

PetroFix Integral to Site Closure Strategy

Reducing Time and Cost-to-Closure at UST Release Sites



Introduction

BJAAM Uses PetroFix to Rapidly Close Petroleum UST Sites



BJAAM - Expert in Securing Funding For UST Site Cleanups in Ohio

BJAAM's success in securing funding for UST cleanups is notable in Ohio. The environmental firm has submitted applications for funding more than \$4M in cleanup costs through the Ohio Abandoned Gas Station Cleanup Grant program, with all receiving approval.

BJAAM Environmental, Inc. (BJAAM) leads the Ohio Valley in providing wide-ranging solutions for impacted properties, delivering rapid regulatory closures and ensuring safe living and working environments for site occupants, neighbors, and surrounding communities.

Established in 1989 at the dawn of federal and state regulations to address petroleum releases from underground storage tanks (USTs), BJAAM is one of the original environmental consulting firms serving the Ohio Valley UST market. Through the years, the company has established itself as a leader in assessing, remediating, and closing UST-contaminated sites.

The company pioneered a streamlined corrective action approach to reduce the time required for achieving site closure, minimizing project costs for its clients. Their approach combines expertly applied Risk-Based Corrective Action (RBCA) with remedial actions and/or institutional controls designed to achieve site-specific target levels (SSTLs) for petroleum contaminants in well-defined areas of concern.





In recent years, BJAAM has utilized PetroFix® Remediation Fluid (PetroFix) to eliminate risks and obtain regulatory closures at UST sites impacted by petroleum hydrocarbons (PHCs). PetroFix aligns with BJAAM’s strategy for managing UST sites as a remedial technology, rapidly reducing and sustaining PHC contaminants below cleanup targets to expedite regulatory closures.

BJAAM designs its PetroFix injection projects using the PetroFix Design Assistant. The online software platform’s ease-of-use and flexibility are designed to help busy environmental firms like BJAAM conduct their projects more efficiently, saving time and money for clients.

Obtaining regulatory approval and funding for proposed remedial actions without delays is fundamental to BJAAM’s success. The company’s experience, integrity, and cost-conscious approach have established trust with state agencies governing UST corrective actions and injection processes, including the Bureau of UST Regulations (BUSTR) and the Ohio Environmental Protection Agency (OEPA) in Ohio, and West Virginia’s Department of Environmental Protection (WVDEP). The PetroFix *in situ* treatment approach has proven to be an effective and low-cost solution to address UST releases through these programs.

The case studies included in this multi-site review highlight BJAAM’s effective use of PetroFix in supporting their RBCA site closure strategy.

PetroFix Design Assistant



The PetroFix Design Assistant™ (Design Assistant) is an online software tool that determines the recommended product dosage and assists consultants in developing an application design for applying PetroFix Remedial Fluid.

Features and Benefits

Simple: easy to use, web based platform

Flexible: create customized designs for unlimited individual treatment areas per site

Efficient: design, estimate costs, and place orders as needed, without waiting

Organized: projects and order history maintained in one location for instant recall

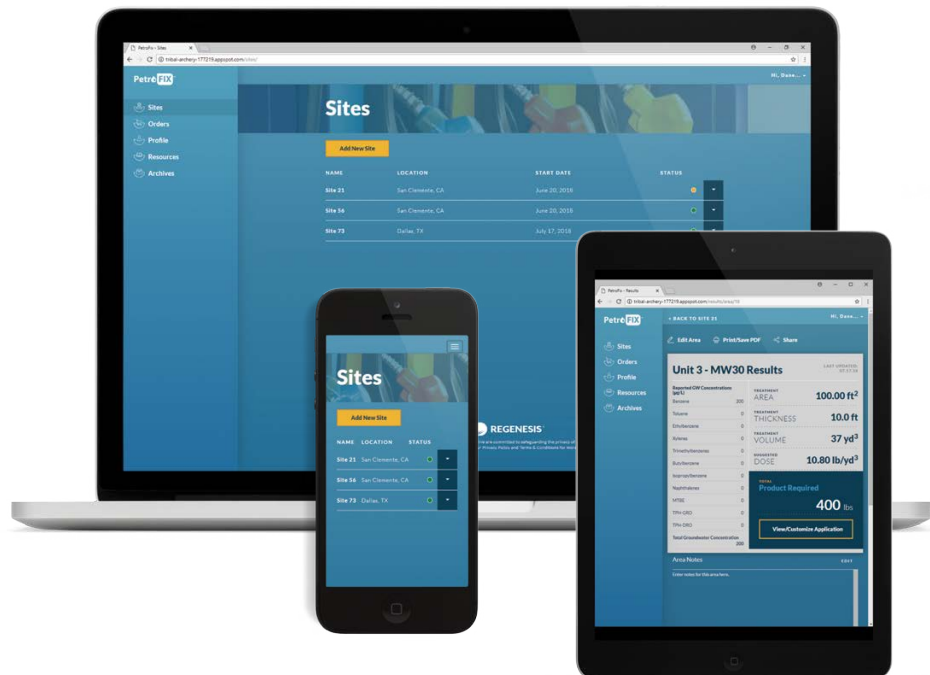
Experience-Backed: built on REGENESIS' foundational knowledge of *in situ* injections at thousands of PHC contaminated sites

Built-In Technical Support: guides users through technical issues like addressing free product, determining injection volumes and injection point spacing, product shipping and storage, and product application procedures

The Design Assistant software is easy to use and founded on fundamental scientific principles relating to contaminant sorption and biodegradation. It leverages REGENESIS' experience in successfully completing thousands of remedial injection projects at petroleum-contaminated sites worldwide.

The software allows users to complete remedial designs for up to five areas on a site. Users determine a PetroFix product dose and a field mixing/injection design for each area using simple inputs for treatment area dimensions, contaminant species, groundwater concentrations, soil grain size, injection point spacing and mixing tank volume. These application design details are communicated on printable design summary tables that can be provided to regulators overseeing projects, injection contractors, and other project stakeholders.

BJAAM is a proficient Design Assistant user, developing its own PetroFix remedial application designs. The remedial designs are stored and accessed through a project dashboard that maintains the PetroFix projects in one place for easy referencing, allowing BJAAM to manage its projects more efficiently.





Northeast Ohio

Former Gas Station

Summary

In response to a UST release, BJAAM completed Tier 1 and Tier 2 Evaluations to define the contamination extent and SSTLs. BJAAM installed and began operating a dual-phase extraction (DPE) system in 2013 and expanded it later, then shut it down in 2019. The DPE system reduced benzene and total BTEX concentrations by more than 90%, with only benzene remaining above the groundwater SSTL near the southern property boundary. To address the residual benzene concentrations in this area, BJAAM developed a revised cleanup plan utilizing the PetroFix Design Assistant. The focused PetroFix injection approach was quickly approved by BUSTR and implemented shortly thereafter.

Results

The PetroFix injection reduced the benzene concentration below the 5 µg/L SSTL by the first post-sampling event. The concentrations remained reduced during the year-long performance monitoring period. Based on the PetroFix injection performance results, BUSTR granted the site a No Further Action status.

Highlights

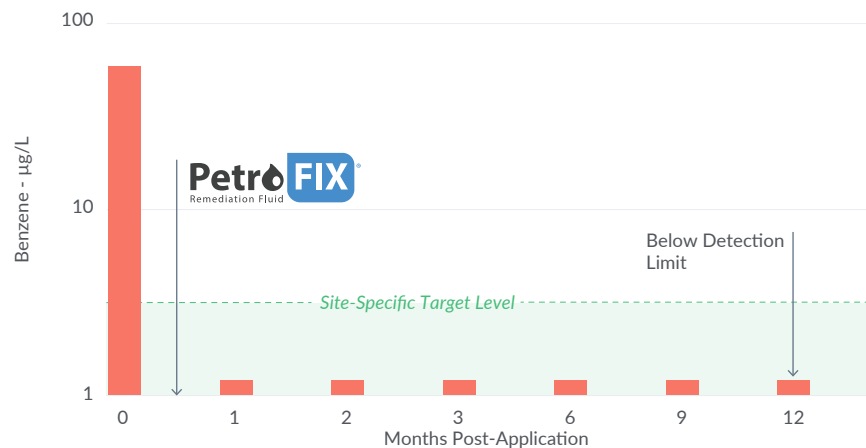
Contaminants of Concern	
Benzene	59 µg/L
Cleanup Goal (i.e., SSTL)	
Benzene	5 µg/L
Geology	
Description	Clayey silts
Results	
Benzene	Reduced below detection limit (1 µg/L) in treatment area

✓ **Status:**
SSTL Achieved, No Further Action Granted

Figure 1

Benzene Concentrations in TMW-9/9R

Benzene results in TMW-9/9R following PetroFix injection





Central Ohio

Former Gas Station

Summary

A release was reported during a 1991 environmental site assessment following UST system removal in 1989. Over the next 30 years, several phases of investigation, natural attenuation/modeling demonstration, and risk assessment were conducted at the site, while property ownership and regulatory jurisdiction changed several times. BJAAM developed SSTLs for the contaminants of concern following the Ohio BUSTR RBCA process. By the end of 2020, only the benzene concentration in groundwater exceeded its SSTL of 135 µg/L.

Highlights

Contaminants of Concern	
Benzene	408 µg/L

Cleanup Goal (i.e., SSTL)	
Benzene	135 µg/L

Geology	
Description	Sandy and Silty Clays

Results	
Benzene	>99.9% Reduction (below detection limits) in treatment area

✓ **Status:**
SSTL Achieved, On Track for Site Closure

In 2021, BJAAM submitted a RAP, using the PetroFix Design Assistant to develop a design for reducing benzene in groundwater to below the SSTL. BJAAM completed the PetroFix injection event in February 2022, injecting the material via eleven direct-push injection points installed in the 400 square feet treatment area.

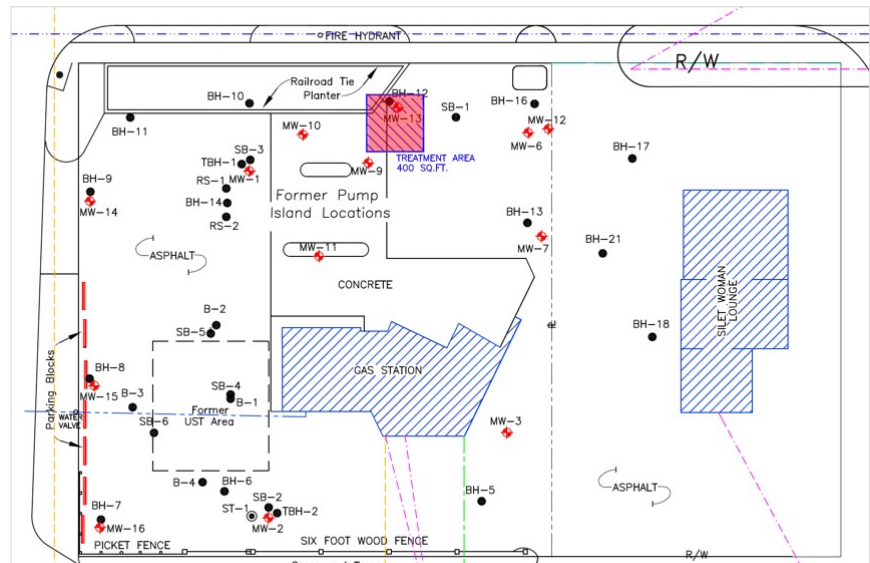
Results

The PetroFix injection reduced benzene below the SSTL (and below detection levels) in the targeted area within 30 days and over subsequent quarterly monitoring events through 12 months. Based on these results, a request for No Further Action status is pending approval by BUSTR.

Figure 2

PetroFix Injection Area

Site map depicting injection areas for PetroFix application.





Northeast Ohio

Former Gas Station

Summary

A Phase 1 Environmental Site Assessment was completed in 2016, revealing a former UST system removed from the site in 1983. BJAAM conducted a BUSTR Tier 1 Evaluation in 2017 and, in 2018, completed an Interim Response Action which included the removal of 554 cubic yards of soil impacted by the former UST operations. Following the excavation, residual benzene and methyl-tert-butyl-ether (MTBE) remained above preliminary action levels (i.e., drinking water levels) in groundwater. In 2019, BJAAM completed the PetroFix injections as part of a Remedial Action Plan to reduce the benzene and MTBE concentrations in two areas where the residual impacts remained. A total of 84 direct-push injection points were used for the treatment.

Highlights

Contaminants of Concern	
Benzene	17-95 µg/L
MTBE	78-184 µg/L

Cleanup Goal (i.e., SSTL)	
Benzene	130 µg/L
MTBE	20 µg/L

Geology	
Description	Silty clays overlie shale

Results	
MTBE	Reduced below cleanup goal
Benzene	Reduced to < 5 µg/L in one treatment area, remaining elevated in another. Subsequent modeling shows no exposure risk from benzene remaining in one monitoring well.

✓ Status:
No Further Action Granted

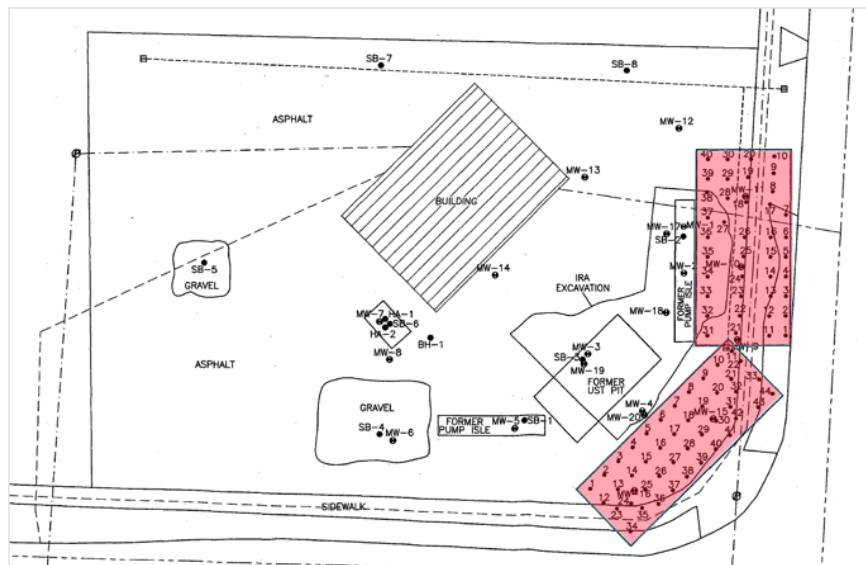
Results

The treatment sharply reduced the contaminant levels and markedly shrunk the impacted area. MTBE concentrations were reduced below the drinking water action level, while benzene exceeded the drinking water action level in a single monitoring well. BJAAM utilized BUSTR's Tier Evaluation Process, performing fate & transport modeling to demonstrate the lack of a complete exposure pathway for the remaining benzene levels. Based on these results, BUSTR granted the site a No Further Action status in 2020.

Figure 3

PetroFix Injection Plan

Site map depicting injection areas for PetroFix application in Brook Park, Ohio.





Northwest Ohio

Active Gasoline Station

Summary

This active gas station site in Northwest Ohio first reported a PHC release in the early 1990s during a product dispenser upgrade and later during a station upgrade in 2010. Ensuing investigations revealed benzene, MTBE, and benzo(b)fluoranthene concentrations in groundwater above BUSTR's Tier 1 Action Levels. Following a Tier 2 Evaluation and modeling to develop SSTLs, BJAAM submitted a Remedial Action Plan to treat MTBE, the only chemical exceeding an SSTL. The remedy involved mobile DPE events and the installation of Oxygen Release Compound® (ORC) socks into select monitoring wells. Although some concentration reductions were observed following these remedial efforts, MTBE remained elevated in an area adjacent to the former UST cavity. Consequently, BJAAM proposed the *in situ* injection of PetroFix, using the Design Assistant for developing a targeted treatment to remediate MTBE below its SSTL. The approach was approved by BUSTR and the Petro Board and implemented by BJAAM soon after.

Highlights

Contaminants of Concern

MTBE	5,680 µg/L
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Cleanup Goal (i.e., SSTL)

MTBE	2,494 µg/L
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Geology

Description	Silty Clays
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Results

MTBE	>99.9% Reduction in treatment area
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✓ **Status:**
 Second application planned to reduce MTBE below SSTL following rebound

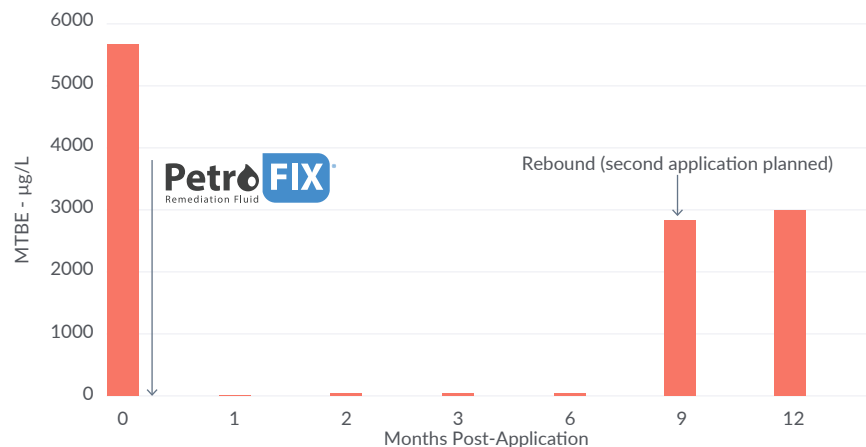
Results

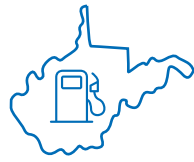
The PetroFix injection initially resulted in a 99% reduction of MTBE (the target chemical) maintained through three monitoring rounds. Benzene was also reduced below its SSTL. Rebound of these contaminants was observed in the key monitoring well, likely due to untreated contaminant mass migrating into the original treatment area. As a result, a second, targeted injection event is planned to reduce MTBE below the SSTL.

Figure 4

MTBE Concentrations in MW-5

MTBE Performance results in MW-5 following PetroFix injections.





Northern West Virginia

Former Gas Station

Summary

The site is a former gasoline station in northern West Virginia with a remediation history that includes the operation of a DPE system, excavation & disposal of 1,800 tons of petroleum-contaminated soils during UST removal, and installation of ORC filter socks in targeted remediation wells. These efforts significantly reduced the PHC impacts. However, benzene concentrations remained in two areas above WVDEP's five µg/L action level.

In February 2021, BJAAM submitted a revised Corrective Action Plan (CAP) for the site, incorporating its own PetroFix designs for treating the two benzene-impacted areas, aided by the online Design Assistant. BJAAM completed the PetroFix injections soon after WVDEP approval.

Results

By the first post-application monitoring event in August 2021, benzene concentrations dropped below the action level in both areas, remaining reduced through one year of monitoring. Based on these results, the WVDEP issued the No Further Action Required letter in November 2022.

Highlights

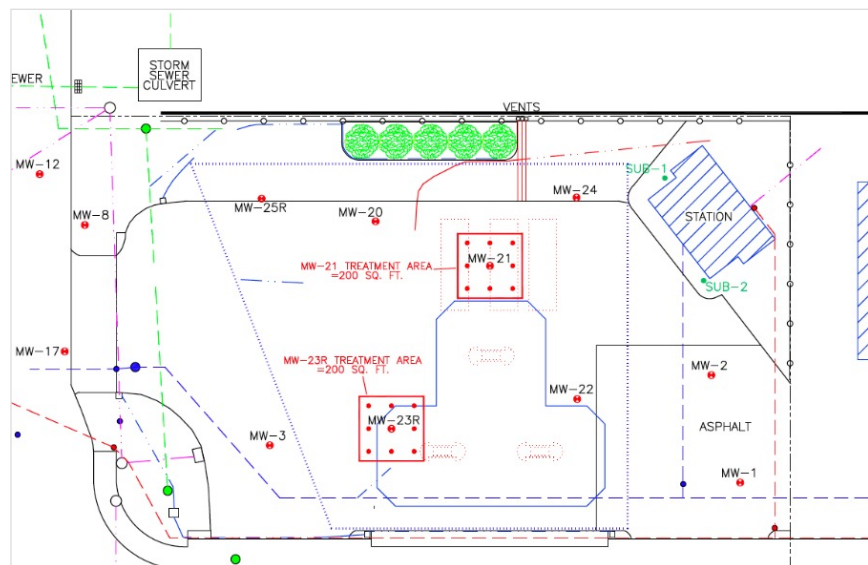
Contaminants of Concern	
Benzene	9-34 µg/L
Cleanup Goal (i.e., SSTL)	
Benzene	5 µg/L
Geology	
Description	Backfill aggregates overlies silts
Results	
Benzene	Reduced below 1 µg/L in both treatment areas

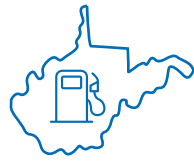
✓ Status:
Cleanup Goal Achieved, No Further Action Required

Figure 5

PetroFix Injection Areas

PetroFix injection areas at former gasoline service station in northern West Virginia.





Southwest West Virginia

Active Gas Station

Summary

In 2014, BJAAM initiated mobile DPE events to remediate a PHC release at this active gas station site. Numerous multi-day DPE events were completed through 2019, along with associated remediation performance monitoring. The remediation efforts were largely successful, leaving only a small area near the site's southeast corner where benzene concentrations remained above the WVDEP's drinking water action level of 5 µg/L.

BJAAM proposed PetroFix, developing its own injection design for treating the remaining benzene-impacted area. The remedy was approved by WVDEP and implemented by BJAAM in 2021. The treatment was completed via fifteen direct-push injection points drilled to 16 feet below the ground surface.

Highlights

Contaminants of Concern

Benzene	7 µg/L
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Cleanup Goal (i.e., SSTL)

Benzene	5 µg/L
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Geology

Description	Clayey Sands
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Results

Benzene	Reduced below 1 µg/L in treatment area
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✓ **Status:**
Cleanup Goal Achieved, No Further Action Required

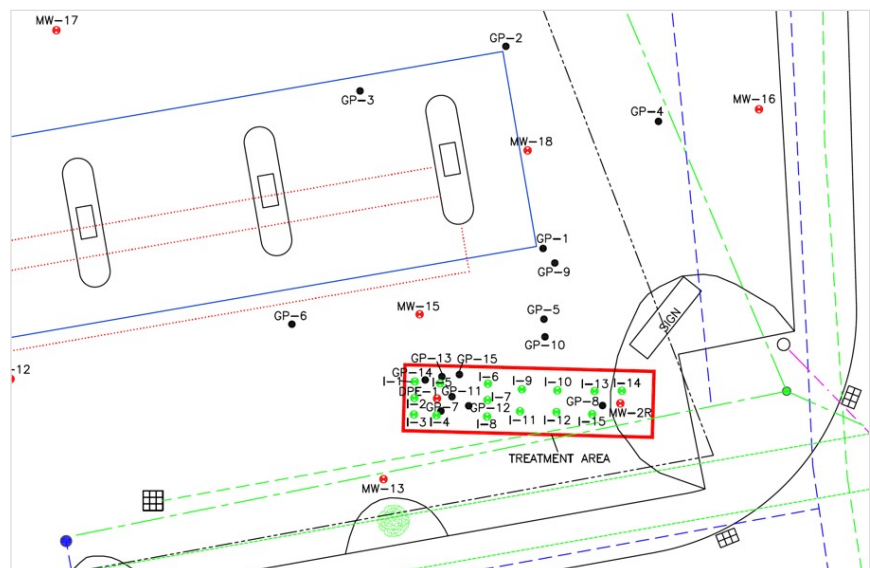
Results

The PetroFix treatment reduced the benzene concentrations to below detection limits (and the WVDEP action level) by the first post-injection monitoring event (i.e., 30-day event). Concentrations have remained non-detect for one year, meeting the site closure criteria. The WVDEP issued a No Further Action Required letter in early December 2022.

Figure 6

PetroFix Injection Areas

PetroFix injection areas at Huntington, WV gasoline station.





Conclusion

PetroFix Reduced Benzene Below Detection Limits in Six Out of Seven Monitoring Wells

BJAAM's expertise in applying the RBCA process across multiple state agencies, along with PetroFix's rapid effectiveness in meeting cleanup goals, has accelerated the closure of long-standing UST release sites. A single application of PetroFix met cleanup targets for benzene or MTBE in eight of ten monitoring wells within the treatment areas, with most contaminants reduced to below laboratory detection limits.

In one treatment area, despite benzene levels slightly exceeding the SSTL, a thorough evaluation confirmed no complete risk exposure pathways, leading to regulatory approval for site closure. In another area, MTBE levels rebounded above the SSTL, likely due to untreated contaminant mass migrating into the original treatment area. A follow-up application is planned to achieve sustained compliance.

To date, BJAAM has successfully closed four sites, achieving NFA status, with one additional site pending agency review and another site set for a secondary application to address MTBE levels.

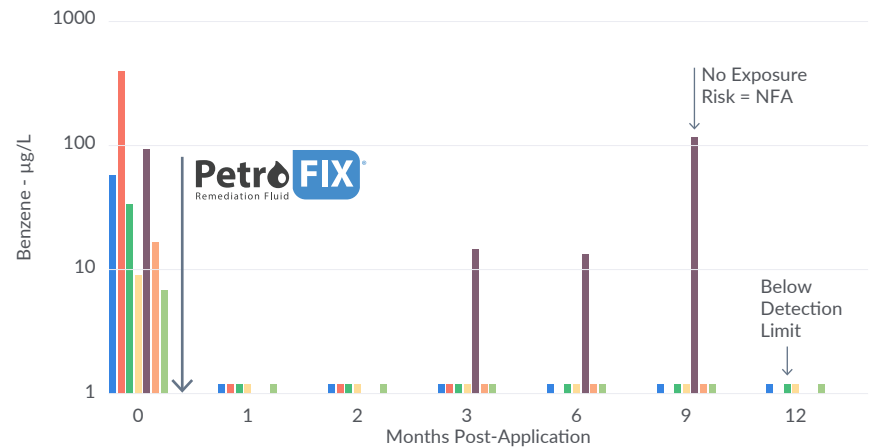
These results underscore BJAAM's proactive, cost-effective application of PetroFix in driving regulatory closures and resolving environmental liabilities at legacy UST sites..

Figure 7

Benzene Concentrations - All Sites

Benzene Performance results at all sites following PetroFix injections.

- NEOH-TMW-9/9R
- COH-MW-13
- NWV-MW-21
- NWV-MW-23R
- NEOH-MW-10
- NEOH-MW-11
- SWWV-DPE-1





About The Consultant

BJAAM Environmental, Inc.

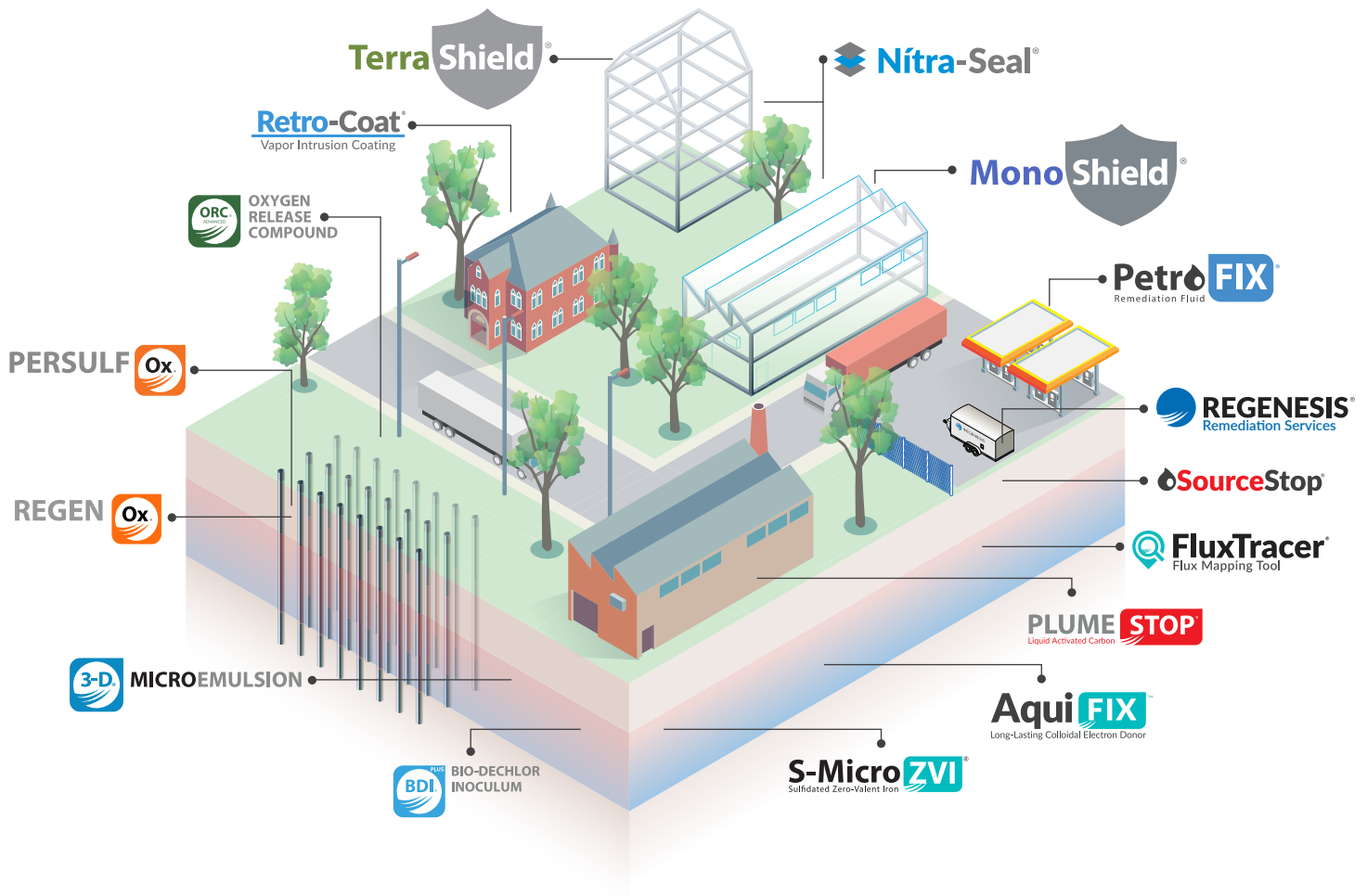


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BJAAM Environmental, Inc. (BJAAM) was formed in 1989 by a group of geologists to provide a wide range of environmental contracting services. Today, our specialists offer clients a superior level of proven technical knowledge and problem-solving skills. We provide our wide range of environmental services to a diverse clientele including private landowners, local and regional government, economic development agencies, legal professionals, fuel distributors and retailers, commercial/industrial real estate agents and brokers, and lending institutions. BJAAM professionals successfully navigate the complex network of differing environmental regulations to develop practical and cost conscious solutions to meet each client's needs.

BJAAM employs staff members across a wide array of disciplines ranging from geological sciences, environmental field services, senior level project managers, remedial design and engineering, Brownfield redevelopment funding, commercial real estate transaction due diligence, accounting and claims services. BJAAM's multi-discipline staff enables BJAAM to not only effectively and efficiently staff projects, but also to assist in all phases of a project where needed and/or requested. The firm is also closely affiliated with a broad network of experts specializing in: engineering, chemistry, occupational medicine, safety, structural and civil engineering, architecture, and environmental law.

Unlike most contracting firms, BJAAM owns and operates our own field investigation, mobile office, and remediation equipment. Having in-house access to this equipment gives BJAAM a tremendous budgeting, scheduling and project management advantage over typical environmental consulting firms. This capability leads to job costs savings and the ability to negotiate lower equipment rates. An added advantage is the elimination of potential sub-contractor scheduling delays and the ability to mobilize equipment and field personnel at a moment's notice.



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.

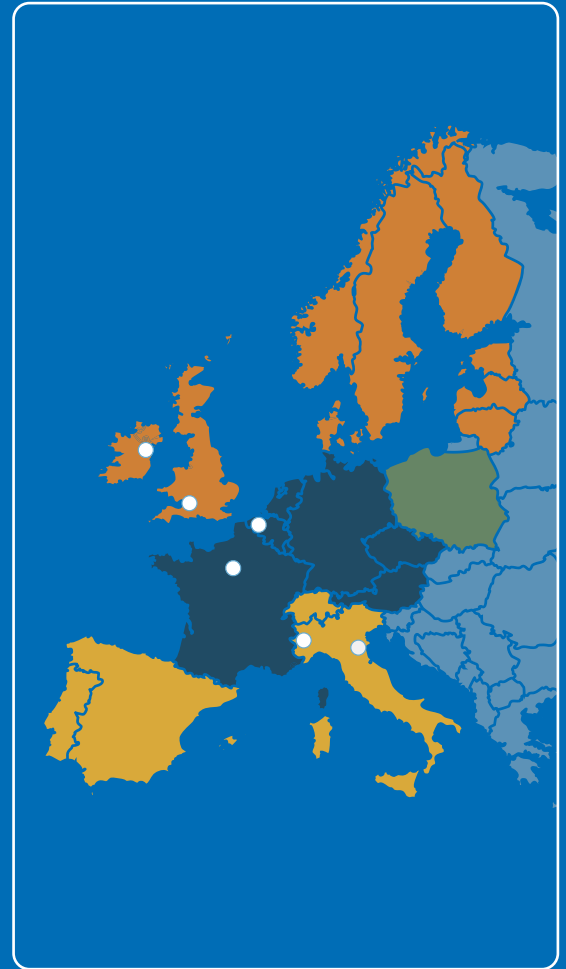
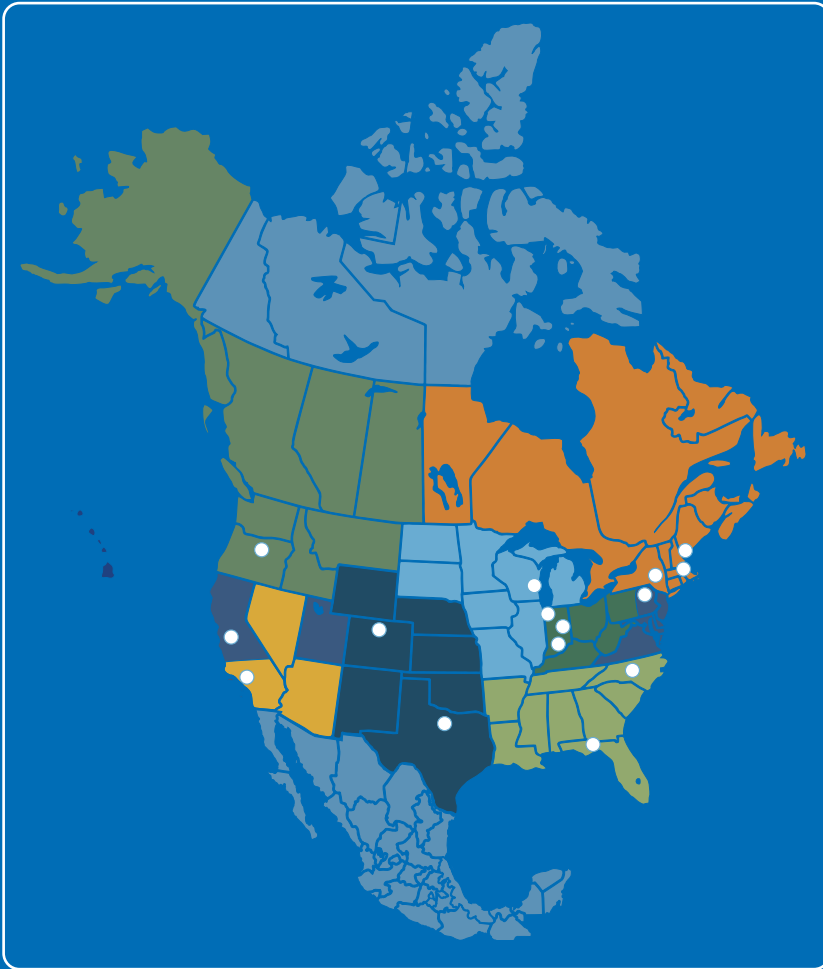
Inherently, innovation imparts new and better ways of thinking and doing. For us, this means delivering expert environmental solutions in the form of the most advanced and effective technologies and services available today.

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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