THE Water Research FOUNDATION

REMWell

In Situ Remediation Technology (InSRT)

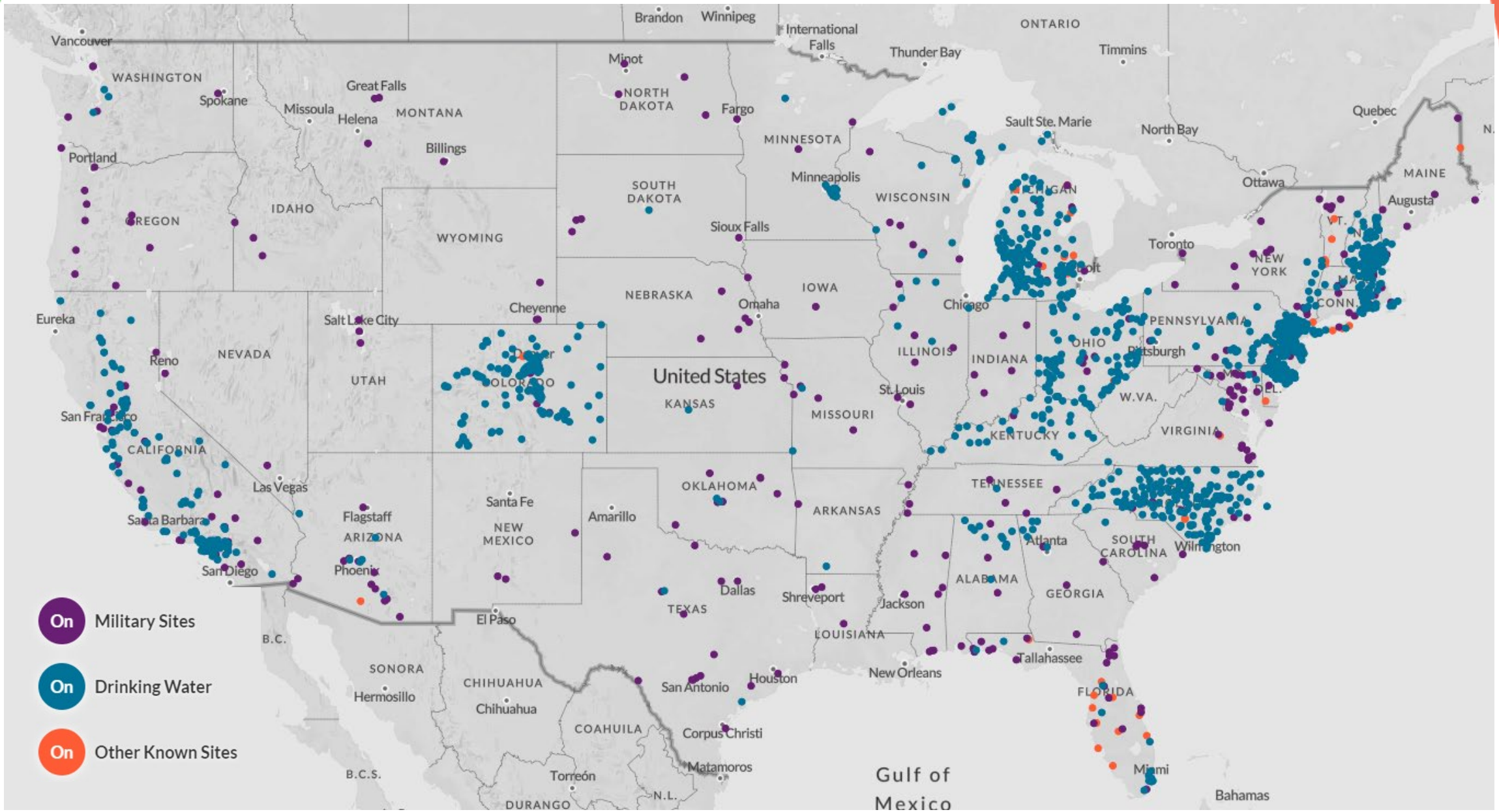
Michelle Crimi
mcrimi@clarkson.edu
315-261-8209

Michelle Crimi, PhD
Co-founder, CEO

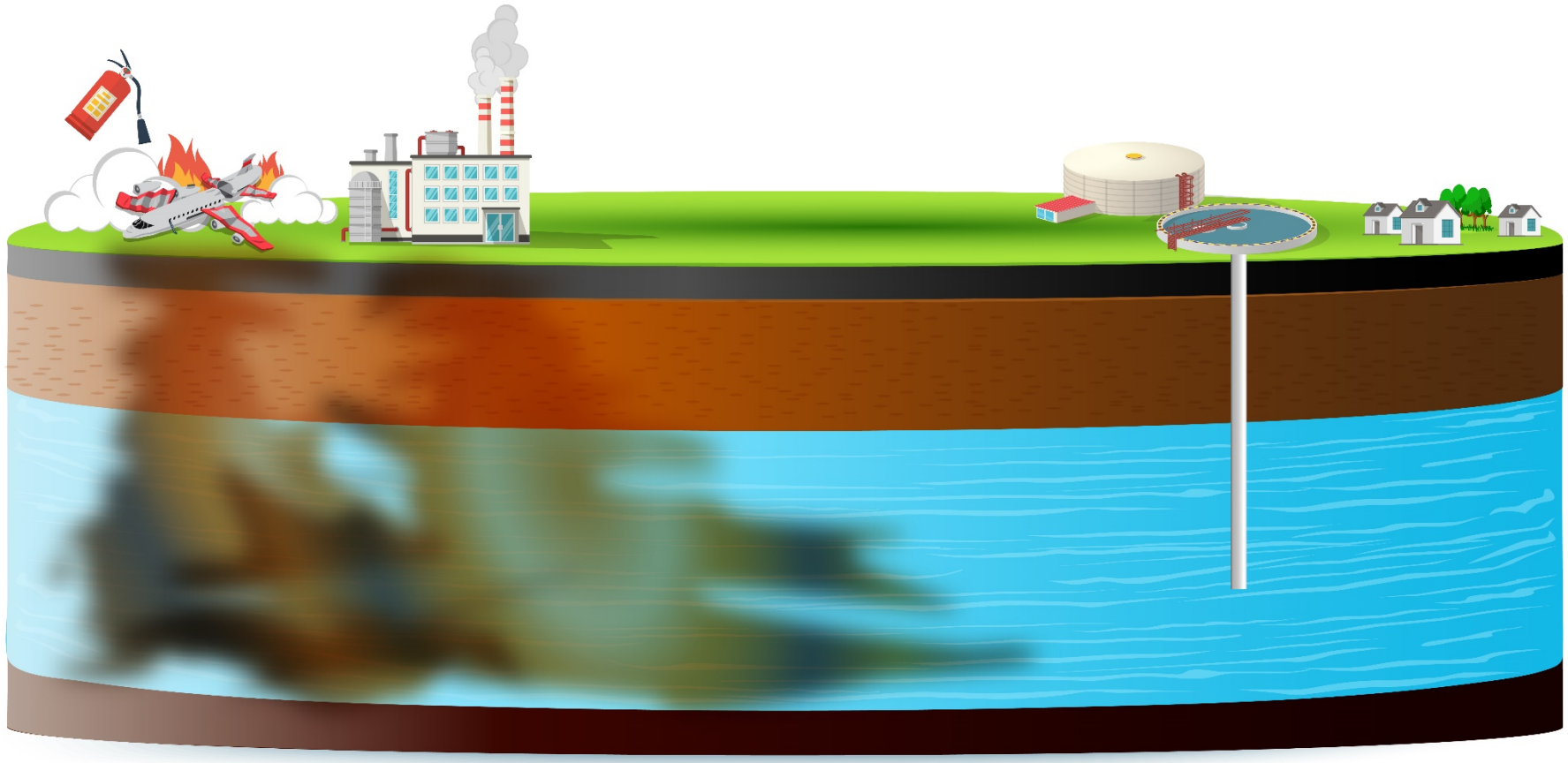
Fiona Laramay, PhD
Co-founder, COO

REMWell

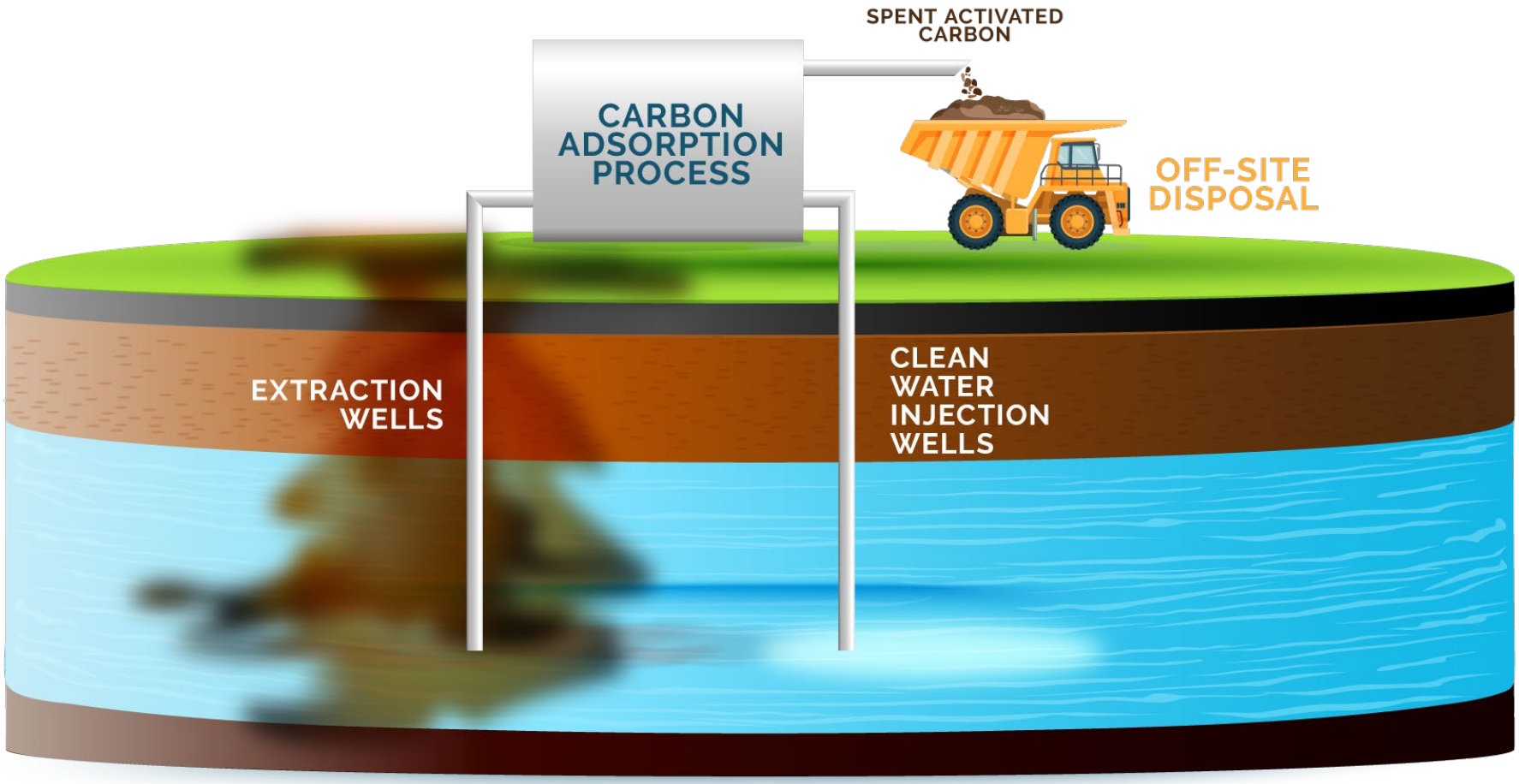
- Michelle is a Professor at Clarkson with 20 years of experience developing and evaluating new technologies for treating contaminated groundwater
- Fiona is a former PhD candidate in Environmental Science & Engineering at Clarkson; now an Environmental Engineering at AECOM
- Business mentors: Joe Dickson, Brad Sparks



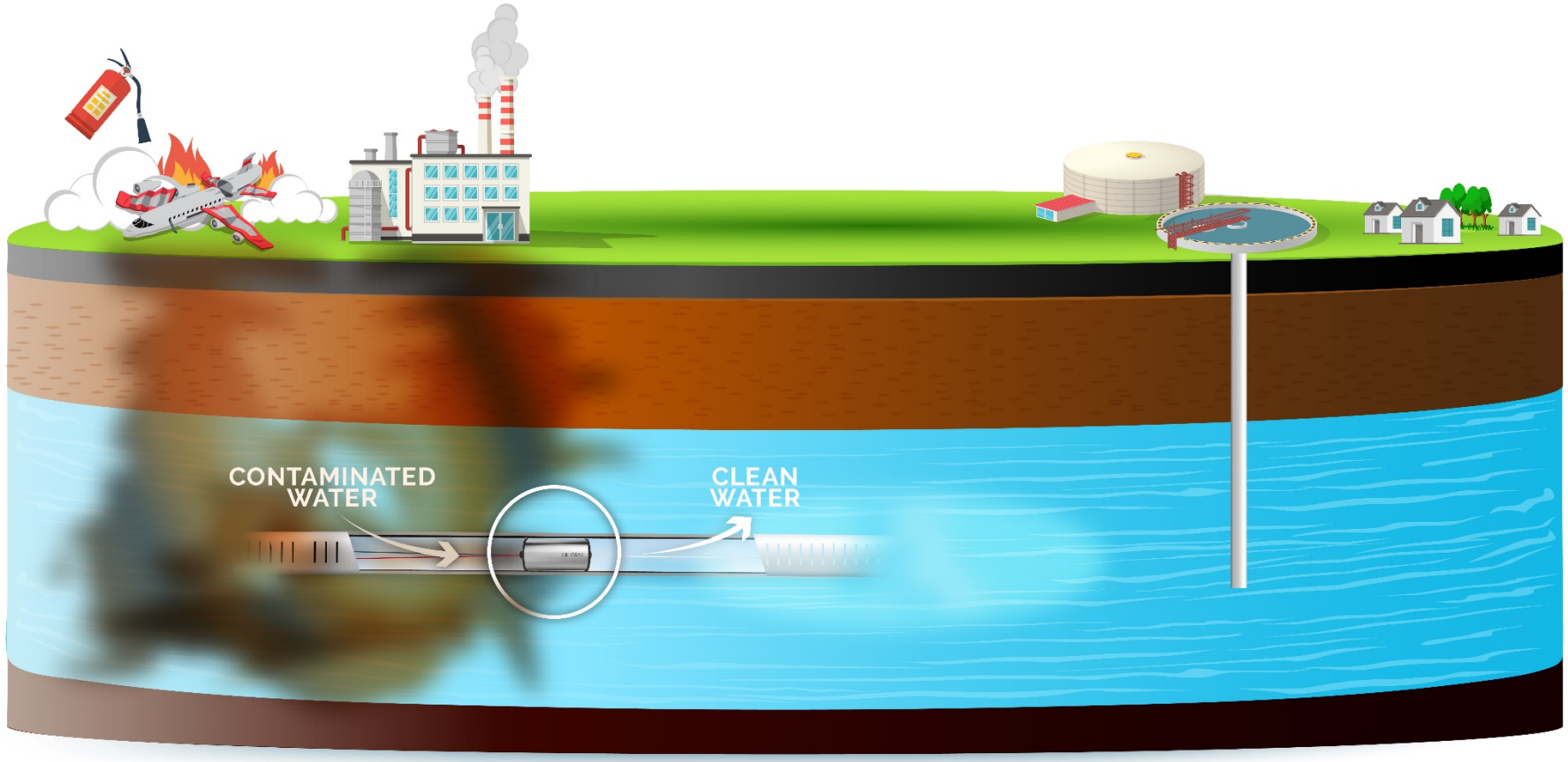
Groundwater Contamination



Pump-and-treat with granular activated carbon (P&T GAC)



The New Way… RemWell's InSRT

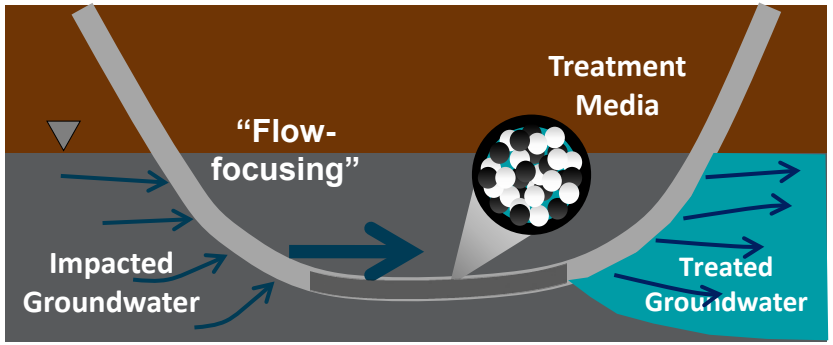


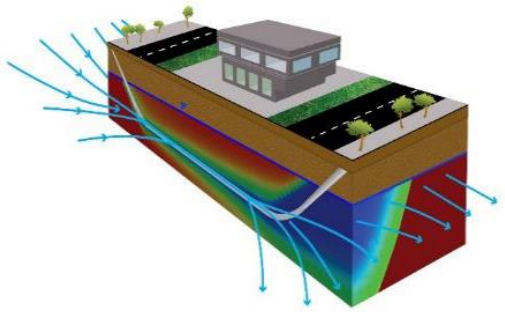
HRX Well® Description

The HRX well concept has been validated and demonstrated through ESTCP project ER-201631

- The HRX Well* is a large-diameter horizontal well installed along the groundwater flowpath that is filled with reactive or other treatment media

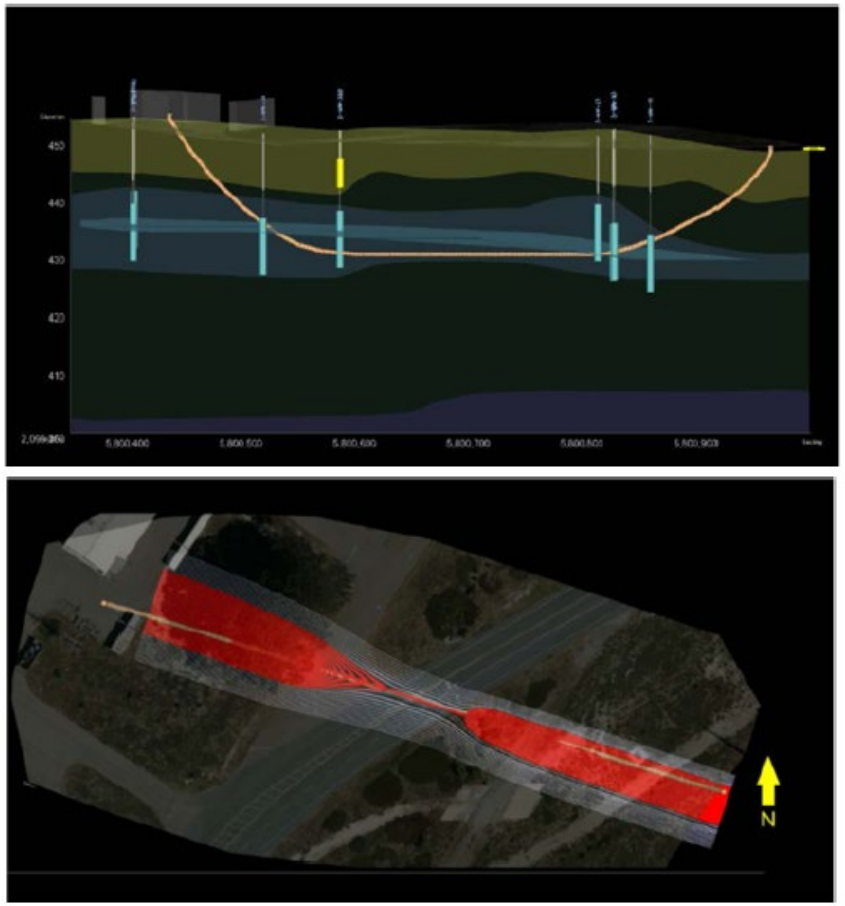
*Patent US20120261125A1

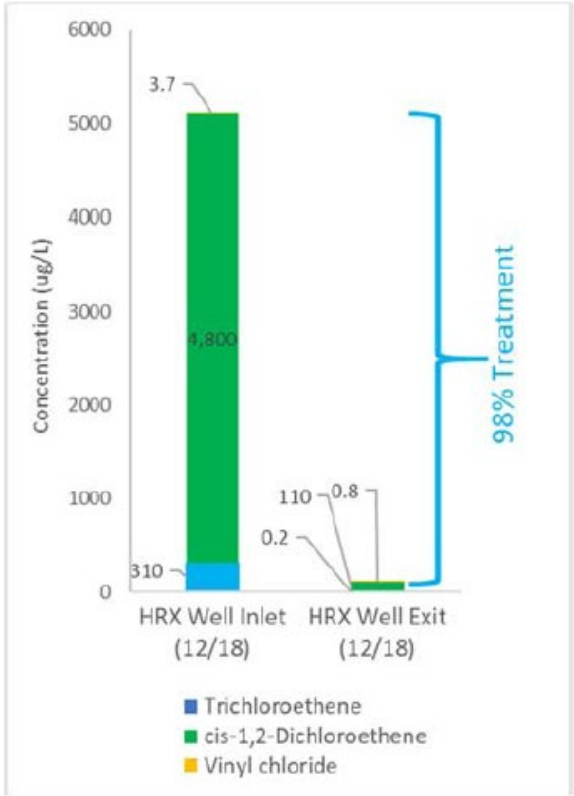




- Passive in-situ treatment
- Many solid-phase reactive media options
- Efficient use of reactive media
- Treatment train approach possible
- Not limited to high-permeability aquifers
- Can be applied in relatively deep settings
- Limited above-ground footprint
- Minimal O&M
- No ongoing energy requirements
- Pumping can enhance treatment zone size

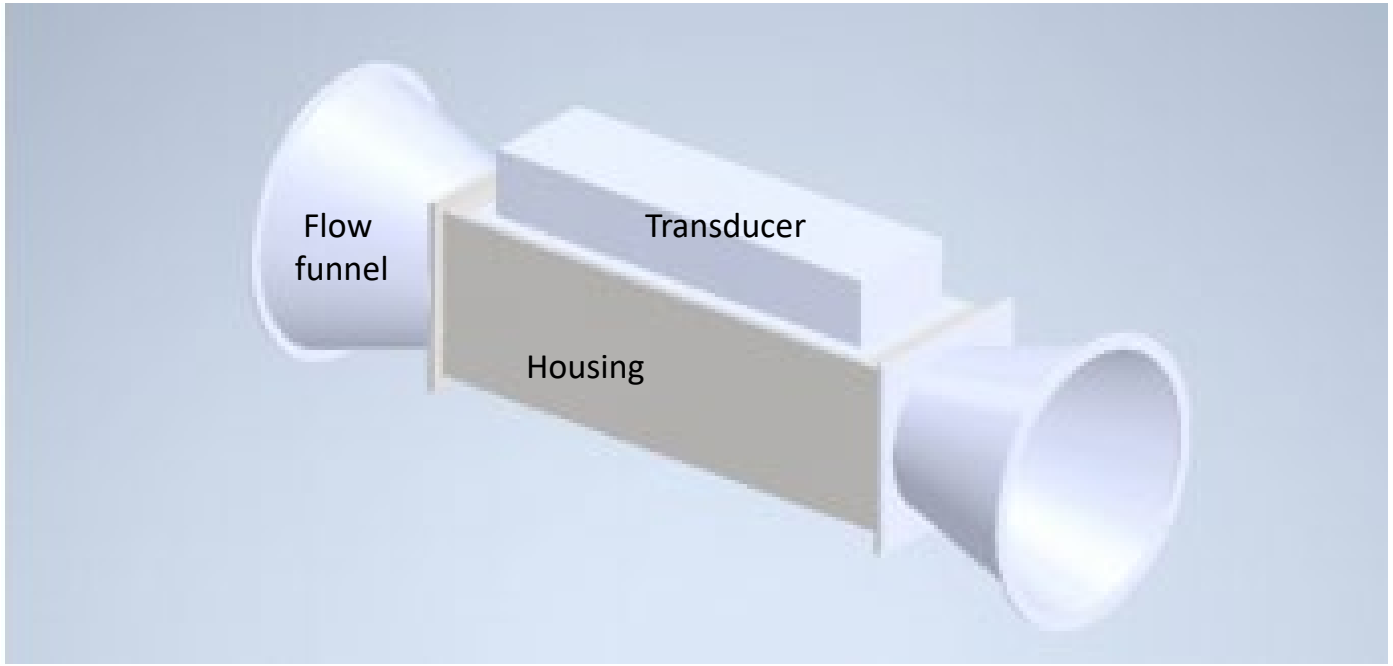
Field Demonstration





Courtesy of Arcadis

In situ reactor technology (InSRT)



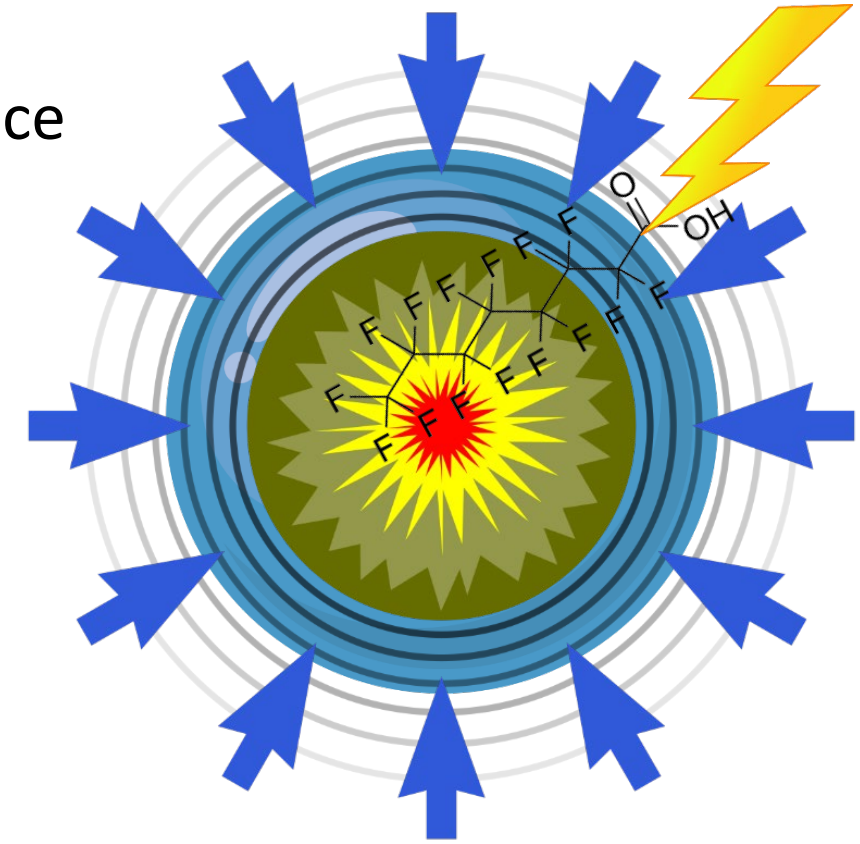
Sonolysis- Background

Sound waves >19 kHz create cavities in liquids

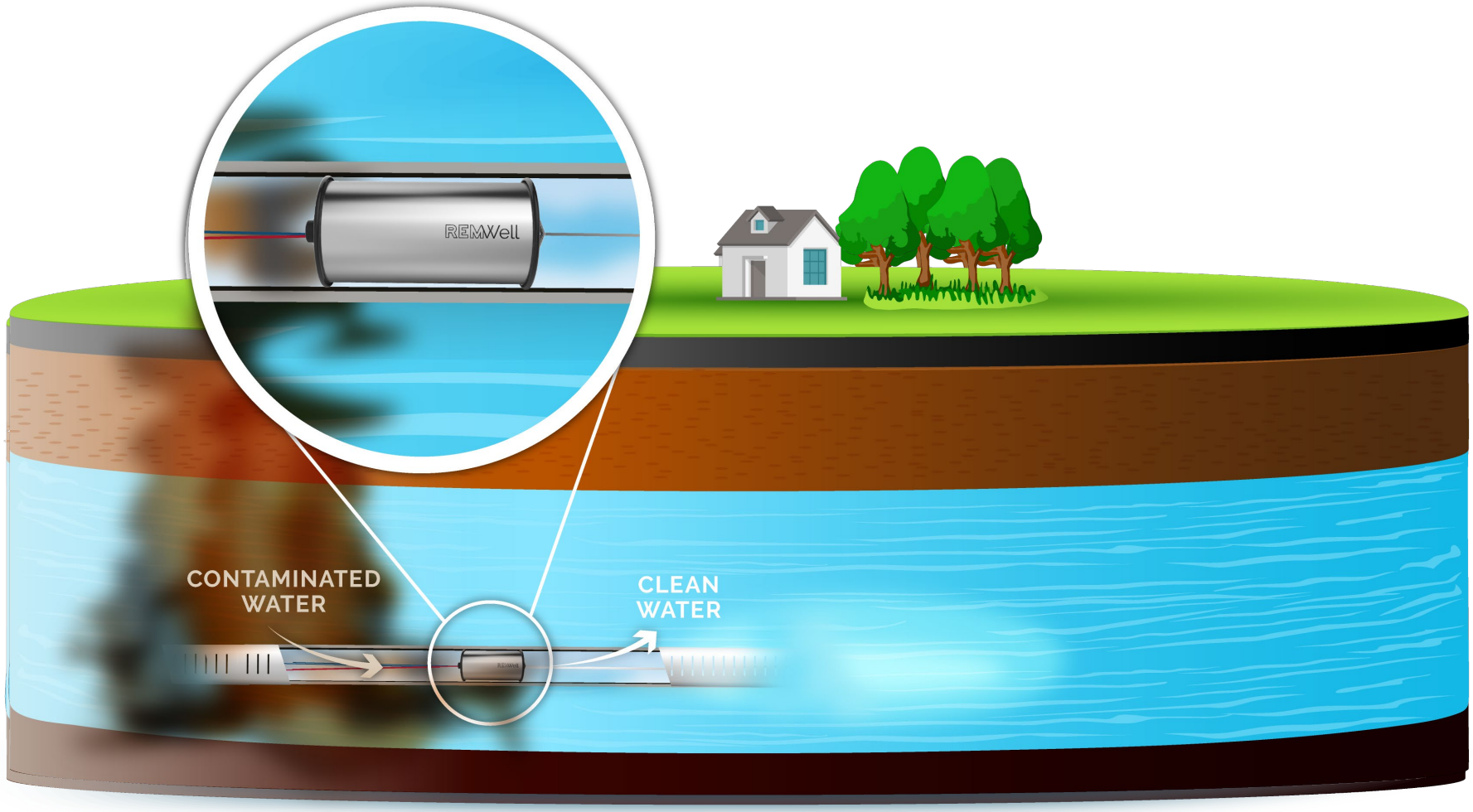
PFAS sorb to the cavity interface

Cavities collapse at maximum radius creating extreme localized conditions

- High heat (5000 °K)
- High pressure (1000 bar)
- Cleaves bond between hydrophobic and hydrophilic portions of molecules



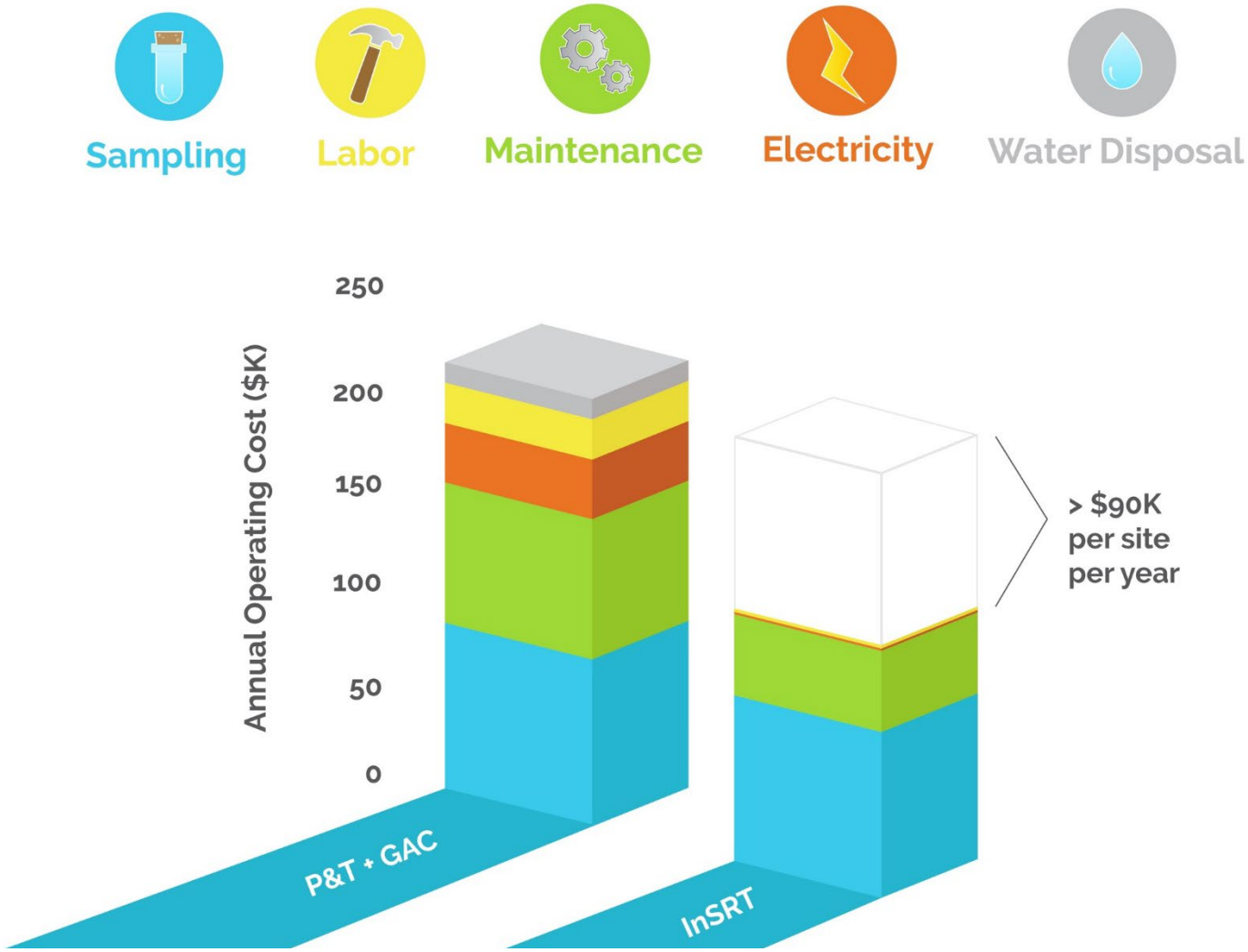
In situ remediation technology (InSRT)



RemWell offers 40% savings

in annual operating costs

compared to carbon treatment



The Competition

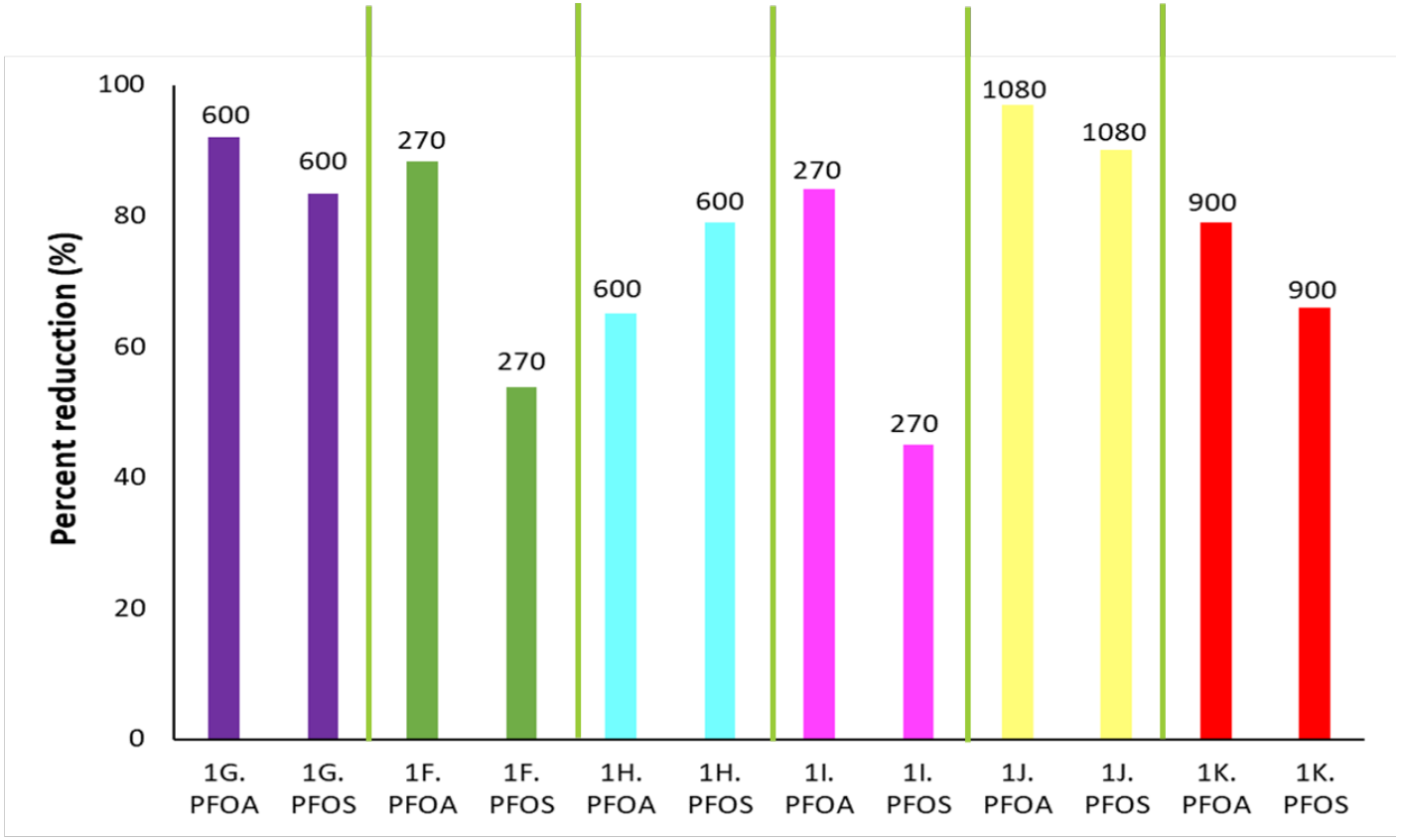
Factor	RemWell	Pump-and-treat GAC	Incineration	Oxidation Reduction	Membrane Filtration
Destroys PFAS	✓	✗	✓	–	✗
Low Operational Cost	✓	✗	✗	✓	✗
Fully On-site, In-place	✓	✗	✗	✓	✗
Addresses Other Contaminants	✓	–	✓	–	–
Uses Existing Standard Equipment	–	✓	✓	✓	✓
Field Validated	Coming Soon	✓	✓	✗	–

Experimental conditions

Experiment	Color	Matrix	Concentration (ug/L)	Percent Power	Treatment time (minutes)
1A		PFOA/DI water	100	60%	90
1B		PFOA, PFOS	10 each	60%	270
1C		PFOA, PFOS	10 each	75%	270
1D		PFOA, PFOS	1 each	60%	270
1E		PFOA, PFOS	1 each	75%	270
1F		Groundwater (Site 1)	$C_{i,PFOS}$ = 351	60%	270
1G		Groundwater (Site 1)	$C_{i,PFOS}$ = 402	60%	600
1H		Groundwater (Site 2)	$C_{i,PFOS}$ = 241	60%	600
1I		Groundwater (Site 3)	$C_{i,PFOS}$ = 2000	60%	270
1J		Groundwater (Site 3)	$C_{i,PFOS}$ = 4000	60%	1080
1K		Groundwater (Site 4)	$C_{i,PFOS}$ = 44	60%	900
1L		PFBA	1300	60%	660
IM		Site 6	$C_{i,PFOS}$ = 0.08	100%	270

Results

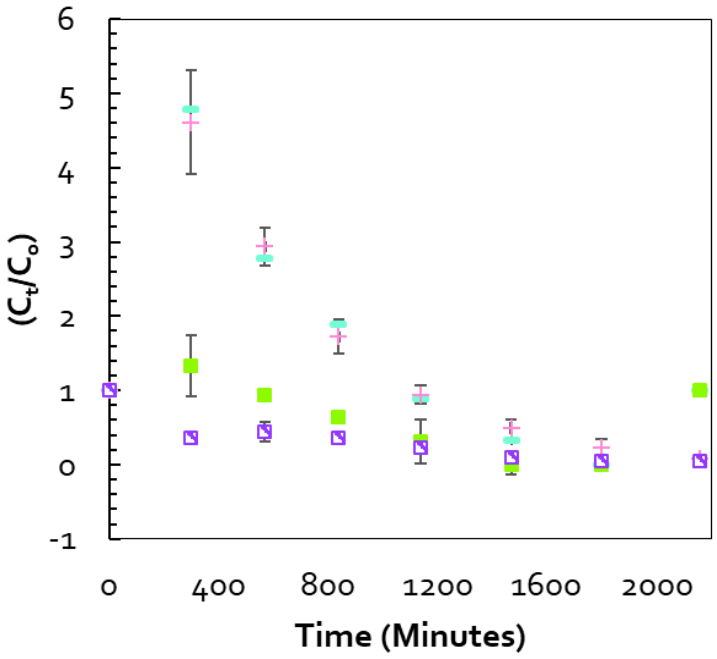
Values above bars = treatment time (min)



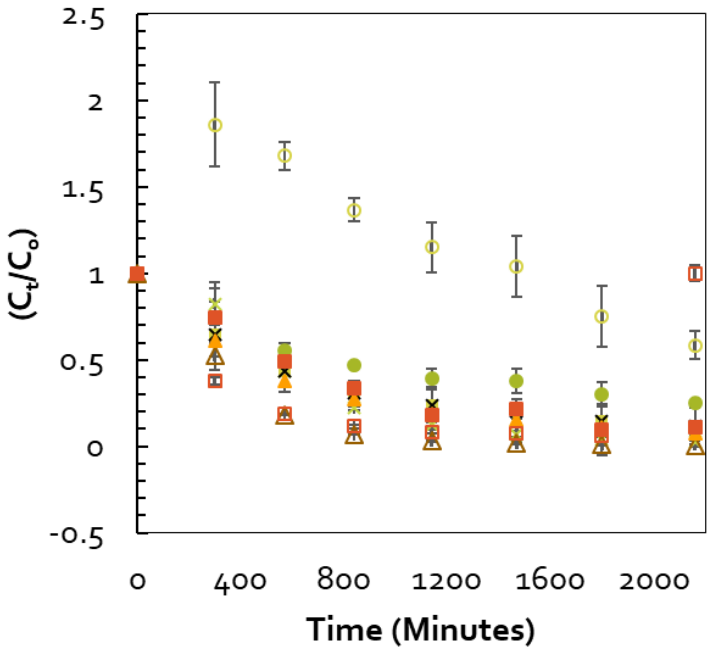
C_i PFOS (ppb) = 402 351 241 2,000 4,000 44

Results: Site 3, Condition J

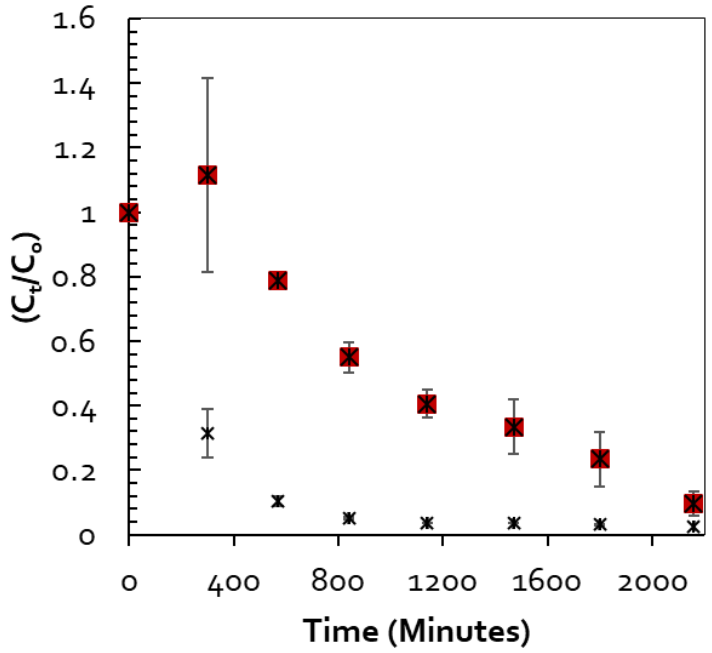
Example precursors



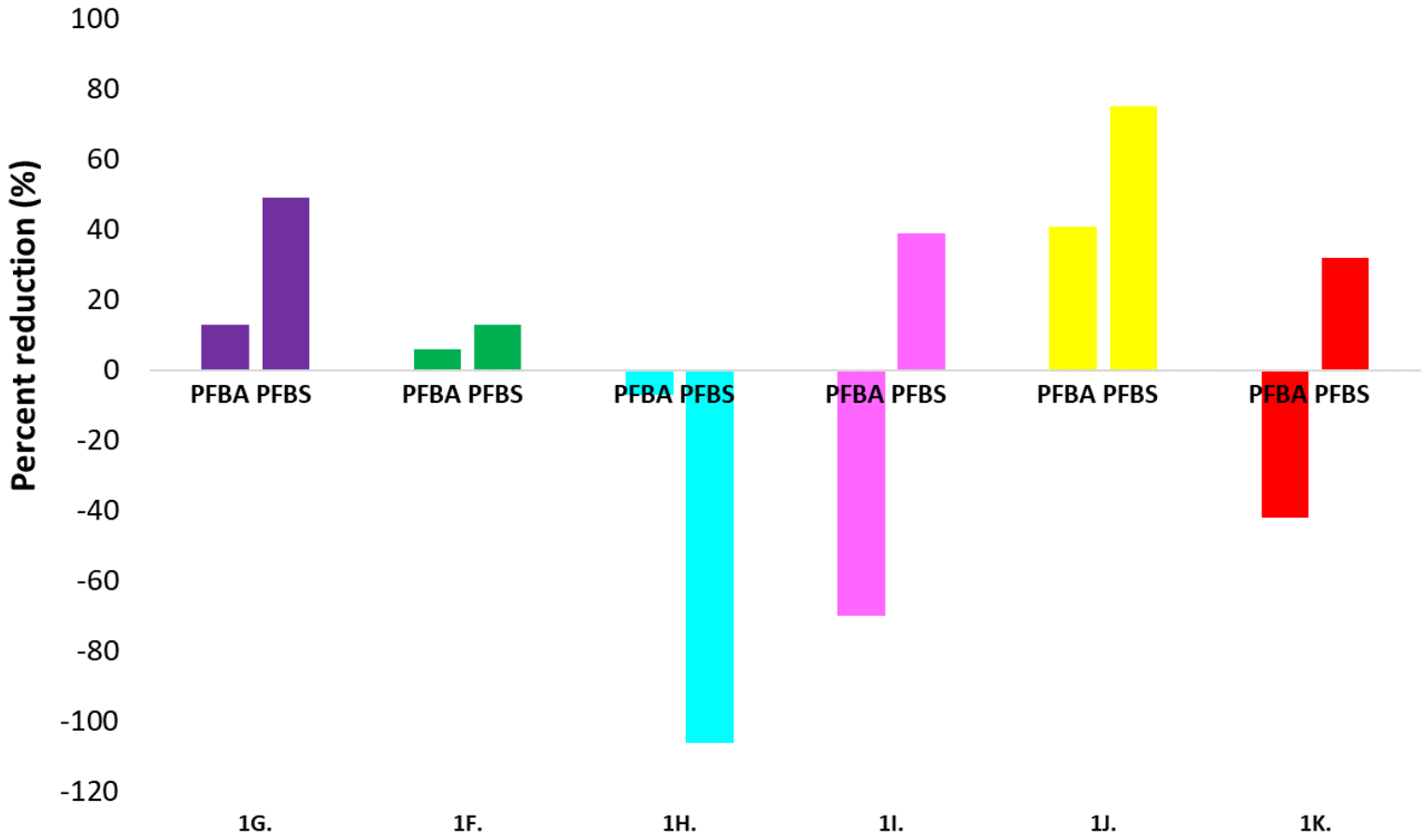
Example shorter-chain compounds



PFOA and PFOS

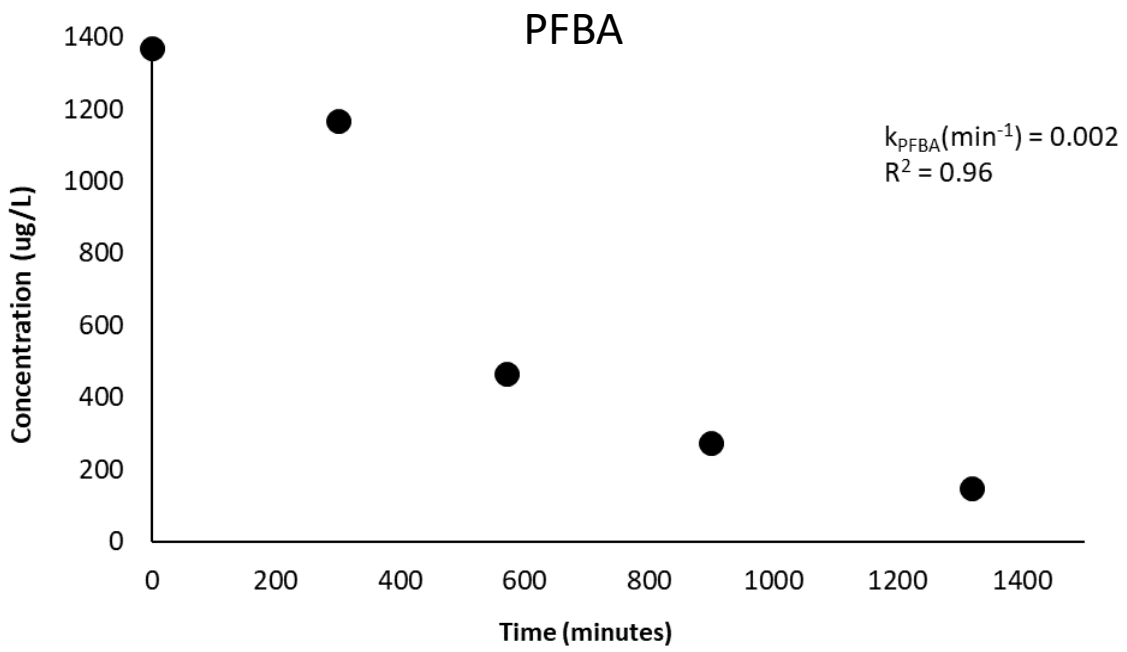


Results

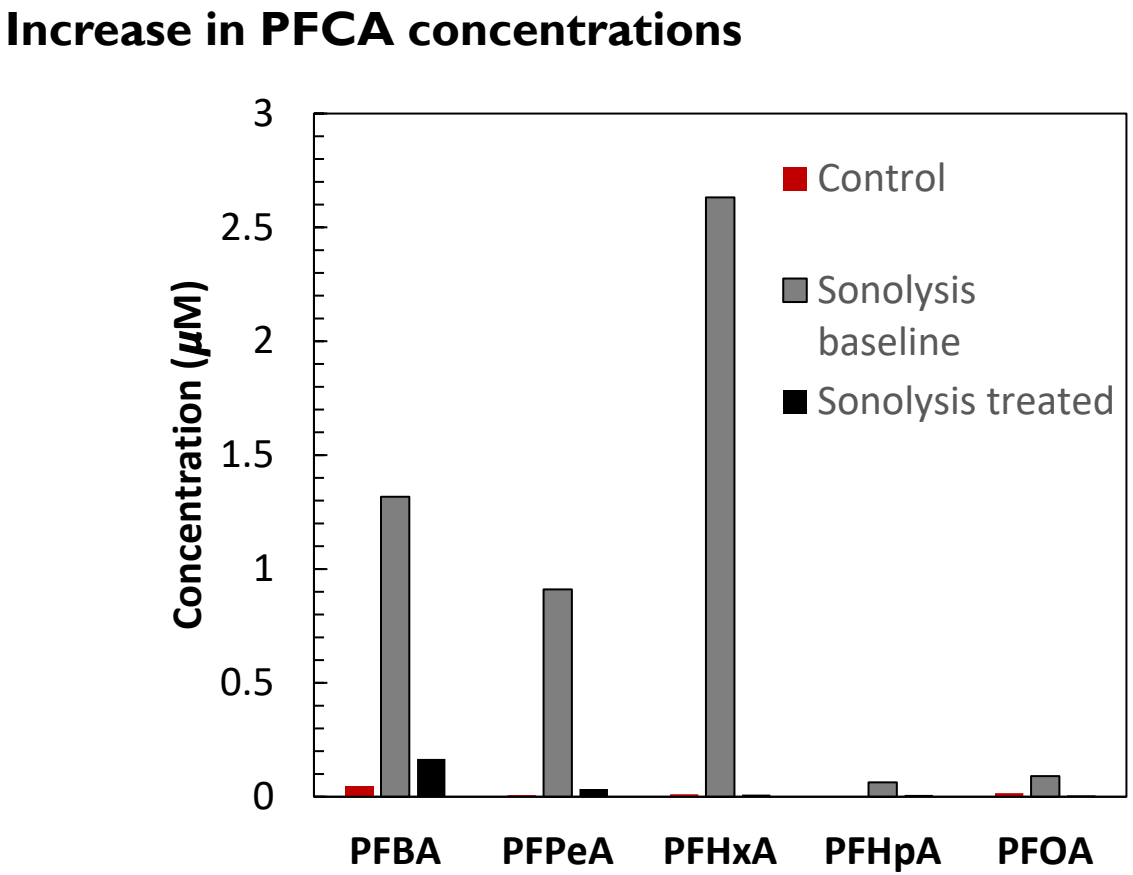


Results

- Shorter-chain compounds are produced as reaction intermediates, but are also degraded by sonolysis
  - Example: PFBA in spiked system



Results: TOP Assay



How can WRF help?

- Improved understanding of relationship between utilities and sources/owners of groundwater contamination
- Connections to sources/sites contributing to contaminated drinking water
- Identify opportunities for pilot testing
  - Can offer complimentary treatability tests

Questions?