REGENESIS®

UST Site Closure Achieved Following Colloidal Carbon and Bioremediation Treatment

PetroFix Achieves Over 97% Benzene Reduction in Weathered Bedrock

Highlights

Site Type:
Commercial Gas Station

Project Driver:
Contamination of drinking wells, plume migration, and need for immediate remediation

Contaminants:
Benzene, up to 1,100 µg/L and other petroleum hydrocarbons

Treatment:
Sorption-enhanced bioremediation

Technologies:
PetroFix

Geology:
Weathered bedrock

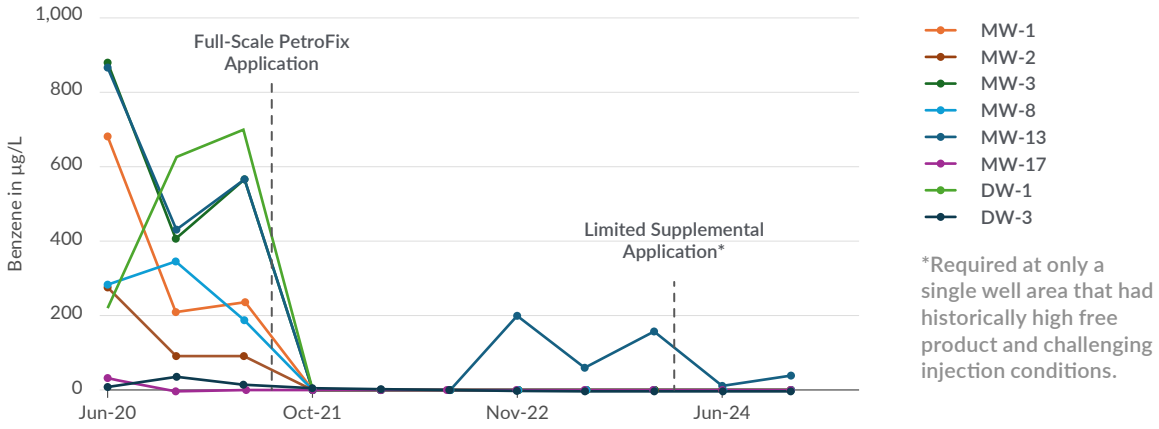
Summary

A petroleum odor discovered in a residential production well led to the identification of an underground storage tank (UST) release at an upgradient active gas station. The contamination plume, containing high levels of total petroleum hydrocarbons (TPH), specifically benzene, threatened eight nearby residential drinking wells. Given the urgent need for remediation, PetroFix® was chosen over other methods, including ozone, due to its rapid and effective treatment capabilities. This first-ever PetroFix application in Alabama was highly successful, achieving the site cleanup objectives to demonstrate offsite drinking water protection and earning the site a No Further Action Status.

Results

- **Site cleanup objectives achieved, offsite drinking water protected**
- **The use of PetroFix enabled the site to earn a No Further Action Status**

Benzene in Performance Monitoring Wells



*Required at only a single well area that had historically high free product and challenging injection conditions.

Background and Site Challenges

An active gas station released gasoline from its UST system, leading to detectable petroleum odors in a nearby residential well. Subsequent testing revealed the well to be contaminated with benzene and other petroleum hydrocarbons. A remedial solution was needed to quickly address high contaminant concentrations. The amendment needed to be evenly distributed through a weathered aquifer (varying proportions of sand, clay, and limestone) to treat a diving plume offsite and ensure long-term treatment while protecting monitoring well integrity.

Remedial Solution and Project Goals

Mid-South Testing (Mid-South), a leading environmental, geotechnical, and civil engineering company headquartered in Alabama, evaluated several remedial technologies in its Corrective Action Plan (Mid-South, 2019), including dual-phase extraction, ozone sparging, *in situ* chemical oxidation, and carbon-based injectates. Ozone treatment was initially proposed but rejected due to concerns about its insufficient distribution, which would prolong the timeline for addressing the impacted wells.

After considering time and site constraints, public roadways, and utilities, Mid-South determined that the PetroFix injection was the best option to remediate the saturated soils and groundwater. A key deciding factor was PetroFix's low-pressure application method, which was deemed less intrusive to nearby private wells and safer to use near the active UST system. The remedy was also expected to deliver rapid results.

The goals of the remediation were to achieve a 90% reduction in benzene concentrations within 12 months and prevent further migration of the contamination plume. Success would be demonstrated by reducing concentrations below the site-specific target levels (SSTL) for benzene assigned to each individual well. Achieving these goals would allow for the continued safe use of eight local drinking water wells.

PetroFix Remediation Fluid

PetroFix is a highly concentrated water-based suspension consisting of activated carbon and added electron acceptors (sulfate and nitrate). The hydrocarbons are removed from the dissolved phase by adsorbing them onto the carbon particles, and biodegradation of the hydrocarbons is stimulated by the electron acceptors.

Remediation Design and Application

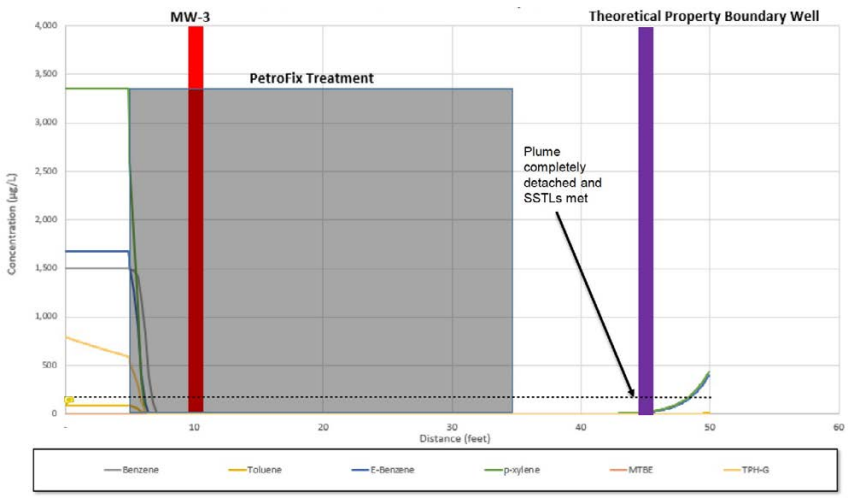
Flux Measurement and Predictive Modeling

Scan here to learn about FluxTracer® Flux Mapping Tools

Before the full-scale application, passive flux meters (PFMs) were placed in two wells to quantify and delineate the contaminant flux zones. The data collected were used to assign PetroFix dosing for each treatment area, allowing for a highly targeted application of PetroFix. PlumeForce™, REGENESIS' proprietary remediation fate and transport model, was used to simulate the effects of the application over time, utilizing site-specific inputs.

Figure 1 Western On-Site Treatment - Day 365

PlumeForce modeling simulation predicts treatment success.



Design Layout

The remediation focused on two areas of the site: the source area (original location of USTs) and the downgradient plume. Grid arrays with tightly spaced injection points were used to address high contaminant concentrations in the source area, while a series of permeable reactive barriers (PRBs) were employed to contain and treat the plume, ensuring no further contaminant migration to the surrounding wells. Soil cores were collected throughout the proposed treatment areas to better understand soil characteristics and potential injection challenges.

Field Application

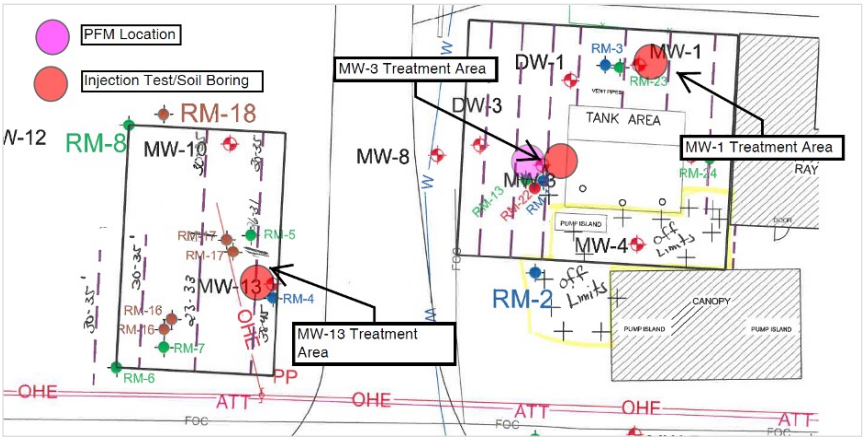
REGENESIS Remediation Services (RRS) completed the application in August 2021, injecting 82,400 lbs of PetroFix through 112 points, where retractable screens were advanced to the target depth using a direct-push technology (DPT) injection method. This material was strategically applied at the site using a tight grid formation in the former underground storage tanks (i.e., the source zone), combined with a series of downgradient permeable reactive barriers (PRBs) to halt further plume migration.

Prior to injecting PetroFix, RRS completed hydraulic radius of influence (ROI) testing, injecting clean water to help assess volumetric loading rates in the key flux zones. This information was used to calibrate injection volumes and spacing to ensure product overlap between source grid and PRB points.

Following the full-scale application, a limited supplemental application of 1,600 lbs of PetroFix was injected to boost the treatment in the offsite area near MW-13, which historically contained free product, and where site slope and geology resulted in poorer distribution in the first injection.

Figure 2 Treatment Area Application Map

Treatment area application map showing PFM and injection test locations.



Application Details

Material Quantities	
PetroFix:	84,000 lbs
Electron Acceptors:	4,200 lbs

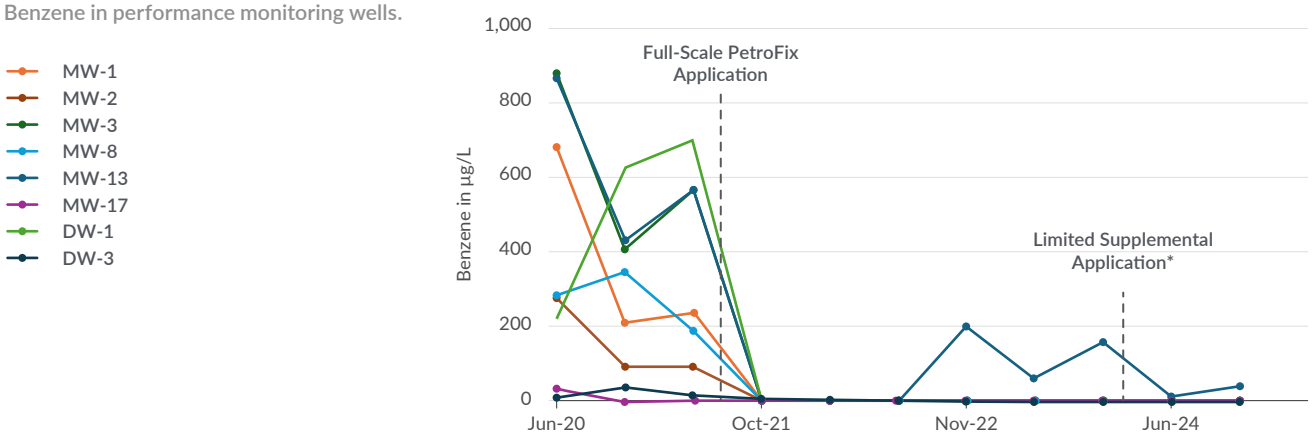
Injection Information	
Total Volume Injected:	57,000 gallons (approx.)
Injection Points:	118
Injection Method:	DPT with retractable screens

Results

The PetroFix treatment resulted in rapid and significant reductions in contaminant concentrations, with seven of the eight treatment zone monitoring wells reduced to below or near detection limits for benzene. A limited supplemental application (six injection points) was conducted in 2023. Following this event, all wells reported benzene concentrations below their respective site-specific target levels (SSTLs), leading Alabama Department of Environmental Management (ADEM) to issue a No Further Action determination for the site.

Figure 3 Benzene in Performance Monitoring Wells

Benzene in performance monitoring wells.



Conclusion

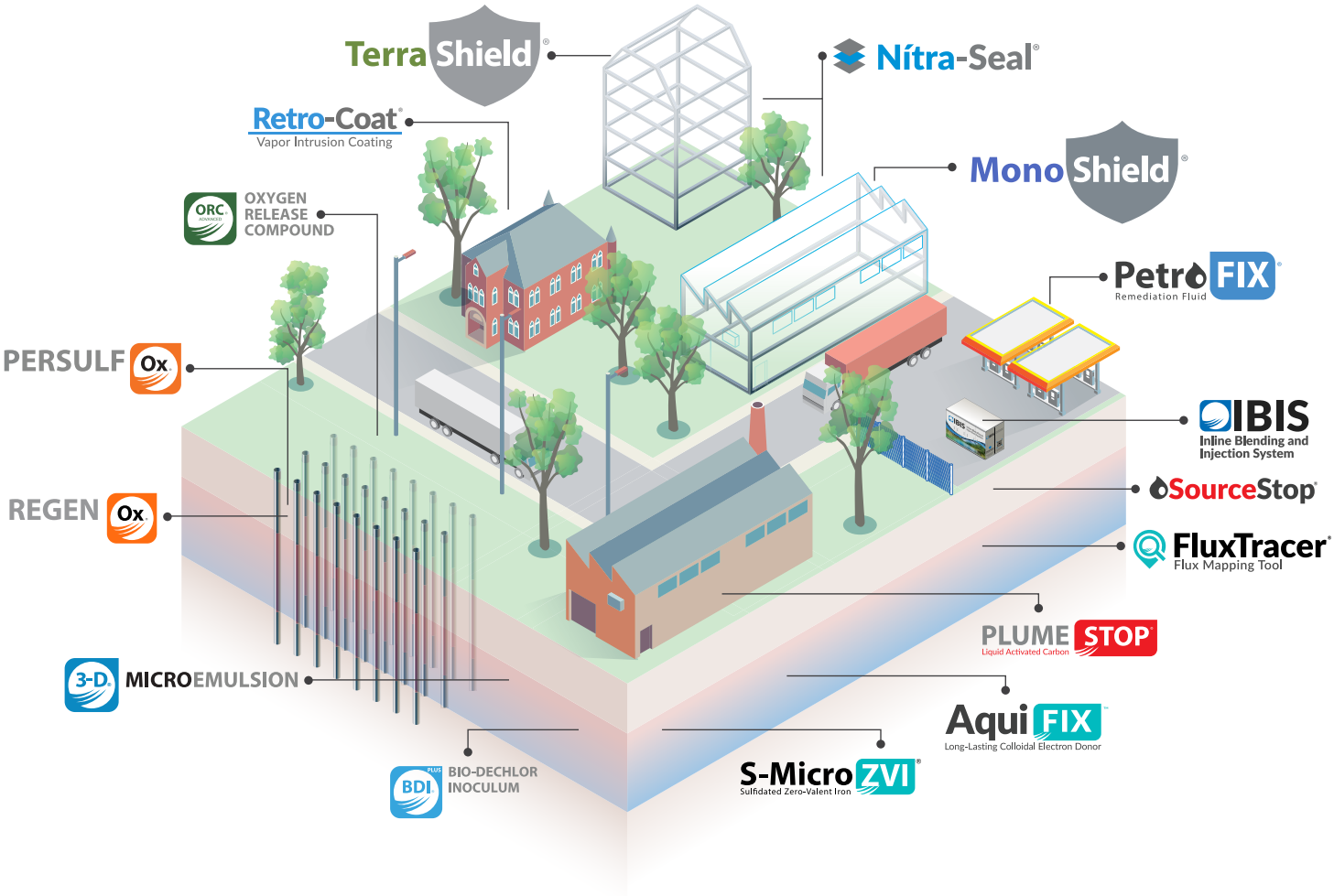
The PetroFix application was the first of its kind in Alabama and demonstrated the effectiveness of treating a complex petroleum hydrocarbon plume using an innovative sorption-enhanced bioremediation approach. The PetroFix application led to the successful reduction of benzene concentrations below the SSTLs, ensuring that the impacted drinking water wells were protected.

> "I could not have achieved this closure without the help of REGENESIS."

— Suzanne Holme, Project Geologist - Mid-South Testing

Reference

Mid South Testing, Inc. (Mid-South) (2021). Corrective Action Plan Modification: PetroFix™ Remedial Injection, Rayo Mart, 6505 2nd Street and 7u, Muscle Shoals, Colbert County, Alabama (Facility I.D. Number 19979-033-003761, UST Incident Number: UST17-02-03, Cost Proposal #38).



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.

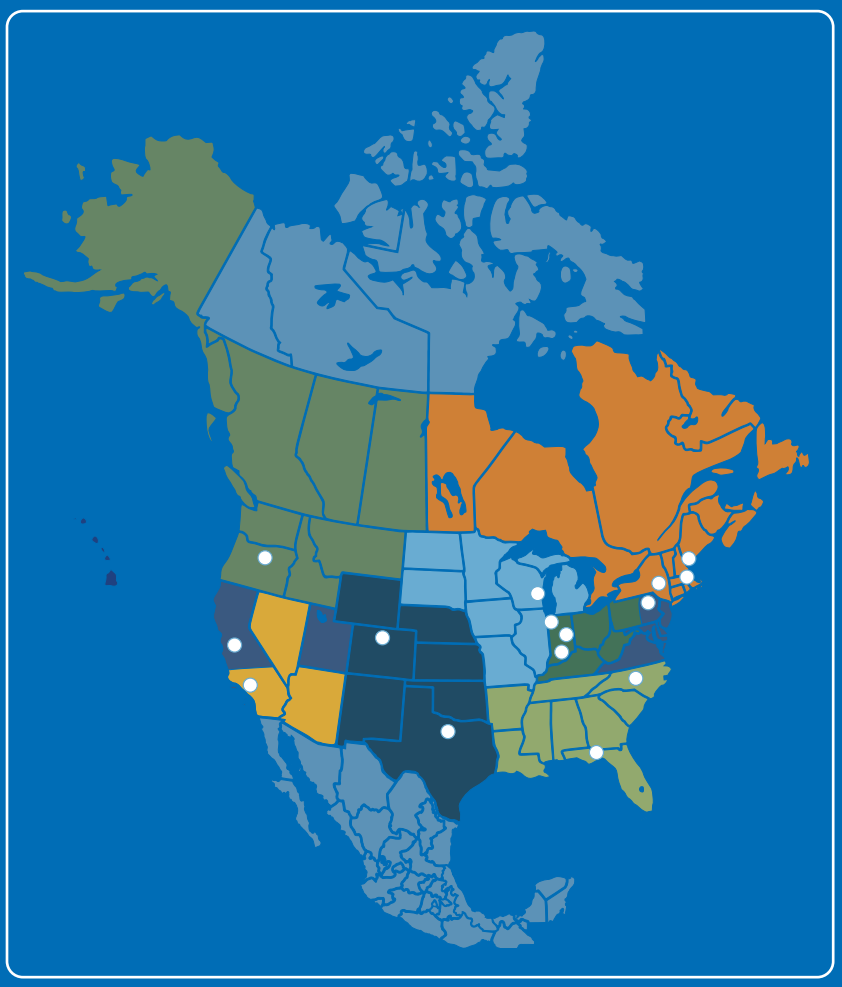
Inherently, innovation imparts new and better ways of thinking and doing. For us, this means delivering expert environmental solutions in the form of the most advanced and effective technologies and services available today.

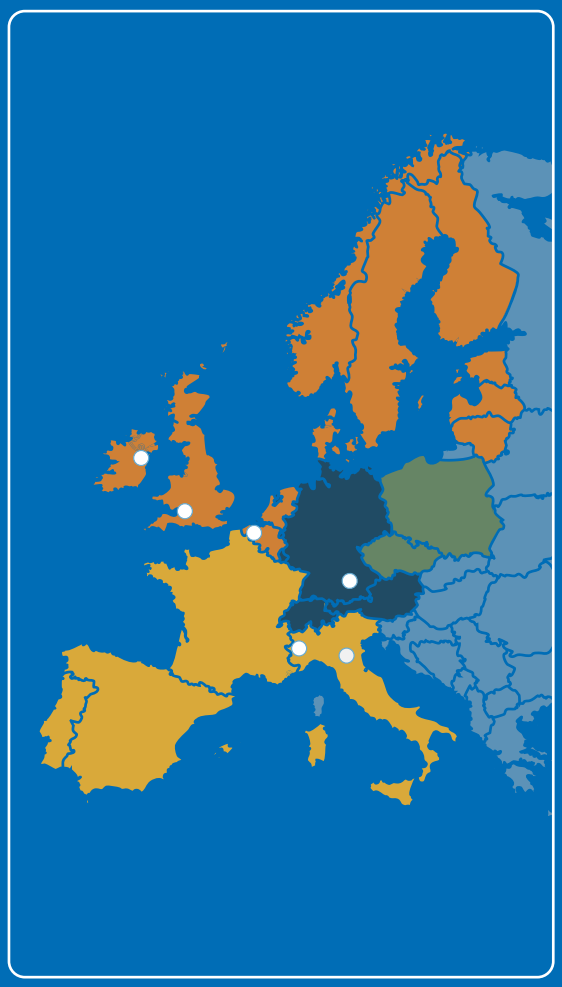
We value expertise, both our customers' and our own. We find that when our experienced staff collaborates directly with customers on complex problems, there is a high potential for success including savings in time, resources and cost.

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.

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





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