NO FURTHER ACTION ACHIEVED AT GASOLINE STATION SITE

CASE STUDY:
Effective Collaboration Contributes to Substantial Cost Savings

REGENESIS®

Background

PersulfOx® and ORC Advanced® Treatment Selected as Most Cost-Efficient Remedial Solution

In October 2009, a subsurface investigation was performed at a gasoline service station near the Mississippi River in central-eastern Louisiana, as part of a property transaction. Petroleum hydrocarbons (PHCs) were detected in soil and groundwater. Further investigation phases were performed to define the magnitude and extent of the PHC plume, confined to predominantly fine-grained soils (i.e., silt and clay) in the upper 15 feet below ground surface (bgs).

In 2015, PPM Consultants, Inc. (PPM) submitted a Corrective Action Plan (CAP) to the Louisiana Department of Environmental Quality (LDEQ) to remediate benzene (i.e., the primary PHC of concern), in soil and groundwater. In the CAP, PPM proposed an *in situ* chemical oxidation (ISCO) and aerobic bioremediation treatment approach utilizing PersulfOx® and ORC Advanced®. The ISCO to bio treatment approach was nearly 50% more cost-effective than the installation of either dual-phase extraction or ozone sparging systems, two possible approaches considered by PPM prior to determining the final remedy.

The remediation design plan specified a phased application approach with three PersulfOx injection events completed at approximately 60-day intervals. This phased approach allowed groundwater sampling and evaluation of the PersulfOx ISCO injection performance between the events. REGENESIS could then use the performance feedback to direct PersulfOx placement and dosing for each subsequent event. Additionally, dividing the PersulfOx injections over three events allowed for better volumetric accommodation by the fine-grained soil matrix. The injection of ORC Advanced was proposed concurrently with the third and final PersulfOx event to provide a long-term source of oxygen to promote aerobic bioremediation of benzene.

Application

REGENESIS Remediation Services Implemented a Highly-Controlled Injection Program

Application Design Summary

Total Treatment Area	5,000 ft^2
Treatment Intervals	6-13 ft bgs.
Application Volume	18,090 gal.

Following the design, REGENESIS Remediation Services (RRS) completed the *in situ* injection application over three events from March through October 2016 utilizing a hydraulic percussion rig and retractable injection screen assembly. PersulfOx was injected over the full area for the initial event and a progressively smaller area for events 2 and 3. PPM completed groundwater sampling between each event and shared the results with REGENESIS to guide product allocation and dosing following the initial PersulfOx event. ORC Advanced was injected during the third event only through separate injection points. Approximately 18,000 gallons of PersulfOx and ORC Advanced were applied throughout the remedial program. RRS maintained low injection pressures (i.e., generally less than 20 pounds per square inch) during the application of PersulfOx, effectively controlling the distribution and minimizing product surfacing. All work was completed safely, on-time, and on-budget.

Event No.	Remedial Solution	Weight	Volume	Injection Points
1	PERSULFOx	12,465 lbs	9,840 gal	72
2	PERSULFOx	6,777 lbs	4,970 gal	39
3	PERSULFOx	3,417 lbs	2,490 gal	20
3	ORC OXYGEN RELEASE COMPOUND	2,400 lbs	790 gal	40

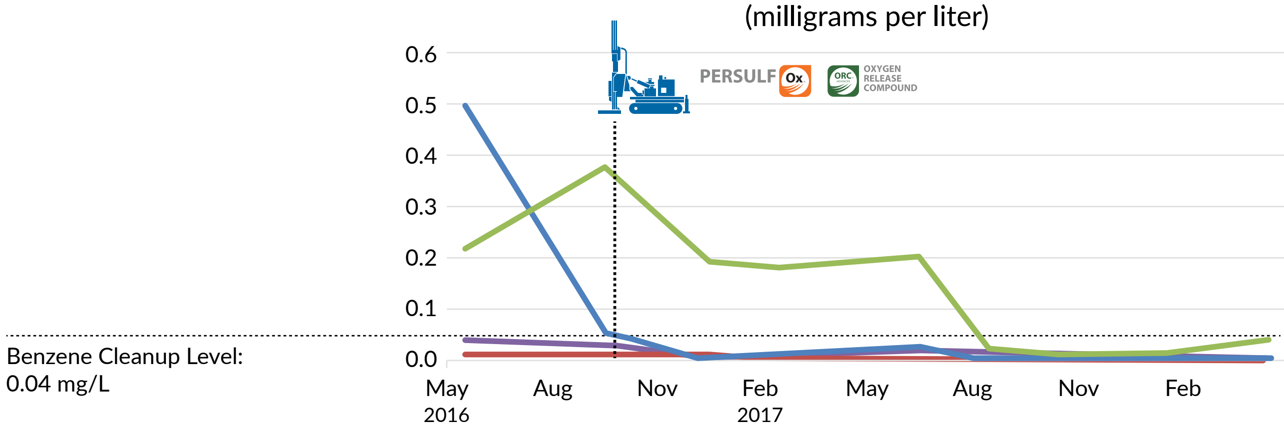
Results

Louisiana DEQ: “No Further Action is Necessary”

Following the application and subsequent monitoring, the treatment objective was met, with benzene reduced to a concentration at or below the site-specific cleanup level of 0.04 milligrams per liter (mg/L) in all treatment area wells for four consecutive quarterly monitoring events. Benzene concentrations have also been reduced 95 percent in the treatment zone overall.

During the performance monitoring phase, the LDEQ requested PPM advance a soil boring and collect a confirmation soil sample from the treatment area. This sample was analyzed for benzene, with the results showing concentrations below the target cleanup objective (i.e., limiting RECAP standard). Based on these results, the LDEQ determined that no further action was necessary for the site. Collaboration between PPM and REGENESIS using a phased, progressive injection plan guided by interstitial performance monitoring resulted in substantial cost savings while achieving the no further action goal.

Benzene in Treatment Area Monitoring Wells (milligrams per liter)



About The Consultant

PPM Consultants, Inc.

PPM Consultants is an environmental and engineering consulting firm providing services to industrial, commercial, and governmental clients. PPM has achieved steady growth and success by providing common sense and cost-effective solutions to our clients' environmental issues. Founded in 1994, PPM now operates eight offices and eight service centers in the U.S. PPM is consistently listed on the ENR 200 list of largest environmental consulting firms in the country, and has been listed twice on the Inc 500 list of fastest-growing privately-held companies in the country.

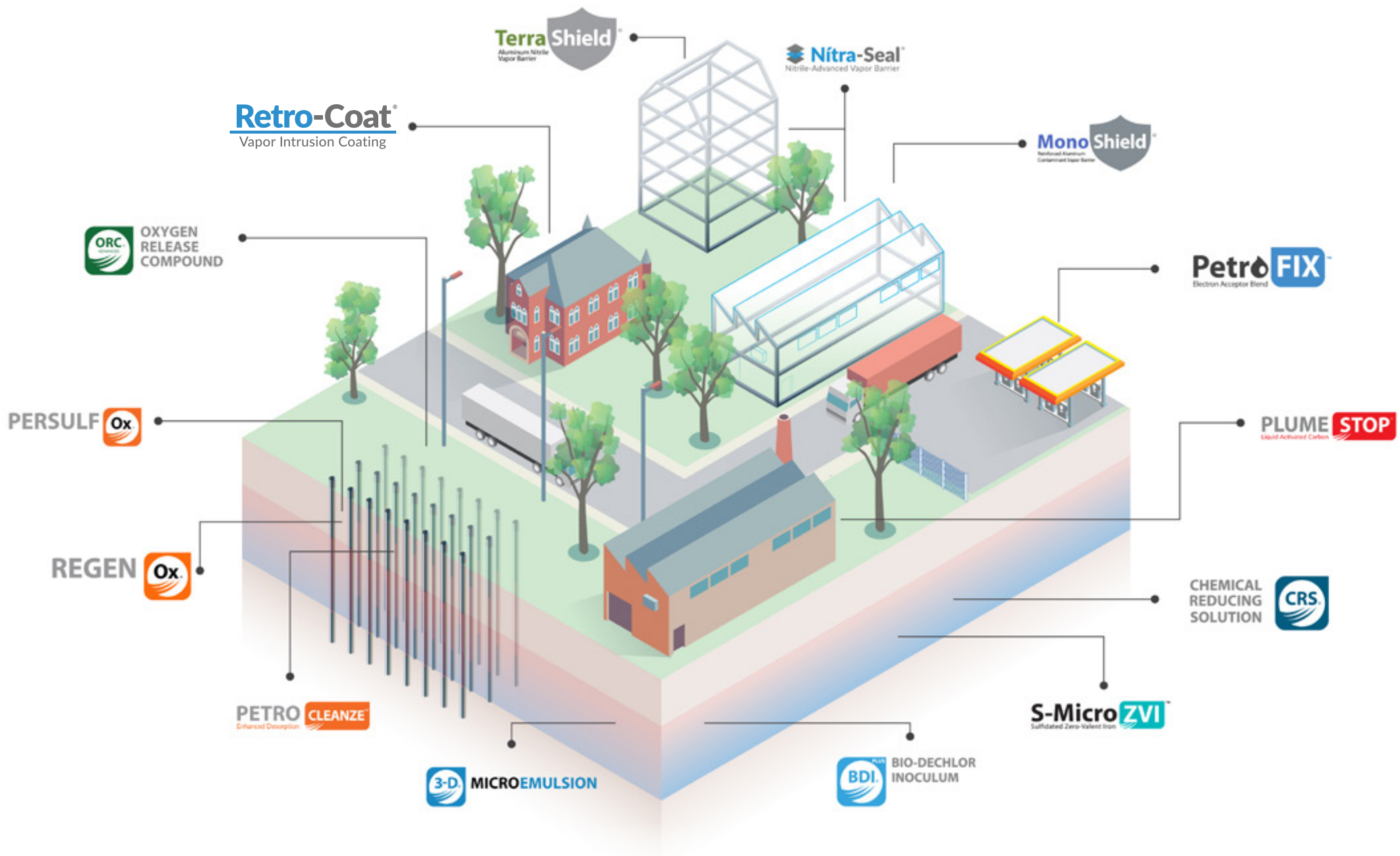
Founded primarily as a firm specializing in providing soil and groundwater assessment and remediation to the petroleum marketing industry, our services have expanded over the years to include a full range of air, water, and waste compliance consulting; due diligence, and other related environmental services. We provide these services to the petroleum marketing, industrial, commercial real estate, legal, and oil and gas/mining sectors, as well as local, state and federal government.

We believe our success is based on our unwavering commitment to exceed client expectations in every facet of our service, and recognize that the success of our organization is inherently tied to the success of yours. Our clients succeed when the delivery of our services lowers their costs, decreases their environmental liabilities, and allows them to get back to focusing on their core business. We measure success by one other yardstick: the establishment of long-term relationships with our clients.

Technologies Used
PersulfOx and ORC Advanced

PersulfOx® is an advanced *in situ* chemical oxidation (ISCO) reagent that destroys organic contaminants found in groundwater and soil through abiotic chemical oxidation reactions. It is an all-in-one product with a built-in catalyst which activates the sodium persulfate component and generates contaminant-destroying free radicals without the costly and potentially hazardous addition of a separate activator. The patented catalyst enhances the oxidative destruction of both petroleum hydrocarbons and chlorinated contaminants in the subsurface.

ORC Advanced® is an engineered, oxygen release compound designed specifically for enhanced, *in situ* aerobic bioremediation of petroleum hydrocarbons in groundwater and saturated soils. Upon contact with groundwater, this calcium oxy-hydroxide based material becomes hydrated producing a controlled-release of molecular oxygen (17% by weight) for periods of up to 12 months on a single application.



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.

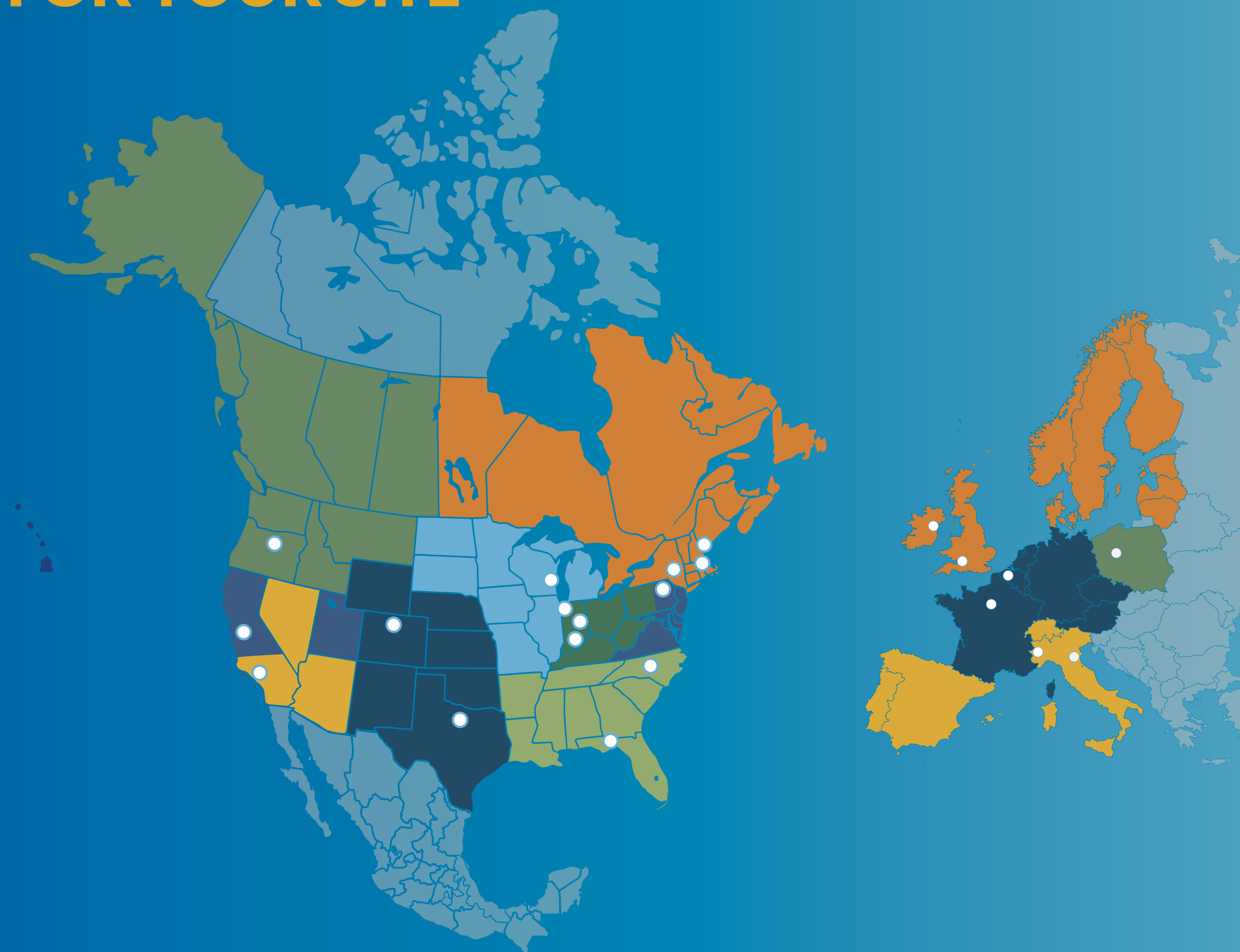
At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking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