REGENESIS®

Proven, Rapid, and Cost-Effective Petroleum Spill Treatment

PetroFix Instrumental in Achieving Site Closures Across Canada



Overview

InSitu Remediation Services, Ltd. Deploys Expertise and Technological Innovation to Cost-Effectively Treat Petroleum Contaminants on Challenging Sites

InSitu Remediation Services Ltd. (IRSL), one of Canada's largest and most experienced environmental remediation services company, uses PetroFix to mitigate sites throughout Canada impacted by petroleum hydrocarbons (PHCs), relying on the technology as an effective, low-cost, and more sustainable remedial solution.

As one of the first to apply PetroFix in the field, IRSL has deployed the PetroFix technology to remediate a large number of PHC-contaminated properties, with land use ranging from gasoline stations and commercial properties to residential homes and a national park lodge. PetroFix has quickly eliminated PHC impacts in groundwater at these sites and prevented contaminant movement away from impacted properties, thus eliminating potential human exposure to PHCs and protecting pristine, ecologically sensitive surface waters.

About PetroFix

PetroFix, a dual-functioning, colloidal activated carbon (CAC) suspension, was introduced to the market in 2018 for remediating underground storage tank (UST) releases and other petroleum spills. Its carbon particles are at least an order of magnitude smaller than powdered activated carbon (PAC) and are suspended in water to allow for low-pressure injection. The technological innovation has been used to treat hundreds of PHC-contaminated sites worldwide successfully.



IRSL has applied these remedies across diverse geologic settings, with treated PHC groundwater plumes in fine- and coarse-grained soils and bedrock, and contaminant concentrations ranging from hundreds to tens of thousands of parts per billion. Many of these projects have been performed under challenging site and weather conditions.

The PetroFix treatments have consistently demonstrated their effectiveness. At more than two-thirds of the 13 sites IRSL has treated, the site cleanup goals were met following a single injection event, with most objectives being met within three months and sustained for at least one year. These treatments' results have provided a notable cost saving for IRSL's clients and shown that PetroFix is a viable method for treating PHC-contaminated sites in Canada

Third-Party Research Paper Demonstrates Subsurface Colloidal Activated Carbon Distribution

Scan to Read the Peer-Reviewed Paper

ISRL performed field injection testing of CAC and PAC at four sites with varying geologies. These side-by-side studies showed CAC achieving a more uniform distribution in aquifers using lower injection pressures (93% detection rate). In contrast, PAC required higher injection pressures and exhibited preferential delivery in high hydraulic conductivity seams (67% detection rate). PAC was observed to accumulate in well screens which could result in sampling bias, whereas CAC injection did not. The study provides strong evidence that CAC is more easily controlled and distributed in aquifers as compared to larger diameter PAC.

1. *McGregor R. Distribution of Colloidal and Powdered Activated Carbon for the in Situ Treatment of Groundwater. Journal of Water Resource and Protection. 2020;12(12):1001-1018. doi:10.4236/jwarp.2020.1212060*

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PetroFix Performance Review Summary

IRSL leveraged its breadth of *in situ* remediation project expertise and economical use of the PetroFix technology to achieve rapid cleanup, leading to release incident closures at multiple site locations throughout Canada. Nine of the 13 sites (69%) IRSL treated with PetroFix have already achieved closure, most within one year after a single injection event. Additional focused treatments at high concentration areas ("hotspots") are being evaluated at a few sites with one site currently in the pilot testing phase.

Site features, PetroFix application details, and closure status are summarized in the following table, along with the current site closure status.

Site Location	Contaminants Max Concentrations		Aquifer Materials	Water Level	Treatment Type	Injection Method	PetroFix Applied	Status
Jasper, AB	Benzene Toluene	300 µg/L 30 µg/L	Sand-Gravel	~2 mbgs	Barrier & Grid	DPT	1,715 kg	Closure Achieved
Cannington, ON	BTEX GRO DRO	1,600 µg/L 1,000 µg/L 450 µg/L	Silty Sand	~1 mbgs	Grid	8 Existing Wells and DPT	2,550 kg	Closure Achieved
Ottawa, ON	GRO DRO	3,540 µg/L 5,430 µg/L	Silty Sand	~1 mbgs	Grid	DPT	540 kg	Closure Achieved
Mississauga, ON	DRO	3,640 µg/L	Sand/Clay	~1.5 mbgs	Grid	Existing Wells and DPT	2,042 kg	Closure Achieved
Toronto, ON	Benzene DRO	110 µg/L 720 µg/L	Sandy Silt	~3.5 mbgs	Grid	DPT	724 kg	Closure Achieved
Toronto, ON	Benzene GRO Xylenes	4,000 µg/L 2,900 µg/L 8,400 µg/L	Silt, Sand Mixture	4.9 mbgs	Grid	DPT	1,882 kg	Closure Achieved
Guelph, ON	BTEX GRO	1,600 µg/L 6,000 µg/L	Silty Sand	~3 mbgs	Grid	DPT	181 kg	Closure Achieved
Ottawa, ON	GRO DRO	3,700 µg/L 2,100 µg/L	Clay, Silty Clay, Sand	1.89-4.78 mbgs	Barrier & Grid	DPT	1,086 kg	Closure Achieved
Masset, BC	Unspecified		Sand	~4 mbgs	Barrier	DPT	3,628 kg	Closure Achieved
Keefer Township, ON	DRO Fuel Oil	~1,300 µg/L ~1,200 µg/L	Sand	7 mbgs	Grid	Existing Injection Wells	1,644 kg	In Progress Additional Hotspot Remediation
Barrie, ON	BTEX GRO DRO	2,500 µg/L 24,000 µg/L 800 µg/L	Dense Sand	24 mbgs	Grid	Existing Wells and DPT	7,286 kg	In Progress Additional Hotspot Remediation
Chilliwack, BC	Benzene Toluene Ethylbenzene Xylenes GRO	5,630 µg/L 197 µg/L 1,010 µg/L 4,660 µg/L 2,400 µg/L	Silt, Sand Mixture	2.6-3.06 mbgs	Grid	DPT	541 kg	In Progress Additional Hotspot Remediation
Ottawa, ON	GRO	14,600 µg/L	Limestone	4.5 mbgs	Grid (Pilot Scale)	New Installed Wells	362 kg	In Review Review for Full Scale

UNESCO World Heritage Site Protected Following Application

Highlights

Site Location	Jasper, Alberta
Contaminants of Concern	
Benzene	300 µg/L
Toluene	30 µg/L
Cleanup Objective	
Reduce Contaminant Concentrations Below Detection Limits	
Geology	
Sand and Gravel	
Features	
Sensitive Water Body, Cold Climate Application	
Results	
Cleanup Objective Achieved	

Design Details

Application Type	Barrier
Barrier Length	42 meters
Treatment Interval	3 to 6 meters
Depth	
Total PetroFix Mixed Volume Applied	40,100 liters

Summary

The site is a well-known resort hotel located in a National Park and UNESCO World Heritage site in Western Canada. An underground storage tank (UST) previously operating at the site had leaked petroleum hydrocarbons (PHCs) and impacted the shallow groundwater, threatening to contaminate a pristine mountain lake adjacent to the site.

Prior remedial activities included excavation of an upgradient source area, followed by injection of Oxygen Release Compound® (ORC). These activities successfully remediated the soil and groundwater impacts to below cleanup standards. However, residual PHC contaminants in the subsurface presented a future risk of impacting the highly sensitive water body. To prevent this occurrence, IRSL was engaged by their client to install a PetroFix permeable reactive barrier next to the lake.





PetroFix Cold Weather Applications

ISRL took necessary precautions to prevent PetroFix remedial fluid from freezing. If it is anticipated that PetroFix will be injected in cold weather the material should be stored in a temperature controlled manner above 4°C.

The project presented several technical challenges, foremost the barrier's location, positioned less than two meters from the lake's edge. This required strict injection management to prevent PetroFix from entering the lake. Additionally, abundant cobbles in the injection zone presented potential difficulties for IRSL's hydraulic percussion (i.e., direct push) rig. Finally, the project was completed in the middle of the winter, where daytime high temperatures were consistently well below freezing and daylight hours limited.

Results

With extensive experience in completing remedial applications in cold climates, IRSL instituted a series of engineering controls and best practices to prevent injection lines and equipment from freezing. Additionally, IRSL's strict application monitoring protocol confirmed that PetroFix did not move beyond the injection zone to impact the lake.

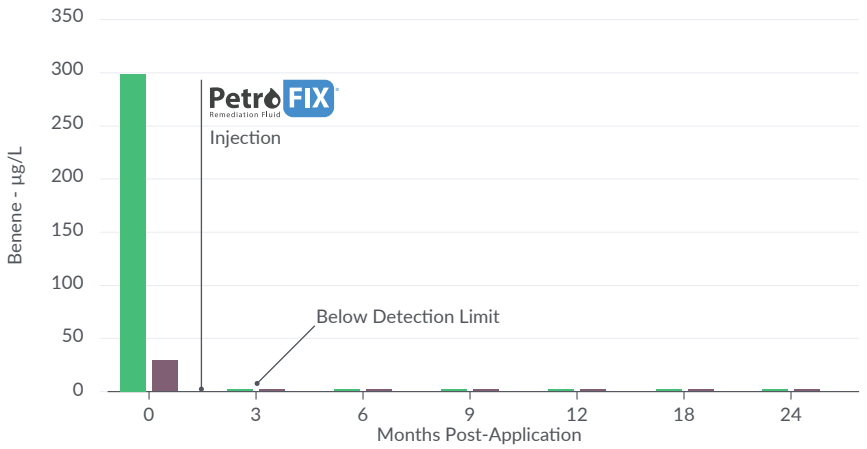
Following the PetroFix injection, contaminant concentrations in wells immediately downgradient of the PRB were non detect for BTEX, TPH-GRO and TPH-DRO within the first sampling event, three months following injection. These results have been maintained through two years of monitoring, proving the remedy's success at achieving the cleanup objective and requiring no further remedial action.

Results

Following the PetroFix injection, contaminant concentrations in wells immediately downgradient of the PRB were non detect for BTEX, TPH-GRO and TPH-DRO within the first sampling event, three months following injection.

- Benzene
- Xylenes

Benzene and Xylenes in Barrier Performance Well



Highlights

Site Location	Ontario, Canada
Contaminants of Concern	
Total BTEX	1,600 µg/L
TPH-GRO	1,000 µg/L
TPH-DRO	450 µg/L
Cleanup Objective	
Reduce Contaminant Concentrations Below Detection Limits	
Geology	
Silty Sand	
Features	
Adjacent to Highway, Cold Climate Application	
Results	
Cleanup Objective Achieved	

Design Details

Application Type	Grid
Area	600m^2
Treatment Depth	0.9 to 2.7 meters
Total PetroFix Mixed Volume Applied	>45,000 liters

PetroFix Treats Highway Truck Spill

A Safer, Easier and More Effective Approach Compared to Hydrogen Peroxide

Summary

An accident involving a fuel transport truck resulted in a spill alongside a major roadway in southern Ontario. Petroleum contaminated soils directly impacted by the spill were quickly excavated in response to the emergency.

Following excavation, soil and groundwater impacts remained downgradient of the spill area, necessitating further remediation. A hydrogen peroxide (H_2O_2) injection was conducted to address these impacts, but significant daylighting was observed while injecting into the shallow soils. The H_2O_2 injection had only limited effectiveness, prompting the need for a new remedial solution that could meet the objectives.



Avoiding Off-Gasing and Daylighting

H_2O_2 and other oxidant-based remedial amendments react with soils to produce off-gases. These off-gases can fill much of the available pore space and displace the amendments, resulting in their "daylighting" at the surface. This effect is especially pronounced at shallow treatment depths. PetroFix does not react with soils to produce off-gases and its micron sized carbon particles transmit through the soils readily. As a result, daylighting is minimal compared to oxidant-based treatment chemistries.

Using the PetroFix Design Assistant, IRSL designed a PetroFix injection program to remediate the residual PHCs to below regulatory standards. The design specified the injection of over 45,000 liters of PetroFix solution into 282 direct push injection points and 8 injection wells. IRSL completed the injection during January and February 2021, overcoming the very cold Central Canada climate.

Results

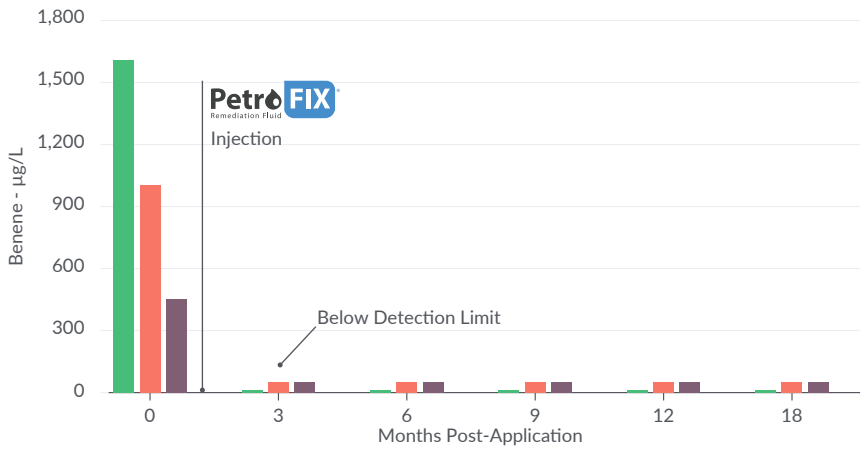
The formation readily accepted the injection of PetroFix into the shallow soils. With only a few exceptions, injection pressures were maintained mostly below 20 psi, indicating the controlled flow of PetroFix into the subsurface. Within two months following the injection of PetroFix, total BTEX, TPH-GRO and TPH-DRO concentrations were reduced to non-detect levels and sustained through 18 months of performance monitoring. Based on these results, the project objectives were achieved, and no further remediation was deemed necessary.

Results

Within two months following the injection of PetroFix, total BTEX, TPH-GRO and TPH-DRO concentrations were reduced to non-detect levels and sustained through 18 months of performance monitoring.

- BTEX
- TPH-GRO
- TPH-DRO

Treatment Zone–BTEX, TPH-GRO and TPH-DRO





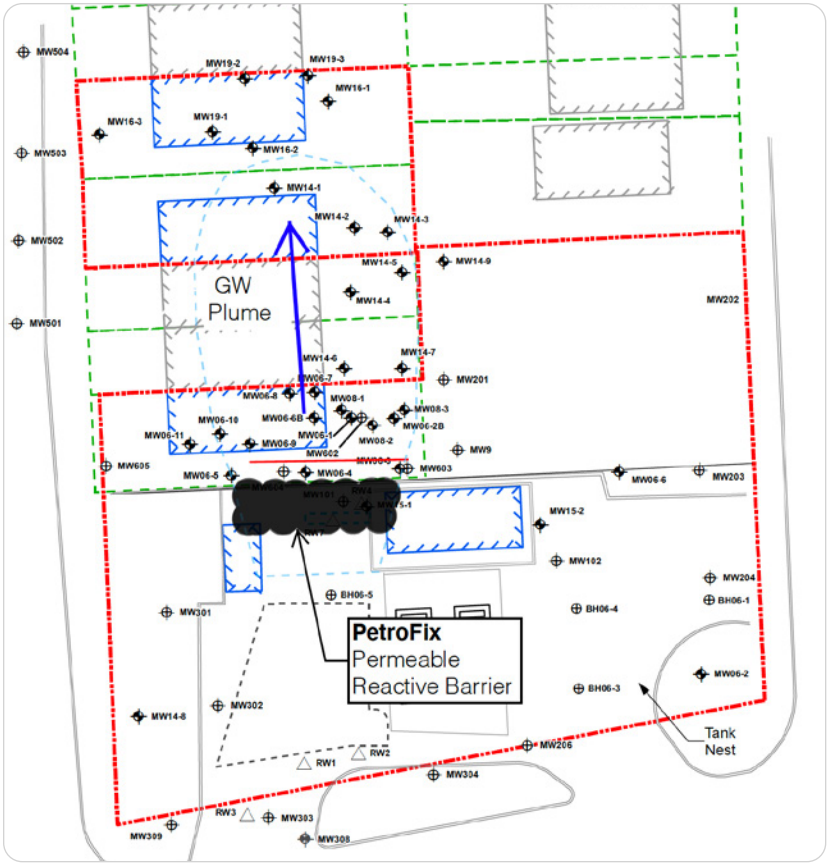
PetroFix Barrier Protects Townhome Complex

Summary

Highlights

Site Location	Ontario, Canada
Contaminants of Concern	
TPH-GRO	3,700 µg/L
TPH-DRO	2,100 µg/L
Cleanup Objective	
Eliminate Contaminant Migration Offsite	
Geology	
Clay, Silty Sand, and Sand Mixtures	
Features	
Work Adjacent to/on Residential Properties	
Results	
Cleanup Objective Achieved	

A petroleum hydrocarbon leak at a gasoline station in Ontario, Canada impacted groundwater, forming a contaminant plume that migrated onto an adjacent townhome complex. TPH contaminants were observed near some of the occupied townhomes. The potential for vapor intrusion of these contaminants was a concern and the primary remediation driver. To mitigate these concerns, a permeable reactive barrier (PRB) using PetroFix was proposed to cut off plume migration at the property boundary separating the gas station and residences. The top of the injection zone and water table were less than two meters deep, conditions that often lead to product surfacing. This needed to be minimized, especially considering the sensitive work environment.



Site Map Showing PetroFix Permeable Reactive Barrier

Design Details

Application Type	Barrier
Barrier Length	15 meters
Treatment Depth	1.9 to 4.8 meters
Total PetroFix Applied	4,000 kg



Results

IRSL's minimally intrusive remediation approach utilized compact mechanical direct injection tooling to apply PetroFix at the highly visible work area. Relying on experience, the field team was able to control the injection rates and minimize product surfacing, while applying PetroFix to the PRB.

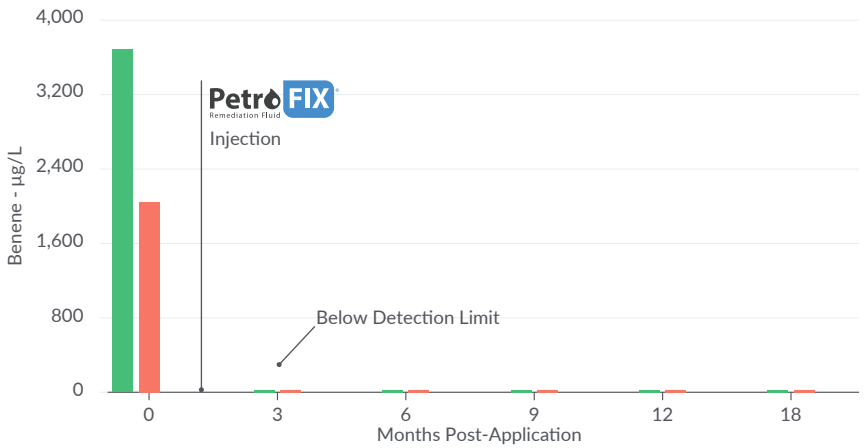
Within three months following the injection of PetroFix, TPH-GRO and TPH-DRO concentrations were reduced to non-detect levels and sustained through 18 months of performance monitoring. Based on these results, the remedial objectives were achieved, and no further remediation was deemed necessary.

Results

Within three months following the injection of PetroFix, TPH-GRO and TPH-DRO concentrations were reduced to non-detect levels and sustained through 18 months of performance monitoring.

- TPH-GRO
- TPH-DRO

Barrier Performance–TPH-GRO and TPH-DRO



Summary

Majority of Sites Reach Closure Following a Single Injection

IRSL has repeatedly demonstrated the efficacy of an *in situ* remediation approach for treating contamination problems in the subsurface in demanding field conditions. The company has quickly realized the benefits of the PetroFix technology, applying it to sites with diverse geologic conditions, contaminant concentration profiles, and land use scenarios. PetroFix's favorable injectability and non-reactivity to subsurface infrastructure has allowed IRSL to treat shallow, constricted injection zones and avoid impacts to sensitive areas successfully.

The PetroFix treatments achieved the project closure objectives at more than two-thirds of the 13 treated sites following a single injection event. In most cases, target objectives were met within three months and sustained through at least one year of performance monitoring. These remedies have led to significant cost savings for IRSL's clients and demonstrated PetroFix as a viable means for treating PHC-contaminated sites in Canada.





About the Applicator

About InSitu Remediation Services

One of Canada's most experienced remediation companies, InSitu Remediation Services Ltd. (IRSL) has designed, implemented, and maintained soil and groundwater remediation programs in diverse geological environments in North, Central, and South America, Europe and the Middle East.



About Rick McGregor

A respected environmental professional with over a quarter century in environmental assessment and remediation, Rick has designed and implemented remediation programs across the globe. An invited speaker at numerous international conferences and workshops, his knowledge leads the industry, based on his extensive experience, his innovative strategies, and his clear, pragmatic approach.

PetroFix Design Assistant

PetroFix Remediation Fluid

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.

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.

IRSL 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 IRSL to manage its projects more efficiently.

Features and Benefits

Simple - easy to use, web based platform

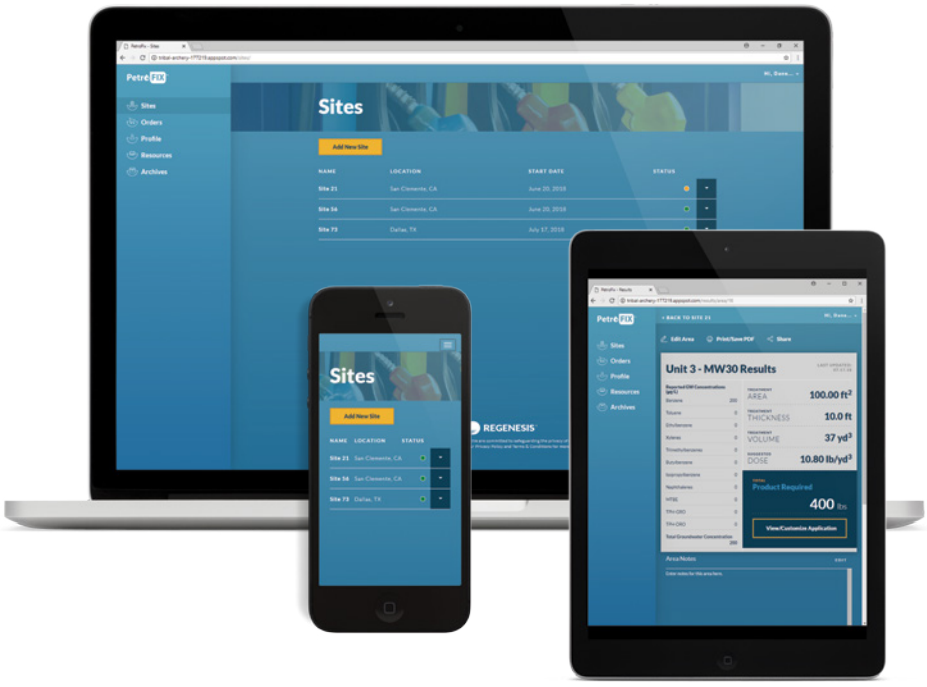
Flexible - create customized designs for unlimited individual treatment areas per site

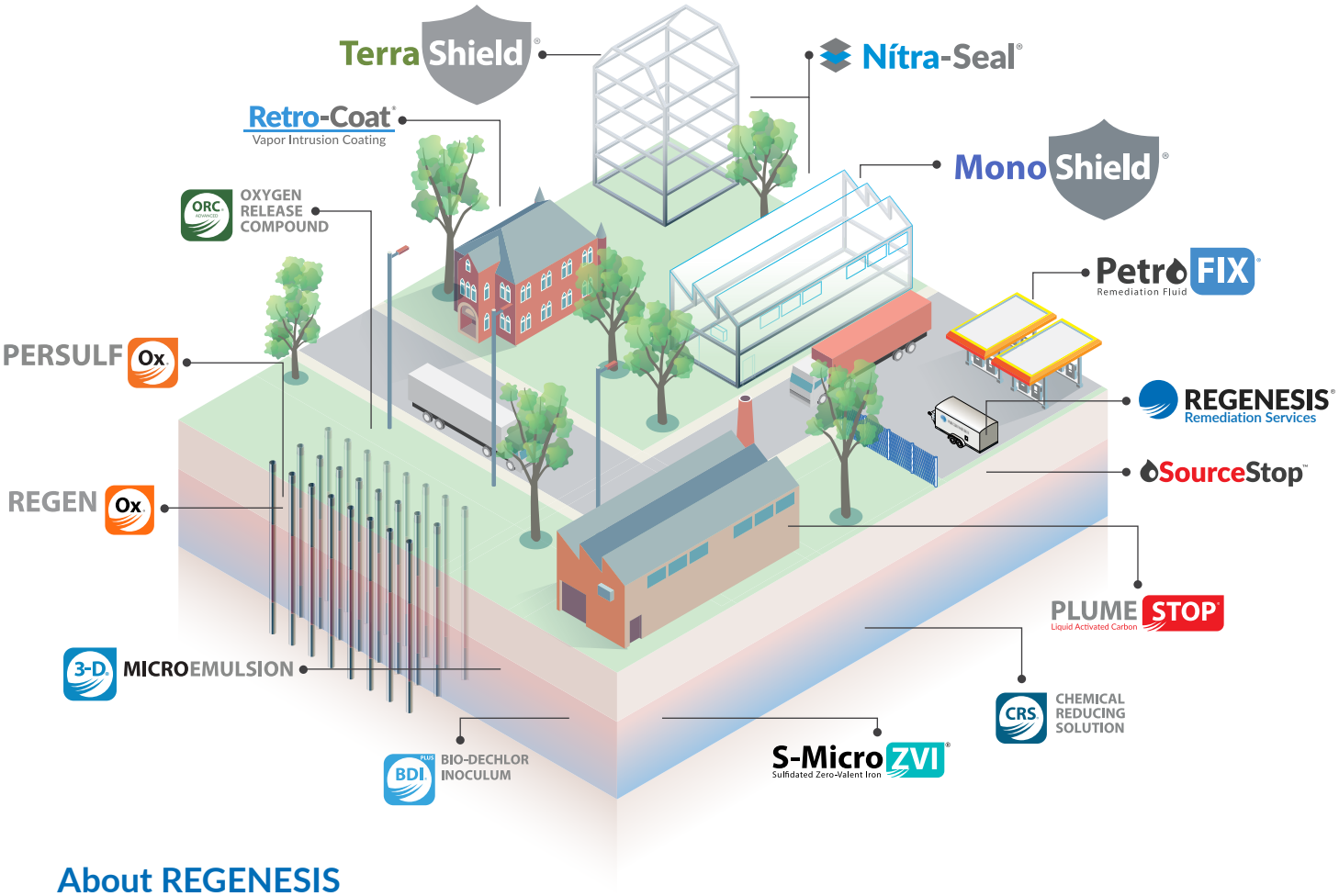
Efficient - design, estimate costs, and place orders as needed, without waiting

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





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.

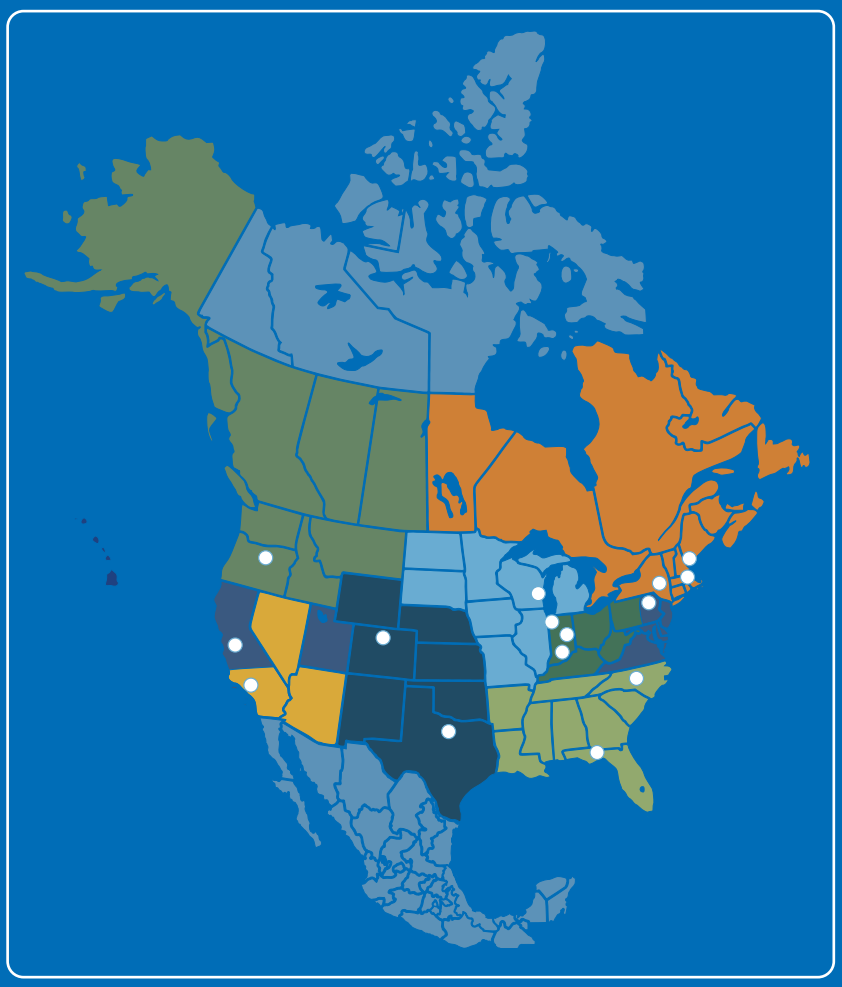
We value expertise, both our customers' and our own. We find that when our experienced staff collaborates directly with customers on complex problems there is a high potential for success including savings in time, resources and cost.

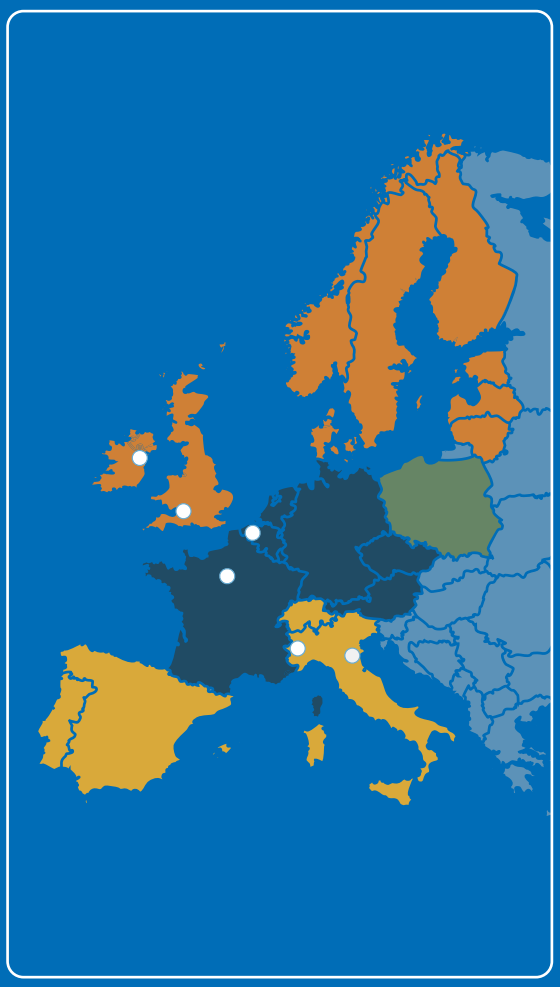
At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking 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.

REGENESIS®

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





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