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ENVIRONNEMENT

CANADIAN LEADER IN ENVIRONMENTAL SOLUTIONS

Innovative In Situ solution to persistent PFAS Groundwater and Soil contamination

Remtech 2023

Banff, AB, Canada

Presented by
Jean Paré, P. Eng., Chemco

remediation technologies symposium 2023

Presentation Agenda

- About us
- PFAS – One water perspective
- Intraplex Modular Approach
- Activated carbon form & Capture Mechanisms
- Utilization schematic – Bank Filtration
- Case Study
- Q & A

About us

Canadian Company founded in 1988

Production and warehouses throughout Canada

- Quebec
- Ontario
- Alberta
- British Columbia

Sectors of activity:

- Industrial and Municipal Potable & Waste Water
- Contaminated Soil and Groundwater
- Air, Odours and Atmospheric Emissions (Activated Carbon, filtering medias)
- Process Water & Thermal Exchange Fluids (Glycols)
- Drilling Fluids (Oil and Gas & Diamond exploration)
- Aircraft De-icing Fluids

Our Services

CANADIAN LEADER IN ENVIRONMENTAL SOLUTIONS

Specialized Products

- Chemical Oxidation
- Chemical Reduction
- Co solvent-Surfactant soil Washing
- Enhanced Bioremediation
- Permeable Reactive Barrier Amendments
- Metals Stabilization
- Activated Carbon Sorption Technologies

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Excellence & Science through proud Suppliers & Partners

CANADIAN LEADER IN ENVIRONMENTAL SOLUTIONS

ADVANCED OXIDATION TECHNOLOGY (AOT) *Since 2005*

EVONIK Leading Beyond Chemistry *Since 2005*

CARBONE CANADA INC *Since 2014*

BIOCONSERVACION *Since 2014*

CARUS® *Since 2014*

EthicalChem An Ethical Solutions, LLC Division *Since 2016*

EOS Remediation, LLC *Since 2016*

ChemBio Formulation *Since 2017*

SiREM *Since 2017*

Höganäs *Since 2018*

RioTinto *Since 2020*

intrapore *Since 2023*

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OUR PRODUCTS FOR IN SITU REMEDIATION.

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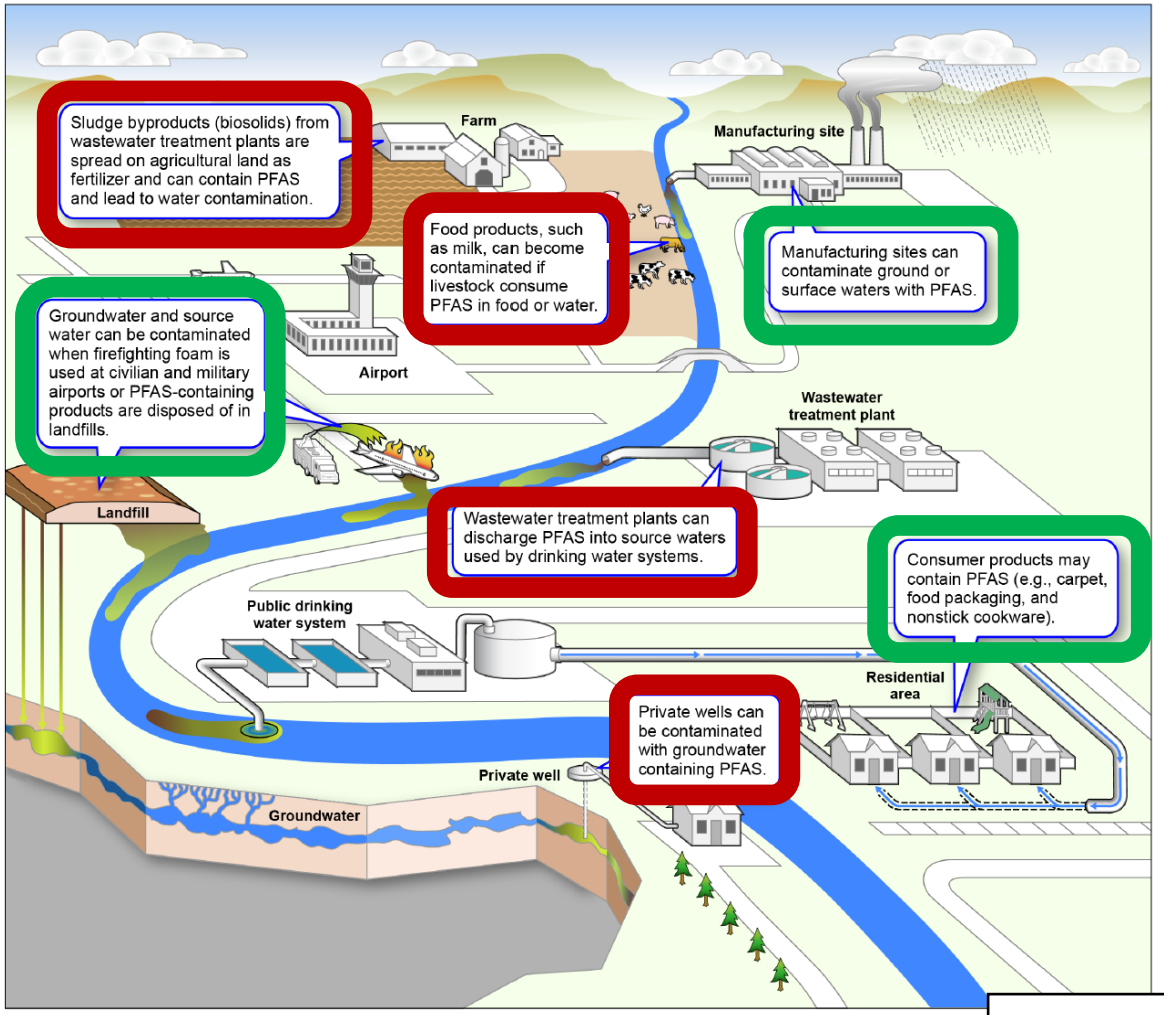
Your Problem	Our Solution				
	intrasorp®	aquaferrox®	carboiron®	trapox®	intraplex®
Material	Colloidal activated carbon	Iron oxides	Iron-activated carbon composite	Zeolithe	Modular
Effect	Adsorption	Adsorption	ISCR	ISCO	Modular
BTEX	✓			✓	
MOHCs	✓			✓	
PAH	✓			✓	
MTBE/ETBE	✓			✓	
VC/Cis			✓	✓	
PCE/TCE			✓		
Pesticides	✓		✓		
Explosives Resid.	✓				
Heavy metals		✓			
Cyanide		✓			
PFAS					✓

PFAS
One Water Perspective

PFAS Sources

PFAS Impacts



Source: United States Government Accountability Office GAO – 12-37, Jan, 2021

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PFAS
One Water Perspective

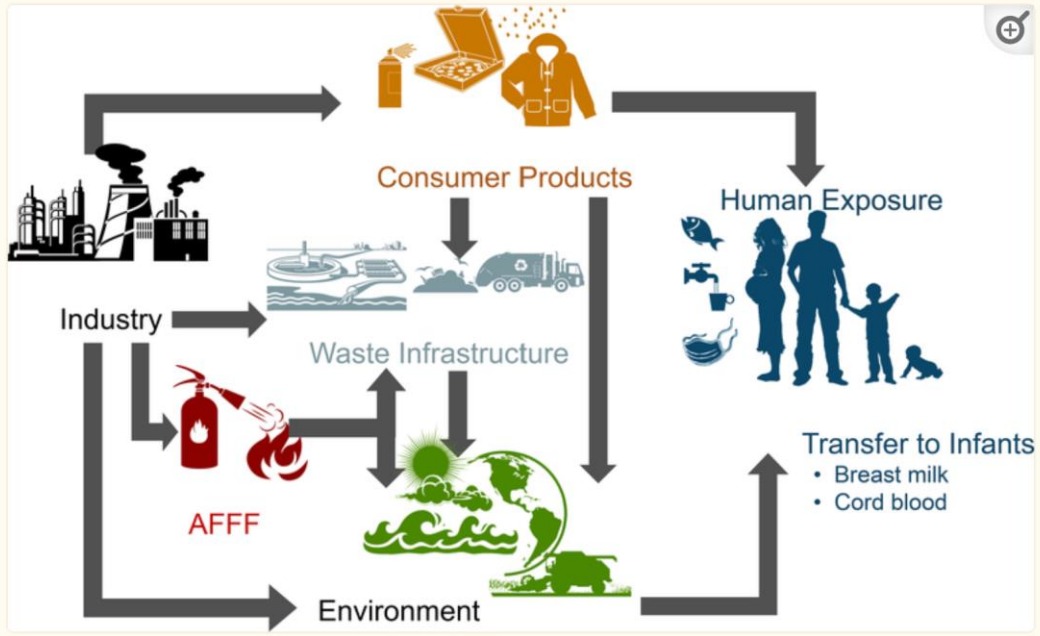

Figure 1.

Overview of PFAS exposure pathways for different human populations outside of occupational settings.

Table 1.

Literature estimates of sources contributions (%) to adult PFAS exposures.

PFAS	Diet	Dust	Tap water	Food Pkg.	Inhalation	Dermal	Other	Reference
PFOA	16	11		56	14		2[a]	Trudel et al.[25]
PFOA	85	6	1	3[b]			4[c]	Vestergren and Cousins[74]
PFOA	77	8	11		4			Haug et al.[76]
PFOA	66	9	24		<1	<1		Lorber and Egeghy[77]
PFOA	41		37				22[d]	Tian et al.[163]
PFOA	99		<1					Shan et al.[164]
PFOS	66	10	7		2		16[d]	Gebbink et al.[165]
PFOS	72	6	22		<1	<1		Egeghy and Lorber[75]
PFOS	96	1	1		2			Haug et al[76]
PFOS	81	15					4[a]	Trudel et al.[25]
PFOS	93		4				3[d]	Tian et al.[163]
PFOS	100		<1					Shan et al.[164]
PFBA		4	96					Gebbink et al.[165]
PFHxA	38	4	38		8		12[d]	Gebbink et al.[165]
PFOA	47	8	12		6		27[d]	Gebbink et al.[165]
PFDA	51	2	4		15		28[d]	Gebbink et al.[165]
PFDoDA	86	2	2		4		5[d]	Gebbink et al.[165]

Open in a separate window

[a]Carpet
[b]Consumer goods
[c]Precursors
[d]Indirect.

Source: A Review of the Pathways of Human Exposure to Poly- and Perfluoroalkyl Substances (PFASs) and Present Understanding of Health Effects

Journal of Exposure Science & Environmental Epidemiology

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Intraplex® ¨Product line for PFAS

- **Modular & Adaptable**

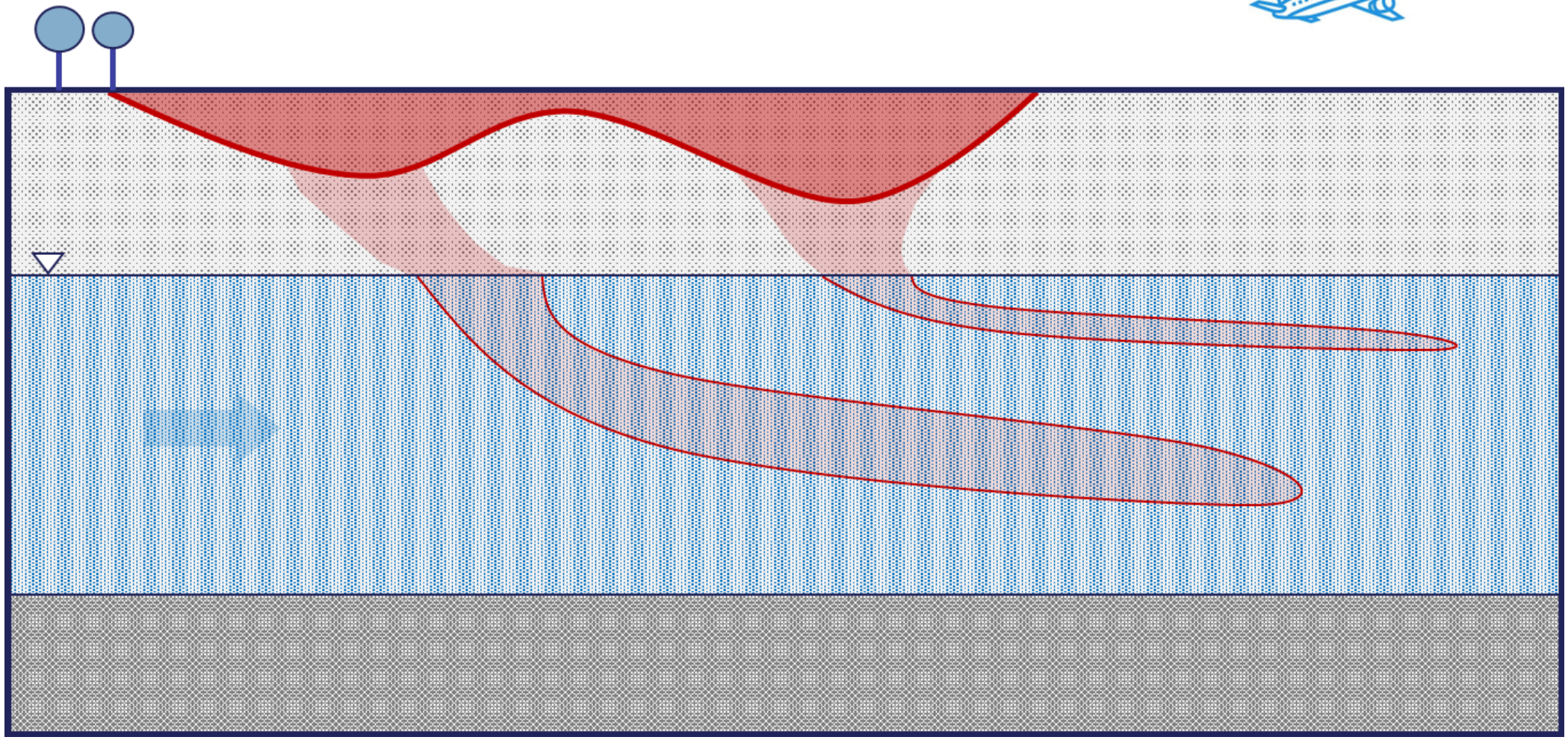
  Intraplex A - Against GW Infiltration

  Intraplex B - Against plumes migration

  Intraplex C - For destruction

  Intraplex D - Against short chains

Your typical PFAS site…



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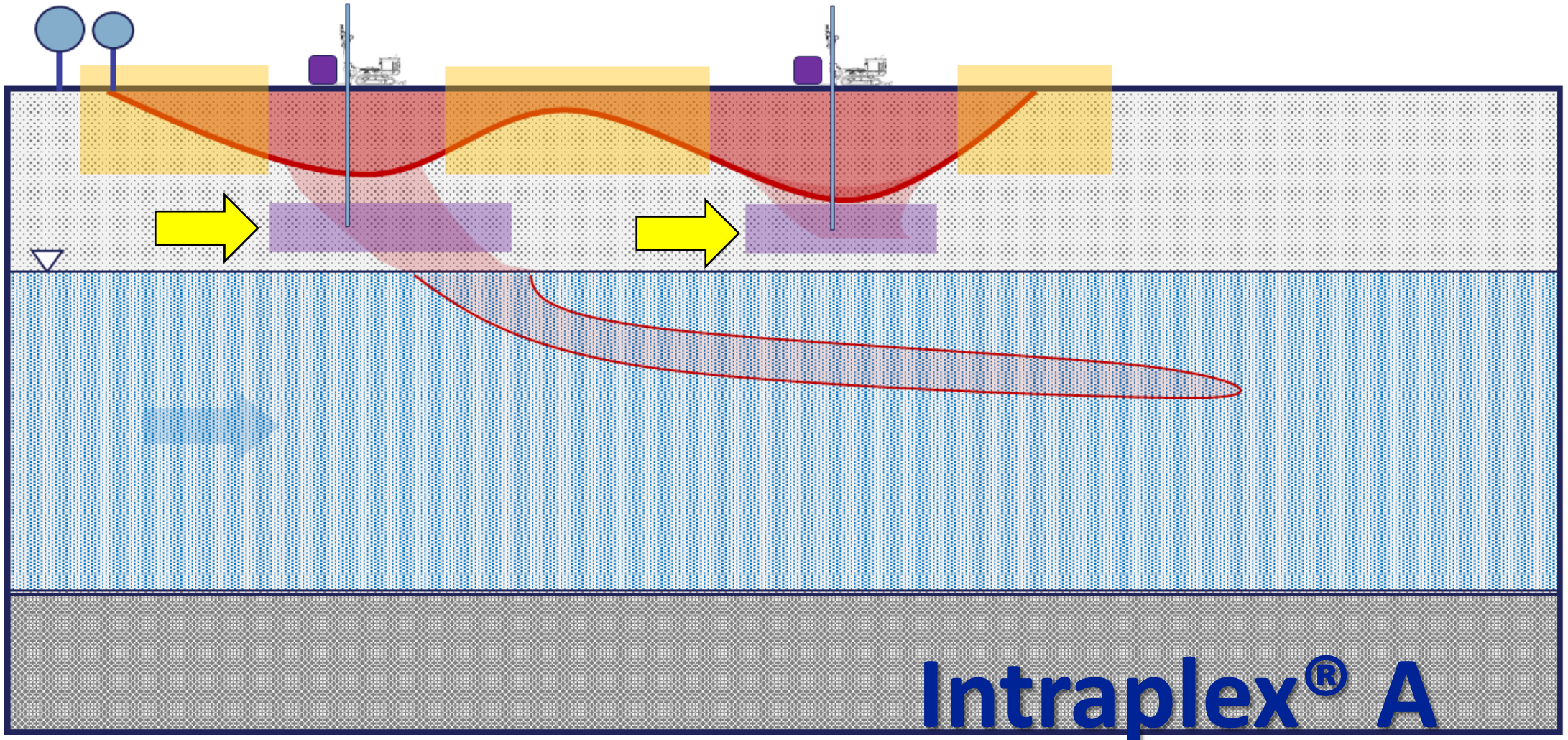
Intraplex® A

Intraplex A®

- Microsized Colloidal suspension clay adsorber for the in situ immobilization of PFAS in unsaturated conditions
- PFAS Source Zone Control Technology
- SSA ~100 m² / g

  Effective at high PFAS concentrations

  - PFOS: 175 mg / g @ 0.45 mg L
  - PFBS: 4.5 mg / g @ 3.6 mg / L
  - PFOA: 12.4 mg / g @ 2.5 mg /L
- Made in Germany

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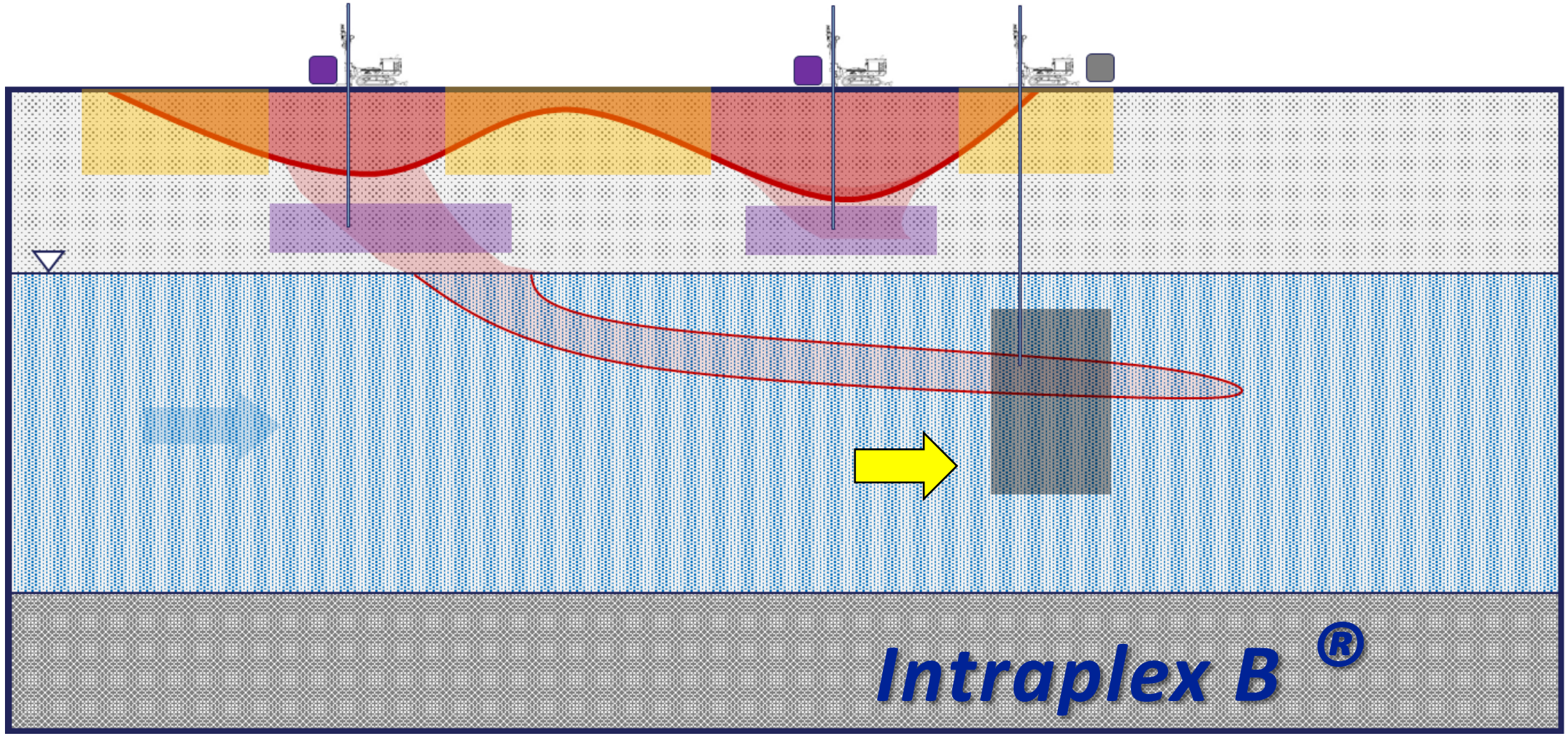

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Intraplex B ®

- Microsized **surface modified activated colloidal carbon** based adsorber for the in situ immobilization of PFAS
- PFAS **Diffuse GW Plume Control** Technology (adsorption barrier)

  High affinities for adsorption of PFAS molecules at low ambient concentrations **(short chains and long chains)**
- Uncoated
- Field tested and highly effective
- Made in Germany

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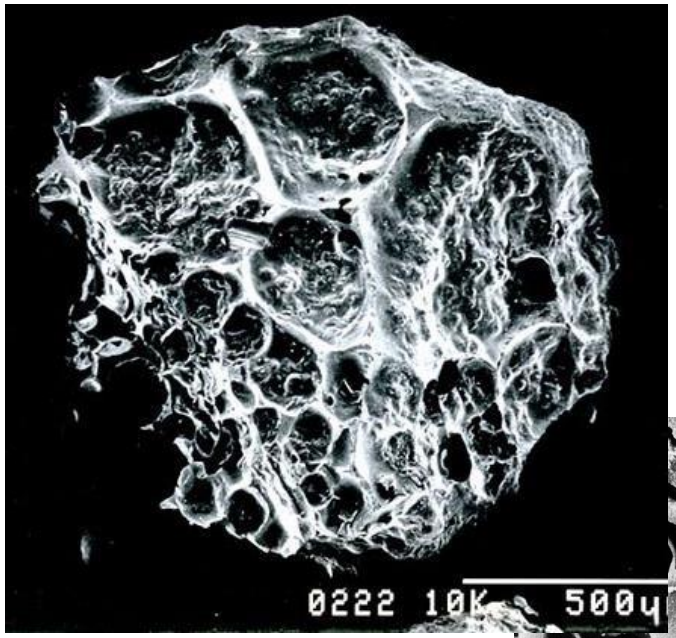
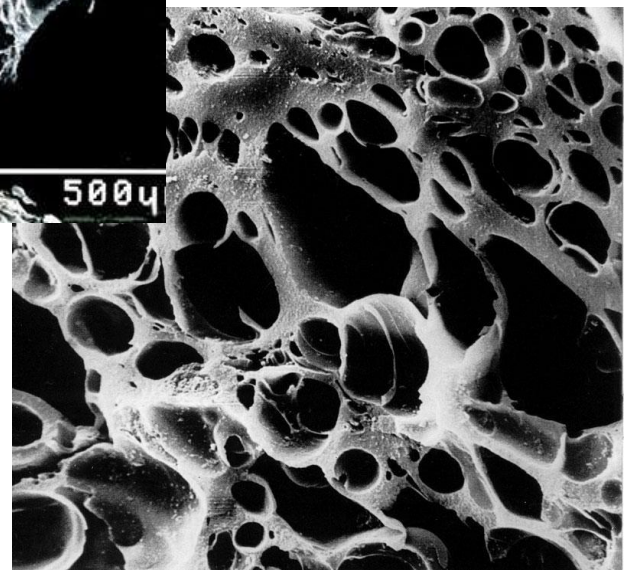
Activated Carbon Form, Capture & Treatment Mechanisms

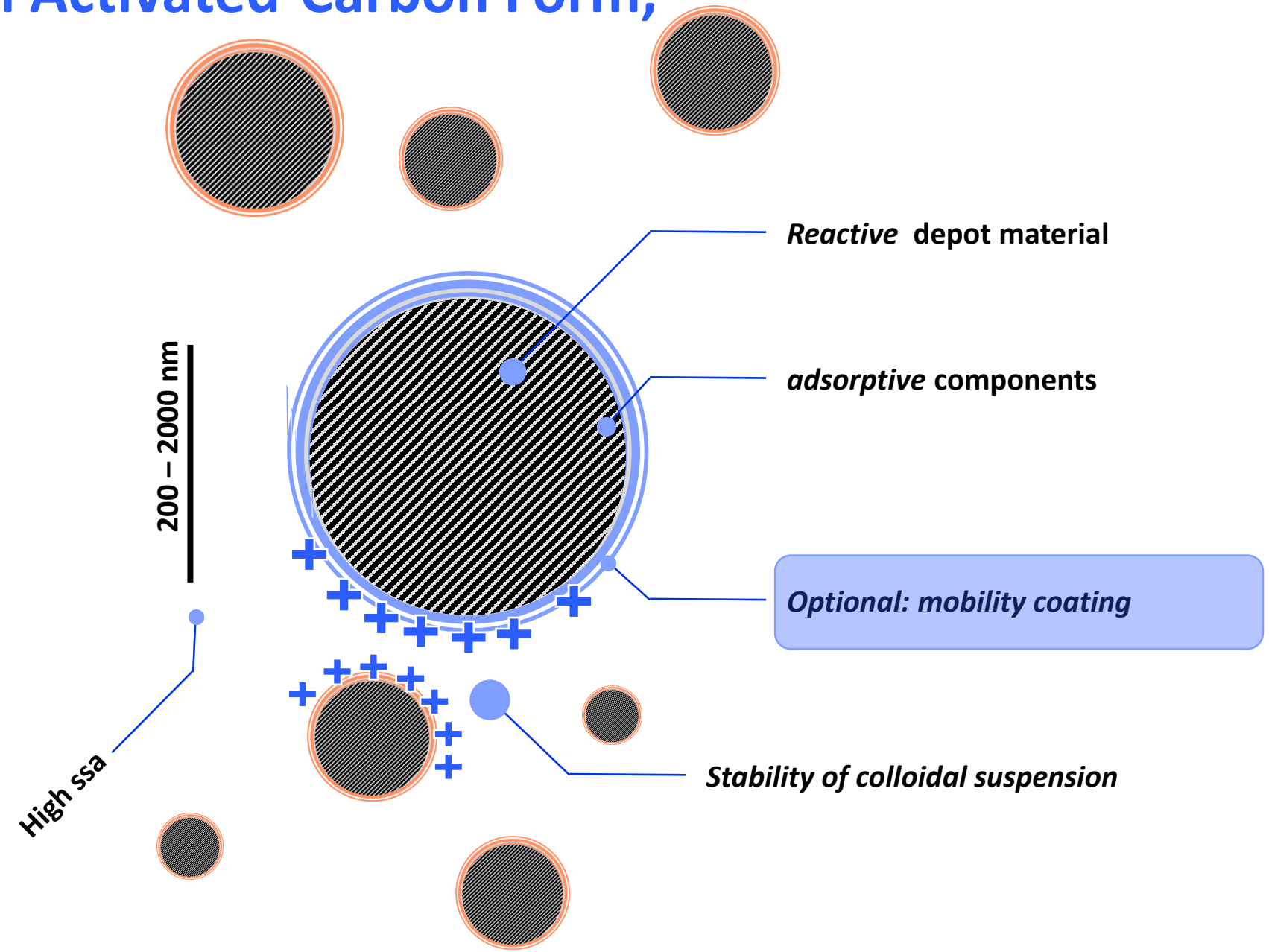
Adsorptive





Granular Activated Carbon

Colloidal Activated Carbon Form,



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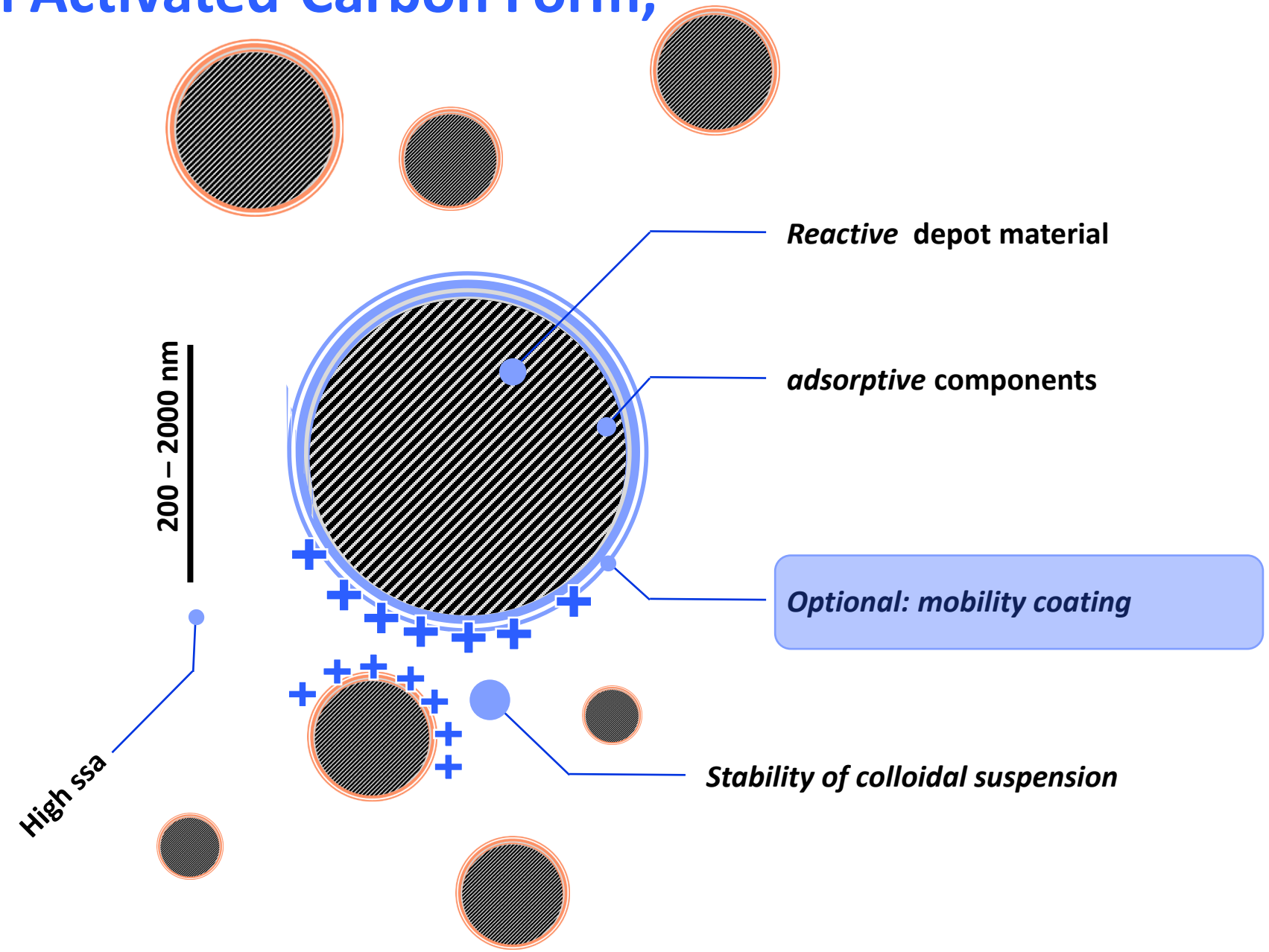
Colloidal Activated Carbon Form,



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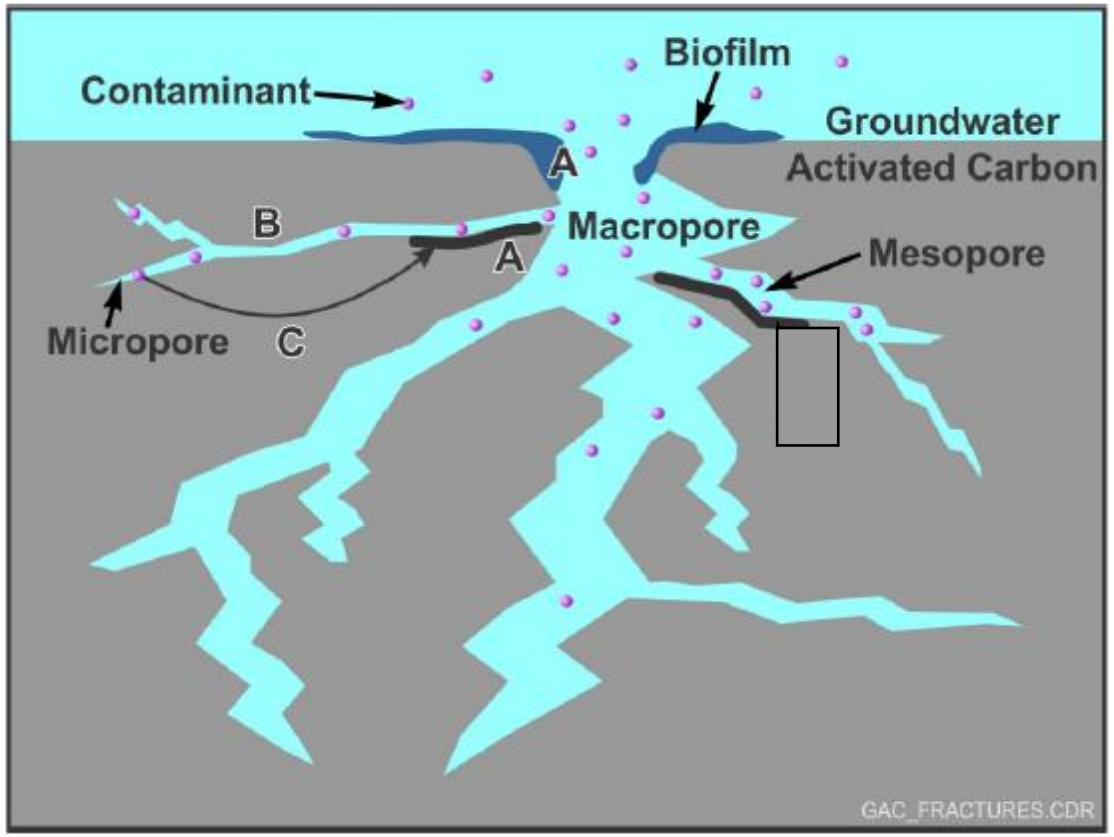
Activated Carbon Form, Capture & Treatment Mechanisms

- **Granular Activated Carbon Particle size** >90% retained by an 80-mesh sieve (177 µ) [ASTM D2862] *> 4x larger than PAC*

- **Powder Activated Carbon Particle size <40 microns (µ)**

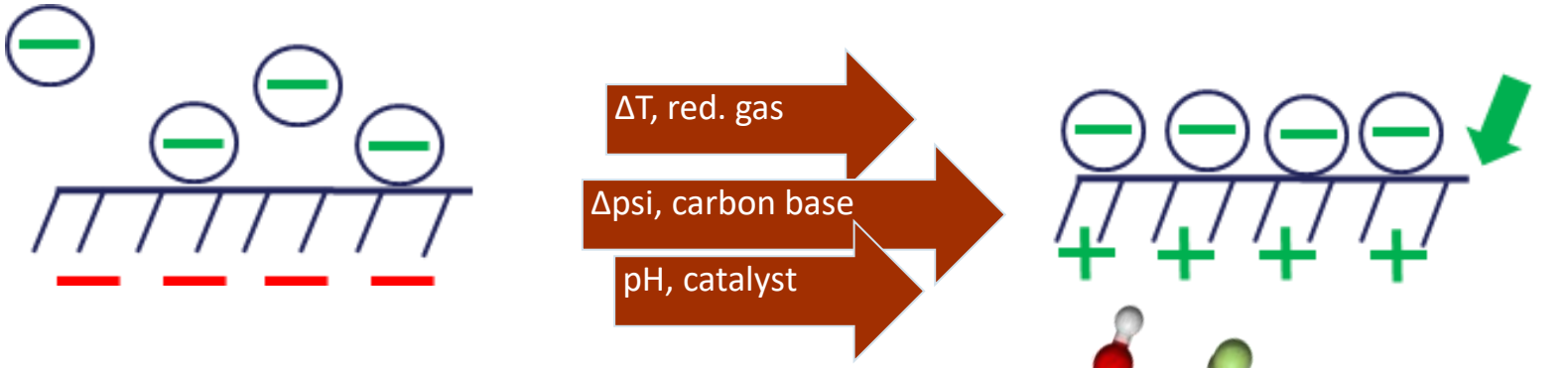
Colloidal Activated Carbon Particle size 1-2 microns (µ)

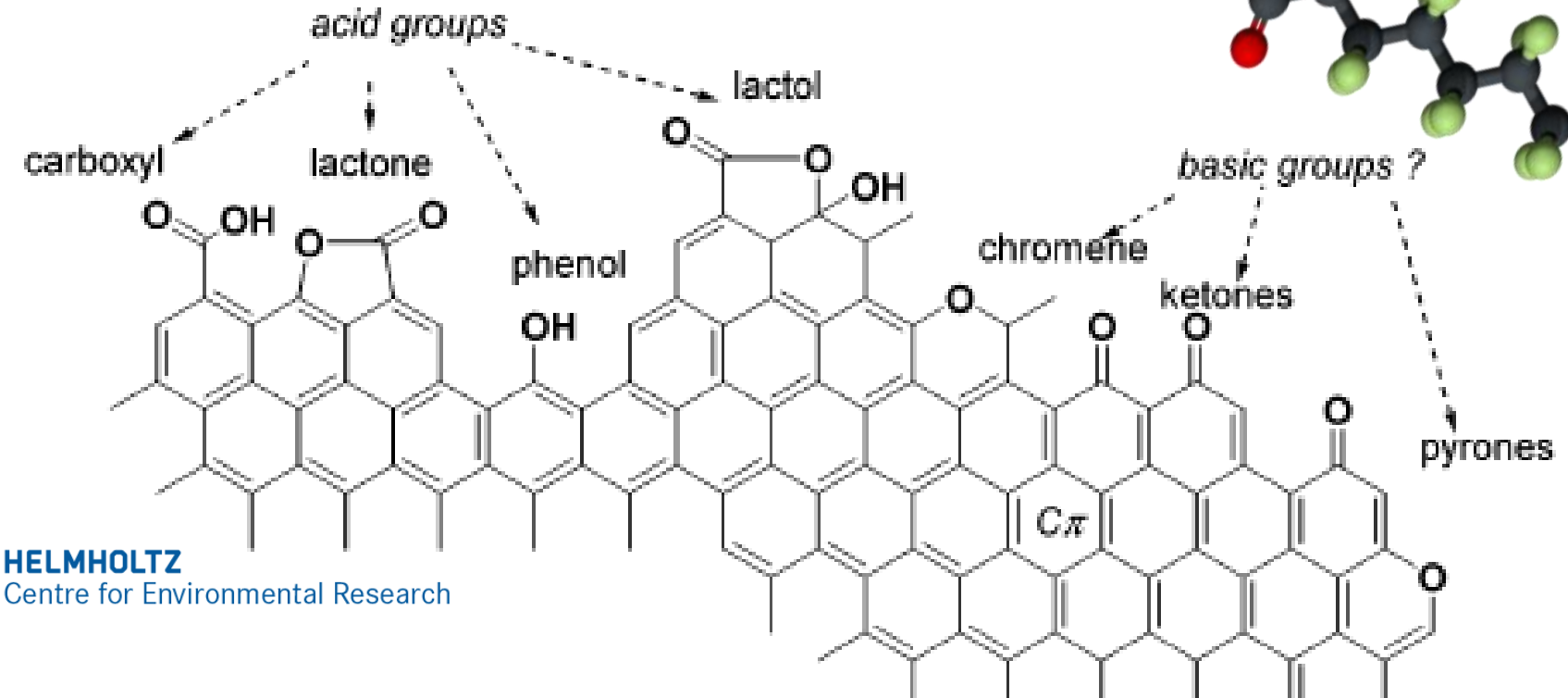
- ✓ 10-slot screen = 256 µ
- ✓ 200-mesh sieve (clay) = 75 µ
- ✓ Bacteria = 0.5 - 2 µ
- ✓ Pore throats (*Nelson, AAPG Bull., 3/09*):
  sand >2 µ *silt* 0.03 – 2 µ *clay* 0.005 – 0.1 µ
- ✓ Mesopore = 0.05 µ; Micropore = 0.002 µ
- ✓ BTEX molecules = 7 Angstroms (Å) = 0.0007 µ
- ✓ ➢Water molecule = 3 Angstroms (Å) = 0.0003 µ



Source – Modified from Fan et al., 2017 and reproduced with permission from Journal of Environmental Management

Activated Carbon Surface modification for enhanced PFAS Capture





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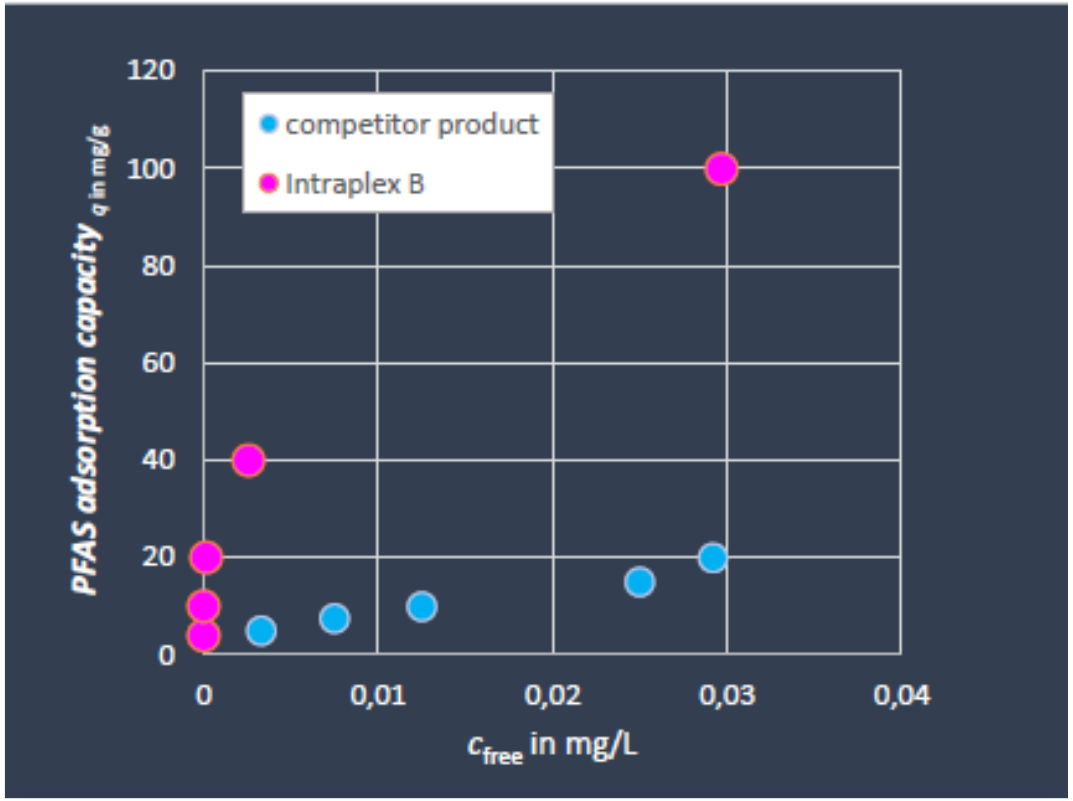
Intraplex B®- Independent scientific comparison:

PFAS adsorption capacity

Intrapore's specialized activated carbon for PFAS adsorption shows a vastly, and significantly higher capacity for PFOS compared to a competitor's products.

The maximum load of **Intraplex B** is about 100 mg PFOS per 1 g activated carbon. The compared competitor's product has a loading of only 23 mg PFOS per 1 g activated carbon



Source

Mole R, Lowry G, et al. (2023) Groundwater solutes influence the adsorption of perfluoroalkyl substances (PFAS) to colloidal activated carbon and impact performance for in situ groundwater remediation – submitted

Carey et al. (2022) Longevity of colloidal activated carbon for in situ PFAS remediation at AFFF-contaminated airport sites. Remediation (33) 2 - 23

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Intraplex B®- Independent scientific comparison:

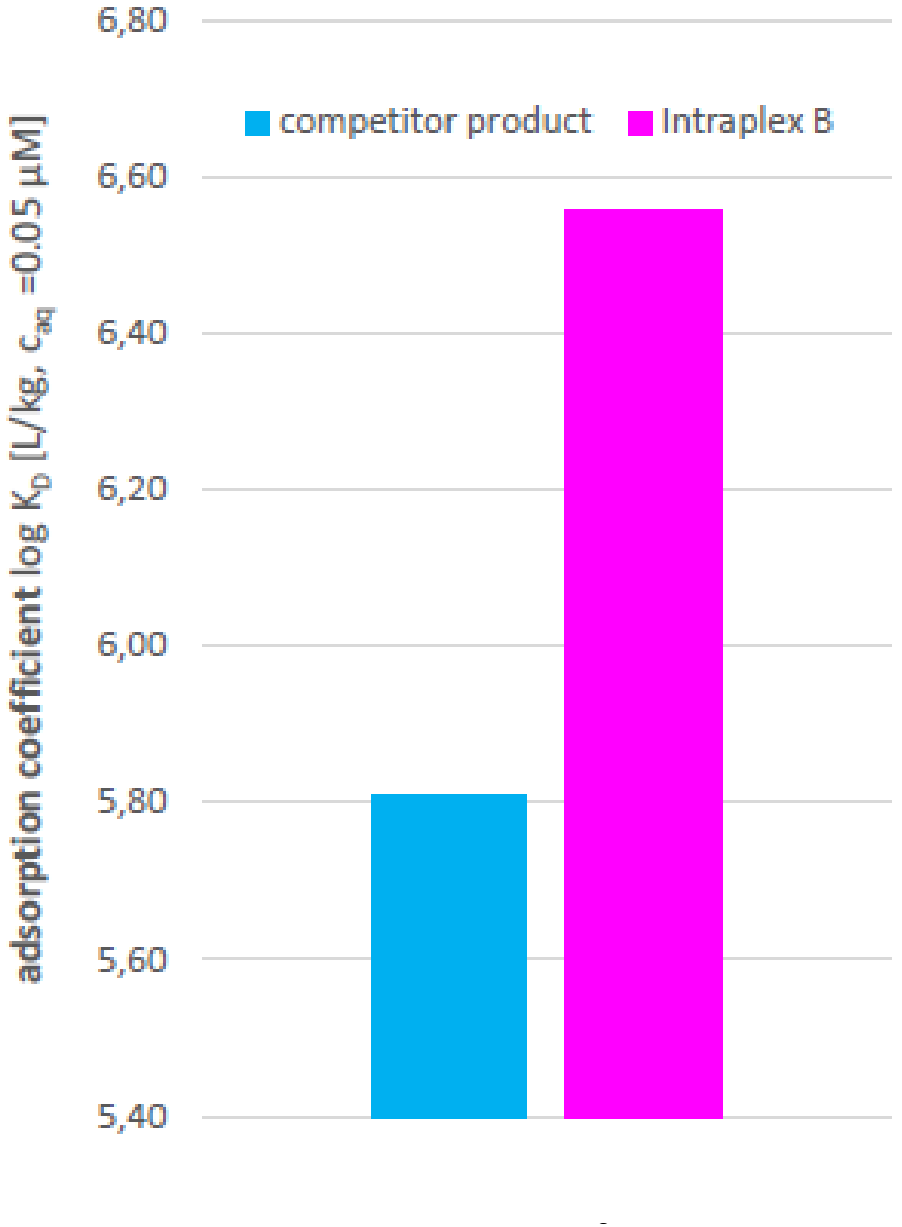
PFAS adsorption capacity

Adsorption coefficient, which is a measure of the quality of the adsorption,

is 5 times higher with **Intraplex B**

This implies that to ensure a barrier lifetime of 10 years for PFOS, 5 times less Intraplex carbon is needed.

For less adsorbing substances like PFBA, this advantage of Intraplex B is assumed to be even more substantial and be in the range of up to 2 – 3 orders of magnitude.



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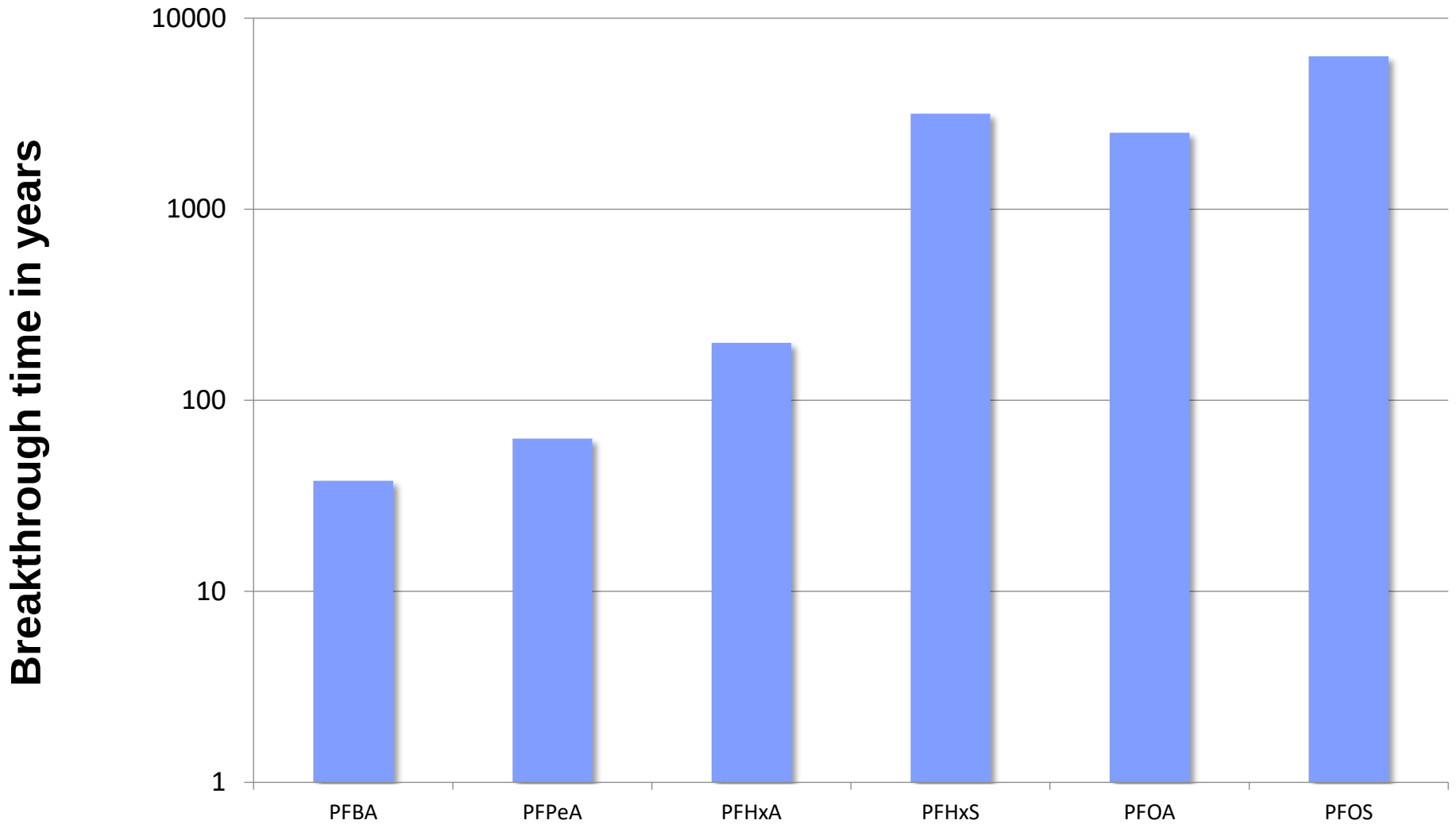
Intraplex B®

- ***Intraplex B enables you:***
  - to install PFAS highly efficient PFAS adsorption barriers
  - in a matter of days, with >90% contaminant reduction
  - with barrier adsorption lifetimes up to several decades
  - typically at as little as 30% of the costs of conventional Pump & Treat systems
  - **The material has been successfully used in large-scale field applications and has been approved by the authorities under local water regulations without any problems.**

Estimate operation time of in-situ AC barriers



Intraplex B®

Properties Intraplex®

- **Specific surface: up to 1.600 m2 / g**
- **Particle size: 1.5 µm**
- **Concentration: 400 g/L concentrate**
- **Components:**
  - ❑ **naked carbon in colloidal wet suspension,**
  - ❑ **In situ Mobility additive, water**

To be deployed for :

Rapid and sustained adsorption of PFAS (carboxylic and sulfonic acids) for long-term immobilization of groundwater plumes

- Can be used in situ, as a colloidally stabilized suspension via direct push / injection into existing measuring points (range up to 20 m)
- Long-term, almost irreversible adsorption of PFAS under typical conditions.
- Applicable for dissolved plume remediation

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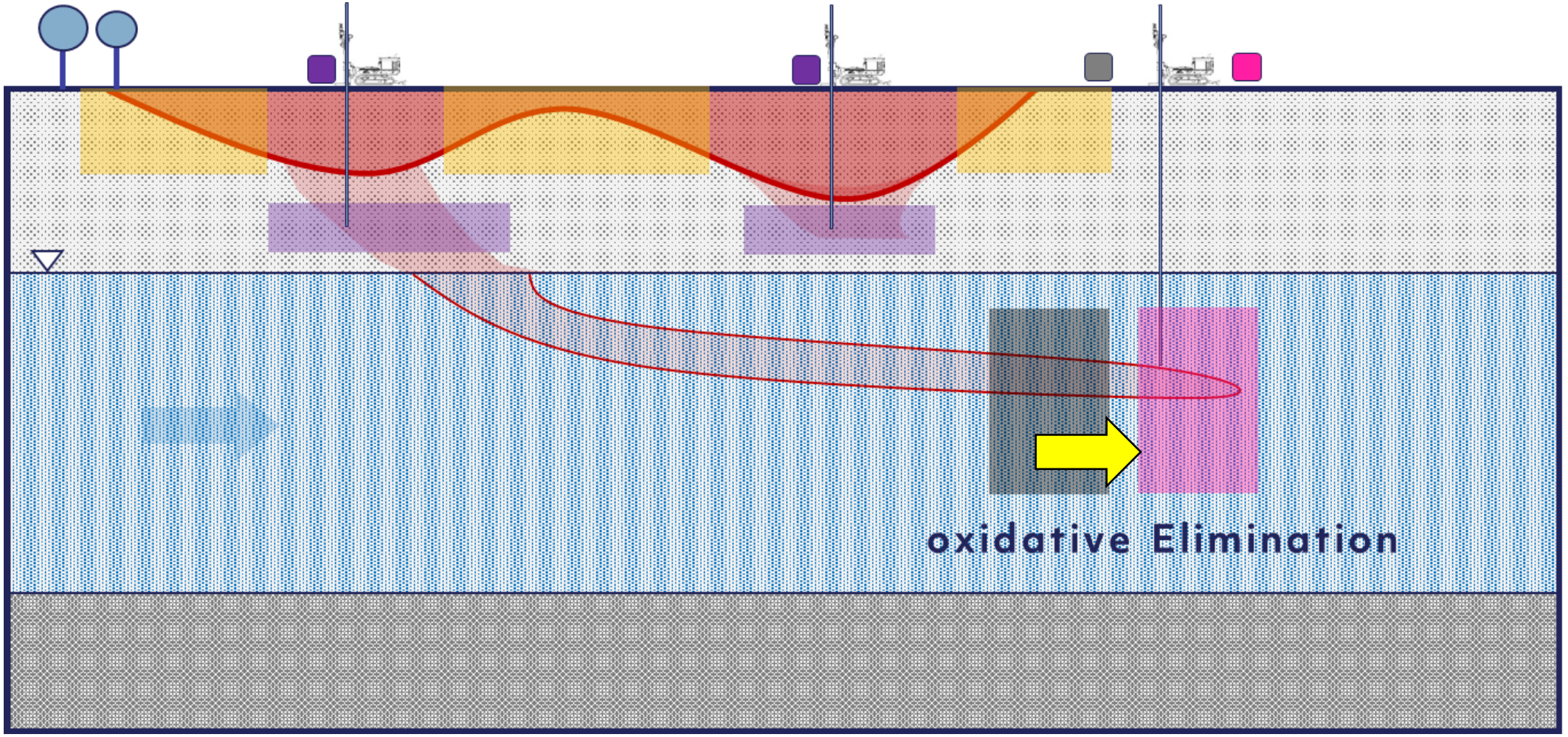
Intraplex B carbon ®

- Optimized for PFAS
- Independent Lab study shows highest quality
- Intraplex successful in field applications
- Straightforward & cost efficient injection
- Eco- and climate friendly
- Go-to solution to cut off PFAS plumes

Intraplex® C (under developement)



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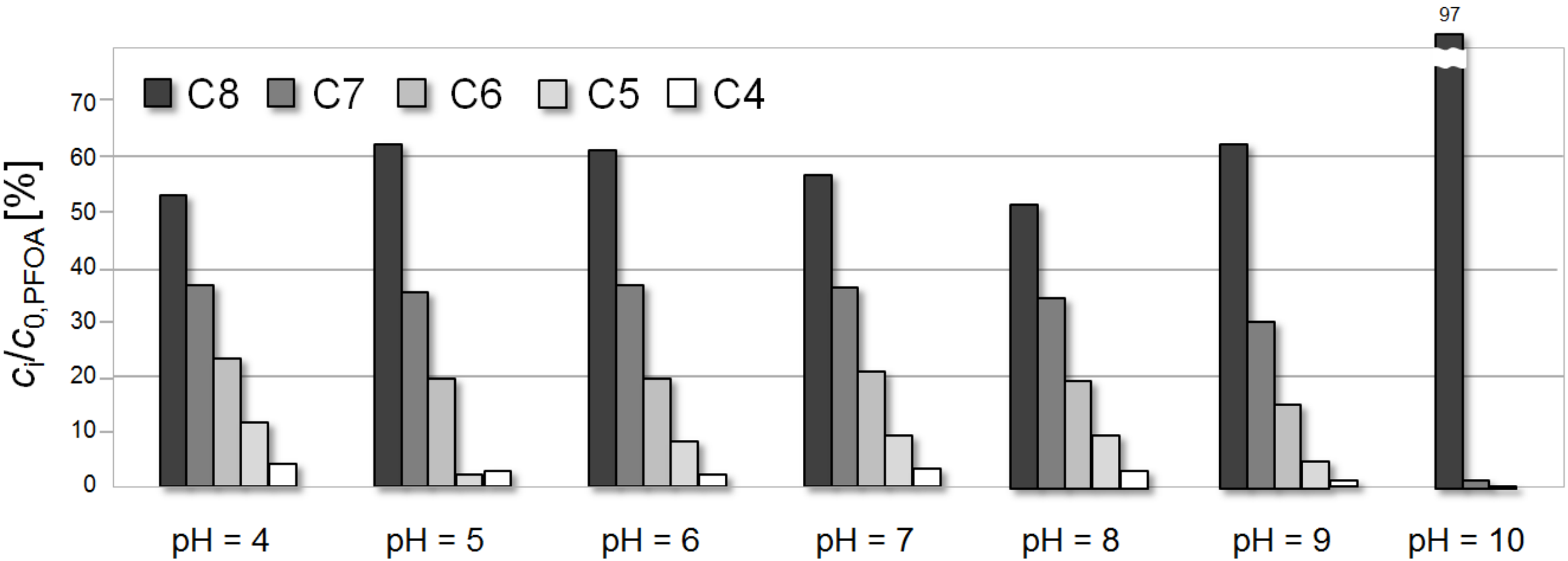
Intraplex® C (under developement)



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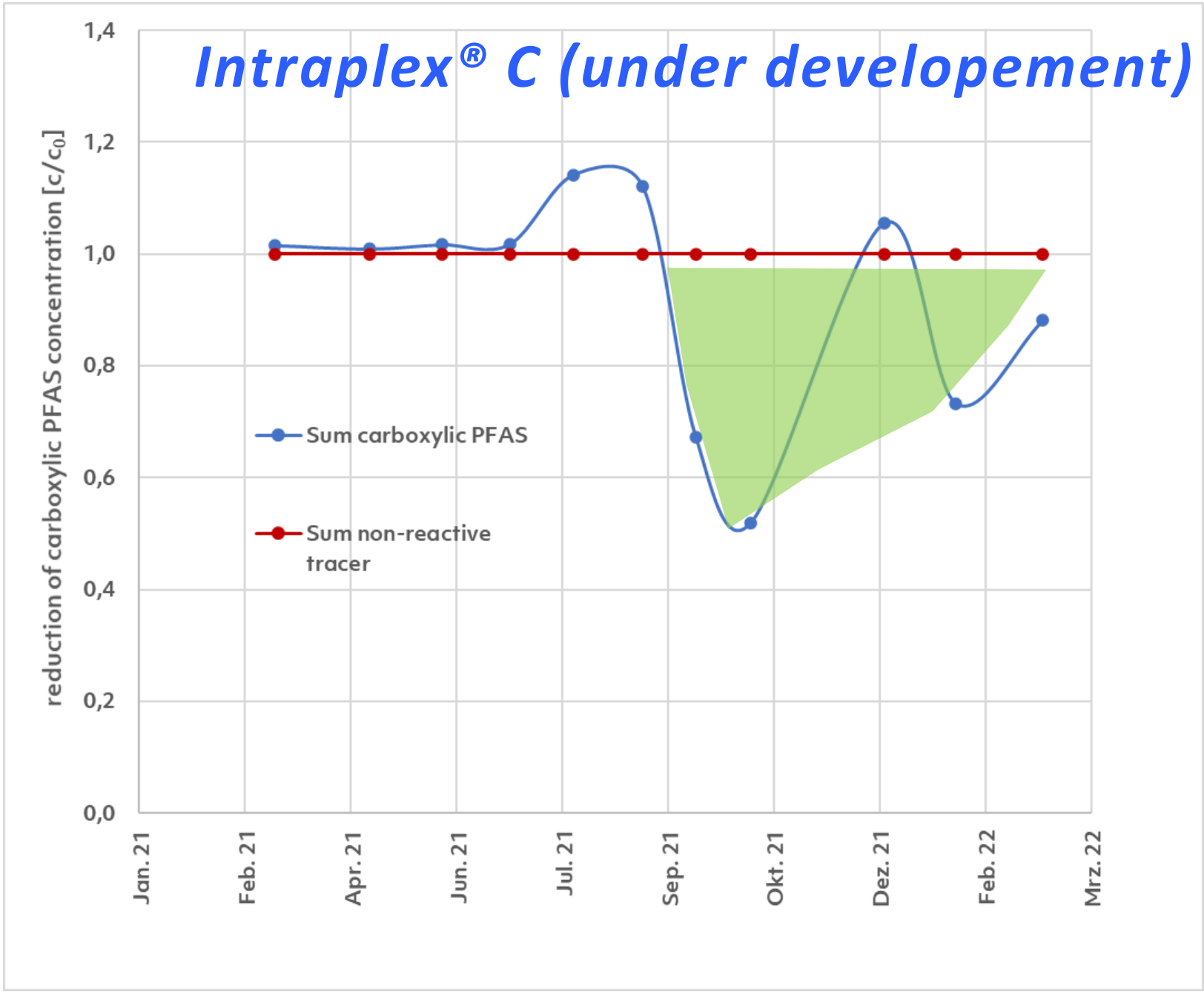

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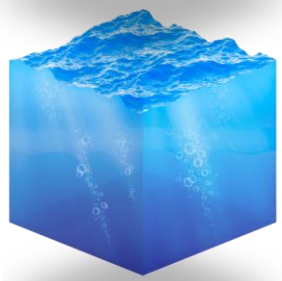

Intraplex B® - Utilization Schematic – BANK FILTRA
Reducing above ground system cost for Point of I Treatment

POET System ($$$)

To the water works

River

Pretreatment

Intraplex B – Sorption Permeable Barrier

Bank filtration

Infiltration

Source: Journal**AWWA** - **Riverbank Filtration: An Overview**

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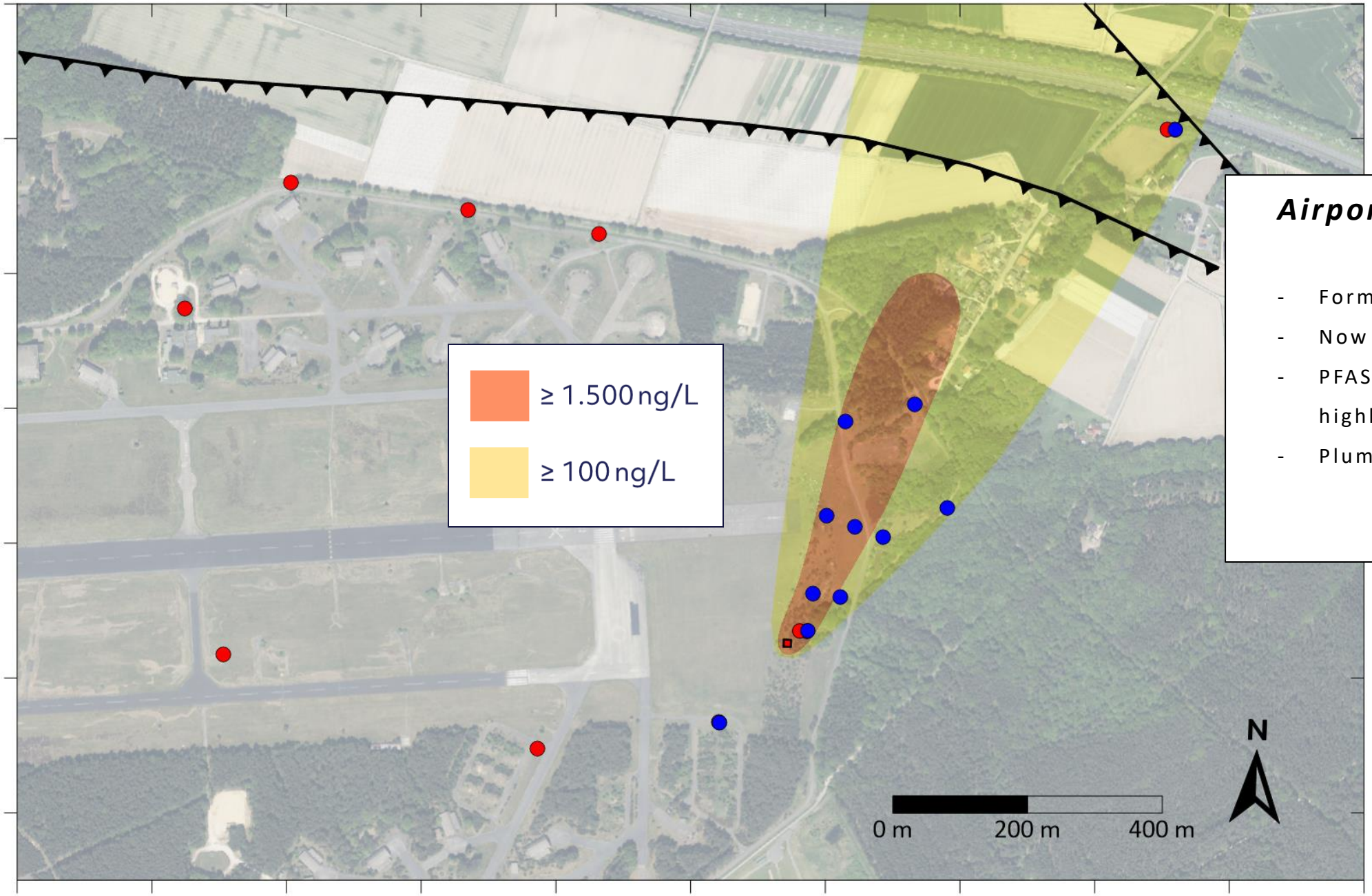
Intraplex B Case study



Airport reference site

- Former NATO airport
- Now under federal management
- PFAS fire fighting training area highly contaminated
- Plume needed containment

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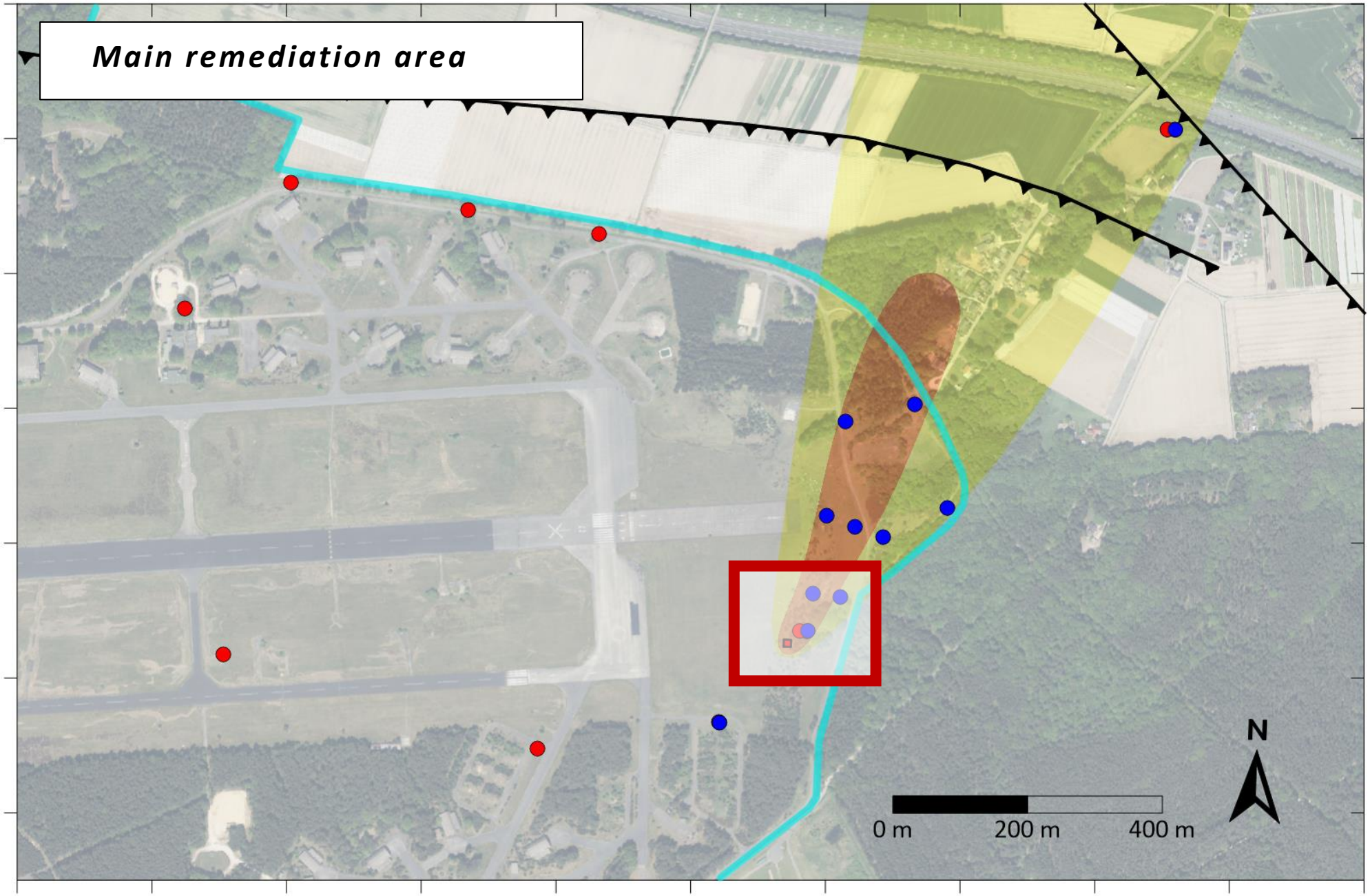
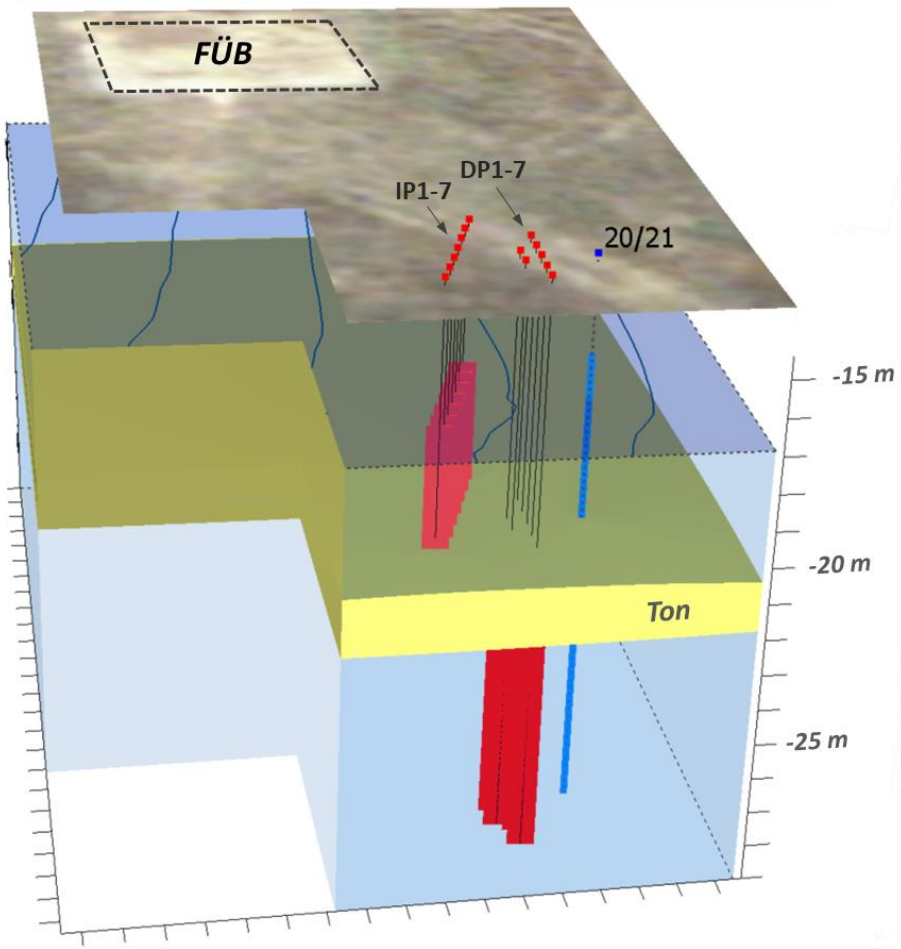

Main remediation area
N
0 m
200 m
400 m

oGWL

uGWL



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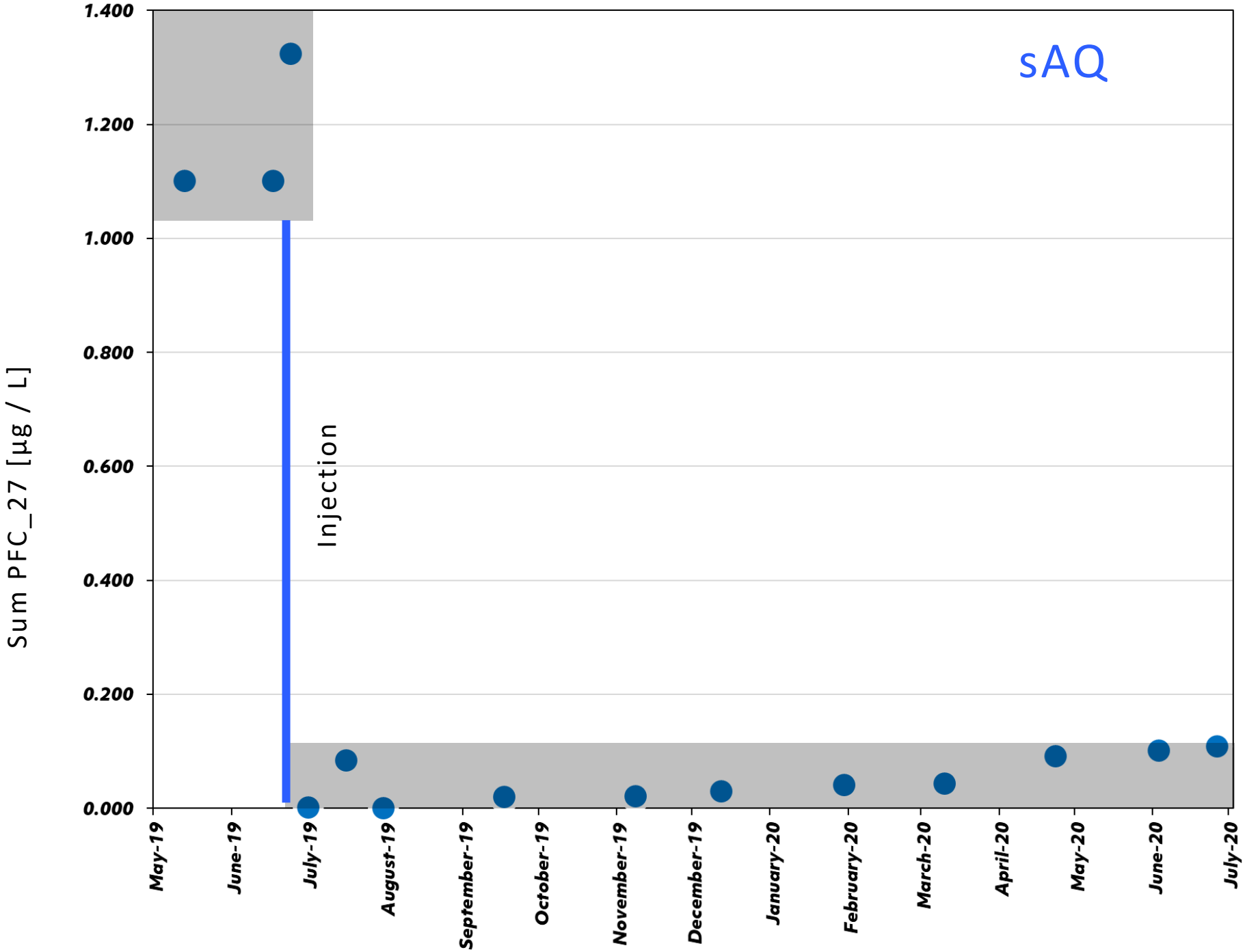
sAQ
Sum PFC_27 [µg / L]
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Injection
May-19
June-19
July-19
August-19
September-19
October-19
November-19
December-19
January-20
February-20
March-20
April-20
May-20
June-20
July-20

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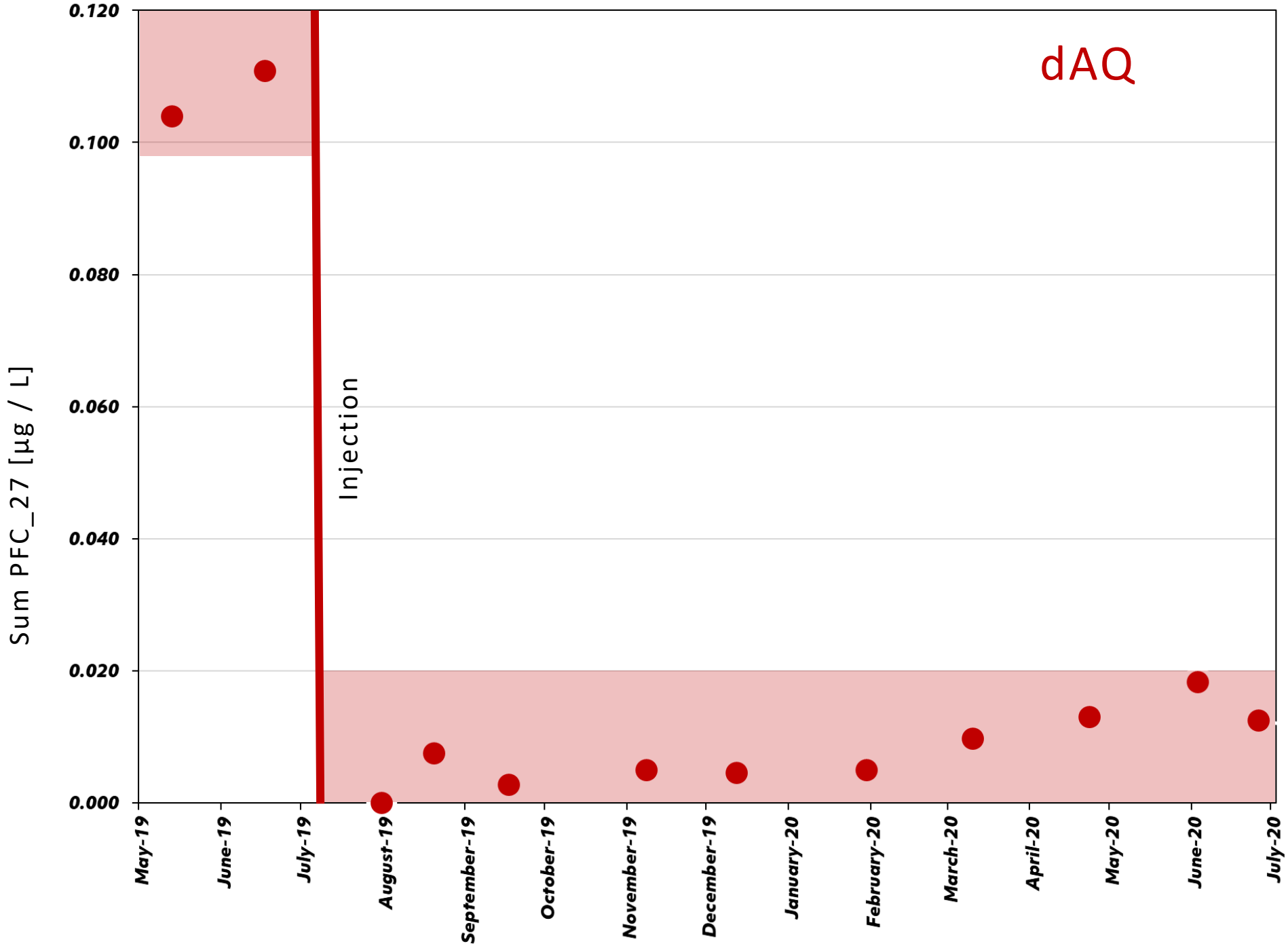
dAQ
Sum PFC_27 [µg / L]
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Injection
May-19
June-19
July-19
August-19
September-19
October-19
November-19
December-19
January-20
February-20
March-20
April-20
May-20
June-20
July-20

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Thank you for your attention !!
Questions ?!?

April 2023

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Chemco-inc.com