NY BROWNFIELD SITE TREATED FOR PFAS

CASE STUDY:
Green, Sustainable Remediation Reduces Cost and Environmental Impact

REGENESIS®

PLUME STOP®
Liquid Activated Carbon

Background

Brownfield Cleanup Program's Green Remediation Policy Leads to PlumeStop for PFAS Treatment

The site is a 25-acre former refinery located in a mixed-use industrial/commercial area that operated from the 1880s until the 1960s when the tanks, piping infrastructure, and berm areas were removed. Since then, this long-vacant brownfield has remained undeveloped.

Site assessment activities identified contaminants on the property, including petroleum hydrocarbons and per- and polyfluoroalkyl substances (PFAS). The source of the PFAS was likely due to fire suppression operations near an access driveway that impacted surficial soils and shallow groundwater. A localized groundwater plume formed near the southeast property boundary, with perfluorooctane sulfonate (PFOS) detected at concentrations up to 83 nanograms per liter (ng/l) and lesser concentrations of perfluorooctanoic acid (PFOA).

The site was entered into the New York State Department of Environmental Conservation's (NYSDEC's) Brownfield Cleanup Program (BCP) to facilitate its commercial redevelopment. Remedial alternatives were evaluated for a comprehensive site closure strategy, and approaches were scored based on NYSDEC's Green Remediation Policy Document DER-31, which considers the "environmental impacts of treatment technologies and remedy stewardship over the long term." Per DER-31, precedent is given to remedies that:

- Reduce greenhouse gases,
- Increase energy efficiency and minimize non-renewable energy usage,
- Conserve and efficiently manage resources and materials, and
- Eliminate waste.

In situ treatments, by their nature, are considerably greener and more sustainable than *ex situ* treatment methods. Understanding this, Benchmark Environmental Engineering & Science, PLLC & TurnKey Environmental Restoration, LLC (Benchmark & TurnKey), a leading engineering and redevelopment consulting company headquartered in Buffalo, New York, engaged REGENESIS for an *in situ* remedy that would effectively and economically cut off the plume and prevent migration of PFAS offsite. Consequently, the REGENESIS team began to design a solution employing a PlumeStop® colloidal activated carbon barrier, the only viable, field-proven *in situ* remedy for PFAS-impacted groundwater.

Assessing Green and Sustainability Remediation for PFAS: *Ex Situ* vs. *In Situ* Methods

Green and Sustainability Remediation (GSR) is defined as the site-specific use of products, processes, technologies, and procedures that mitigate contaminant risk to receptors while balancing community goals, economic impacts, and net environmental effects. GSR is a beneficial approach that optimizes all phases of site remediation, from site investigation to project closeout. Therefore, it is useful to review the two primary treatment methods, categorized as either ex situ or in situ, to treat PFAS contamination in groundwater, according to GSR best practices.

Ex situ treatment involves extracting groundwater and filtering the groundwater using sorbent media such as activated carbon or ion-exchange resins. This pump-and-treat (P&T) method relies on fixed, mechanical systems to move PFAS-impacted groundwater from the subsurface to aboveground, where the PFAS are filtered out of the water, and the clean water discharged, commonly to a publicly-owned treatment works (POTW), where it is in turn, discharged back into the environment. In the case of ex situ, the treatment amounts to aboveground filtering to remove the PFAS and eliminate the risk to a potential human or environmental receptor. The filtering materials used to contain PFAS are now mainly being managed or disposed of as hazardous waste in response to recent advances in state and federal regulations to reduce PFAS exposure.

Since the inception of groundwater remediation, P&T systems have been in use and are generally, if not always, reliable instruments for source control, intercepting, or containing groundwater contaminant plumes upstream of a sensitive receptor or property boundary. Substituting new contaminants such as PFAS into the old P&T approach is a natural fallback position, particularly for groundwater remediation practitioners well-versed in its design and application.

Over time, however, environmentally conscious consultants, property owners, and regulatory agencies have concluded that in most cases, P&T's performance track record (especially for contaminant mass removal) does not justify the costs for the decades-long operational life cycles of these systems. The financial and environmental costs to install, operate, and maintain these systems are numerous and include most or all of the following:

- *High up-front capital costs for installation,*
- *Long-term energy usage and inefficiencies,*
- *Fossil-fuel consumption,*
- *System infrastructure disruptive to business operations,*
- *Noise pollution,*
- *Operation and maintenance costs persisting with no endpoint, and,*
- *Waste generation, uniquely important for PFAS.*

On the other hand, in situ treatments substantially reduce or entirely avoid many of these cost burdens and thus have become increasingly favored by the industry. For PFAS, the treatment mechanism for in situ is the same as for ex situ remediation: removing risk by filtering PFAS out of groundwater and onto a sorbent media. However, in situ treatment of PFAS maintains the filter below the ground surface, relying on natural groundwater advection to move the PFAS through a treatment zone, where they are immediately sorbed onto an immense surface of activated carbon. Moreover, based on its colloidal chemistry, which allows it to permeate through and deposit onto aquifer materials, PlumeStop is the only viable and proven in situ treatment option for PFAS.

Compared to ex situ pump-and-treat approaches, as applied, PlumeStop in situ treatments produce no greenhouse gas emissions or disposal waste, do not consume energy, generate no noise pollution, require minimal infrastructure (i.e., only the performance monitoring wells), and no post-installation operation. Due to these factors, the use of PlumeStop is the only viable GSR alternative PFAS remediation.

Remediation

PlumeStop Barrier for PFAS Treatment is a Key Component in Pursuit of Site Closure

Injection Summary

Design Type
Permeable Reactive Barrier

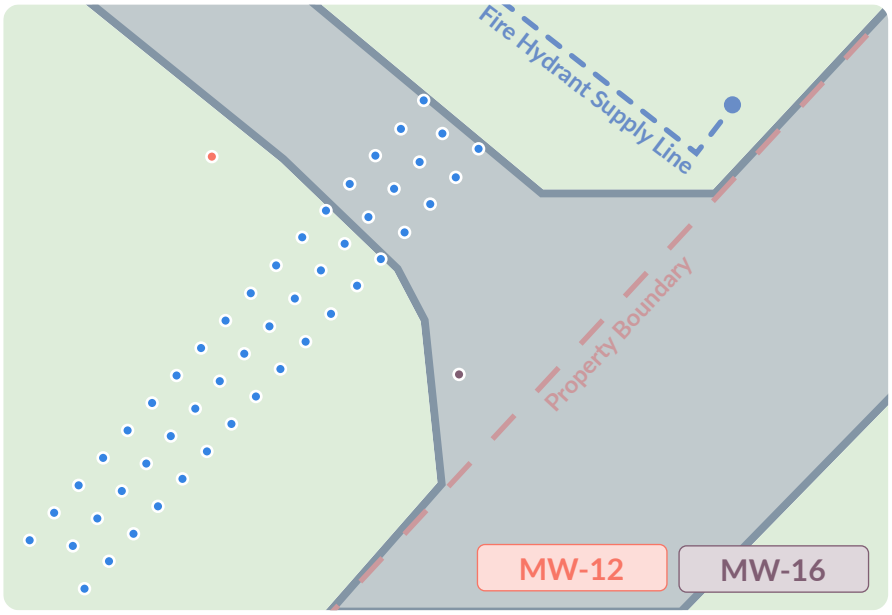
PRB Length
100 feet

Direct-Push Injection Information

50 Injection Wells	12-18 Feet bgs

PLUME STOP® Liquid Activated Carbon
12,200 Gallons Applied

PlumeStop was proposed to form an *in situ* permeable reactive barrier (PRB) along the southeast property boundary and prevent the migration of PFAS offsite through groundwater. The target treatment interval encompassed a shallow groundwater zone between 12 and 18 feet below ground surface (bgs) where PFAS were detected. Monitoring wells were installed upgradient and downgradient of the PRB to demonstrate PFAS removal from groundwater as it passes through the barrier.



The PlumeStop PRB was a component of the remedial plan which also included:

- Removing underground piping,
- Excavating and disposing of grossly impacted shallow soils,
- *In situ* stabilization of surficial soils to prevent further contaminant leaching to groundwater,
- Building a cover over the site to limit contact with the remaining soil, and
- Filing of an environmental easement to restrict future use of the property to commercial or industrial uses

Results

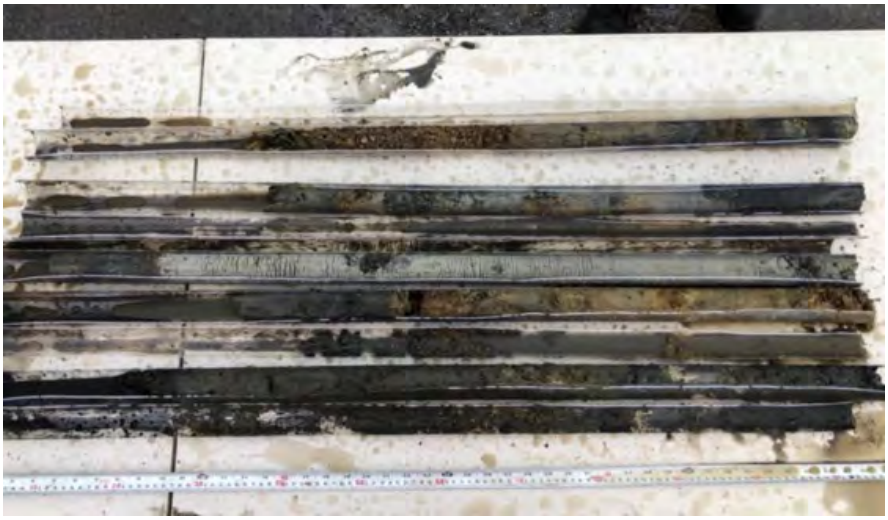
Skillfully Managed PlumeStop Application Achieves GSR and Cost Reduction Objectives – Enters Performance Monitoring Phase

REGENESIS® REMEDIATION SERVICES
Technology-Based Solutions for the Environment

REGENESIS Remediation Services successfully completed the PlumeStop PRB installation during August 2021. A volume of over 12,000 gallons of PlumeStop was injected through 50 direct push injection points over the proposed treatment interval. A controlled flow rate was used to maintain low injection pressures, averaging approximately 20 pounds per square inch during the application. Samples from nearby installation performance monitoring wells and confirmation soil cores were collected during and post-application to validate PlumeStop placement onto the aquifer materials. With the installation complete, the application has entered the performance monitoring phase.

The *in situ* application of the PlumeStop PRB to treat PFAS has already tremendously reduced the project costs, and environmental impacts that would have been generated had an *ex situ* approach been employed at the site. Through the remedy-selection and implementation process, Benchmark has once again demonstrated its understanding of the true cost of environmental remediation in selecting this GSR-principled approach through this process.

Visual confirmation of PlumeStop in nearby groundwater monitoring location



Soil core depicting complete coverage of PlumeStop onto aquifer soil materials.

About The Consultant

Benchmark Environmental Engineering & Science, PLLC and TurnKey Environmental Restoration, LLC

A recognized environmental remediation/engineering leader in New York State, Benchmark/TurnKey has investigated and remediated nearly every environmental contaminant in soil, sediment, air, biota, structures, surface water and groundwater on hundreds of abandoned, underutilized, and environmentally-impaired sites encompassing over 2,000 acres, representing more than $150,000,000 in remedial costs and over $1.3 Billion in redevelopment construction costs. Benchmark/TurnKey staff have investigated, planned, designed, constructed and operated remediation, restoration and/or redevelopment projects, including a wide range of Federal National Priority List (NPL) sites, State Superfund sites, New York Voluntary Cleanup Program (VCP) sites, New York Brownfield Clean Program (BCP) sites and Resource Conservation and Recovery Act (RCRA) corrective action sites. These include high-profile assignments such as the Love Canal Site Creeks and Sewers Remediation, Former Bethlehem Steel RCRA/BCP projects, the liability transfer and cleanup of the former Republic Steel and Donner-Hanna Coke Plant (Steelfields, aka Riverbend) site, the liability transfer, and many other remediation/redevelopment projects in western New York.

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Michael Lesakowski, President

Mr. Lesakowski holds Bachelor of Science in Biology and Master of Science in Environmental Engineering Science from University of Buffalo. He has over 23 years' experience in the environmental engineering and consulting field at numerous industrial, commercial and hazardous waste sites throughout the northeast United States. Mr. Lesakowski has been involved with all aspects of New York Brownfield Cleanup Program, New York State Superfund Program, New York Petroleum Spills Department, over 1,000 Phase I Environmental Site Assessments, including multi-site portfolio environmental due diligence assignments, and more than 300 Phase II Site Investigations associated with property acquisition and divestiture. He has managed assessments, investigations and remediation projects on properties with a multitude of historic uses (e.g., petroleum storage refineries and terminals, gas stations, automobile dealerships, rail yards, foundries, drycleaners, steel manufacturing, metallurgical plants, metal plating operations, junk yards), media types (surface and subsurface soil, groundwater, sediments, soil vapor, indoor air, building materials) and contaminants (e.g, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), heavy metals, per- and polyfluoroalkyl substances (PFAS)). Mr. Lesakowski has managed remediation projects, ranging from simple underground storage tank (UST) removals to large-scale soil excavations, in-situ soil stabilization, and complex groundwater remediation programs, such as biological and/or chemical in-situ groundwater treatment and permeable reactive barriers for VOCs and PFAS.

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Thomas Forbes, President

Mr. Forbes holds a bachelor's degree in chemical engineering from the University at Buffalo and is a licensed professional engineer registered in New York, Ohio and Pennsylvania. He has 33 years of environmental engineering experience, with a particular focus on brownfield and hazardous waste site investigation and remediation; petroleum-impacted site remediation; due diligence for environmentally impaired properties; and industrial wastewater treatment. Investigations and cleanups Mr. Forbes has directed have included well over 300 sites contaminated with a wide range of materials, including Per- and polyfluoroalkyl substances (PFAS), chlorinated solvents, polyaromatic hydrocarbons, PCBs, heavy metals, cyanide, radioactive isotopes, and petroleum contamination. He has successfully implemented numerous remedial technologies including physical-chemical and biological processes as well as removal and containment methods.

REGENESIS®

Technologies Used

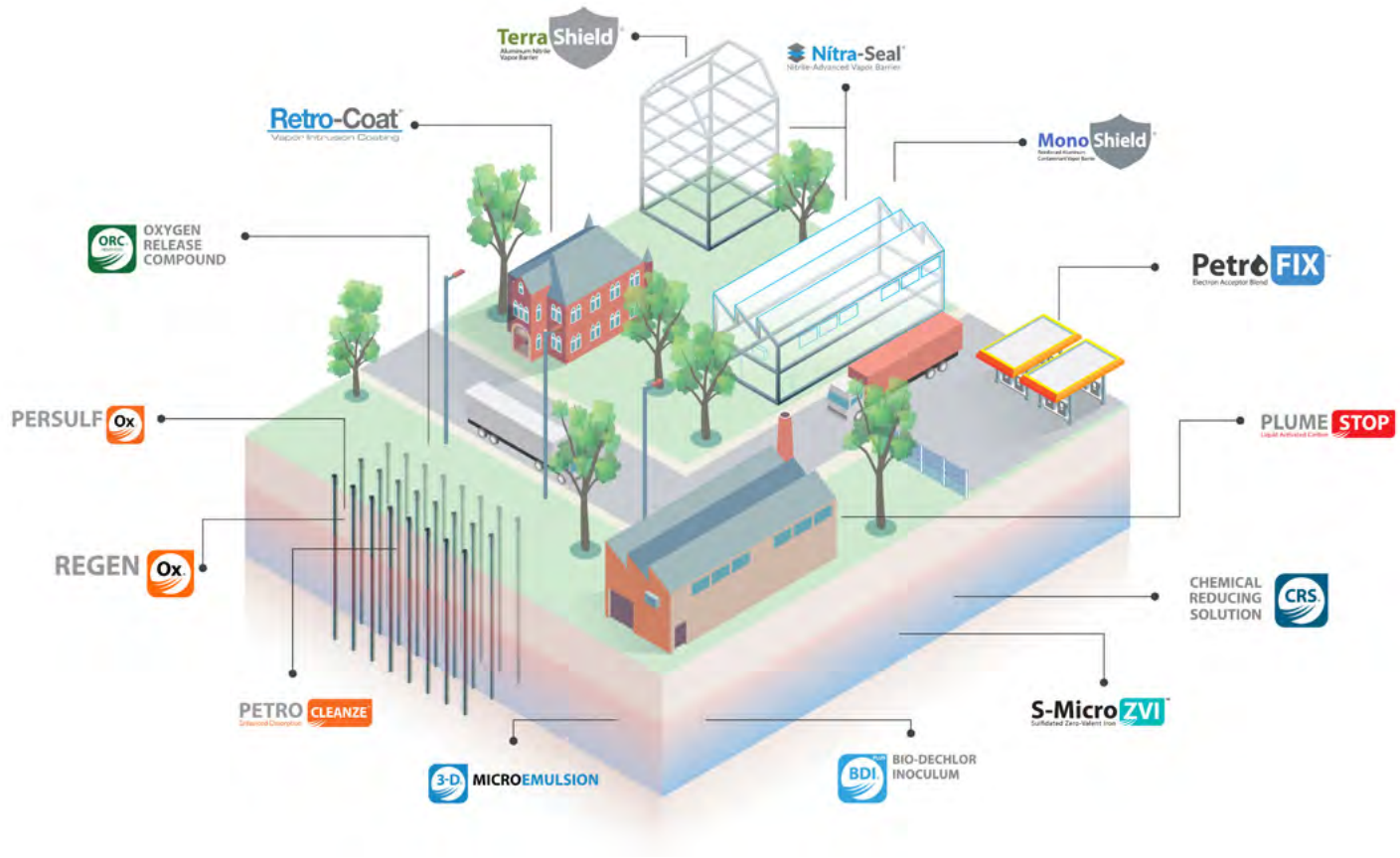
PlumeStop, A Colloidal Activated Carbon Remedy with Seven Years of Proven Performance

PLUME STOP® Liquid Activated Carbon

PlumeStop® Colloidal Activated Carbon is a fast-acting groundwater remediation reagent which captures and biodegrades a range of contaminants, thus accelerating the successful treatment of impacted sites and leading to their permanent closure. As a science-based, *in situ* treatment technology, REGENESIS' PlumeStop rapidly removes contaminants from groundwater and stimulates their permanent degradation.

Proven Effective on a Wide Range of Contaminants

- CVOCs
- BTEX, PHCs, TCE, PAHs
- MTBE, BTEX
- TNT
- Pesticides, Herbicides
- PFOA, PFOS



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.

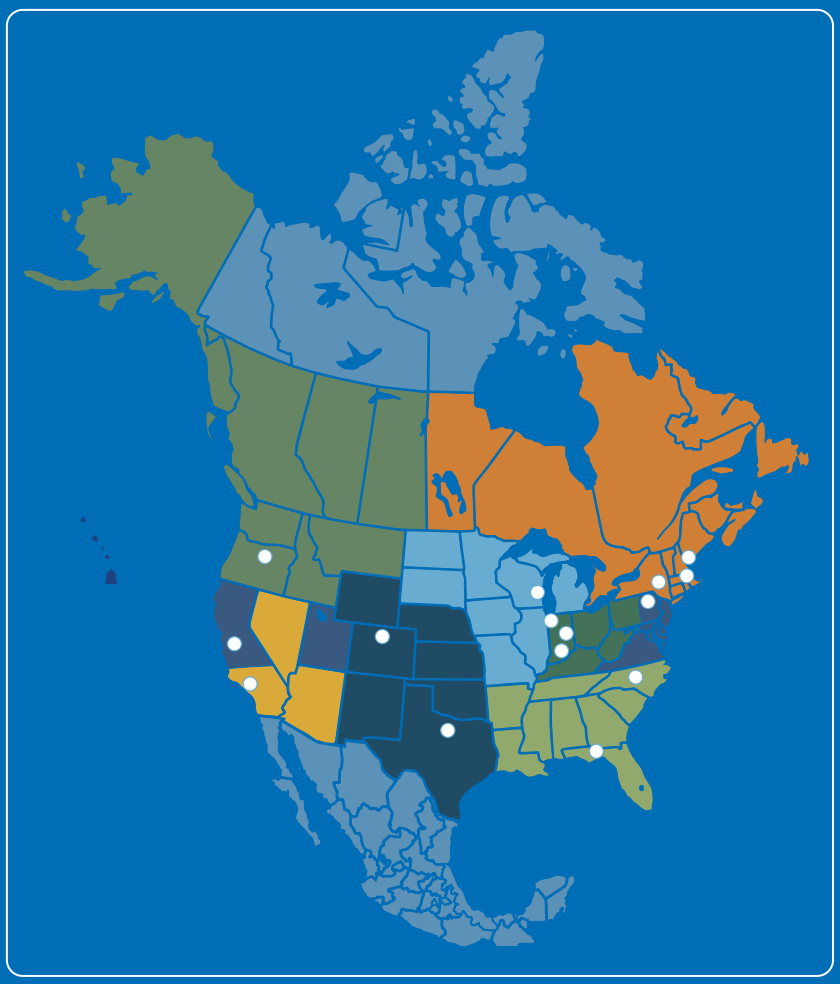
At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking time to understand the people we work with and their circumstances. We believe this is a key factor in achieving successful project outcomes.

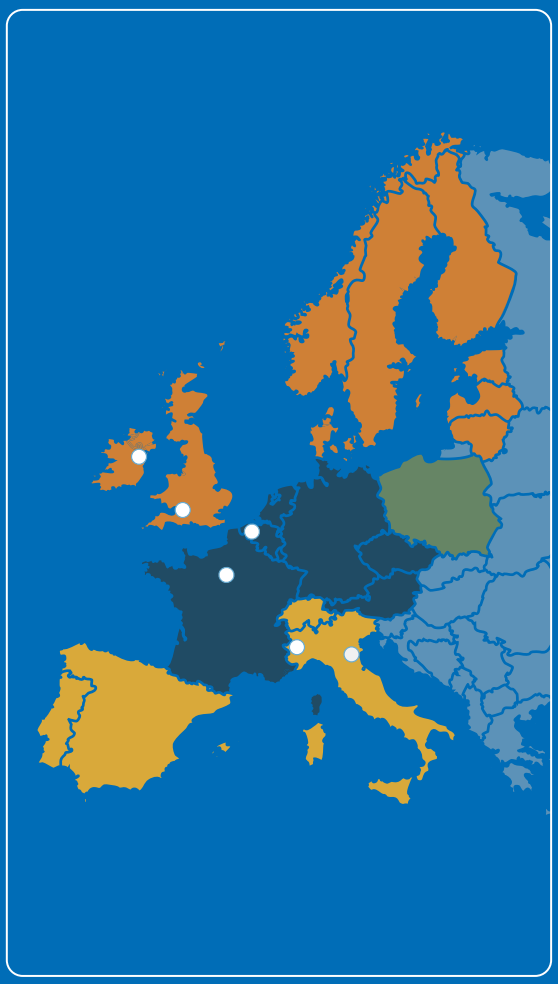
We believe that by acting under this set of values, we can work with our customers to achieve a cleaner, healthier, and more prosperous world.

REGENESIS®

We're Ready to Help You

Find the Right Solution For Your Site





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