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# Sustainable in situ solutions for PFAS source-plume systems using colloidal activated carbon

*Kris Maerten, REGENESIS, Technical Manager Europe*

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# Sustainable in situ solutions for PFAS source-plume systems using colloidal activated carbon

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Technical Manager, Europe
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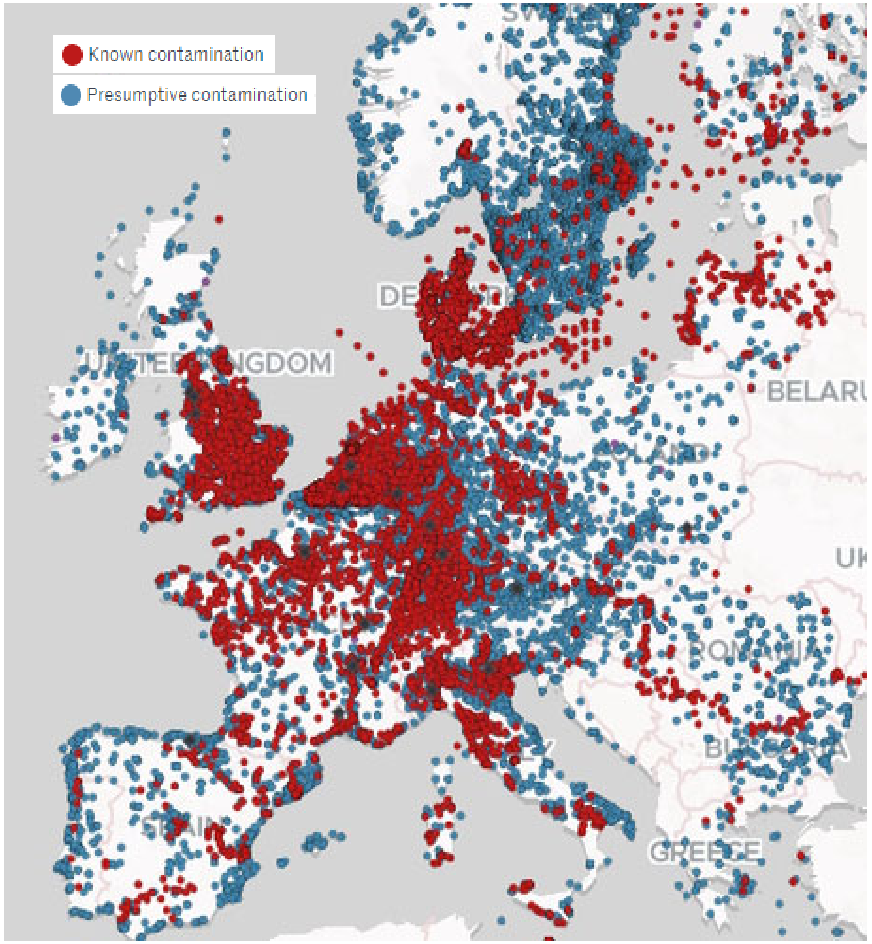
ENSOr, March 14th 2024

**How can we treat PFAS?**

➔ **PFAS are EVERYWHERE!**

## ➔ Available technologies

- Feasibility and costs
- Risk for secondary sources
- Sustainability?




(ISO 18504:2017) definition:

**Sustainable Remediation** is the

*'elimination and/or **control** of unacceptable **risks** in a safe and timely manner **whilst optimizing the environmental, social and economic value** of the work.´*

➔ Can we treat PFAS in a sustainable way?

https://www.lemonde.fr/en/les-decodeurs/article/2023/02/23/forever-pollution-explore-the-map-of-europe-s-pfas-contamination_6016905_8.html

# Colloidal Activated Carbon: SourceStop and PlumeStop

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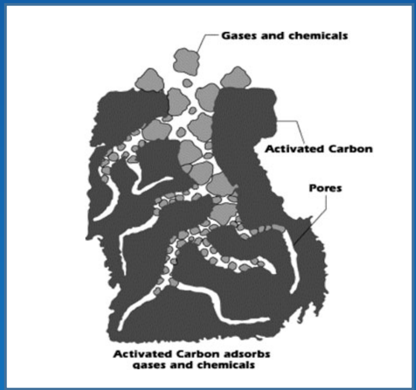



**Wide area distribution**

- No high-pressure fracturing needed

**Coats aquifer surfaces**

- Creates subsurface activated carbon filter

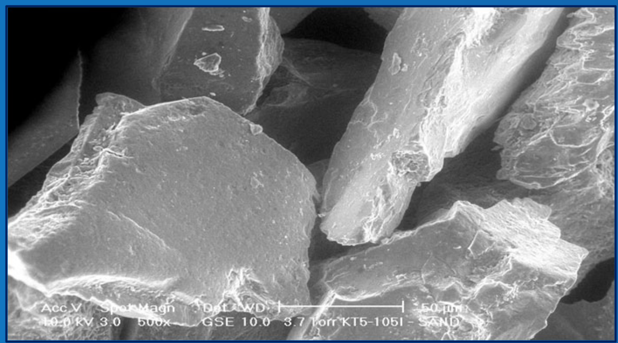
**Extremely fast sorption of PFAS**

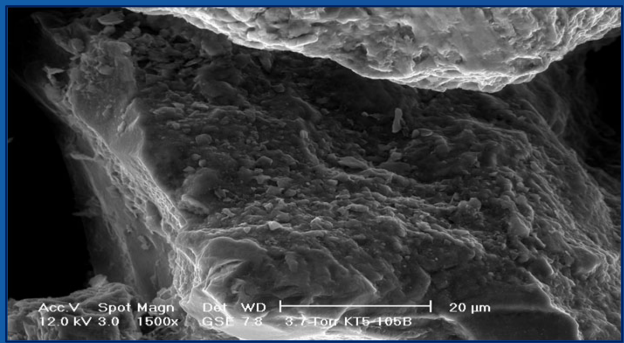
- Smaller particles provide more exterior surface
- Shorter distance to all the sorption sites compared to GA

Xiao, Ulrich, Chen & Higgins. Environ. Sci. Technol. 2017, 51, 6342-6351

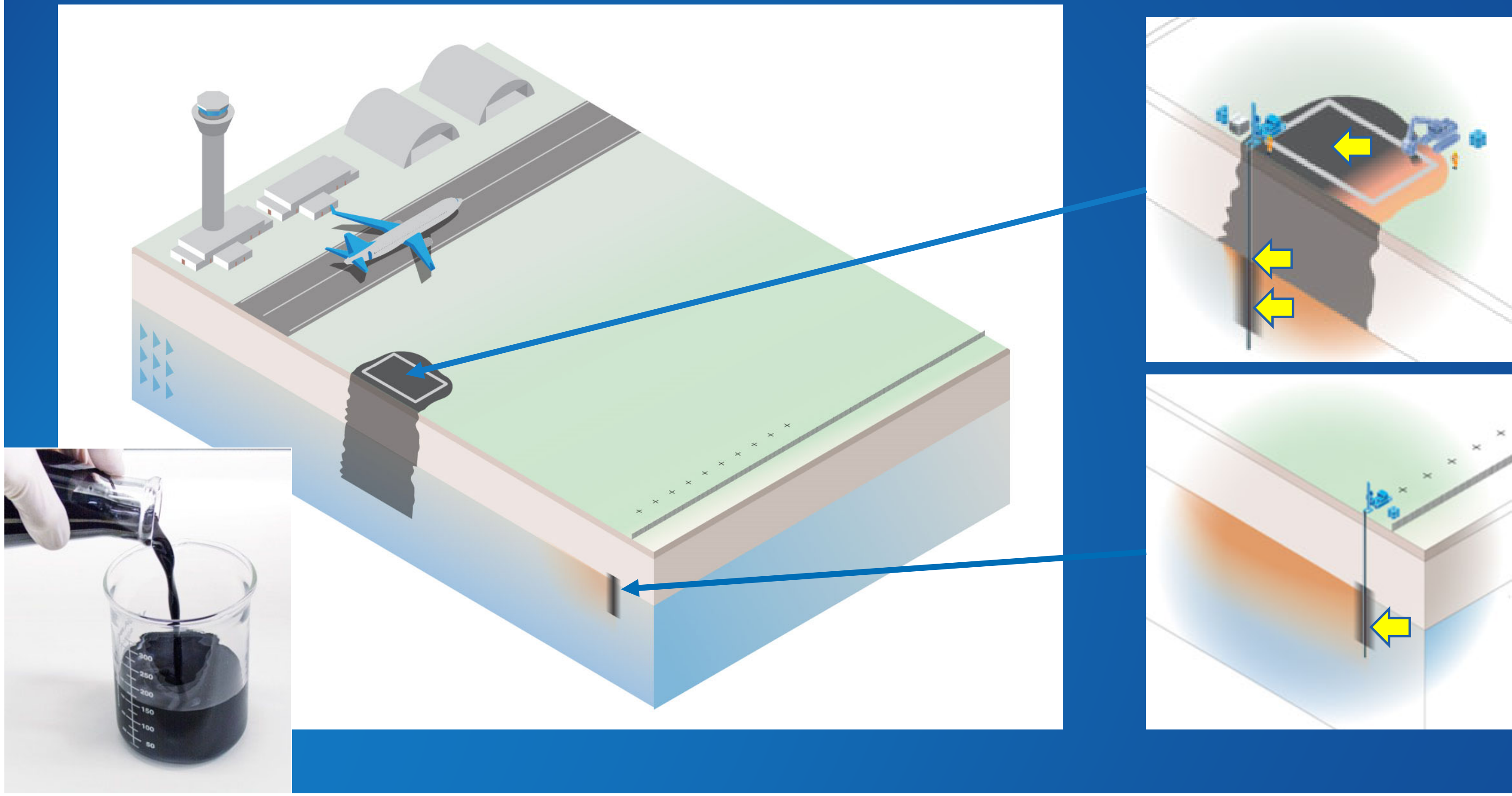
**Size: 1 – 2 µm =** Size of a red blood cell

**Suspended in water**





# PFAS Source-Plume System



**1. Soil - unsaturated**

2. Soil – Capillary fringe

3. **Groundwater -** Source

4. **Groundwater - Plume**

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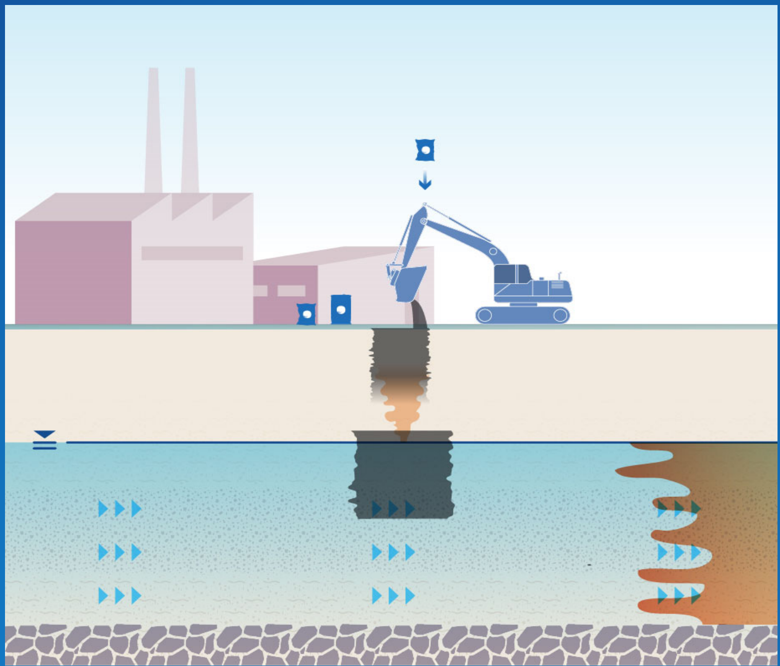
## Result



- Stabilization of PFAS source
- Stop leaching ('bleeding') of source
- Elimination of risks inside treatment area and for downgradient receptors
- (Enhanced) attenuation!

DOI: 10.1002/rem.21731

RESEARCH NOTE

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### Enhanced attenuation (EA) to manage PFAS plumes in groundwater

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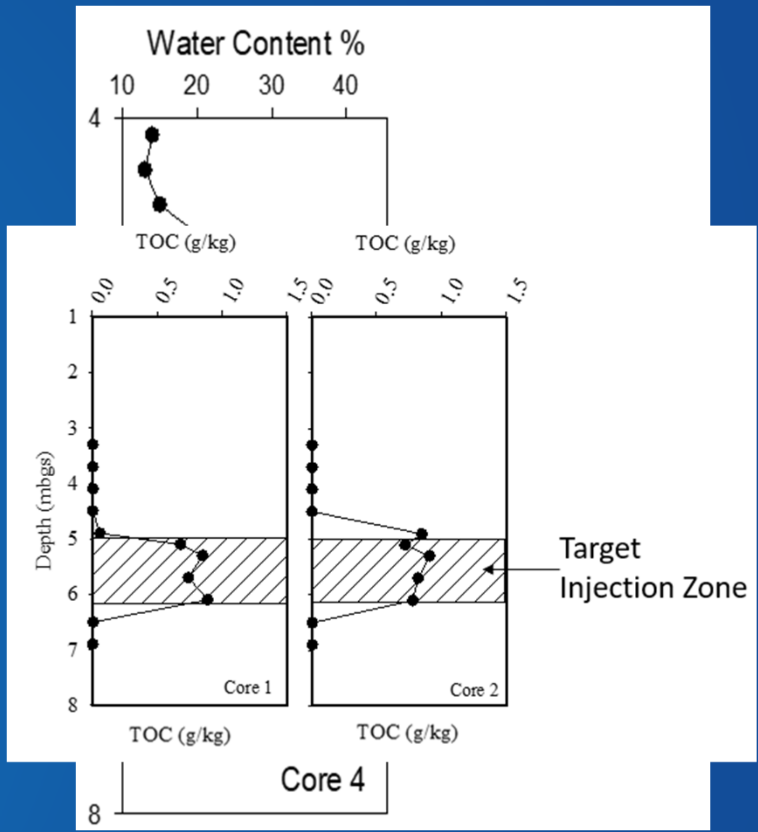
described in a companion paper (Newell et al., 2021). The three-tiered approach applies direct measurements and indirect measurements, calculations, and more complex field and modeling methods to assess PFAS retention in the subsurface. Data requirements to assess the LOEs for quantifying retention in both the vadose and saturated zones are identified, as are 10 key PFAS MNA questions and 10 tools that can be applied to address them. Finally, a list of potential methods to enhance PFAS MNA is provided for

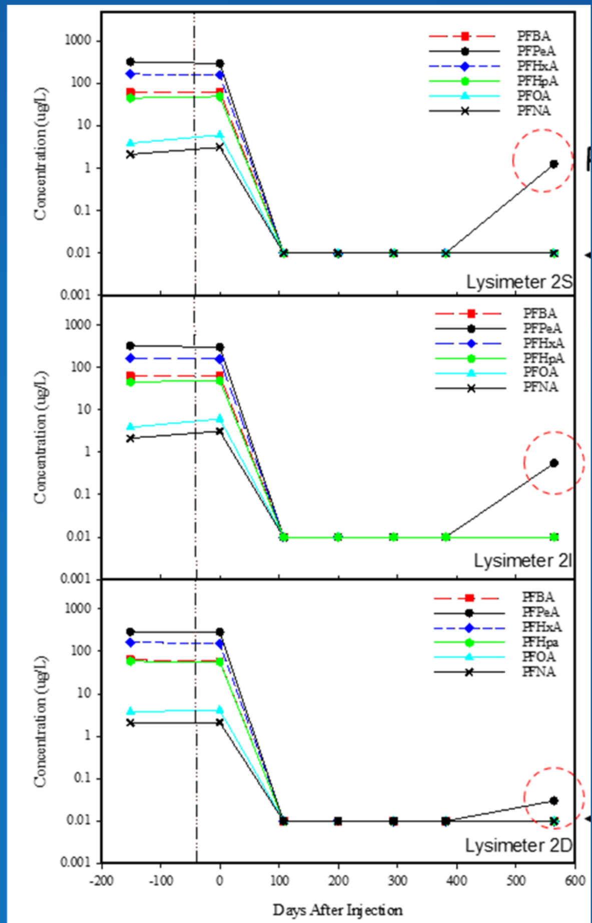
Example site: treatment capillary fringe (InSitu Remediation Services, Canada)

- Geology: silty sand
- Extensive investigation incl. porewater samples collected from lysimeters
- Importance of capillary fringe!
  - Groundwater: max. 66 µg/l (sum ind. compounds)
  - Porewater: max. 709 µg/l (sum ind. compounds)
- Treatment targets air-water interface only
- Injection of PlumeStop
- Placement validation through TOC analyses



# Treatment capillary fringe – Results lysimeters

Lysimeter 2



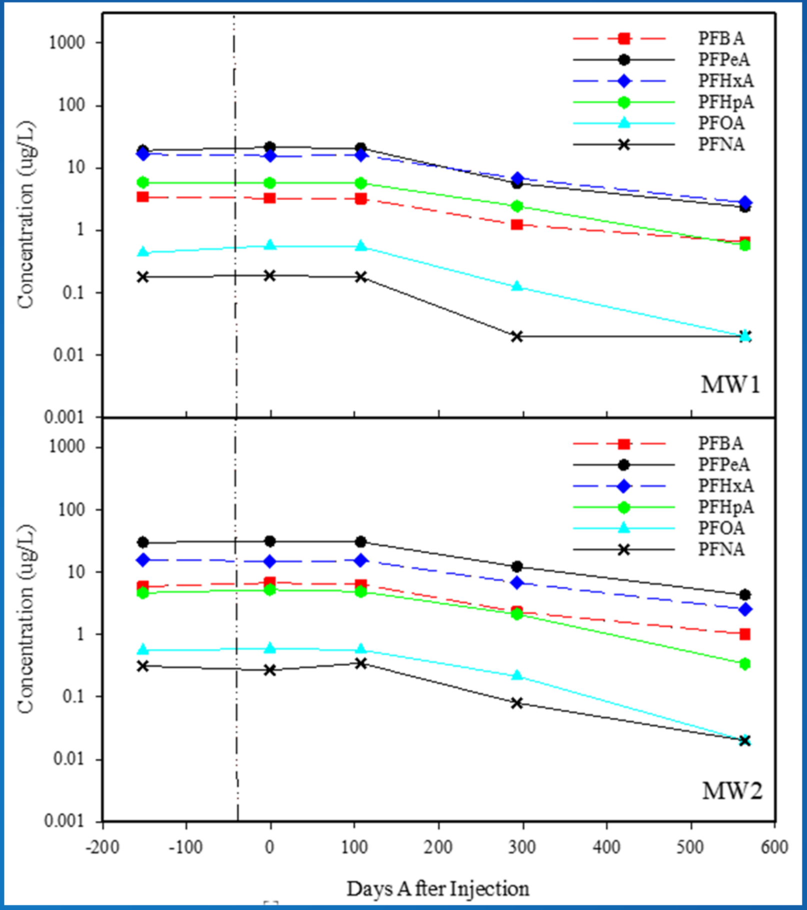

PFPeA - short C chain PFAS (5)

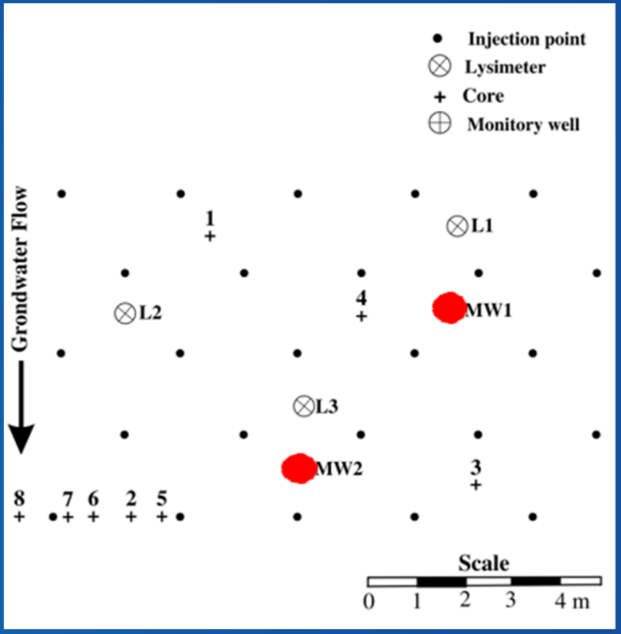
Detection Limit

Detection Limit

Detection Limit

## Treatment capillary fringe – Results groundwater



# Plume Treatment

# PlumeStop barriers – proven technology

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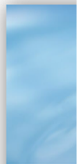
Grid View   List View

### Award-Winning PFAS Remediation At A Private Airfield

In situ PlumeStop barrier treatment unlocks site divestment and redevelopment in England, UK A sustainable solution - REGENESIS and Mott...

### PlumeStop Eliminates PFAS For 7 Years

Download Case Study10m 46s reading time This case study reviews the first known full-scale in situ PFAS treatment worldwide completed in...



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RESEARCH ARTICLE

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## Longevity of colloidal activated carbon for in situ PFAS remediation at AFFF-contaminated airport sites

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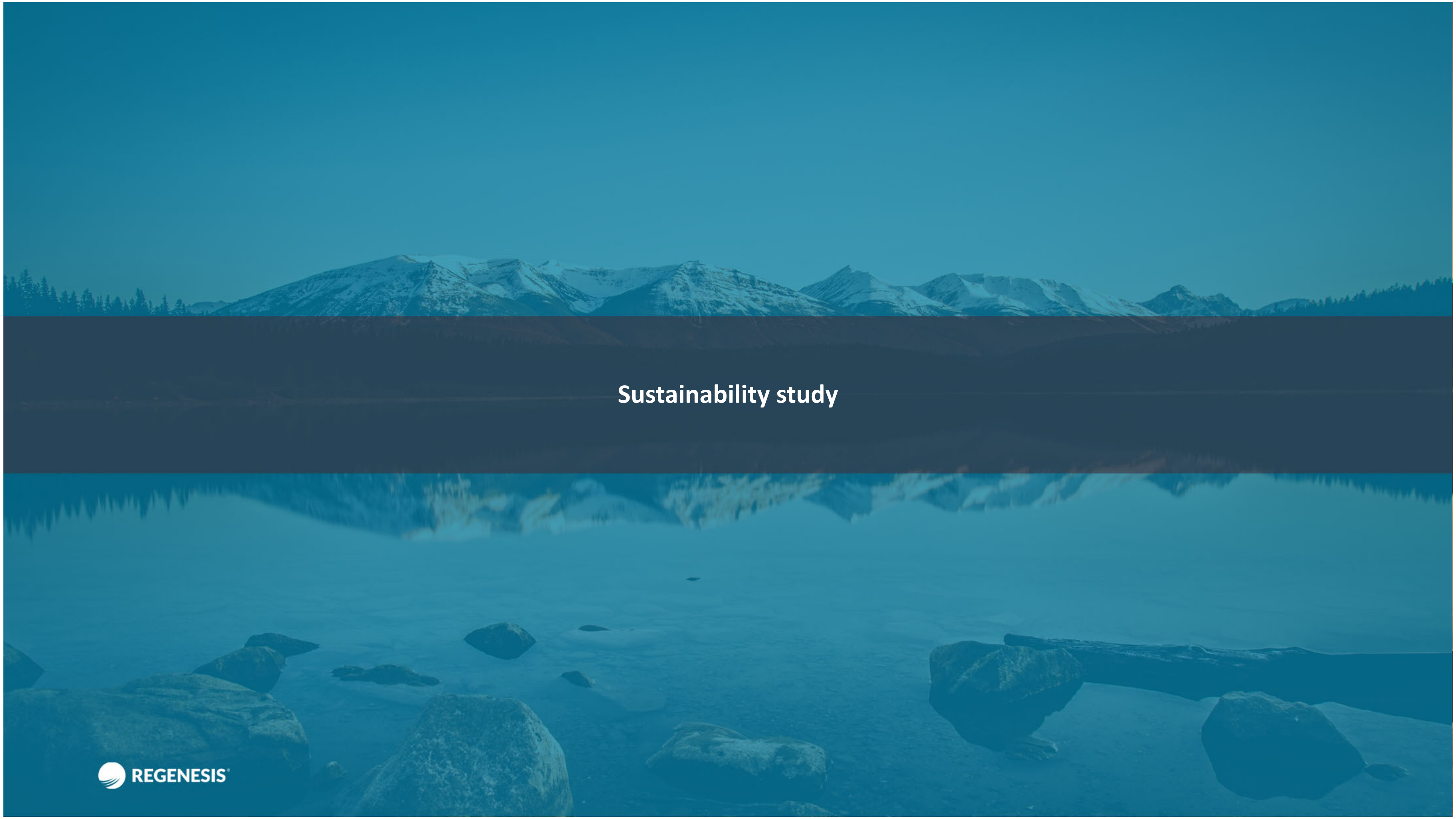
**Abstract**

A review of state per- and polyfluoroalkyl substances (PFAS) guidelines indicates that four long-chain PFAS (perfluorooctanesulfonic acid [PFOS] and perfluorooctanoic acid [PFOA] followed by perfluorohexanesulfonic acid [PFHxS] and perfluorononanoic acid [PFNA]) are the most frequently regulated PFAS compounds. Analysis of 17 field-scale studies of colloidal activated carbon (CAC) injection at PFAS sites indicates that in situ CAC injection has been generally successful for both short- and long-chain PFAS in the short-term (0.3–6 years), even in the presence of low levels of organic co-contaminants. Freundlich isotherms were determined under competitive sorption conditions using a groundwater sample from an aqueous film-forming foam (AFFF)-impacted site. The median concentrations for these PFAS of interest at 96 AFFF-impacted sites were used to estimate influent concentrations for a CAC longevity model sensitivity analysis. CAC longevity estimates were shown to be insensitive to a wide range of potential cleanup criteria based on modeled conditions. PFOS had the greatest longevity even though PFOS is present at higher concentrations than the other species because the CAC sorption affinity for PFOS is considerably higher than PFOA and PFHxS. Longevity estimates were directly proportional to the CAC fraction in soil and the Freundlich $K_f$, and were inversely proportional to the influent concentration and average groundwater velocity.


Sustainability study
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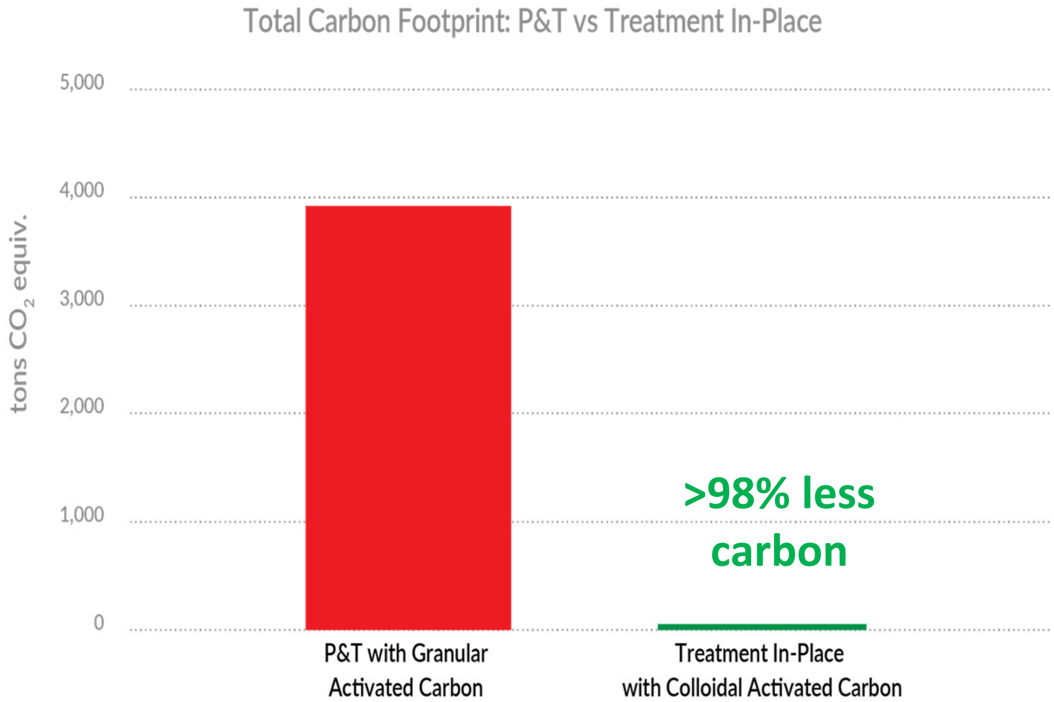
**Carbon Footprint**




| | PlumeStop | P&T w/ GAC |
|---|---|---|
| **Remediation equipment** | | 15,2 |
| **Civil works** | | |
| Fixed installations | 0,05 | 0,9 |
| Machinery | 1,0 | 1,3 |
| **Remediation and operations** | | |
| PlumeStop / GAC | 50,5 | 2 860 |
| Electricity | | 281 |
| **Maintenance** | | 3,6 |
| **Monitoring** | 4,0 | 4,0 |
| **Waste management** | | |
| Hazardous waste | | 112 |
| Wastewater treatment | | 644 |
| **Total carbon footprint** | **56** | **3 922** |

carbon footprint = 70 x

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# Thank you


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