

PETROFIX REDUCED BENZENE BY 99%

CASE STUDY:

Following Numerous Alternative Approaches, BTEX and TPH Plume Greatly Reduced, and Site Positioned to Achieve Closure Status

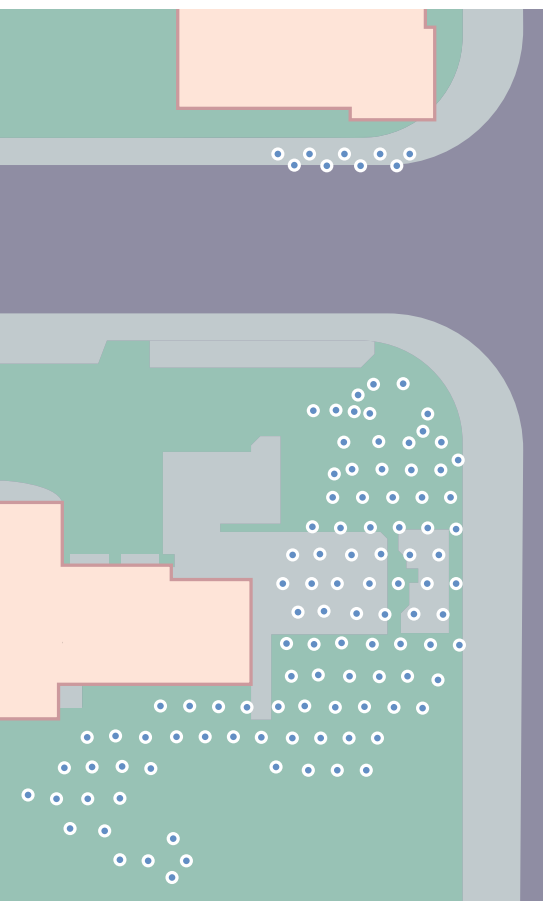


REGENESIS®



Background

PetroFix is Chosen as the Final Remediation Solution to Achieve Site Closure



Map depicts approximate treatment area.

Between 1976 and 1992, a retail gas station operated at a site along the Colorado front range, near Denver. The former underground storage tank (UST) system had no cathodic protection and consequently, corrosion of the tanks occurred with a number of holes observed in the tanks upon removal. Subsequent investigations revealed a petroleum hydrocarbon plume originating from the UST pit and extending offsite across a roadway and onto another commercial property.

Prior to the PetroFix® treatment, the environmental consultant, CGRS, performed numerous remediation activities between 2003 and 2019, including, excavation, air sparge system pilot testing, soil vapor extraction, in-well oxygen diffusion systems, pilot and/or full scale injections of carbon-based and chemical oxidizing mixtures.

The combination of these remediation activities substantially reduced much of the soil and groundwater contaminant mass over time. However, the overall magnitude and extent of the benzene plume persisted above the site closure objectives, prompting further remediation.

After evaluating a range of remedial options, CGRS specified PetroFix as the most economically feasible option to quickly remediate the benzene plume and achieve site closure. CGRS worked directly with REGENESIS to design the *in situ* remediation.

Application Design Summary

Contaminants of Concern:

Benzene: 5-21,200 µg/L

Treatment Area: 6,000 Sq. Ft.

Injection Points: 111

Application Quantities:

PetroFix: 29,600 lbs

Electron Acceptor Blend: 1,480 lbs

Application Volume: 20,000 gallons

PetroFix Application

Low Injection Pressures Maintained Throughout the Application

To ensure an efficient and safe application, CGRS contracted REGENESIS Remediation Services (RRS) to conduct the PetroFix injection. RRS completed the work in September 2019, injecting 29,600 pounds of PetroFix and 1,480 pounds of electron-acceptor blend through 111 hydraulic-percussion (i.e., direct-push) injection points completed at depths ranging from 6 to 25 feet below ground surface (bgs).

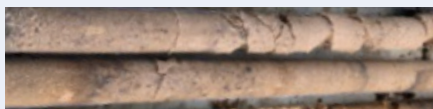




Verifying PetroFix Distribution is Key to Remediation Success



A combination of pre and post-injection soil cores and groundwater samples were collected in the treatment area throughout the course of the project to confirm and document PetroFix distribution.



Example image of soil cores taken prior to PetroFix application.



Example image of soil cores taken after a PetroFix application.



Based on visual confirmation of PetroFix in soil cores and monitoring wells, the crew was able to make real-time adjustments to injection volumes, pressure, tooling, and locations to accomplish the distribution goals.

Soil cores were collected before the application to verify soil conditions. Soils in the treatment area were heterogenous, displaying a mix of fine-grained and coarse grained textures and a coarsening-downward sequence. RRS modified the injection interval on a point-by-point basis to be responsive to the heterogenous soil conditions. If a zone did not naturally permit flow at a moderate injection pressure, the rods were lifted until the flow zones were intercepted and the design was calibrated accordingly. RRS was able to maintain low injection pressures overall, averaging nearly 20 pounds per square inch (PSI) while pumping between 2 and 4 gallons per minute per point. Treatment area monitoring wells were also sampled; PetroFix was observed in all treatment area wells.

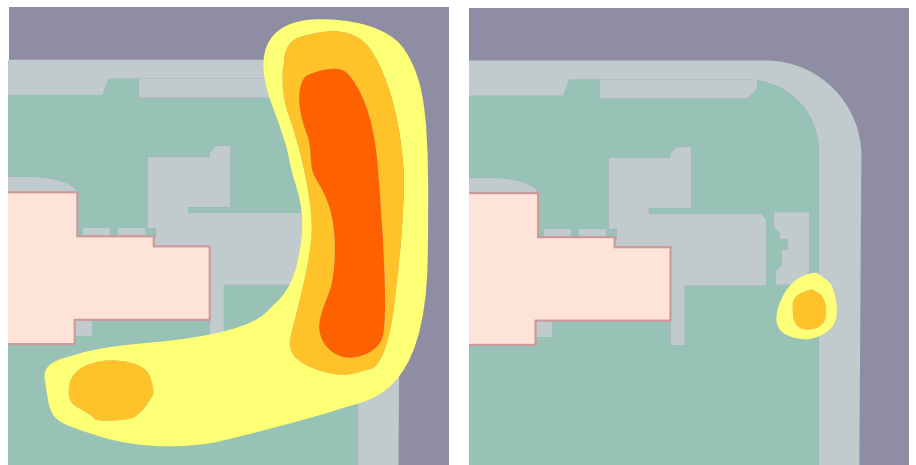
Multiple points were injected simultaneously to optimize application efficiency. The application was safely completed and met the time and budget requirements of the client.

Results and Conclusion

With 99% Benzene Plume Reduction Maintained, the Site is Positioned to Achieve Closure Status

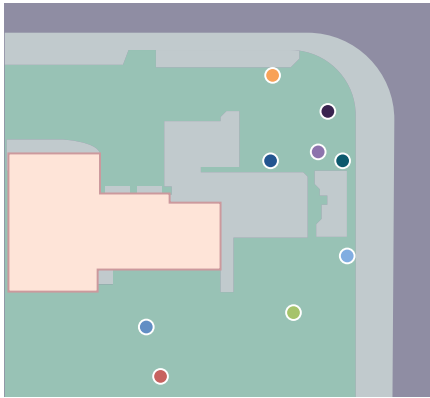
To assess performance, CGRS completed post-injection monitoring events two months, six months, eleven months, and eighteen months after the application. The PetroFix application has been highly effective at reducing benzene concentrations– the primary project goal. Benzene concentrations decreased sharply by the first sampling event and have maintained a 99% reduction compared to baseline after eighteen months. The overall extent of the benzene plume has been reduced accordingly.

Benzene Concentrations Before and After PetroFix Application



Key: ● >5 µg/L ● >100 µg/L ● >1,000 µg/L

Benzene concentrations in groundwater before (left) and after (right) PetroFix Application, in main treatment area monitoring wells.



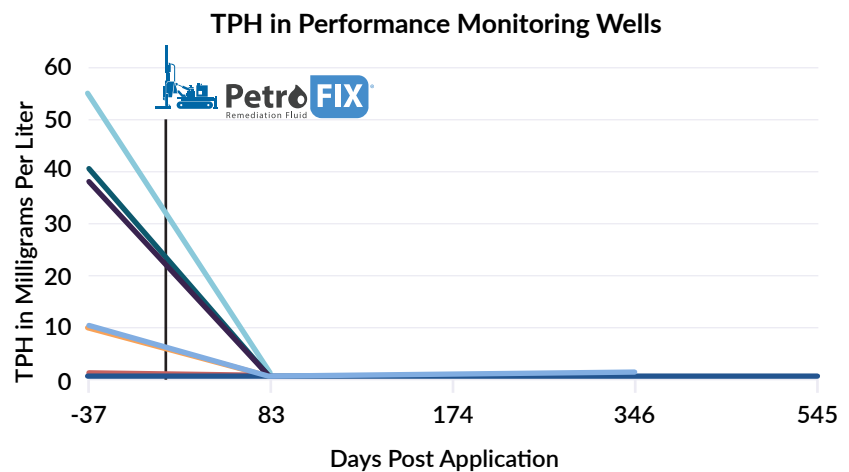
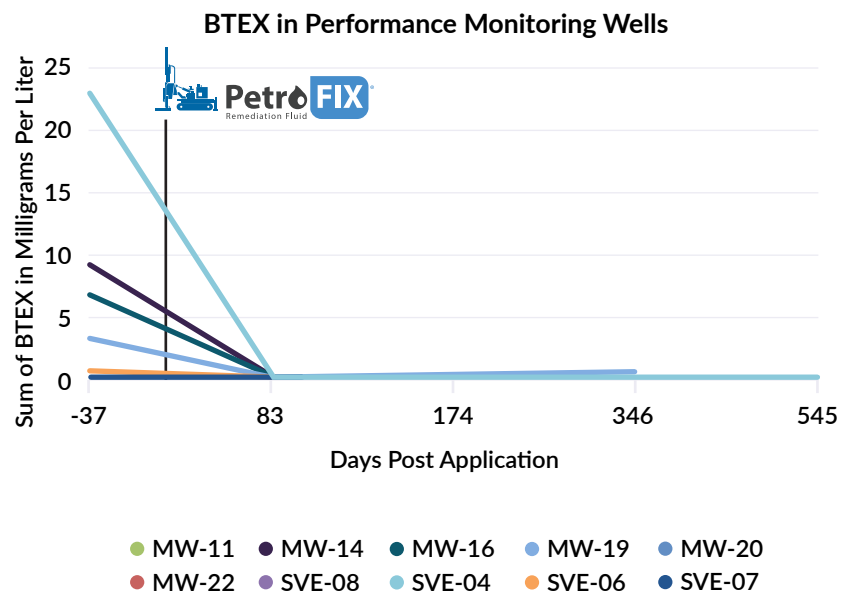
Approximate locations of monitoring wells

99% Reduction in Benzene Concentrations

Benzene concentrations have met and maintained a 99% reduction level for over 18 months

Total benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH) concentrations have both been reduced more than 98% in the treatment area.

Of the ten performance monitoring wells observed in the treatment area, only one well, MW-19, has benzene remaining above 10 µg/L, exhibiting a slight rebound to approximately 15% of its baseline concentration at the eighteen month sample event. Well MW-19 is adjacent to a sidewalk and it is suspected that complete distribution of PetroFix around this well was incomplete. The well could not be accessed for sampling at the day 545 event due to its location under a snow pile but will continue to be monitored.





The PetroFix sulfate and nitrate electron-acceptor blend initially charged the area with these terminal electron acceptors. They were later reduced to non-detect in several of the wells following the application, indicating robust anaerobic bioremediation is occurring.

As with most retail gasoline station environmental incidents, benzene in groundwater is the primary driver for remedial corrective action at this site. With the intent of the application to remediate benzene in groundwater, the PetroFix application has reduced the mass of benzene by 99%, after eighteen months of performance monitoring. Total BTEX and TPH have been similarly reduced. Based on these results, the site is anticipated to achieve regulatory incident closure in the near future.

Technology Used

PetroFix Remediation Fluid



PetroFix Remediation Fluid is a concentrated, water-based, activated carbon suspension specifically designed to treat PHC plumes stemming from bulk storage, gas station and UST spills. Safe, fast, effective and easy-to-apply, PetroFix is designed to specifically sorb and biodegrade petroleum hydrocarbons (PHC), diesel, BTEX, MTBE, and TPH-G. Composed of a mix of micron-scale activated carbon and electron acceptors to promote biodegradation, PetroFix offers an in-situ approach designed specifically for sites where PHC levels are above regulatory standards for complete remediation, at the lowest total cost-to-closure. PetroFix can also be applied to excavation sites.



PetroFIX[®]

Remediation Fluid

Composition/Information on Ingredients

Chemical name	CAS Number
Water	7732-18-5
Colloidal Activated Carbon <10 µm	7449-44-0
Calcium sulfate dihydrate	10101-41-4

Precautionary Additives

Precautionary Statement

Observe good industrial hygiene practices.

Response

Wash hands after handling.

Storage

Store away from incompatible materials.

Disposal

Dispose of waste and residues in accordance with local authority requirements.

In Case of Fire

In case of fire use carbon dioxide, water-resistant foam, dry chemical, water fog or water spray to extinguish.

First Aid

Inhalation

Move to fresh air. Call a physician if symptoms develop.

Eye contact

Wash off with soap and water. Get medical attention if irritation develops and persists.

Skin contact

Rinse with water. Get medical attention if irritation develops and persists.

Ingestion

Rinse mouth. Get medical attention if symptoms develop.

Signal Word

DANGER

Hazard Statement

The material may irritate the respiratory system.

In Case of Emergency

For Hazardous Materials: See RegenesiS Safety Data Sheet (SDS) for more information.

ONLY call, ask for assistance, or contact the emergency service.

For all other inquiries, contact 800-366-8000 or email sales@regenesi.com.

See Safety Data Sheet (SDS) for more information.

Net Weight: 400 lbs (181.4 kg)

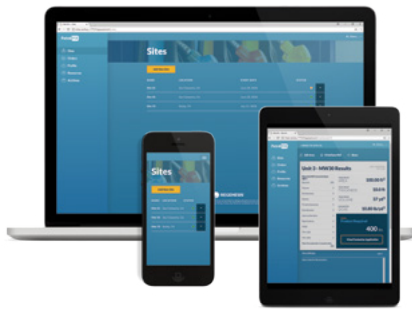
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The PetroFix Design Assistant: You Design Use our Online Software to Generate an Estimate When you Need it



To make applying PetroFix simple and easy to use, REGENESIS created an innovative and effective online tool for developing recommended dosage and designs for your site. The PetroFix Design assistant equips environmental professionals with the tools to design individually-tailored remediation plans. This self-design, self-apply tool guides users toward effective designs that will yield the best results and allows users to easily order PetroFix through REGENESIS' customer service department. Educational resources and best practices are also offered along with an online video tutorial which walks the user step-by-step through the design and ordering process.

1 Create Your Account

Begin by creating an account with details about your site including the surface area and average vertical thickness and whether or not NAPL is present at this time.

2 Recommended Treatment

After providing the soil grain size and the groundwater contaminant levels, the Design Assistant will provide results showing the suggested treatment including the recommended volume, dosing, and product required for treatment.

3 Order PetroFix

Once all areas for the site are submitted, start the order process directly within the Design Assistant.



Simple
Easy to Use



Flexible
Designs Tailored
to Your Site



Fast
No Waiting
for a Design



About The Consultant

CGRS, Inc.



CGRS began in 1987 as an environmental consulting company, providing industry- and regulatory-compliance expertise and services to owners and operators in the upstream and downstream petroleum industry. Over time they have diversified to meet the ever-changing customer needs by becoming experts in the markets of environmental services, liquid and CNG fueling, oil and gas, and water and wastewater. They are always on the lookout for the next opportunity to help clients succeed.

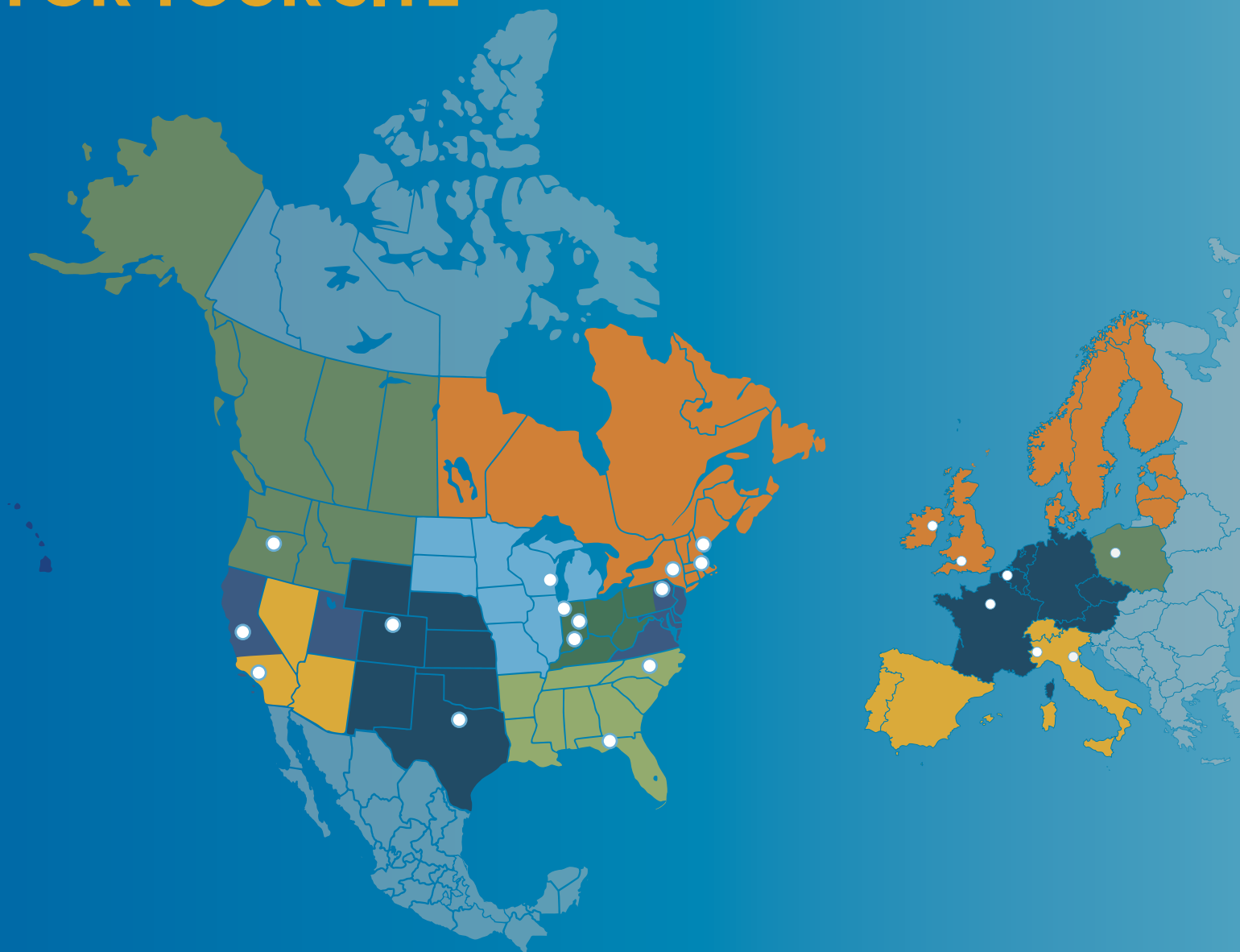


About The Project Manager

Monica Young

With over 20 years of environmental experience, Monica Young, Project Manager/Environmental Scientist with CGRS, a leading environmental consulting firm, brings a diverse and accomplished background to her work. In addition to the broad experience she's garnered while at CGRS over the past 19 years, Young has also served as an Environmental Protection Specialist for the U.S. Environmental Protection Agency in Denver, Colorado, where she performed inspections, managed contractors, and worked as a Project Officer for several states. She is also a Recognized Environmental Professional (REP) with the Colorado Division of Oil and Public Safety (OPS) and works primarily assessing and remediating petroleum hydrocarbon releases.

WE'RE READY TO HELP YOU FIND THE RIGHT SOLUTION FOR YOUR SITE



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