown of contaminants through enhanced bioremediation and chemical reduction.

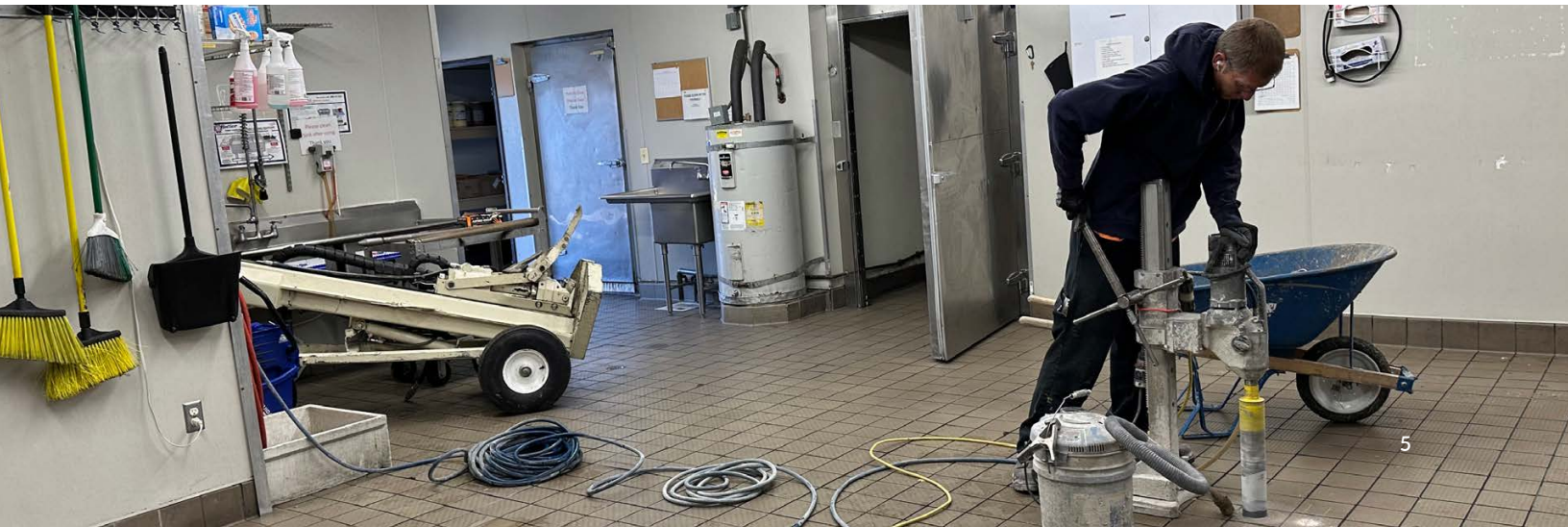
Sulfidated Micron Scale Zero Valent Iron (S-MZVI): A highly efficient and reactive ZVI material that facilitates chemical reduction to transform the contaminants into less harmful byproducts.

Bio Dechlor Inoculum Plus (BDI Plus): A bioremediation additive that enhances the biodegradation of chlorinated solvents by introducing microbial populations capable of dechlorinating the contaminants.

The project goals using these technologies were to:

1. Implement a sustainable, cost-effective solution that minimizes disruption to the site.
2. Achieve a 90% reduction in cVOC concentrations in the source area and downgradient plume within the first 9 months.
3. Prevent further migration of the contamination plume.

The remediation solution was approved by the California Regional Water Quality Control Board, ensuring regulatory compliance and alignment with local groundwater protection goals. Implementing this solution required careful planning for injection points and the use of direct-push technology to access deep subsurface zones while minimizing disruption to ongoing site operations. Numerous injection points were located within the building.



Application

Injection Application Details	
Treatment Dimensions	Source area: 1,000 ft^2 Two PRBs: 60 ft length (each)
Amendments Applied	3-D Microemulsion, S-MicroZVI, BDI Plus
Injection Points	52
Injection Depth	23-40 ft bgs

The design plan incorporated a grid-based injection point array in the source area with permeable reactive barriers (PRBs) placed downgradient, across the plume to passively treat the dissolved-phase CVOCs brought into the PRBs by the in-fluxing groundwater. The source area consisted of a 1,000 ft^2 section, with a 15-foot thick treatment zone (23 to 38 feet below ground surface). Two 60-feet-long PRBs were placed across the plume inside of the building, spanning a depth of 29 to 40 feet to reduce contaminant migration.

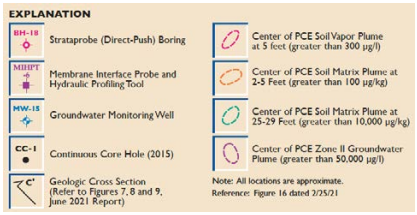
Injection points were strategically placed to optimize reagent distribution between injection points. The remedial amendment mixture (3DME, S-MZVI, and BDI Plus) was applied through 52 injection points over an 8-day period. The injection was safely completed with minimal impacts on the operating business.

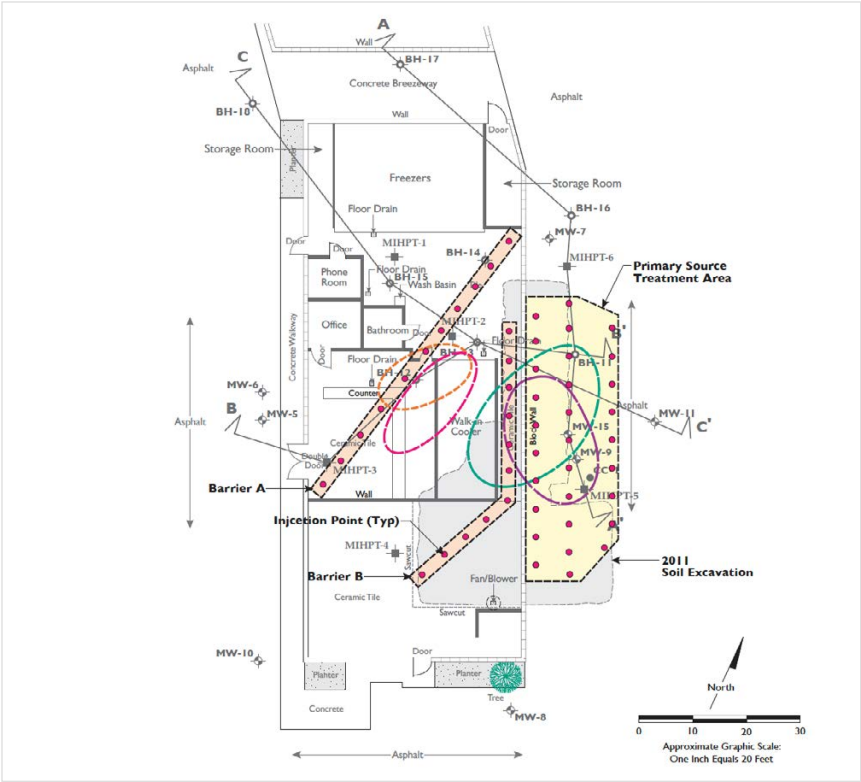
Groundwater samples were collected and analyzed for the presence and concentration of CVOCs to track the effectiveness of the remediation process.

Figure 2

Injection Point Locations

Map depicting injection point locations. Image provided by Bryant GeoEnvironmental.





"Bryant Environmental and the responsible party were impressed with the field work and resultant success of the project. The advance planning, expertise, and organization provided by the REGENESIS design team and field crew resulted in the successful completion of the injection activities, particularly considering the difficult working conditions and tightly confined space within a fully operational food-service facility."

Mark Bryant
Bryant GeoEnvironmental, Inc.

Results

>99.9% **Reduction in CVOCs**

CVOC concentrations reduced by more than 99.9%

In the source area, the concentrations of PCE in groundwater dropped to non-detect levels from the previous 12-month average of more than 55,000 µg/L (>99.9% reduction) within one year, with no significant daughter products formed. Key findings include:

Source Area: The 90% CVOC concentration reduction goal was achieved within four months post-application.

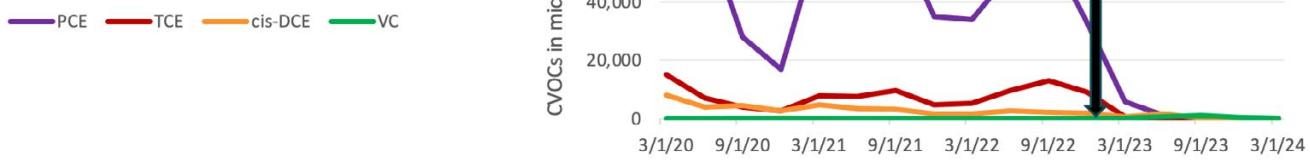
Plume: Monitoring wells downgradient of the PRBs show >98% reduction in CVOC concentrations compared to historical maximums, demonstrating the CVOC plume is not migrating.

Long-Term Monitoring: Ongoing monitoring indicates the continued effectiveness of the treatment, with additional reductions expected in the following months.

Figure 3

CVOCs in MW-15

Chart showing CVOC concentrations in source area well MW-15. Results show all chlorinated ethenes being reduced to near or below detection limits from a baseline concentration of nearly 60,000 µg/L after 12 months.



The results confirm that the choice to apply a combination of chemical and biological treatments can effectively achieve remediation targets, particularly in reducing CVOC concentrations and preventing plume migration.

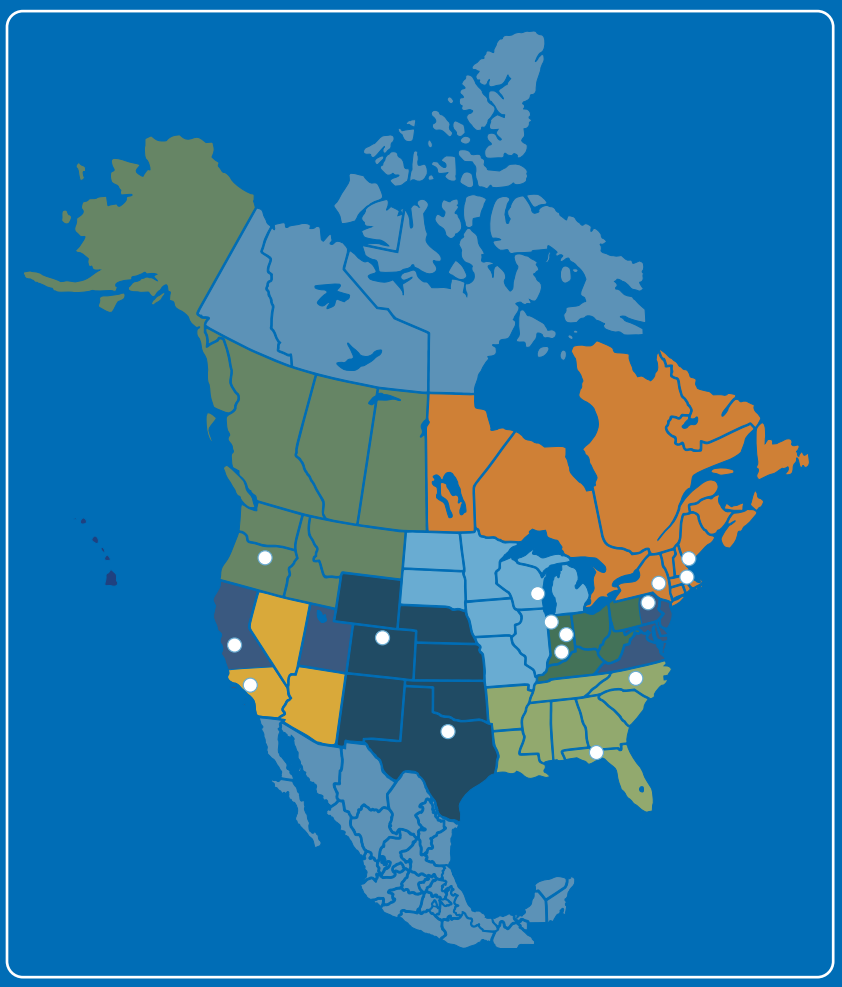
Conclusion

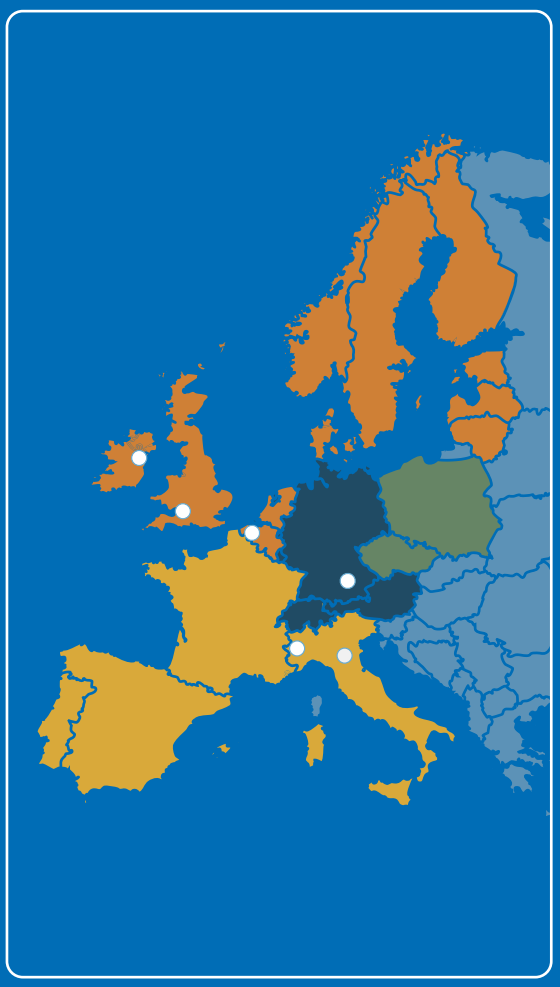
The *in situ* remediation project successfully utilized an innovative combination of 3-D Microemulsion, S-MZVI, and Bio Dechlor Inoculum Plus to treat chlorinated solvent contamination. The approach proved effective in meeting the site goals within a short time frame. Currently, there remains only a small area of the site, where groundwater was previously absent due to drought conditions, which is being evaluated for supplemental injections.

The project demonstrated the viability of using a combined ERD/ISCR treatment strategy for complex CVOC contamination in urban environments, ensuring long-term protection of groundwater resources and the surrounding community.

- No large-scale remediation expected to be required in the future

We're Ready to Help You Find the Right Solution for Your Site





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