



# Plume Treatment Chemistries and Enabling Technology

One Partner. Many Solutions.



[www.cascade-env.com](http://www.cascade-env.com)



**Ready to get results with Cascade Chemistries?  
We're ready to help.**  
Call or email us to get started.



**Eliot Cooper**  
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# Cascade Chemistries

## PATHFINDER



### WHAT IS THE PATHFINDER?

Although research over the last 20 years has shown distribution and contact of in situ chemistries is a key success factor, injection technology has not advanced. That's why Cascade developed a fully-automated injection system called the Pathfinder, designed to deliver microscale solids like ZVI and activated carbon more effectively in transmissive zones. It addresses the issue of distribution by providing an automated system that takes human variables out of the equation, while Cascade Chemistries products provide persistent contact with contaminants in the subsurface.

### HOW DOES IT WORK?

The automated system involves:

- Flow control via automated valves that adjust automatically to meet pressure and flow set points.
- Control of injection pressures, groundwater depth changes, and flows minimizing fracturing, excessive groundwater mounding and short circuiting.
- Continuous monitoring and data logging of injection rates, pressures, and in-well pressure transducers, thermocouples, and water chemistry.



### Pathfinder Benefits

Colloidal solids and liquids can be distributed through transmissive zones via soil pore throats, but existing injection technology is imprecise and cannot prevent distribution through new flow paths by exceeding the fracture pressure or the site's hydraulic capacity. Automation that sets precise shutdown or control setpoints ensures optimal distribution with supporting documentation. This system can achieve injection performance at up to 10 simultaneous locations with direct push or injection wells.

### Pathfinder Return on Remediation Investment

- Considering the large life cycle costs of remediation and the investment made in characterization, design, chemistries and their injection, it only makes sense that injection approach be optimized.
- Automation results in lower costs and a shorter time frame to achieving remediation goals.

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# Cascade Chemistries PATHFINDER



## TURNKEY SOLUTIONS

While effective chemistries are a key part of successful remediation solutions, Cascade's turnkey solution meets the overall in situ remediation objective "to make contact with contaminant mass for a long enough period of time to achieve destruction." Cascade adds significant value and higher performance to the application its Chemistries by providing:

- High resolution design optimization through our MIHPT and Waterloo<sup>APS</sup> subsurface technologies to identify target zones based on mass, lithology, and hydraulic conductivity.
- Bench-scale and column testing as needed.
- Advanced automated injection and fracturing technologies for both liquids and solid slurries.
- Client design support for chemistry dosing and critical injection parameters, including spacing and injection volumes and concentrations based on geology and hydraulic conductivity.
- Water hydraulics testing and field design optimization to eliminate any full-scale unexpected conditions.

REACH SITE CLOSURE FASTER

# CASCADE CHEMISTRIES



## WHAT IS CASCADE CHEMISTRIES?

Cascade Chemistries is a new line of amendments for in situ groundwater remediation, designed to help you reach site closure faster and cost-effectively. The products are exclusively offered by Cascade Environmental, and include a colloidal zero valent iron, emulsified zero valent iron, colloidal activated carbon, and encapsulated enzymes.

## CAPABILITIES

Addresses contaminants like chlorinated solvents (including DNAPL), petroleum, and emerging contaminants like PFAS

Provides sufficient contaminant contact in transmissive (high K) and/or storage (low K) zones thanks to integrated approach



Cascade's proprietary Inner-Hose was invented to improve distribution of chemistries and optimize their results.

## HOW IT WORKS

Cascade's proprietary chemistries are applied to contaminated sites by Cascade's remediation experts, who have decades of experience in the integration of high resolution characterization design optimization (HRDO) with injection and fracturing. We provide consultants with the data needed to identify where and how to apply remedies for best results, implement the approved remediation design, and partner with the client to monitor for optimization opportunities.

This means you get an integrated solution that is cost effective, reduces risk, and is designed to provide an excellent return on your remediation investment.

To provide this integrated approach, we utilize multiple existing services in conjunction with the new chemistries, including but not necessarily limited to:

- HRDO
- 3D visualized targeted remediation plans
- Hydraulic testing of wells or DPT screens
- Design optimization testing (DOT) prior to full scale remediation
- Manifolding automated injection of liquid and colloidal amendments
- Pneumatic & hydraulic emplacement
- Downhole pulsing for delivery into highly heterogeneous and moderate K zones
- Post remediation troubleshooting

**By leveraging new chemistries, the best technologies, and the most experienced experts, you'll achieve site closure faster and more cost efficiently.**



Design optimization investigation allows a more targeted injection of chemistries, leading to a more efficient and cost effective remedy.



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# Cascade Chemistries

## CLEANER™ iZVI



### WHAT IS CLEANER iZVI?

CleanER iZVI is the industry's newest injectable zero valent iron (iZVI) technology specifically developed for remediating chlorinated solvent (CVOC) soil and groundwater contamination. Offered exclusively by Cascade Environmental, it is manufactured by Höganäs Environment Solutions, LLC, the world's leading supplier of iron-based media.

### HOW DOES IT WORK?

CleanER iZVI is a precisely blended liquid-suspension concentrate that is injected, via DPT and other methods, to address CVOCs and heavy metal contaminants such as hexavalent chromium, arsenic, and selenium. The unique formulation promotes broad dispersion in the subsurface at low injection pressures, which accelerates treatment. Through the process known as reductive dechlorination for solvents and chemical reduction for metals, the contaminants are degraded upon contact with the ZVI, and the byproducts are broken down via biological activities in the subsurface.



### Advantages for distribution, contact & residence time

- Direct injection into wells or DPT injection points at sub-fracture pressures
- Rapid dispersion in the subsurface
- Minimized potential for daylighting
- Flexible chemistry that allows up to 80:1 dilution to customize distribution & residence time for specific project needs

### Benefits of ZVI biotic/abiotic reactions and...

- Up to 2 years of persistence in the subsurface to overcome back diffusion issues
- Neat, pre-blended colloidal ZVI suspension that eliminates clumping and blending issues in the field
- Simple mixing and dilution without the need for further suspension chemistry
- Easily integrated as a combined remedy with other remediation chemistries and amendments

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# Cascade Chemistries CLEANER™ iZVI



## TURNKEY SOLUTIONS

While effective chemistries are a key part of successful remediation solutions, Cascade's turnkey solution meets the overall in situ remediation objective "to make contact with contaminant mass for a long enough period of time to achieve destruction." Cascade adds significant value to the application of CleanER iZVI by providing:

- High resolution design optimization through our MiHPT subsurface technologies to identify target zones based on mass, lithology, and hydraulic conductivity.
- Screening of DNAPL sites using our expert rules framework
- Advanced pneumatic and hydraulic fracturing technologies with high flow and pressure pumping systems to optimize contact.
- Client design support for dosing and critical injection parameters, including spacing and injection volumes and concentrations based on geology and hydraulic conductivity. Bench-scale and field design optimization services available.

# Cascade Chemistries

## SOURCEKILL<sup>SM</sup>



### WHAT IS SOURCEKILL?

SourceKill is the most reactive and DNAPL specific chemistry on the market today. Offered exclusively by Cascade Environmental, it is manufactured by TEA Inc. the first and US leader to providing this engineered in situ chemistry solution for DNAPL.

### HOW DOES IT WORK?

SourceKill involves placing micro-scale zero valent iron (ZVI) particles into a surfactant-stabilized, biodegradable water-in-oil emulsion. This emulsion is injected into the DNAPL-contaminated zones. The DNAPL is then pulled (sequestered) into the emulsion where the CVOC's react with the ZVI. Through a process known as chemical reduction, primarily through the beta elimination pathway, the DNAPL and its daughter products are degraded into ethene, ethane and other hydrocarbons. The by-products are finally broken down through biological activities in the subsurface.



### Advantages for distribution, contact & residence time

SourceKill can be emplaced into target DNAPL zones, typically in a grid pattern through direct push, sonic or straddle-packed boreholes either by pneumatic or hydraulic fracturing into either lower and/or higher K zones.

### Benefits of ZVI biotic/abiotic reactions and...

- Injected as neat solution, at 10% to 20% of pore space while requiring no dilution.
- High persistence in the subsurface, 5 to 10 years (or more), to account for DNAPL diffusion into the EZVI.
- Optimized propriety manufacturing process resulting in EZVI consistent with the NASA patent.
- Can be integrated into combined spatial remedies with other chemistries including bioremediation, chemical oxidation/reduction, or sequestration.

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# Cascade Chemistries

## SOURCEKILL<sup>SM</sup>



### TURNKEY SOLUTIONS

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- Screening of DNAPL sites using our expert rules framework
- Advanced pneumatic and hydraulic fracturing technologies with high flow and pressure pumping systems to optimize contact.
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# Cascade Chemistries

## CASE STUDY

### LOCATION

Livingston, Louisiana

### TECHNOLOGY

In situ chemical reduction (ISCR)

### CHEMISTRY

SourceKill<sup>SM</sup> eZVI



### PROJECT OVERVIEW

In 1982, an Illinois Central Gulf Railroad Company (ICG) train derailed along U.S. Highway 190 in Livingston, LA resulting in damage to several railcars and the release of hazardous materials at the site, including tetrachloroethene (also known as perchloroethylene or PCE). Following emergency response operations, a slurry wall and a pump and treat system were installed to contain and remediate the remaining PCE at the site over a 10-acre area. This system has been operated for close to 30 years. Concern developed that site surveillance funds made available by ICG would be depleted before the remedial goals were reached. In 2009, they decided to take another approach and develop a more effective remedial plan. Additional site evaluation was performed and SourceKill<sup>SM</sup> emulsified zero valent iron (eZVI) was selected to destroy the residual PCE in the subsurface. SourceKill degrades DNAPL with its primary contaminant, PCE, abiotically, and daughter products of the degradation are further biodegraded by the bacteria to innocuous byproducts, such as carbon dioxide and water.

### RESULTS

SourceKill was injected (as well as food grade vegetable oil and bacterial cultures designed to biodegrade PCE and associated breakdown products including vinyl chloride) at designated locations using direct push technologies. Remedial goals developed for both soil and groundwater were established to be protective to human health and the environment and were met within two years of project implementation. All wells, sumps and infrastructure have been either plugged and abandoned or have been removed from the site.

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