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Site Goals Met Within 60 Days

PlumeStop Barrier Eliminates Offsite TCE Migration 5 Years to Date

Highlights

Site Type:
Industrial

Project Driver:
Reduce offsite TCE migration

Contaminants:
TCE up to 600 micrograms per liter (µg/L)

Geology:
Silty Sand

Treatment:
Sorption-enhanced reductive dechlorination

Technologies:
PlumeStop, HRC, BDI Plus

Quantity Applied:
64,000 gallons

Rapid Results:
TCE eliminated within 60 days

Summary

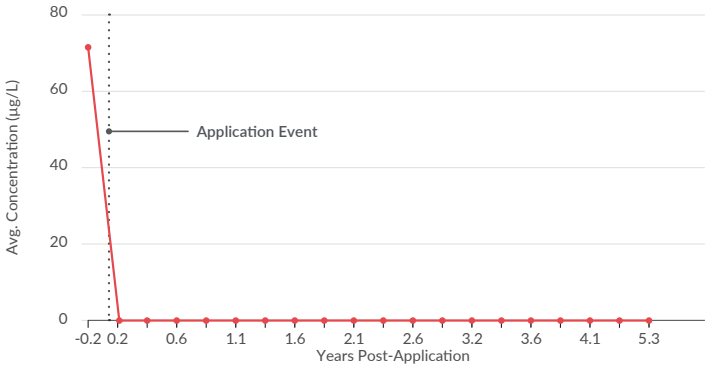
REGENESIS Remediation Services (RRS) completed a large-scale in situ groundwater treatment of trichloroethene (TCE) at a former industrial manufacturing facility in the Midwest that quickly achieved and then sustained performance objectives. TCE and low concentrations of other chlorinated volatile organic compounds (CVOCs), cis-1,2-dichloroethene, vinyl chloride, and 1,1,1-trichloroethane, were treated using an innovative sorption-enhanced reductive dechlorination (ERD) approach that virtually eliminated groundwater contaminants within 60 days of application.

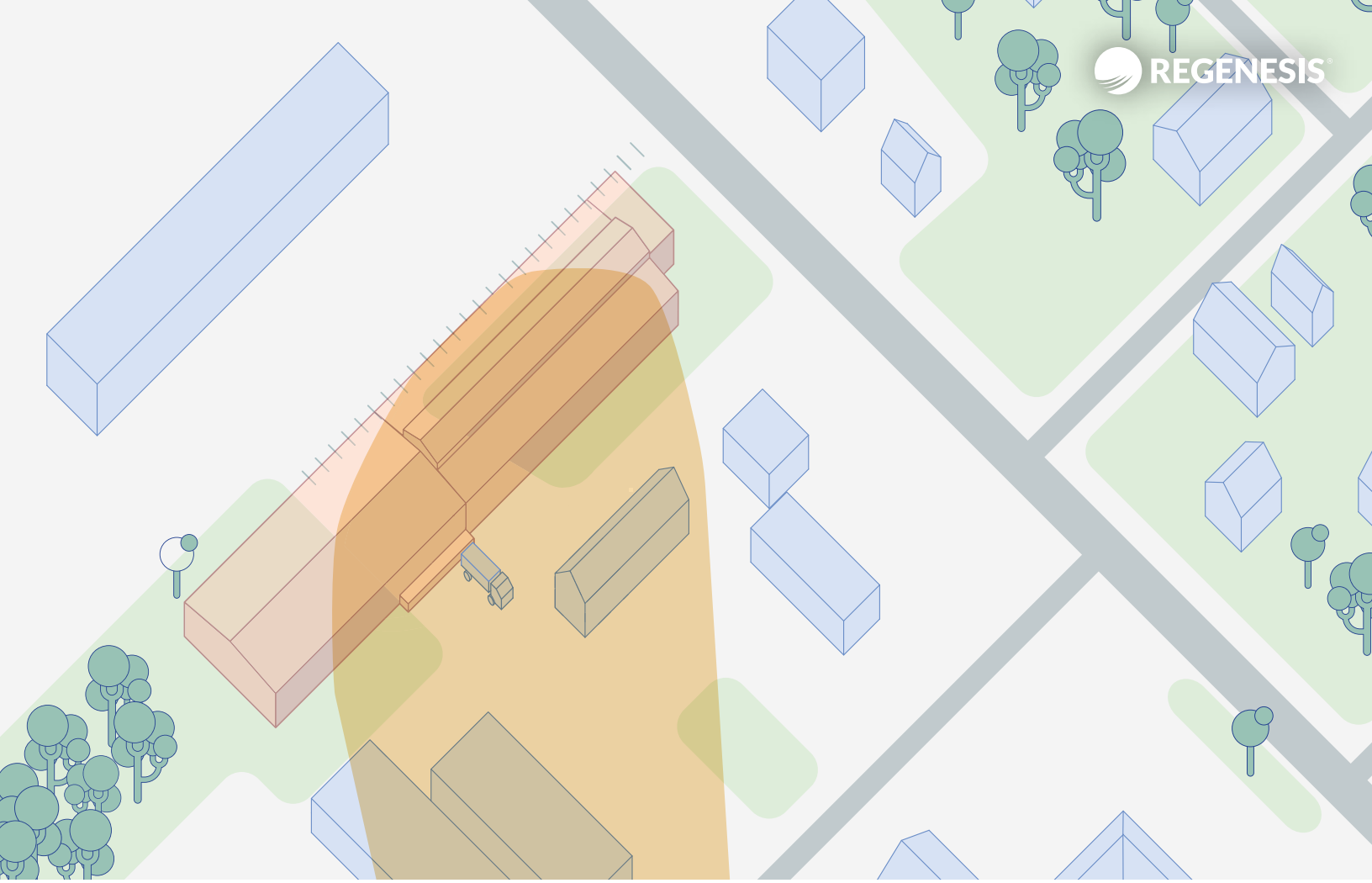
The permeable reactive barrier (PRB) installed at the site property boundary has eliminated TCE for over five years, meeting the application's performance objectives by cutting off the site's contribution to a more extensive groundwater TCE plume.

A collaborative remedial design and strategic implementation effort between REGENESIS and the consulting firm resulted in the project's success. This collaboration led to a dynamic remediation application strategy entailing planned, in-field adjustment to the design based on information obtained and assessed during remediation. An innovative remediation approach was needed to meet a very stringent deadline for the work's completion. Through careful planning and scheduling, RRS met the implementation deadline, which included work inside an active warehouse and retail business.

Results

- **TCE eliminated within 60 days post-application**
- **100% reduction maintained over 5 years**





Background

Eliminating TCE Using a Dynamic Remediation Approach

The site is comprised of a former manufacturing facility that currently operates as a commercial warehouse and retailer, along with other nearby industrial properties. Historical operations surrounding the site involved the use of TCE solvents, which spilled and migrated into the groundwater. This formed a groundwater plume extending more than 400 meters beyond the property boundary. The surrounding area is a mix of industrial, commercial, and residential properties, and several nearby residences use potable wells. Although the full nature and extent of impacts upgradient and cross-gradient were not yet defined at the time of treatment, the objectives were to eliminate the highest groundwater impacts, immediately halt further downgradient migration of impacts, and create an area of continued treatment to address any future impacts migrating through the treatment zone.

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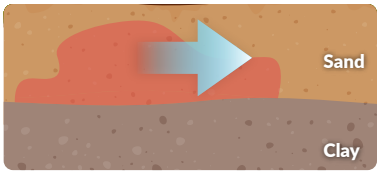
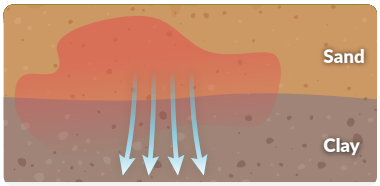
What is Back Diffusion?

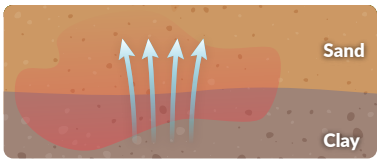
In aquifers composed of heterogeneous materials (e.g., sand and clay layers), the pollutant tends to flow primarily through higher permeability zones (e.g., sands).



As higher permeability zones transport elevated pollutant concentrations, a diffusion gradient is established that drives the pollutant into adjacent lower permeability zones (e.g., clays). Over time, this can result in adjacent lower permeability zones storing significant masses of dissolved contaminants.



Most remediation approaches remove contaminant concentrations from the more permeable zones, leaving lower permeability zones less treated. This condition sets up a reversal in the contaminant diffusion gradient referred to as “back diffusion’, in which dissolved contaminant concentrations stored in the lower permeability zones diffuse back into the areas of higher permeability where contaminants have been removed.

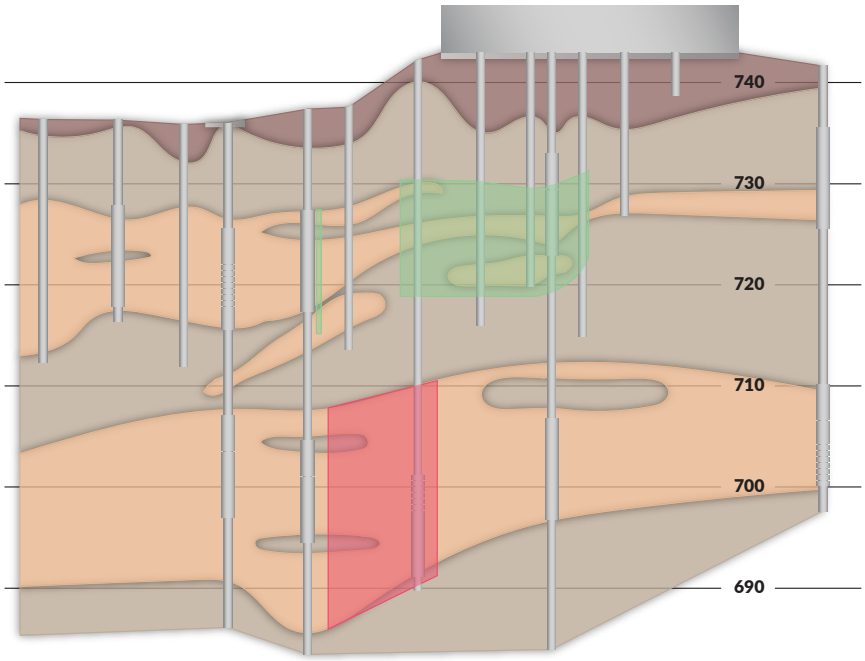


Back diffusion has been shown to occur over very long periods, causing persistent low levels of contaminants to impact groundwater wells long after aquifer remediation attempts. PlumeStop was designed for and has demonstrated the ability to effectively address back diffusing contaminants from lower permeability zones in third-party performed case studies.

Remedial Design Development

Following years of extensive soil and groundwater characterization activities, the consultant developed a groundwater remediation plan to address the area of highest TCE concentrations and halt further downgradient migration. The remediation plan specified the use of PlumeStop® Activated Carbon™ along with electron donor and bioaugmentation substrates, HRC® and BDI Plus®, respectively.

The consultant worked with REGENESIS to develop the remediation design. The team completed a detailed site hydrogeological characterization and used the data to create the conceptual site model (CSM). The CSM depicted TCE migrating downward from nearby and underneath the building, through fill materials and lower permeability soils into two underlying water-bearing sand units. The shallow water-bearing sand began at approximately 3m below ground level (BGL), and the deep water-bearing sand extended below 15m BGL. An intermediate clay separated these shallow and deep water-bearing units. Although TCE was present in groundwater in both water-bearing zones, the treatment primarily targeted the shallow zone to eliminate TCE and other CVOCs inhibiting further contribution to the larger TCE plume, and preventing back-diffusion.



Lithology Key

- Concrete/Asphalt
- Fill/Top Soil
- Sand/Silt/Gravel
- Clay

Remedial Installation Key

- Well
- Screened Section
- Shallow Water-Bearing Unit
- Deep Water-Bearing Unit

Dynamic Remediation

Application Design Summary

Baseline TCE Conc. Upper Sand Max.	
Within Study Area	127 µg/L
Property Boundary (Downgradient)	599 µg/L
Seepage Velocity:	200 ft/yr

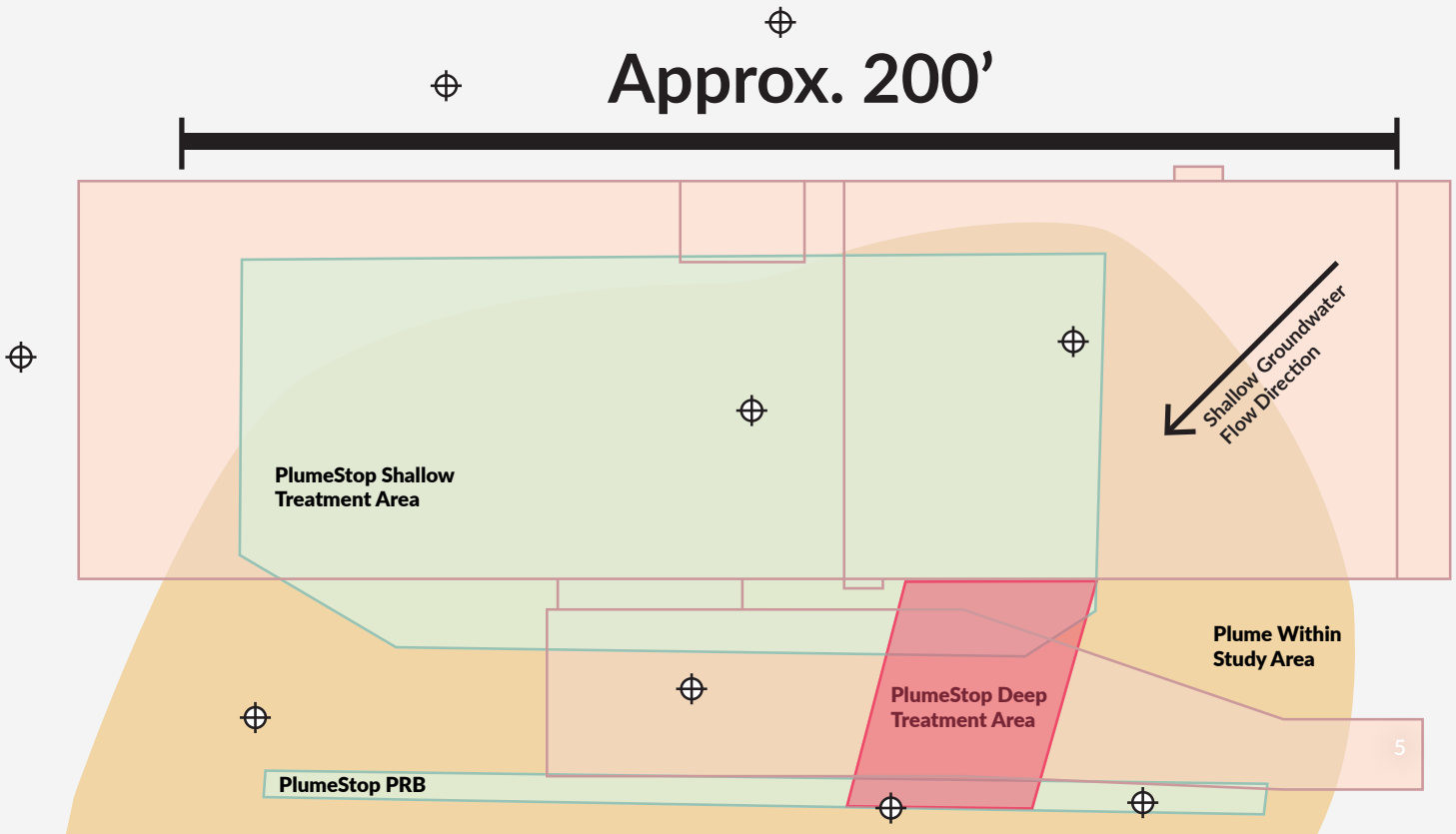
PRB Construction:	
Application Area:	25,000 ft²
Injection Points: (Direct Push)	82
Application Volume	64,000 gal.

Treatment Intervals:	
Shallow:	8-25 ft bgs.
Deep:	33-48 ft bgs.

The project provided the specific challenge of working inside an active retail warehousing business under a strict project completion timeline. The application needed to occur quickly and needed to be controlled and correctly targeted to the proper TCE-impacted, water-bearing sand units. Although the overall distribution of contaminants was understood, the approach required detailed spatial mapping of the water-bearing sand units targeted for application in the relatively extensive treatment areas. The necessity for detailed mapping of the sand zones led the consultant and REGENESIS to develop a dynamic remediation application method where the remediation design would accommodate the information gained during remediation.

The dynamic remediation process involved:

- Dividing the application areas into discretized sections;
- Collection of soil cores at each section to map the water-bearing sand unit depths targeted for application; and,
- Adjustment of the design in the field based on the sand thickness deviation from average.
- This dynamic remediation method ensured accurate placement and dosing of PlumeStop while negating additional site characterization delays by performing adjustments in real time.



Application

Close Collaboration Minimizes Impact to Operating Business

RRS mobilized to the site in May 2017, beginning with design verification testing (DVT) at the southern property line PRB. DVT included injection distribution confirmation testing at the start of injection to confirm the estimated injection radius and injection point spacing for PlumeStop. Additionally, the field crew collected soil cores along the PRB to identify the upper sand unit and define point-specific vertical treatment intervals and injection volumes. This process was repeated for discretized application areas within larger treatment areas underneath and adjacent to the warehouse building. RRS adjusted the original application design based on the feedback obtained from these ongoing DVT activities.

The consultant and RRS worked closely with the current site owner to delineate and schedule specific work at the injection area sections within the building to allow for the movement of warehouse inventory and set-up of working injection zones. The coordinated effort between the business owner, the consultant, and RRS allowed the injection work to proceed smoothly while minimizing business interruptions and downtime.

The application was completed in one month, successfully meeting the aggressive timeline while accommodating the active retail warehouse business' operations. RRS maintained the application at moderate delivery rates and low injection pressures, ranging from 1 to 1.7 bar. The adaptive but highly controlled application resulted in no incidence of product surfacing while completing the injection work inside the building, which was a key consideration for this project.

The consultant collected soil confirmation cores from the injection areas after the application. These cores showed even distribution throughout the target treatment interval.

RRS worked closely with the site owner to minimize impact to operations inside the fully operational warehouse

Results

PRB Eliminates TCE Migration in Less than 60 Days and Continues to Remain Effective for Over 5 Years

Following the application, TCE was virtually eliminated onsite by the first sampling event at two months post-application.

100% **TCE Reduction**

Remediation efforts have resulted in complete elimination of TCE at the property boundary for five years post-application

Within the building and the PRB, TCE has been eliminated to below detection limits for five years. Additionally, no significant formation of daughter products have been observed with total CVOCs having been reduced by 97 percent, on average. Moreover, ethene has been detected in the PRB performance wells above 200 micrograms per liter, and an increase in chlorinated solvent degrading bacteria was observed, providing two lines of evidence for post-sorption degradation of TCE and other CVOCs.

Figure 1 TCE Plume Before, and 60 Days Post-Application

Study area TCE plume extents prior to application (top) and 60 days post-application (bottom)

- >500 ppb TCE
- >100 ppb TCE
- >5 ppb TCE
- Application Area

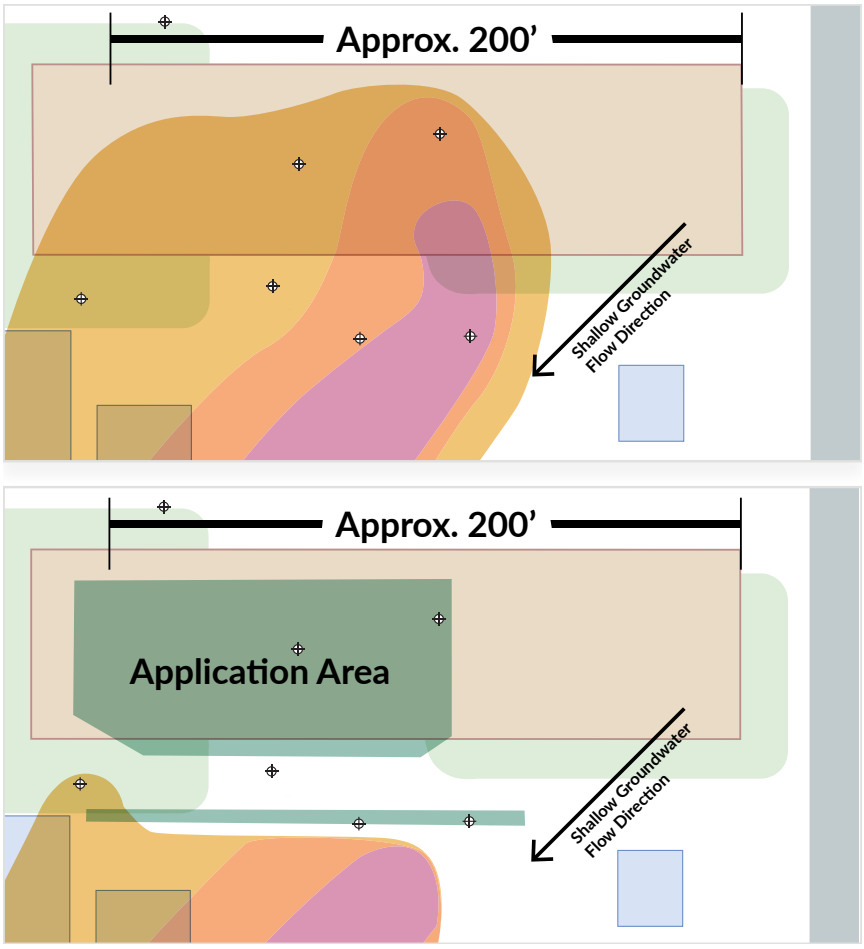
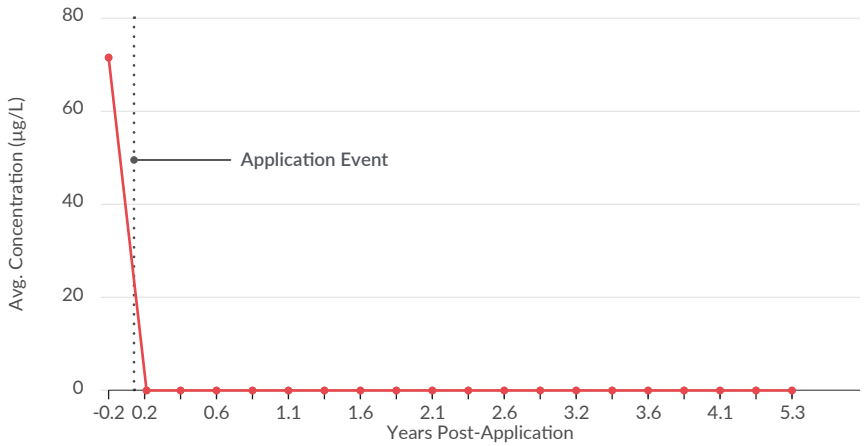


Figure 2

Average TCE Concentrations in Building Wells

Average TCE concentrations in building wells MW-10 and MW-8



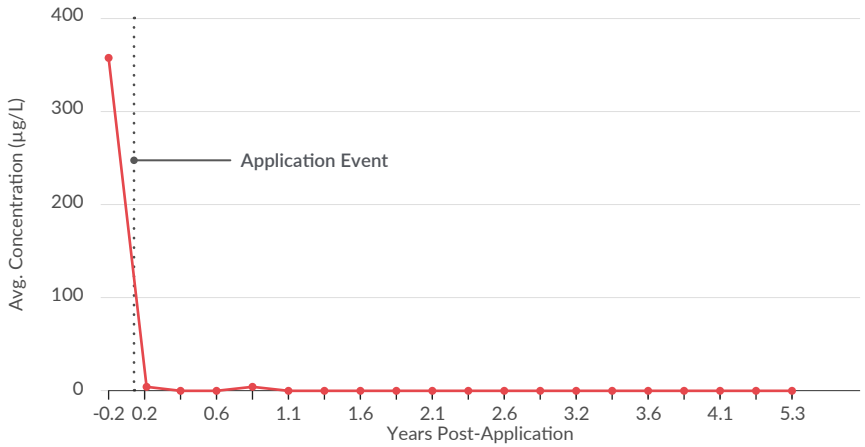
60 Days

Results achieved within 60 days post-application.

Figure 3

Average TCE Concentrations in PRB Wells

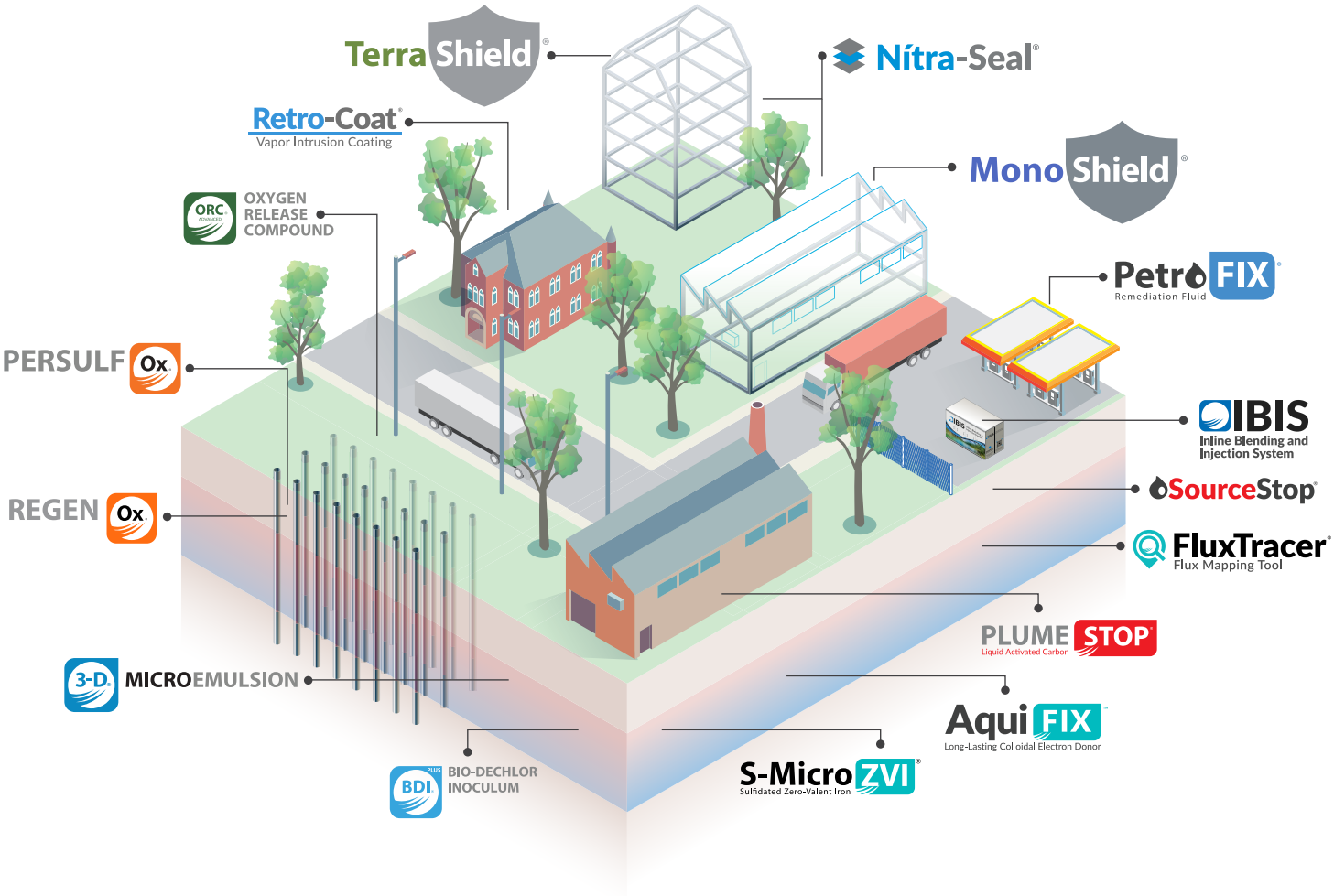
Average TCE concentrations in PRB wells MW-24 and MW-7



>5 Years

TCE remains completely eliminated more than 5 years post-application.

These results met the remediation goals to quickly reduce TCE in groundwater, thereby eliminating further contribution to the downgradient TCE plume. The treatment continues to remain effective, backed by over five years of performance data.



About REGENESIS

At REGENESIS we value innovation, technology, expertise and people which together form the unique framework we operate in as an organization. We see innovation and technology as inseparably linked with one being born out of the other.

Inherently, innovation imparts new and better ways of thinking and doing. For us, this means delivering expert environmental solutions in the form of the most advanced and effective technologies and services available today.

We value expertise, both our customers' and our own. We find that when our experienced staff collaborates directly with customers on complex problems, there is a high potential for success including savings in time, resources and cost.

At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking time to understand the people we work with and their circumstances. We believe this is a key factor in achieving successful project outcomes.

We believe that by acting under this set of values, we can work with our customers to achieve a cleaner, healthier, and more prosperous world.

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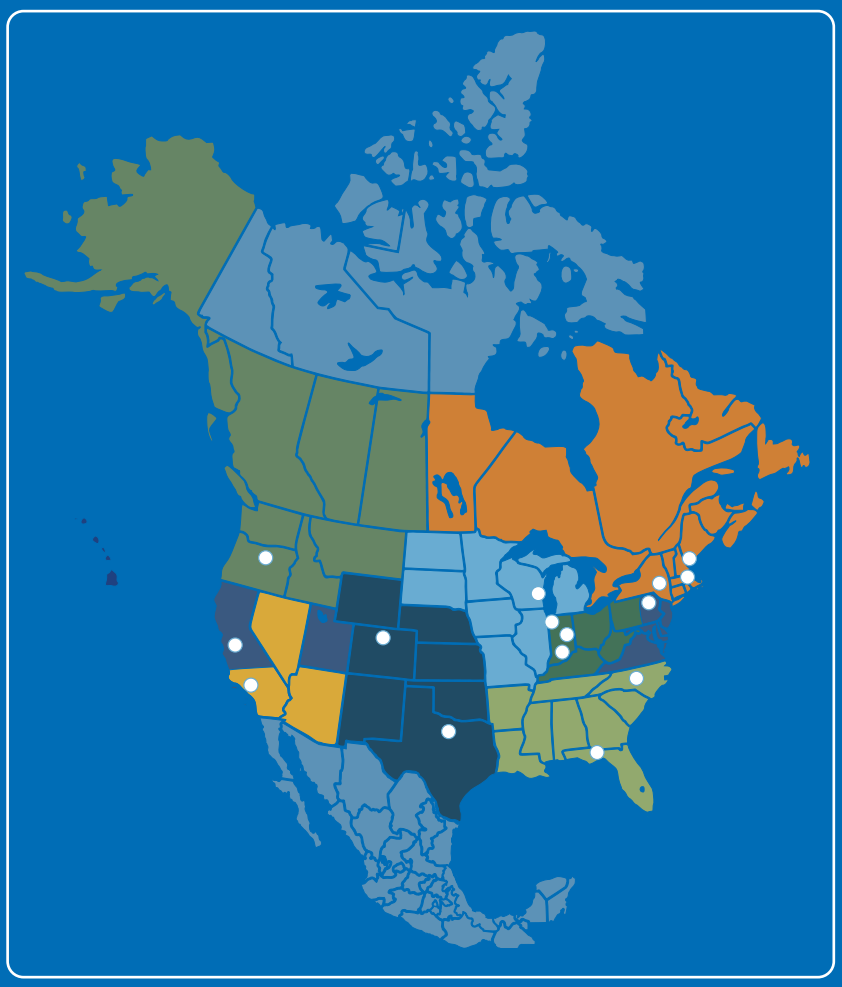
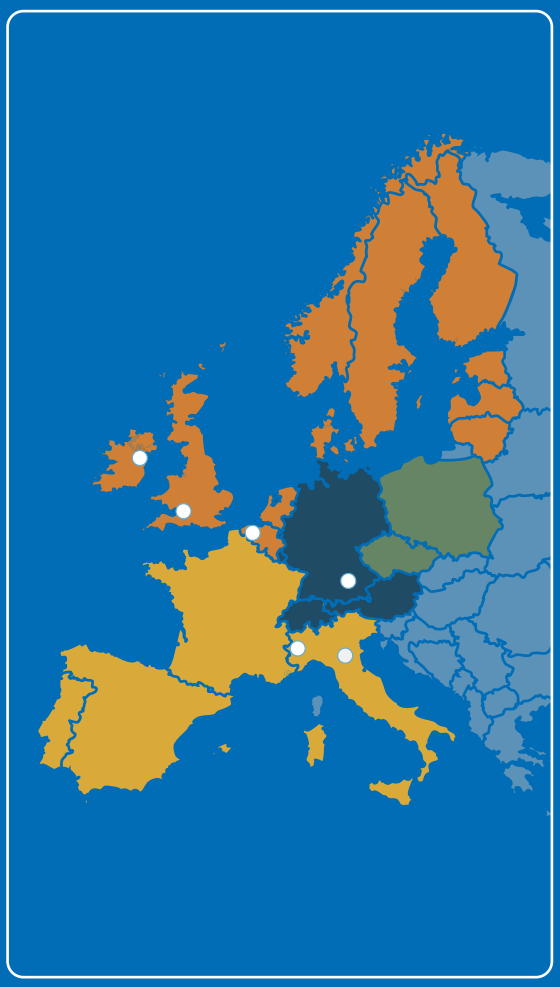
We're Ready to Help You Find the Right Solution for Your Site





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