

PFAS REMAINS AT NON-DETECT AFTER TWENTY MONTHS

CASE STUDY:

**Michigan Dept. of Military and
Veteran Affairs Employs PlumeStop
at Grayling Army Airfield**





Background

PFAS is Discovered in Groundwater at a Michigan Army National Guard Base



New, innovative approach using colloidal activated carbon barrier to eliminate PFAS exposure pathway and protect the community.



Highly collaborative effort amongst interdepartmental groups.



Economical and effective pilot study design.

Camp Grayling in Crawford County, Michigan, is a year-round training center for the Michigan Army National Guard (MIARNG). As the largest National Guard training installation in the U.S., Camp Grayling provides year-round training support for the MIARNG along with military commanders and civilian leaders to meet their readiness requirements. Camp Grayling has a proud history dating back to the first World War and has been instrumental in training U.S. multi-reserve troops and Michigan National Guards corpsmen and women for every major war over the last 100 years. Camp Grayling is recognized internationally for hosting the event, Northern Strike, a joint training exercise involving all U.S. armed forces and armed forces from 12 other countries. The area surrounding Grayling is home to recreational activities that include hunting, boating, and fishing. It is known for its beauty, abundant wildlife, and many lakes and waterways.



Firefighting training activities were conducted onsite previously, leading the DMVA to suspect PFAS contamination.



Groundwater sampling and laboratory analysis confirmed PFAS was present in groundwater.



The U.S. EPA regulatory guidelines for two PFAS compounds, PFOS and PFOA, are set at 70 parts-per-trillion, equivalent to a single drop in three Olympic-size swimming pools. This concentration is 70 times lower than the U.S. EPA drinking water maximum contaminant level for benzene.

“We have great partners with Wood, my staff, and REGENESIS to come up with a good strategy for an effective pilot study...”



— Jonathan Ederly
Environmental Manager
Michigan National Guard

Site Remediation History and Recent Discovery of PFAS

Since the late 1980s, the Michigan Department of Military and Veteran Affairs (DMVA) has been remediating groundwater impacted by chlorinated solvents historically used at the facility. In 2016, the DMVA became aware of the potential contamination of PFAS from past operations such as on-site firefighting training. In response, they began testing groundwater at the Grayling Army Airfield (GAAF). The testing revealed PFAS (per- and polyfluoroalkyl substances), commingled with chlorinated solvents, migrating towards the property boundary.

PFAS - Problematic for Remediation

PFAS are a large group of human-made chemical compounds that have been in use since the 1940s. The remediation of PFAS is particularly challenging since these compounds were designed to be very stable, making them highly persistent in the environment. They are mobile in groundwater and are very slow to biodegrade naturally. In addition, their reported toxicity has led to the establishment of exceedingly low cleanup goals by the Michigan Department of Environment, Great Lakes & Energy (EGLE), and other regulatory agencies, most often in the part-per-trillion range. PFAS have been used in consumer products for decades, and their ubiquity in the environment is a dawning realization for the environmental industry. As a result of these factors, few *in situ* treatments are available for PFAS, and fewer still have demonstrated effectiveness.

Michigan's PFAS Response

Michigan government leaders have been proactive in addressing PFAS as emerging contaminants of concern in groundwater. In 2017, the Governor of Michigan launched an interagency group called the Michigan PFAS Action Response Team (MPART) tasked with investigating sources and locations of PFAS and protecting drinking water and public health. This group, of which the Michigan DMVA is a member, frequently meets to address PFAS contamination and collaborate on proactive solutions.



Remedial Technology Evaluation

PlumeStop, an *In Situ* PFAS Treatment Technology, Emerges as the Solution to Test

DMVA's Remedial Technology Evaluation and Decision



Remedial Technology Evaluation

The DMVA completed a remedial technology evaluation, ultimately deciding to pilot test a PlumeStop colloidal activated carbon PRB in the field. Expected performance and cost were the driving factors for the DMVA's decision.

The DMVA's environmental task force evaluated possible groundwater remedial technologies to address PFAS, including classical mechanical approaches such as pump-and-treat. During the evaluation, the task force became aware of a new method to eliminate risk through *in situ* treatment, using REGENESIS' PlumeStop®, a form of colloidal activated carbon. This innovative technology has demonstrated effectiveness at other PFAS-impacted groundwater sites, quickly removing these contaminants from the dissolved phase and eliminating downgradient exposure risk. PlumeStop's effectiveness at PFAS removal from groundwater is expected to last for decades at these sites based on internal and third-party modeling simulations.



What is a PlumeStop PRB?

A PlumeStop PRB is constructed of an injection point array with its orientation perpendicular to the principal groundwater flow direction. Soon after injection, PlumeStop binds to the aquifer soil, leaving the soil grains coated with carbon and creating a reactive sorption zone.

After reviewing potential remedial options to pilot-test in the field, including pump-and-treat, the DMVA ultimately decided to pilot test PlumeStop in a permeable reactive barrier (PRB). The primary reason DMVA chose PlumeStop for the pilot test was its demonstrated potential to remove PFAS from the dissolved phase quickly combined with long-term treatment promise. Additionally, the project life-cycle cost was a consideration for the DMVA in their selection. The projected cost for installing a PlumeStop PRB was significantly lower than operating a mechanical system over a similar timeframe.

Throughout the remediation process, the DMVA has hosted multiple town hall meetings to ensure clear communication with the Grayling community.

Pilot Test

REGENESIS Develops and Implements an Efficient Pilot Test Barrier Design, Documenting Consistent PlumeStop Distribution

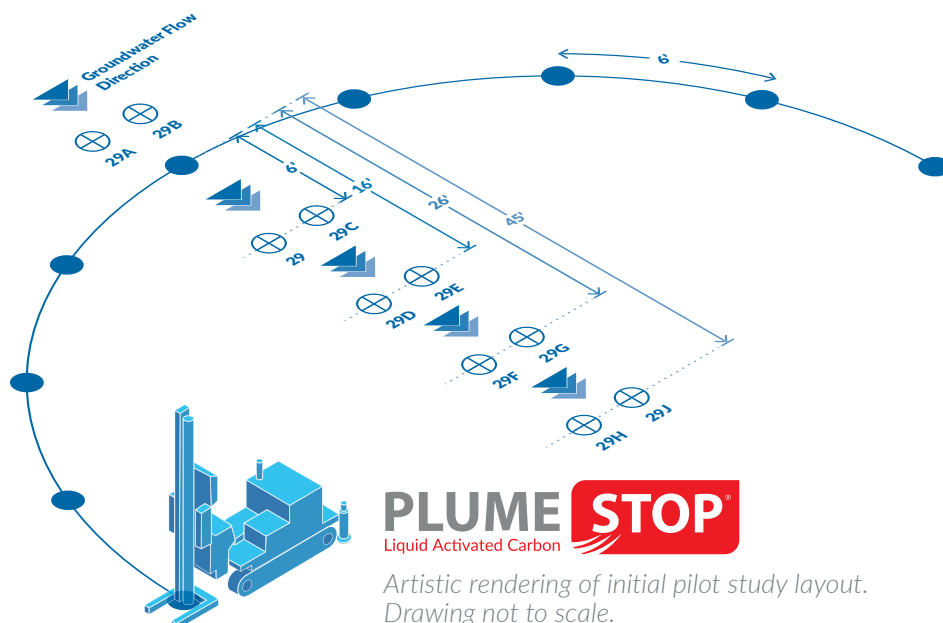


How Does a PlumeStop PRB Work?

As groundwater passes through the treatment zone, the flow of PFAS and other contaminants are slowed (i.e., retarded) by orders of magnitude, effectively binding them, halting their movement, and eliminating exposure to down-gradient receptors. As the exposure to downgradient receptors is eliminated, so is the risk. In essence, a PlumeStop PRB functions as an *in situ* purifying filter for groundwater.

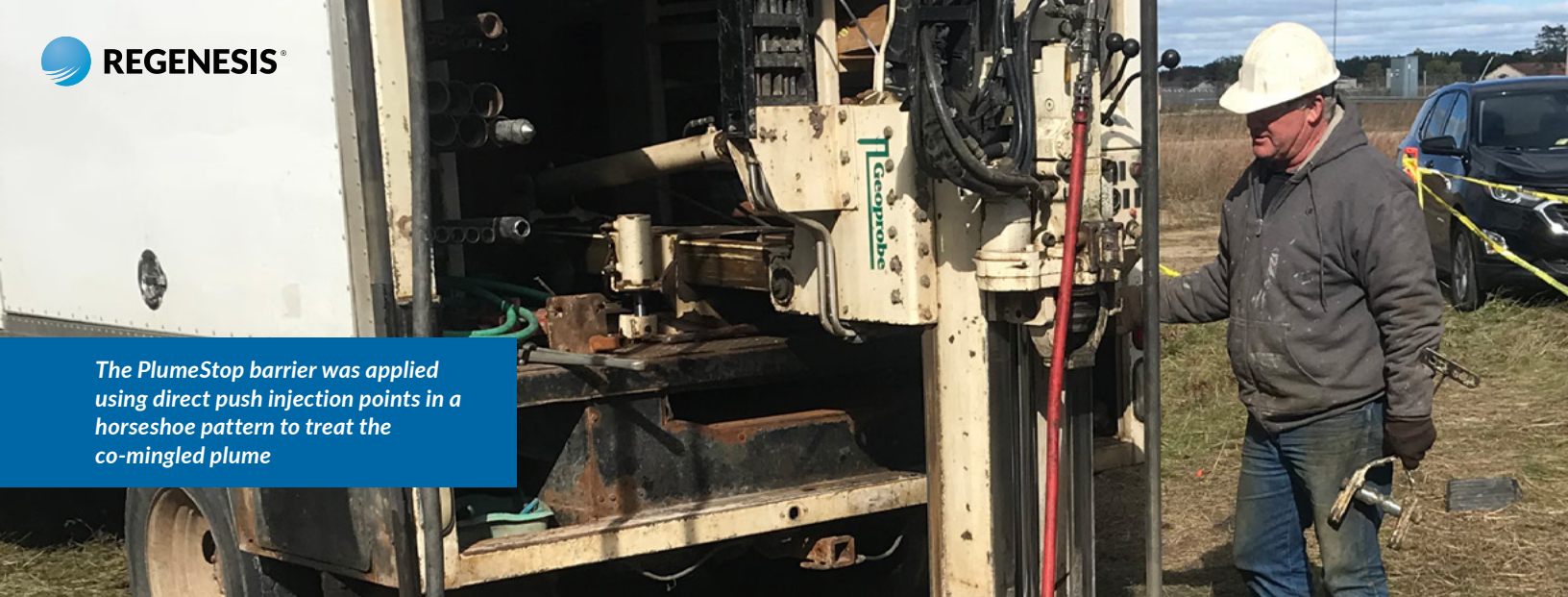
Following the selection process, REGENESIS and the Michigan DMVA team moved quickly to develop a pilot test plan for the PlumeStop PRB. The goal of the pilot test was to demonstrate both immediate and long-term removal of PFAS and the commingled chlorinated solvents by the PlumeStop PRB. The pilot test's efficient scoping minimized the materials needed and cost to accomplish the goal.

To determine the amount of PlumeStop needed for any PRB, REGENESIS utilizes a proprietary finite-difference model explicitly developed for PlumeStop. This model accounts for site-specific factors such as hydrogeology and contaminant flux and considers competitive sorption and biodegradation to determine the quantity of PlumeStop needed over a user-defined period.



Artistic rendering of initial pilot study layout.
Drawing not to scale.

The application design consisted of a single row of nine direct push injection points positioned upgradient of a previously installed monitoring well, MW-29. The injection line was configured as an arc to account for temporal and spatial variability in the groundwater flow direction. Initially two downgradient well pairs (MW-29/29C and MW-29D/29E) were placed 6 feet and 16 feet downgradient of the barrier, respectively, to monitor the pilot test performance. Each well of a well pair was installed with a 5-feet screened section to monitor the upper and lower treatment interval sections.



The PlumeStop barrier was applied using direct push injection points in a horseshoe pattern to treat the co-mingled plume

Application Design Summary

Contaminants of Concern

PFAS	150 ng/L
PCE	6 µg/L

Seepage Velocity

200 feet per year

PRB Construction

PlumeStop/S-MicroZVI
9 injection points
6 feet spacing

Treatment Interval

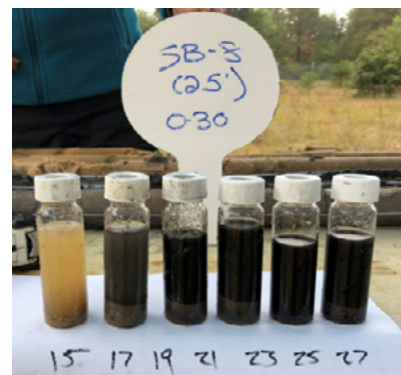
15-27 feet below ground surface

Application Volume

8,500 gallons

The vertical injection interval was specified from 15 to 27 feet below the ground surface (bgs) to match the PFAS flux zone and accommodate seasonal water table fluctuations. In the pilot test area, this PFAS flux zone was predominantly comprised of sand and gravel overlying a clay layer. Before injection, REGENESIS Remediation Services (RRS) verified this target interval by collecting soil cores, observing the soil grain size, and noting the degree of saturation.

RRS commenced the PlumeStop barrier application in October 2018. RRS performed optimization testing at the outset, methodically adjusting injection variables, including flow rate, screen size, injection volume, and injection point positioning. The purpose of the optimization testing is to ensure even placement of PlumeStop horizontally and vertically. RRS documented PlumeStop distribution by collecting soil cores and groundwater samples from temporary piezometers placed between injection points. The soil cores revealed consistent PlumeStop distribution over the target interval, while the groundwater samples collected from the piezometers indicated robust PlumeStop presence in groundwater.



Core samples and settling tubes taken from SB8-2.5 depicting consistent PlumeStop saturation from 15-27 feet bgs.

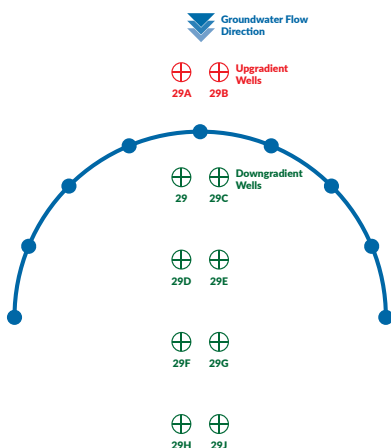


Results

PlumeStop Removes PFAS and Chlorinated Solvents Immediately, with Levels Remaining Non-Detect after Nearly Two Years, Thus Far...

PFAS Levels at Non-Detect 1 Month Post Application

Approximately one month after installing the PlumeStop PRB, PFAS was reduced in downgradient wells to concentrations below the standard method detection limit of 10 nanograms per liter (ng/L).

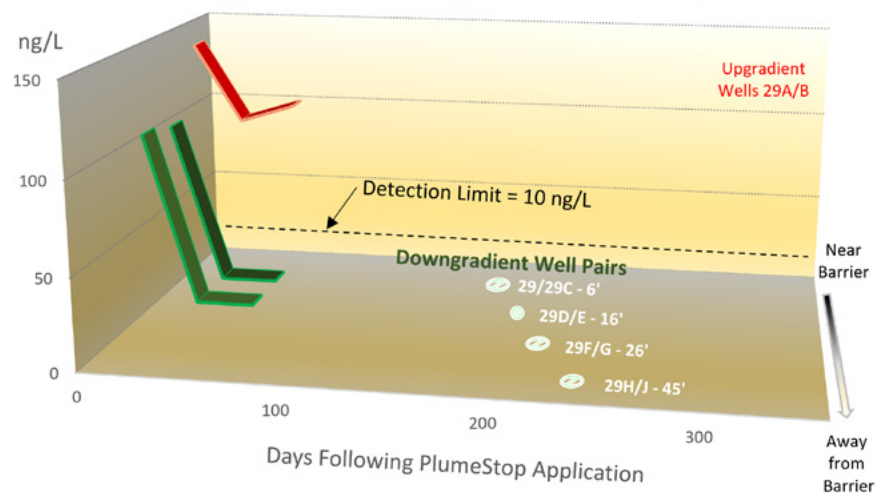


PFAS Levels Remain Non-Detect Two Years Later

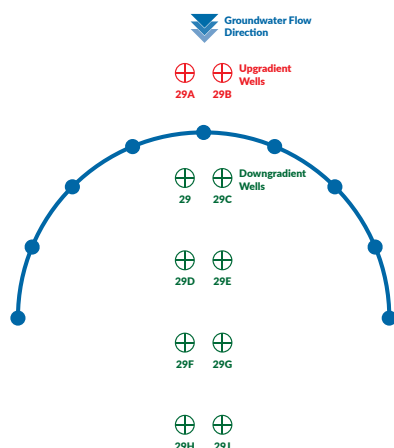
Post-injection PFAS levels have not been detected above 10 ng/L during any monitoring events.

In the first sampling event, approximately one month after installing the PlumeStop PRB, PFAS was reduced in downgradient wells to concentrations below the standard method detection limit of 10 nanograms per liter (ng/L). Initial reductions were also observed in upgradient well-pair (MW-29A/B), indicating potential injection influence. However, by the second event, approximately two months after injection, concentrations in these upgradient wells had begun to rebound while the downgradient wells remained at non-detect.

Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier

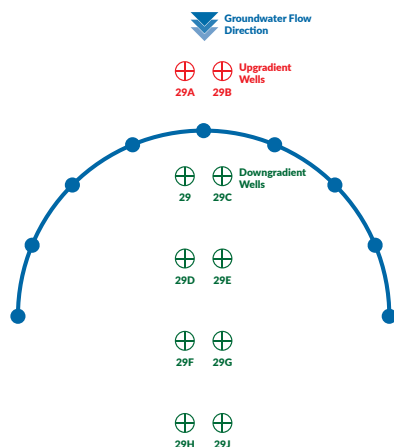


Since then, the PlumeStop PRB has maintained PFAS levels below this concentration in all downgradient wells for twenty months thus far. In addition to the well pairs installed initially for the pilot test, two well pairs were later installed 26 feet and 45 feet downgradient of the PRB to monitor progress further from the PRB. PFAS has not been detected above 10 ng/L during any event in any well. However, in the furthest downgradient well, 45 feet from the barrier, an estimated detection of 9.6 ng/L was reported at the 6-month sampling event. Based on REGENESIS' model projections, this estimated detection corresponds to the predicted modeled concentration at this distance from the barrier over time following PlumeStop PRB placement.



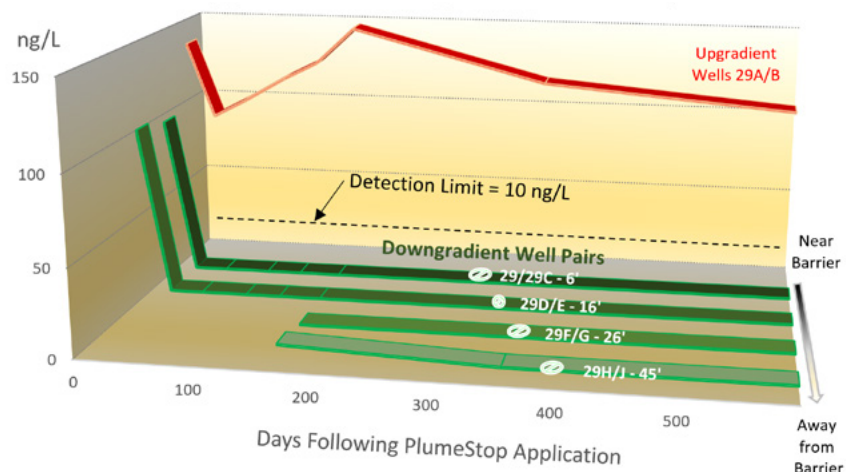
PCE Levels Immediately Reduced Following PlumeStop Application

PCE Levels were immediately reduced to less than 1 µg/L following the installation of the PlumeStop PRB.



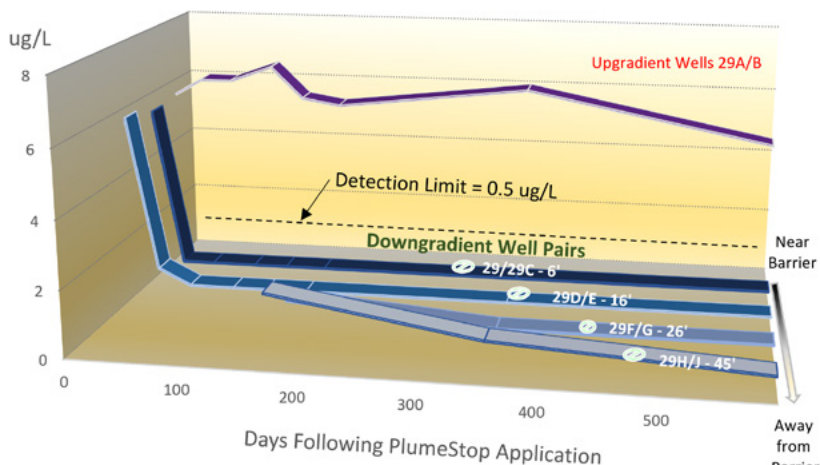
Positive Results Spell Long-term Remedial Success for Camp Grayling

Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier



PCE concentrations followed a similar pattern as PFAS: immediate reduction to non-detect (1 microgram per liter) followed by sustained non-detect levels. As with PFAS, the distant monitoring well pair, 45 ft away, depicts the PlumeStop-treated, clean water moving through this location, with declining PCE concentrations reaching non-detect levels after one year.

Average Total PCE in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier



PlumeStop has achieved the remedial objectives for the pilot test. Modeling suggests that PlumeStop is only near the beginning of its treatment term with PFAS removal expected to persist for decades. The Michigan DMVA is pleased with the performance results. The DMVA is continuing its CERCLA Remedial Investigation as it considers the next steps for a successful, long-term remedy for the PFAS-impacted groundwater at Camp Grayling.



Technology Used

PlumeStop Liquid Activated Carbon

PlumeStop® Liquid Activated Carbon™ is an innovative groundwater remediation technology designed to address the challenges of excessive time and end-point uncertainty in the *in situ* remediation of groundwater contaminants. PlumeStop is composed of very fine particles of activated carbon (1-2µm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material binds to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation.

About MPART

Michigan PFAS Action Response Team

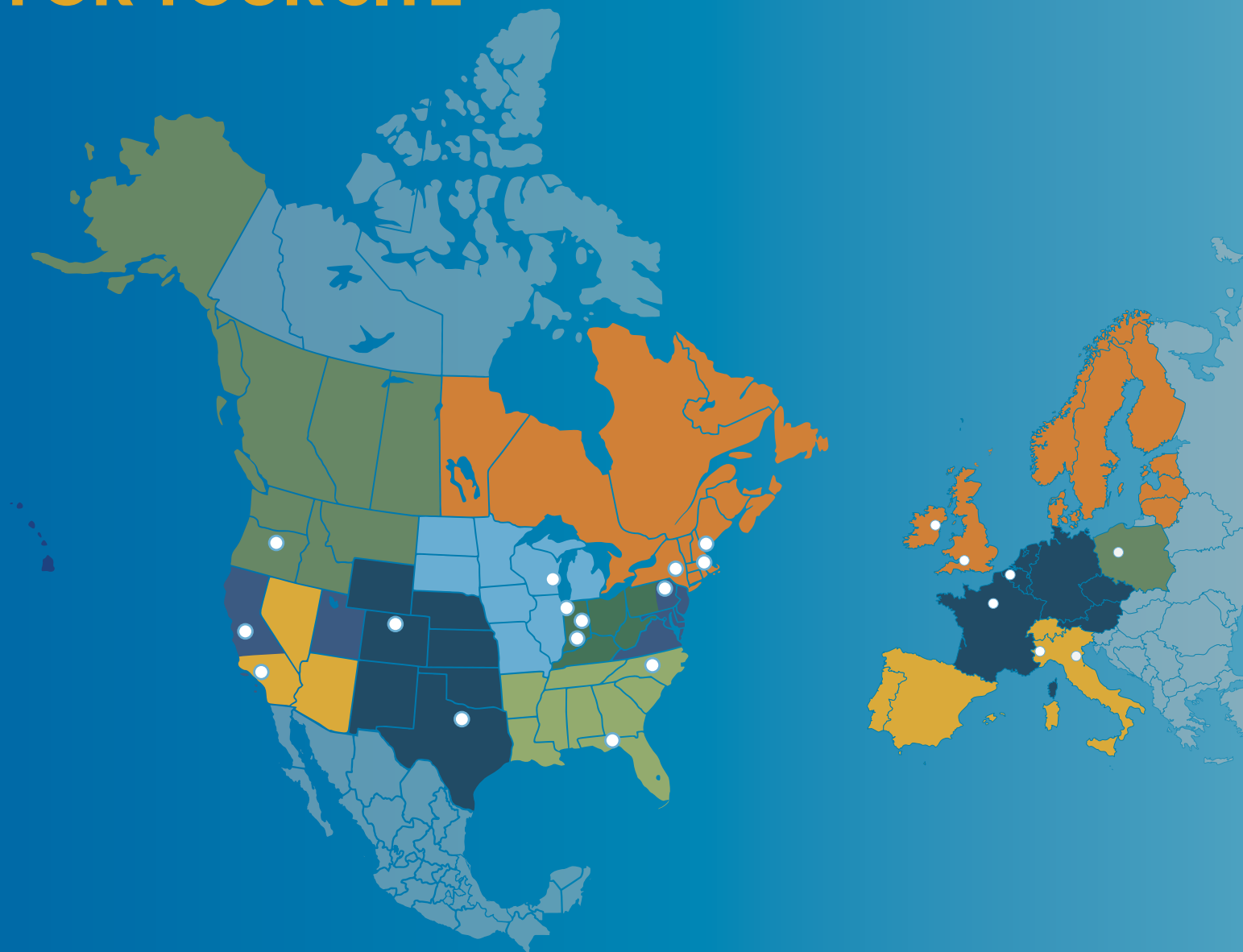
Launched in 2017, the Michigan PFAS Action Response Team (MPART) is the first multi-agency action team of its kind in the nation. Agencies representing health, environment and other branches of state government have joined together to investigate sources and locations of PFAS contamination in the state, to take action to protect people's drinking water, and to keep the public informed as we learn more about this emerging contaminant. The state of Michigan taking action to address this issue in a proactive and innovative way. Ten state departments, in coordination with local and federal officials across Michigan, are working together to ensure that the public health and safety of residents is protected while ensuring our environmental heritage is secure.

Additional information regarding the State of Michigan's response to PFAS can be found at:

<https://www.michigan.gov/pfasresponse/>



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



Global Headquarters

1011 Calle Sombra
San Clemente, CA 92673 USA
Ph: (949) 366-8000
Fax: (949) 366-8090

Europe

Bath, United Kingdom
Ph: +44 (0) 1225 731 447

Dublin, Ireland
Ph: +353 (0) 1 9059 663

Torino, Italia
Ph: +39 (0) 11 19781549

leper, België
Ph: +32 (0) 57 35 97 28



www.REGENESIS.com

©2020 All rights reserved. PlumeStop and REGENESIS are registered trademarks of REGENESIS Bioremediation Products. All other trademarks are the property of their respective owners.

