



REGENESIS[®]

ADVANCED REMEDIAL TECHNOLOGIES RESTORE NEIGHBORHOOD

CASE STUDY:

**Former Michigan Industrial
Site Treated Using Combined
Remedy Approach**

Case Study Overview

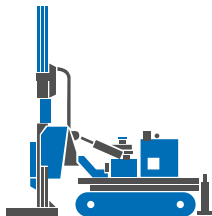
A former plating facility in southwest Michigan, released chlorinated volatile organic compounds (CVOCs) into shallow groundwater which resulted in a ¼-mile long contaminant plume. This fast-moving contaminant plume extended beneath a residential neighborhood and discharged to the nearby Paw Paw River. The contaminated groundwater infiltrated into a nearby storm water system and into several residential basement sumps.

In response, the Michigan Department of Environmental Quality (MDEQ) and the environmental firm, DLZ, implemented a combined remedy which included mitigating vapor intrusion in the residential basements and treating the groundwater plume with a novel, multi-phase Enhanced Reductive Dechlorination (ERD) approach. These efforts succeeded in eliminating the immediate vapor intrusion risk at the residences and virtually eliminating the dissolved-phase CVOC plume, negating any potential future risks to the residences and the surface water.

Project Highlights



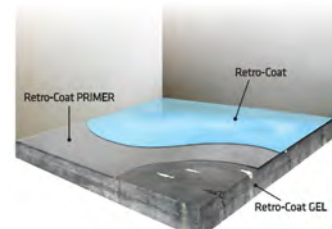
3DME was injected with little disruption to the residential community.



PlumeStop bio barriers were installed strategically to protect against further plume migration.



Retro-Coat Vapor barriers were installed in residential basements to protect occupants.



**98-100%
CONTAMINANTS
ELIMINATED**

Treatment reduced the total cVOC plume extent by 95% and reduced mass by 99.8% to-date.

**DEGRADATION
ONGOING AND
PROGRESSING**

Indicator parameters are showing positive results, indicating the degradation process is ongoing and progressing.



**LIMITED
DISRUPTION
TO RESIDENTIAL
NEIGHBORHOOD**



About the Project

The MDEQ (Michigan Department of Environmental Quality) began state-funded activities at an industrial plating facility in southwest Michigan to determine the nature and extent of contamination emanating from an area of the facility where degreasing agents were used. The investigation identified CVOCs and impacted groundwater. The impacted groundwater was in a ¼-mile long shallow plume ranging from 2 to 5 feet in depth migrating from the site and throughout a residential area. Contaminated water was found in some of the basement sumps in the residential area. After assessing a nearby storm water system, it was clear that the contaminated groundwater was also discharging into the East Branch of the Paw Paw River.

Environmental consultant firm, DLZ, was engaged to evaluate the site and determine recommendations for clean up.



The extent of the groundwater CVOC plume circa 2010. The plume moved south to north through a residential neighborhood toward the Paw Paw River to the north.



DEQ Department of Environmental Quality

David Harn, MS
Assistant District Supervisor at Michigan Department of Environmental Quality

About the Consultant

DLZ partners with clients to develop the best solutions to achieve the goals of any project. DLZ's multidisciplinary staff includes architects; civil, traffic/transportation, structural, mechanical, electrical, geotechnical, sanitary, chemical, and construction engineers; environmental specialists; land and community planners; computer applications specialists; surveyors; drillers; geologists; landscape architects; interior designers; ecologists; and specification writers. DLZ's subsurface investigation division offers a full range of drilling services for a variety of environmental projects and is capable of providing most types of rotary, coring, and auger drilling. DLZ personnel are familiar with the proper field protocols outlined by ASTM, AASHTO, USEPA, and USACE, as well as various local, state, and federal specifications and guidelines.

DLZ is one of the top consulting firms in the architectural, engineering, and surveying industry. The firm was ranked by Engineering News Record as Midwest Design Firm of the Year in 2016 and currently ranked as one of the Top 150 in the U.S. and the 8th largest in the Midwestern United States. Our multidisciplinary, collaborative approach to professional services allows us to build and lead successful project teams that are dedicated to providing solutions that save money, improve operations, and solve problems with our competency, integrity, and contributions to the people and communities we serve. Our vision is simple: Create successful partnerships with our clients that facilitate trust, commitment, and communication. DLZ is one of the top consulting firms in the architectural, engineering, and surveying industry. The firm was ranked by Engineering News Record as Midwest Design Firm of the Year in 2016 and currently ranked as one of the Top 150 in the U.S. and the 8th largest in the Midwestern United States. Our multidisciplinary, collaborative approach to professional services allows us to build and lead successful project teams that are dedicated to providing solutions that save money, improve operations, and solve problems with our competency, integrity, and contributions to the people and communities we serve. Our vision is simple: Create successful partnerships with our clients that facilitate trust, commitment, and communication.



Timeline

2010

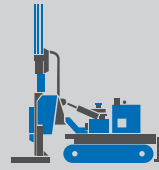
Vapor Intrusion Mitigation: To diminish vapor intrusion in several residential basements, the sumps were capped and vented, and Retro-Coat was applied to the floors and walls.



Pilot Test: The six-month pilot test demonstrated effectiveness of the 3DME technology.

2011

CVOC Groundwater Plume Treatment: 3DME was applied to the groundwater plume at large. The 3DME technology allowed for minimal interferences with residents and a low pore volume displacement.



2013



Industrial Building Demolition: A grid based injection point array was used to administer the 3DME treatment underneath the former Paw Paw Plating building following demolition and removal. CVOCs were drastically reduced in the source and near-source areas.

2015

Residential Area Plume Maintenance: PlumeStop biobarriers were employed within the residential plume area to provide a final polishing treatment of residual low levels of CVOCs and to protect against any future migration of residual CVOCs.



2016

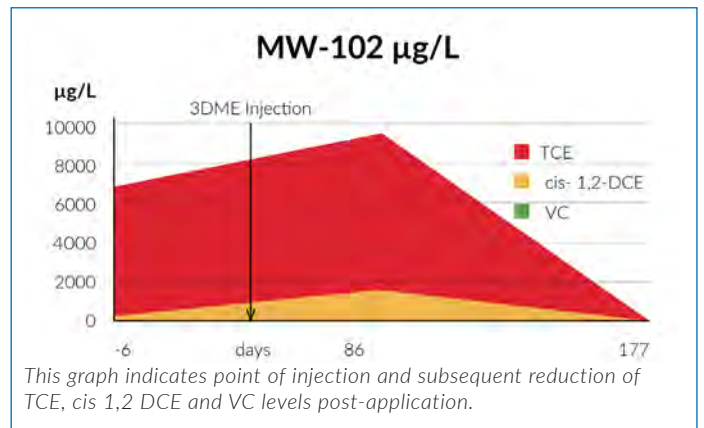
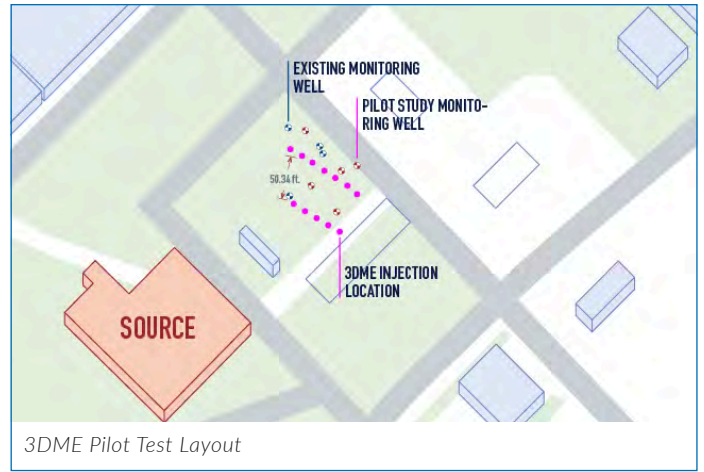


Results: After treatment, the CVOC plume has been eliminated. The treatment reduced the total CVOC plume extent by 95% and reduced the cumulative mass by 99.8%, thus far.

The Pilot Test Demonstrates Technology Efficacy

MDEQ and DLZ conducted a six month pilot test to demonstrate the efficacy of 3-D Microemulsion or 3DME technology. The remediation team spaced two rows of injection points approximately 50 feet apart for the test. The graph shown is from a representative well (MW-2) depicting 97% reduction in CVOCs within six months.

Based on the successful pilot test, MDEQ proceeded with the full-scale application. 3DME was the chosen technology for this project because it has unique subsurface distribution characteristics and a beneficial, sequential staged release of three unique electron-donor materials. Because of its staged release mechanism, 3DME is highly efficient, providing the optimal amount of electron donor for complete dechlorination of CVOCs. This mechanism along with its distribution characteristics allows there to be less injection sites making 3DME both time and cost-effective compared to other enhanced natural attenuation approaches.



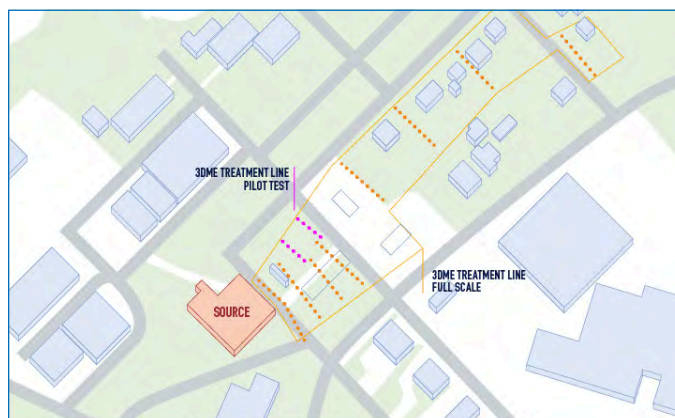
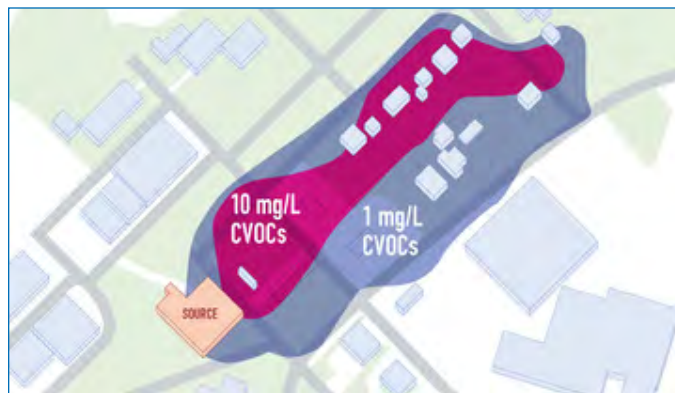
Full-Scale Application

Following the successful proof-of-concept pilot test, 3DME was applied to the groundwater CVOC plume downgradient of the former Paw Paw Plating facility. The design challenges of a fast-moving aquifer (more than one foot a day) migrating through a residential neighborhood required an innovative remedial design approach consisting of treatment lines spaced approximately 200 feet apart (on average) between residential properties. In this manner the natural groundwater advection could be utilized to take advantage of 3DME's unique micellar distribution properties. Closer to the source, treatment lines were spaced approximately 50 feet apart.

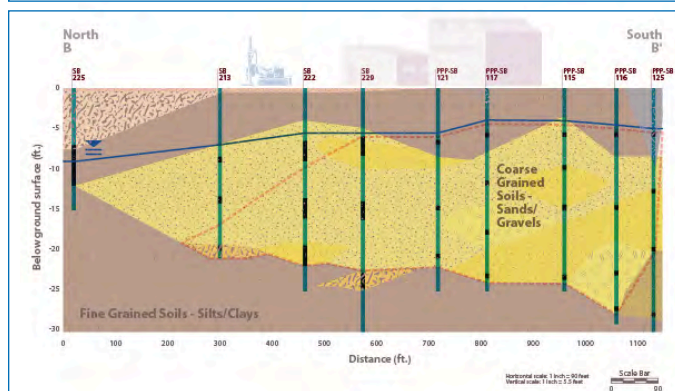
The effective pore volume within the target treatment zone was estimated to be 1.3 million gallons. The injected 3DME dilution mixture was approximately 15,000 gallons, resulting in a minimal 1.7% effective pore volume displacement. This very low-volume approach is afforded by the mobile properties of 3DME which do not require it to be pushed by pumping for final displacement. Instead, natural groundwater advection may be used to distribute 3DME. This was a critical consideration because it minimized both the installation costs and onsite time, while maintaining sufficient treatment coverage to achieve the desired result: elimination of the CVOC plume.

Following the full-scale application of 3DME, the industrial building was demolished so that the source area for the contaminants could be accessed for treatment using the ERD approach. A grid based injection point array was used for 3DME treatment in this area. As with the plume-wide treatment, contaminants were drastically reduced.

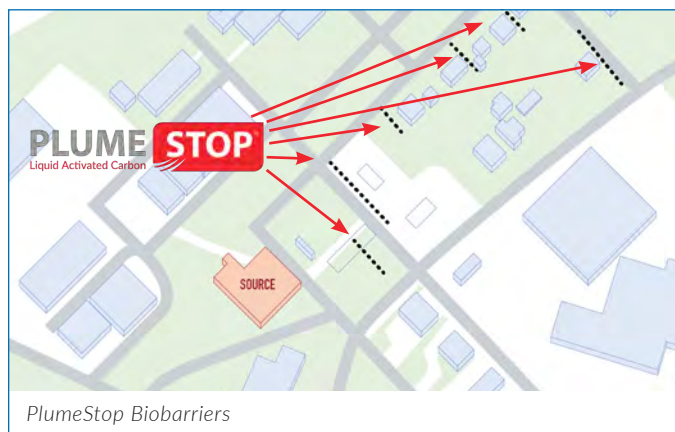
PlumeStop was used as a final polishing treatment to address residual low levels of CVOCs not treated with 3DME. A series of biobarriers was placed strategically within the residential plume area to protect against any future migration of residual CVOCs from untreated or not-fully treated areas. The biobarriers employed PlumeStop along with a polylactate-based electron donor (Hydrogen Release Compound [HRC]) and Bio-dechlor INOCULUMN Plus (BDI-Plus), a microbial consortium containing *Dehalococcoides sp* (DHC) to promote sorption-enhanced ERD.



Site Plan Depicting The 3DME Full Scale Injection Layout. Neighborhood Treatment Lines Are Spaced Approximately 200 Feet. Apart With Closer Spacing Near The Source.



Cross section shown depicting the shallow saturated coarse-grained outwash deposits... CVOCs moved through the outwash soils, but also diffused into the lower permeable soils underneath.



PlumeStop Biobarriers

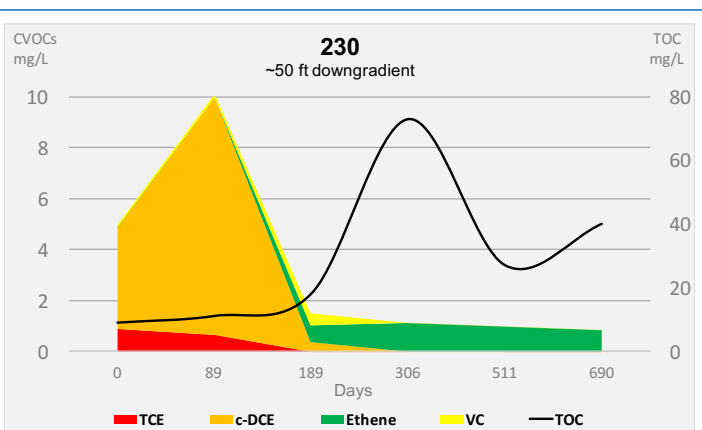
Results

The ERD treatment used the natural groundwater gradient along with the mobile properties of 3DME to sweep the treatment from line to line throughout the residential neighborhood. The following figures and charts demonstrate how this was accomplished with a focus on two wells downgradient of a treatment line.

The mobile portion of the 3DME was observed between 3 and 6 months as indicated by the gradual rise in total organic carbon (TOC). Once the TOC was observed, total CVOC concentrations were reduced three orders of magnitude within 10 to 12 months. Additionally TOC longevity was greater than 600 days

while ethene persisted above 0.5 milligrams per liter (mg/L) for 500 days.

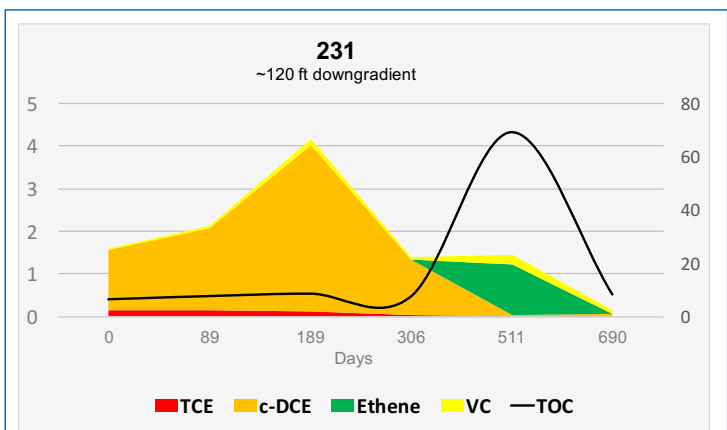
The remediation team observed a rise in TOC at Well #231 after 300 days post-injection. When this occurred, CVOCs were reduced to ethene almost immediately. The team noted the time of the TOC rise and compared it to the time and distance of the injection line to determine that the mobile fraction of the electron donor migrated at approximately 1/3 the speed of the groundwater. This distributive behavior is consistent with observations at other project sites for 3DME in moderate to highly conductive aquifer systems (i.e., >0.5 feet/day).



CVOCs and TOC in days following injection at Well #230



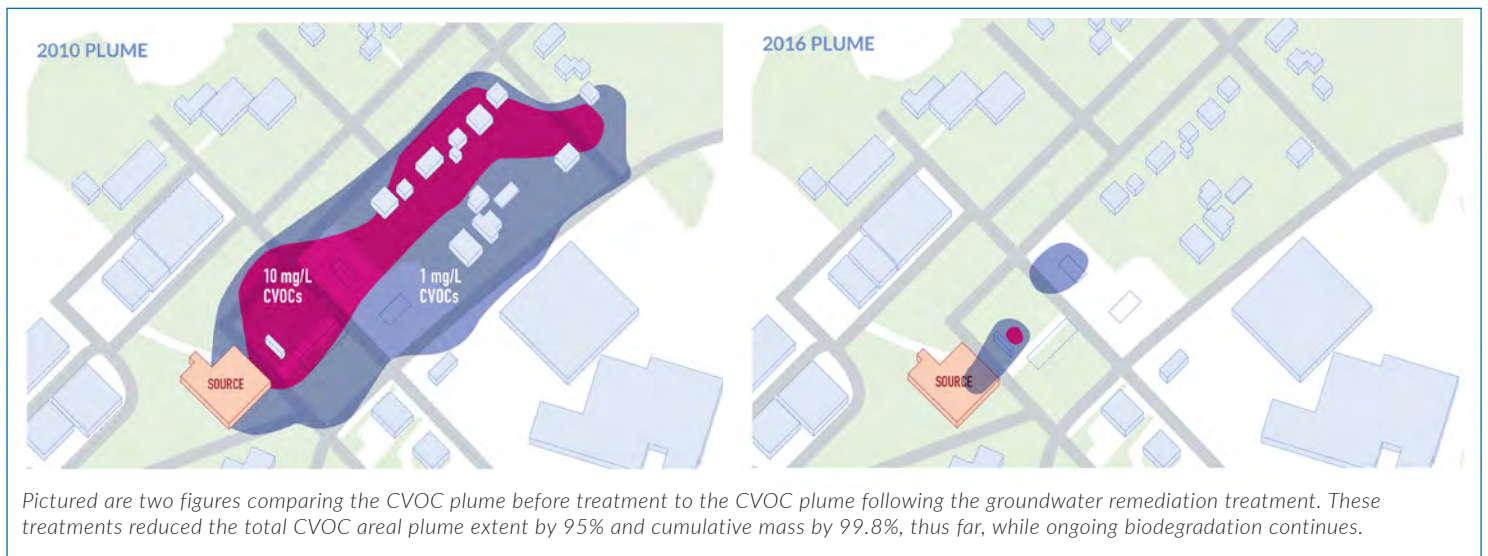
Well #230 - Approximately 50 feet away from the nearest upgradient treatment line



CVOCs and TOC in days following injection at Well #231

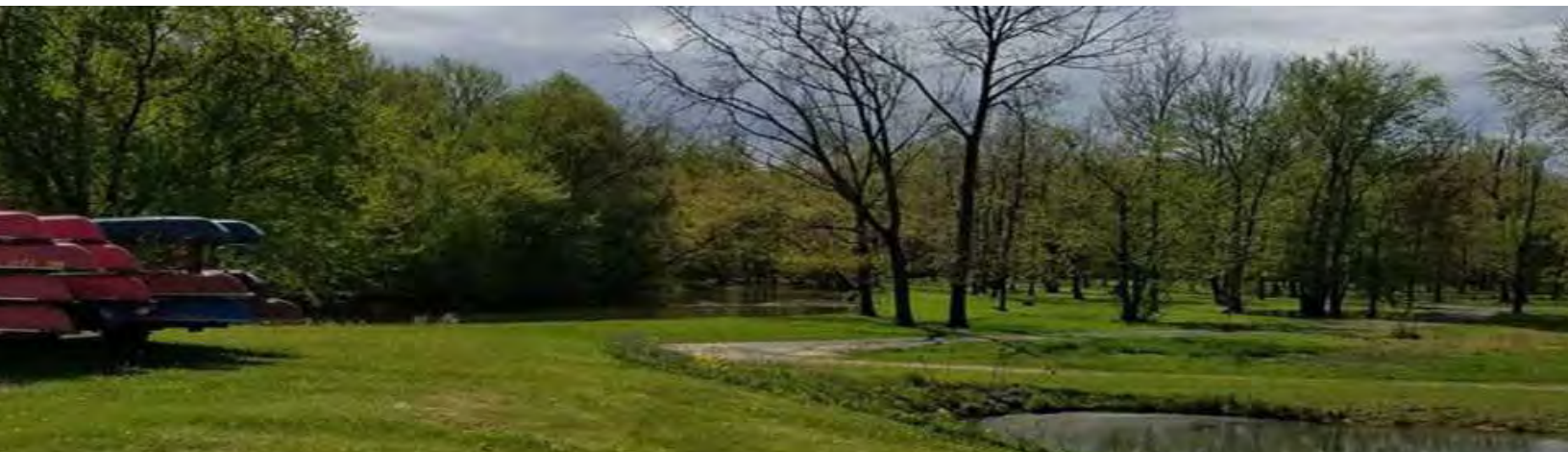


Well #231 - Approximately 120 feet away from the nearest upgradient treatment line



Summary Highlights

- An investigation led by MDEQ and DLZ identified contamination under a residential neighborhood and within basement sumps.
- Through the use of passive venting, crack sealing, and reconditioning of the basements with Retro-Coat, the risk of further vapor intrusion was nullified.
- With REGENESIS design support, MDEQ and DLZ implemented a multi-stage groundwater remedy to address the groundwater CVOC plume. The design allowed for the mobility and persistence of 3DME to be harnessed by utilizing the natural groundwater gradient in a fast moving aquifer system.
- The strategic design allowed sweeping of the reagent using a limited number of injection points to minimize disturbance to the residents in the neighborhood.
- The mobile properties of 3DME do not require it to be pushed by pumping for final displacement which allowed the effective pore volume displacement to be only 1.7%, greatly reducing application costs.
- Biobarriers using PlumeStop's technology were strategically placed within the residential plume area to protect against further migration of residual CVOCs over the long-term from untreated or not-fully treated areas.
- The remediation design and the use of 3DME minimized the installation costs and onsite time while maintaining sufficient treatment coverage to achieve the desired result.



Technologies Used

PLUME STOP Liquid Activated Carbon

A Liquid Activated Carbon™ material that's designed to address the challenges of excessive time and end-point uncertainty in the *in situ* remediation of groundwater contaminants.

HRC HYDROGEN RELEASE COMPOUND

An injectable liquid electron donor material with wide-area surface distribution properties and staged hydrogen release profile specifically designed for *in*

3-D MICROEMULSION

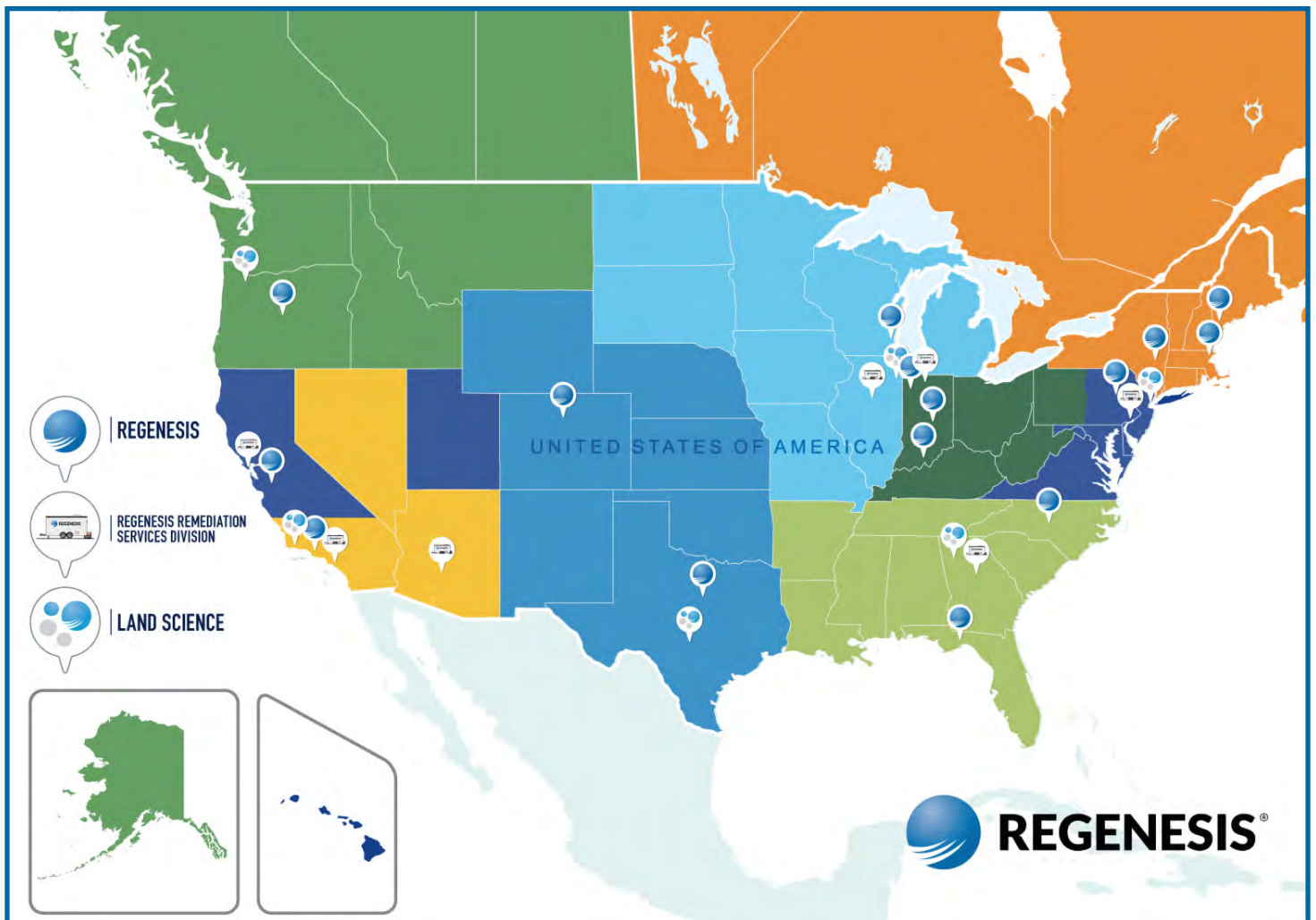
An injectable liquid electron donor material with wide-area surface distribution properties and staged hydrogen release profile specifically designed for *in situ* remediation projects where the anaerobic biodegradation of chlorinated compounds by enhanced reductive.

Retro-Coat™ Vapor Intrusion Coating

A vapor intrusion protection coating that consists of chemically resistant materials which properly eliminates the threat of contaminants.



REGENESIS Is Ready To Assist You In Determining The Right Solution For Your Site



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