Innovative In Situ solution to persistent PFAS Groundwater and Soil contamination

Remtech East 2023

May 2023

Presented by
Jean Paré, P. Eng., Chemco

Presentation Agenda

- About us
- PFAS – One water perspective
- Intraplex Modular Approach
- Activated carbon form & Capture Mechanisms
- Case Studies
- 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

124, rue de Hambourg
St-Augustin-de-Desmaures, QC G3A 0B3

chemco-inc.com

Our Services

CANADIAN LEADER IN ENVIRONMENTAL SOLUTIONS

Training & Education

Technical and Design Support

Field-Proven Technologies

Expert Technical Team

chemco ENVIRONMENT

R&D and Treatability Laboratories

Field Support & Logistic

Mixing and Handling Equipment

Specialized Products

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

chemco ENVIRONMENT

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*

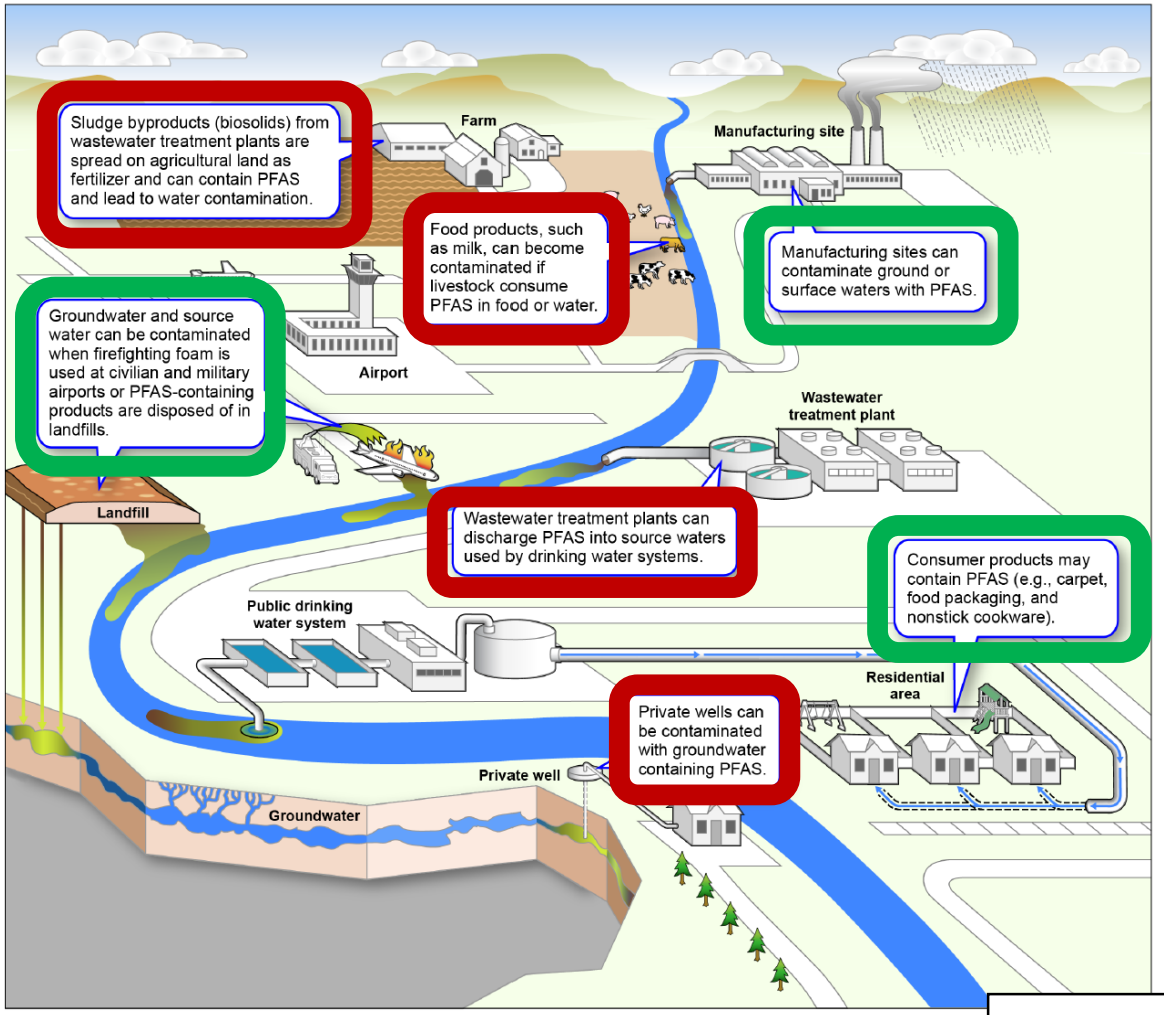
intrapore *Since 2023*

chemco ENVIRONMENT

PFAS
One Water Perspective

PFAS Sources

PFAS Impacts



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

CANADIAN LEADER IN ENVIRONMENTAL SOLUTIONS

chemco ENVIRONMENT

OUR PRODUCTS FOR IN SITU REMEDIATION.

intrapore

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					✓

intrapore


intrapore
intrasorp®
intrapore
aquaferrox®
intrapore
carboiron®
intrapore
trapox®
intrapore
IN SITU REMEDIATION.
intraplex®
intraplex®

intrapore


intrapore
intrasorp®
intrapore
aquaferrox®
intrapore
carboiron®
intrapore
trapox®
intrapore
IN SITU REMEDIATION.
intraplex®
intraplex®

Intraplex® ¨Product line for PFAS

- **Modular & Adaptable**

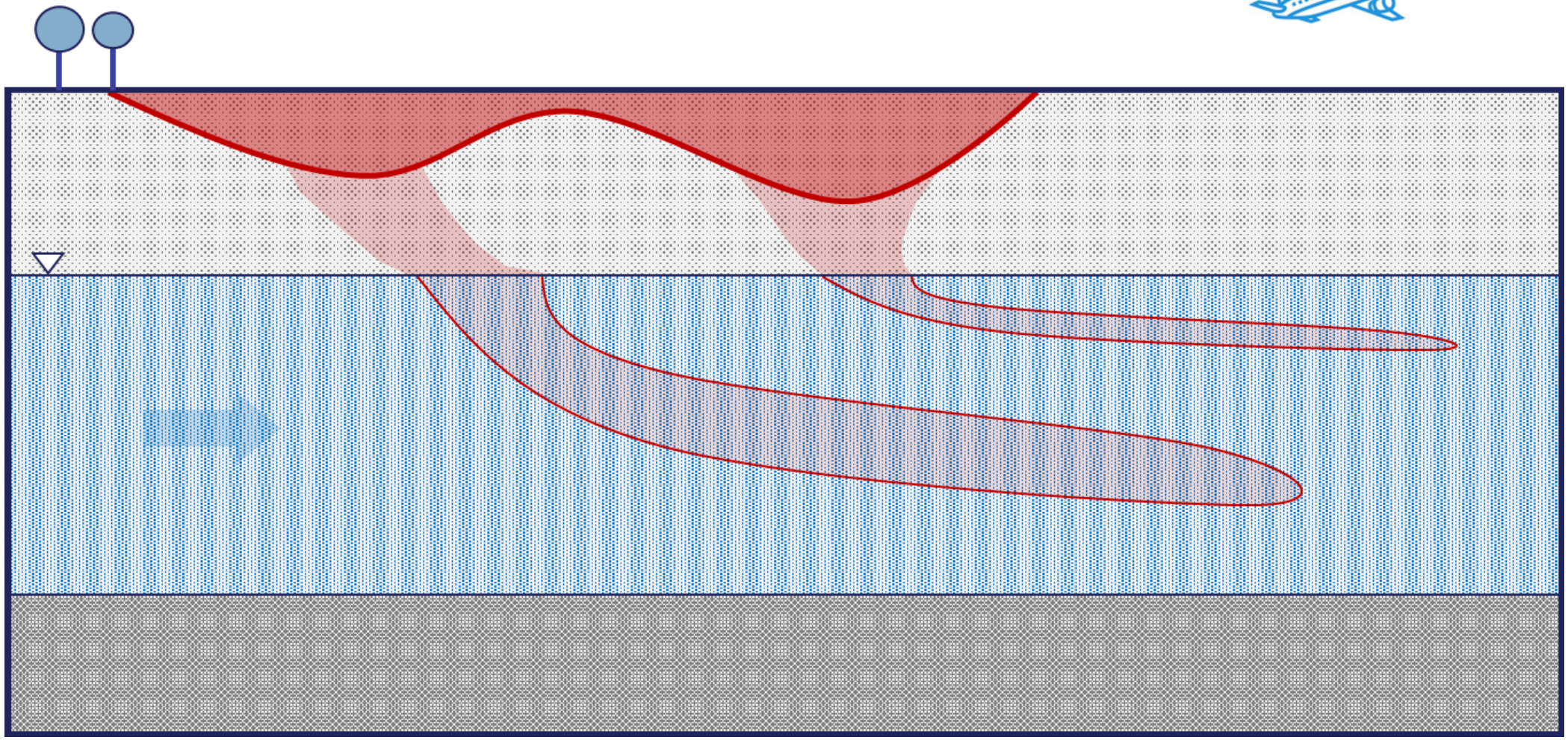
  Intraplex A - Against GW Infiltration

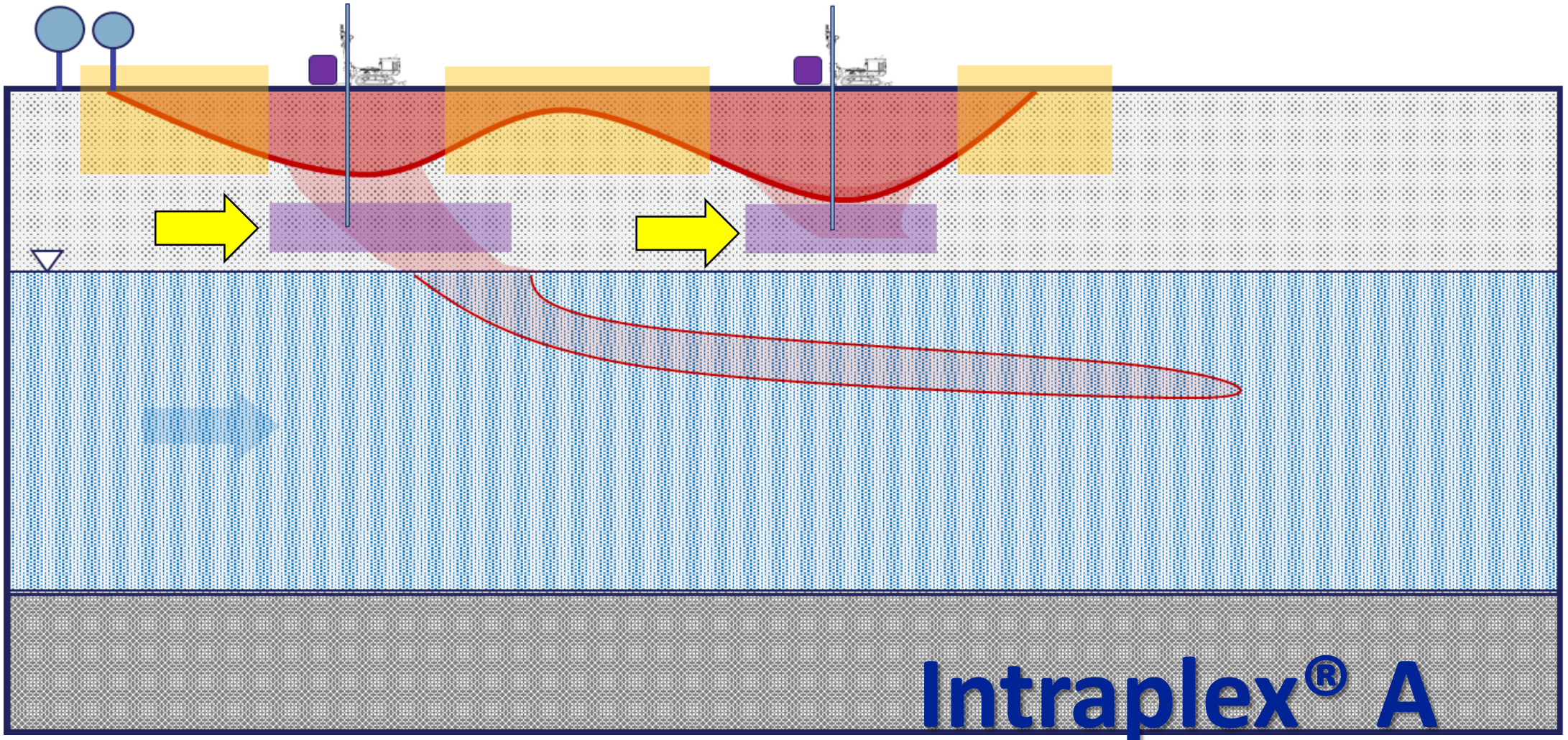
  Intraplex B - Against plumes migration

  Intraplex C - For destruction

  Intraplex D - Against short chains

Your typical PFAS site…




Intraplex® A

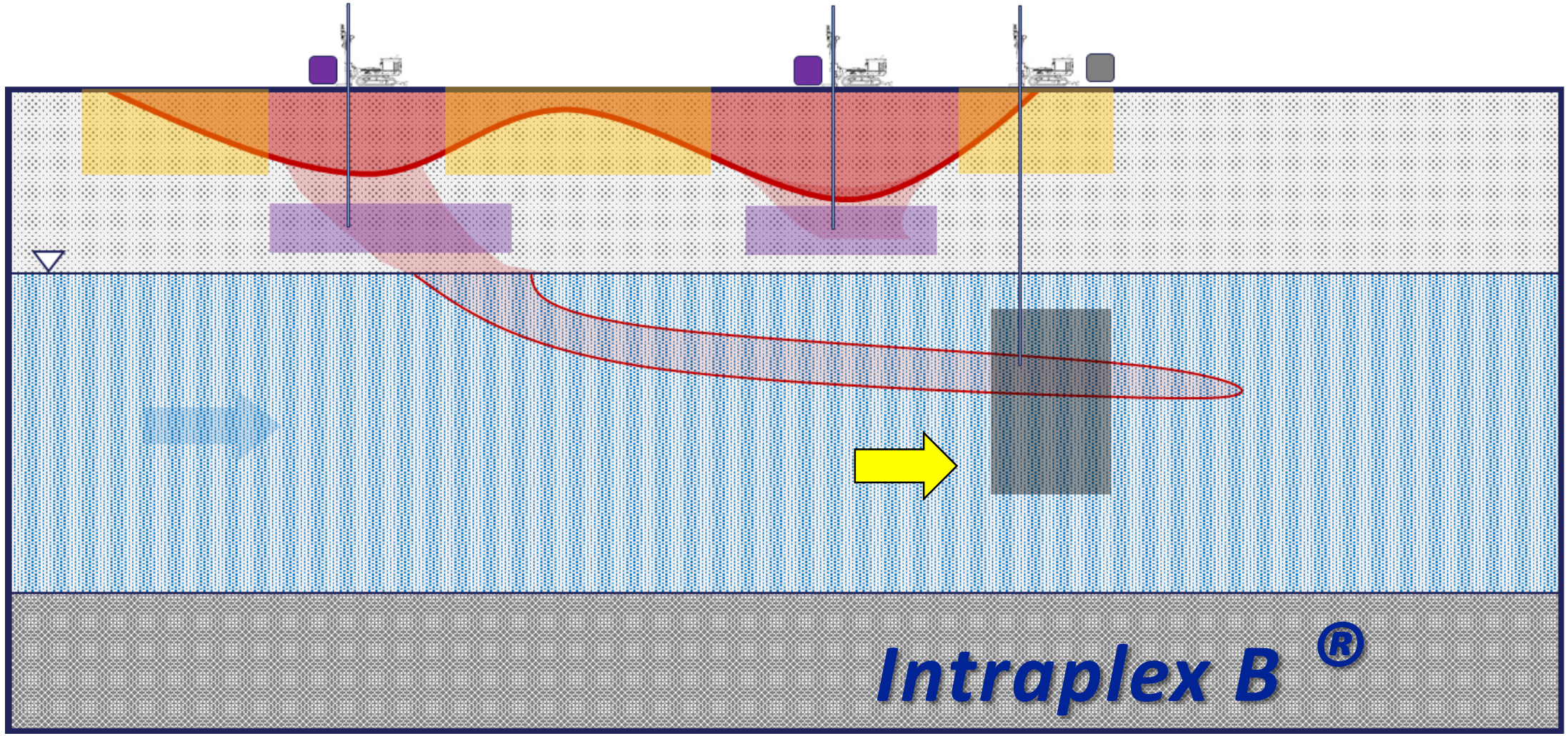

Intraplex® A

Intraplex B ®

- Highly specialized
- Microsized activated colloidal carbon based adsorber for the in situ immobilization of PFAS
- Uncoated
- Field tested and highly effective
- Made in Germany

UFZ HELMHOLTZ Centre for Environmental Research

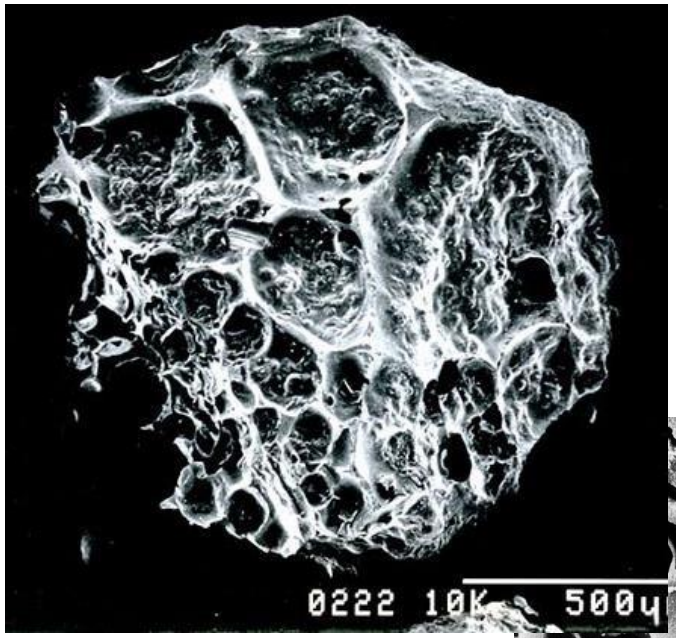
intrapore

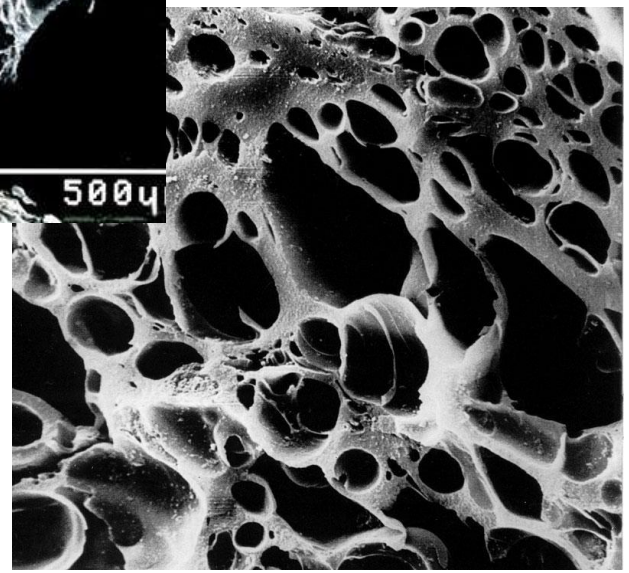


intrapore

Activated Carbon Form, Capture & Treatment Mechanisms

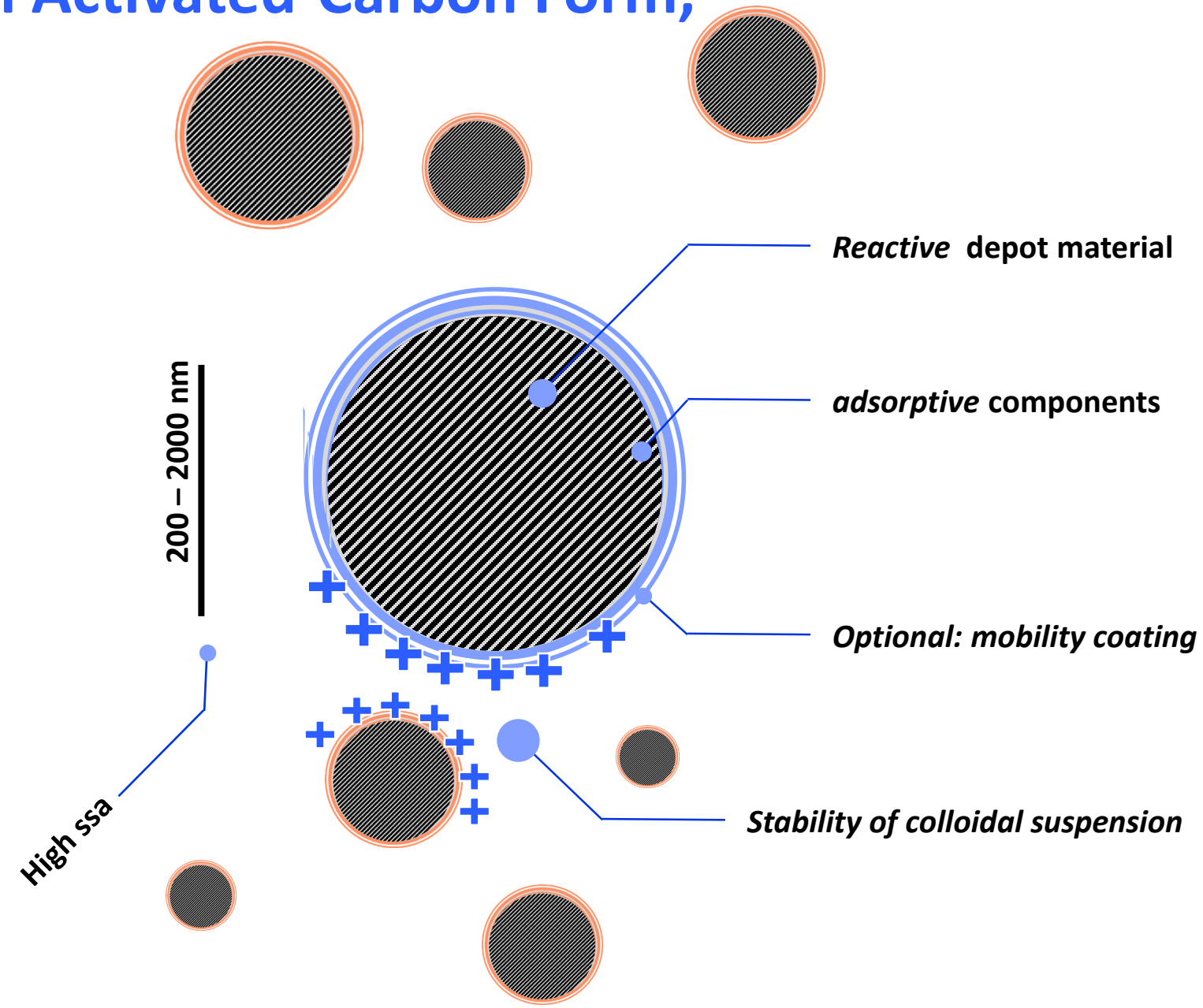
Adsorptive





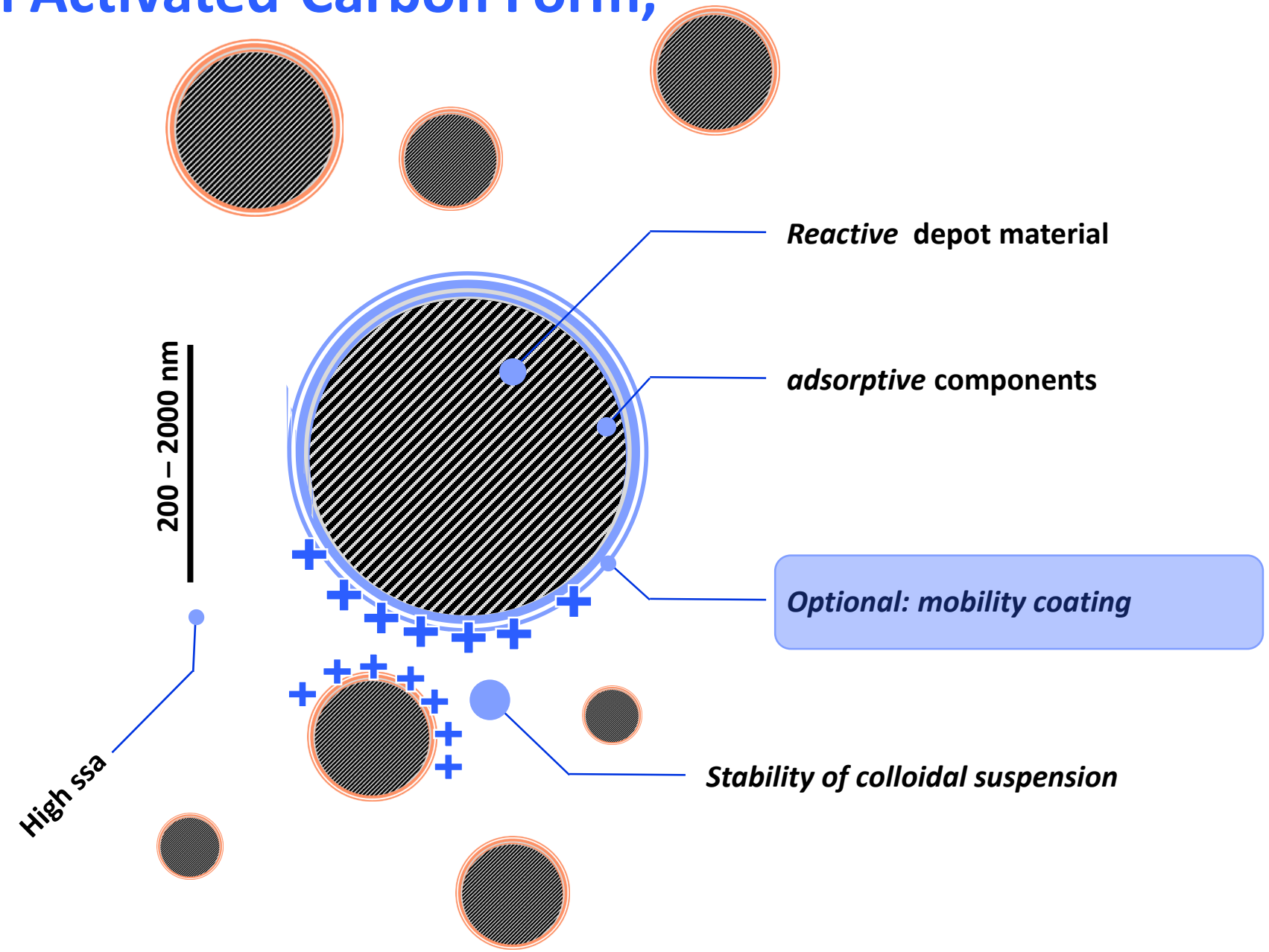
Granular Activated Carbon

Colloidal Activated Carbon Form,



intrapore

Colloidal Activated Carbon Form,



intrapore

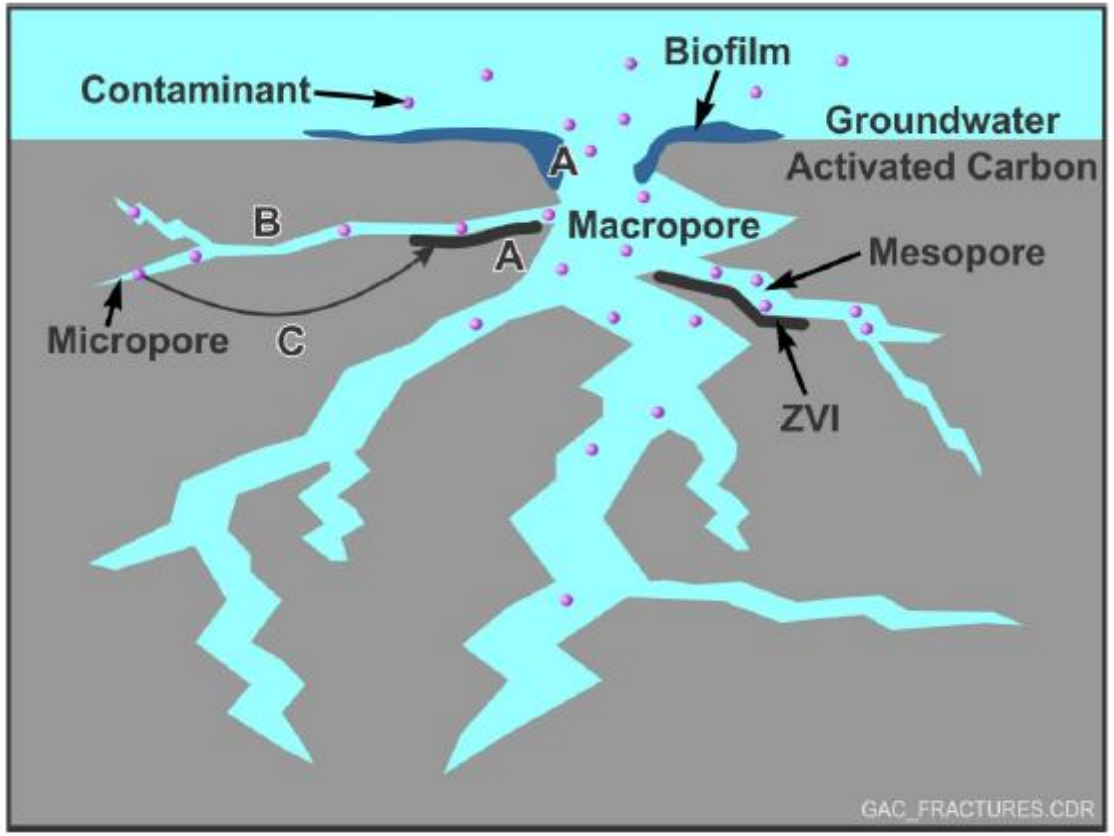
Activated Carbon Form, Capture & Treatment Mechanisms

- **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

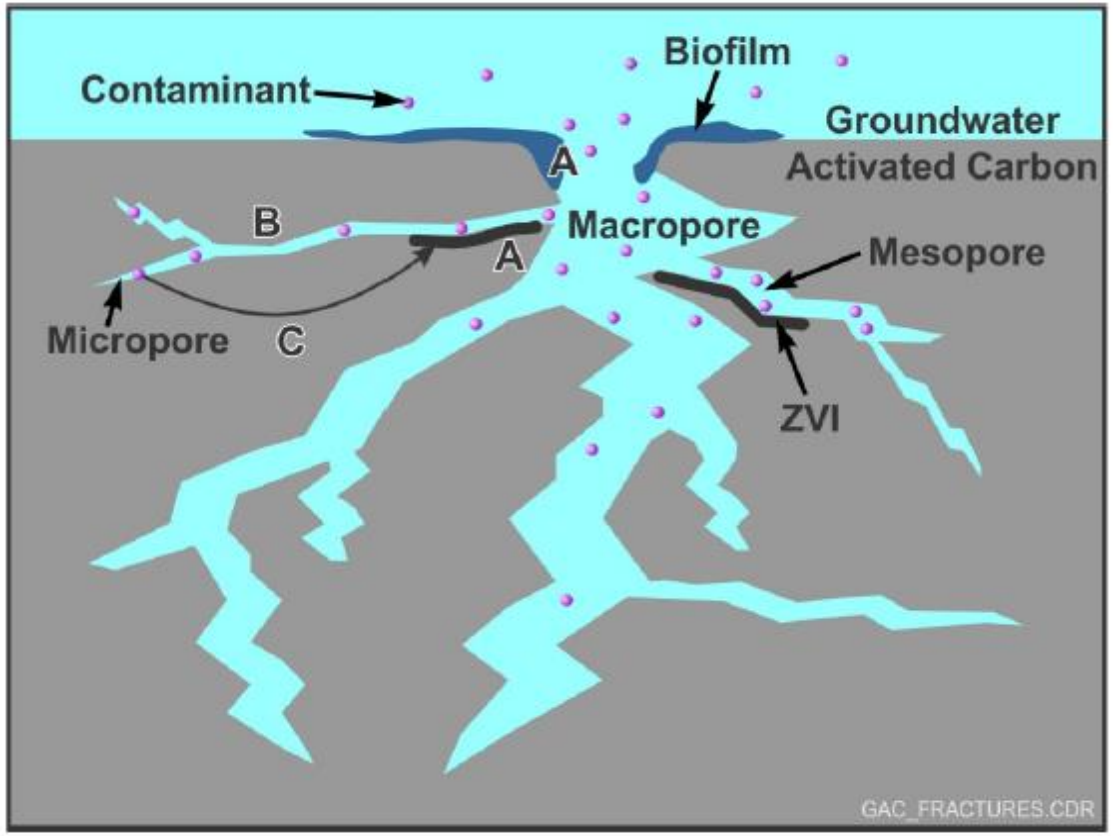
Activated Carbon Form, Capture & Treatment Mechanisms

- **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)**

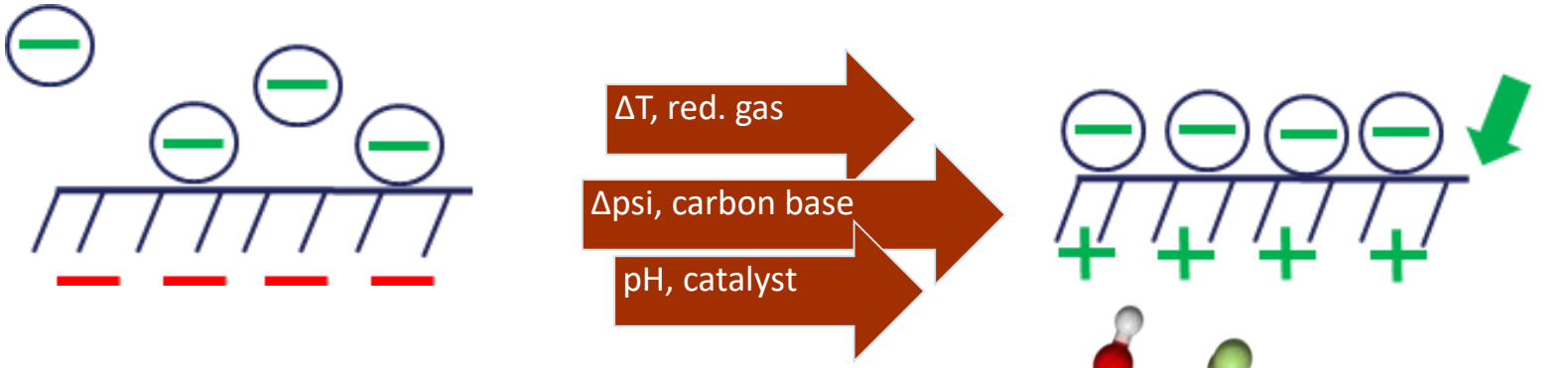
- **Colloidal Activated Carbon Particle size 1-2 microns (µ)**

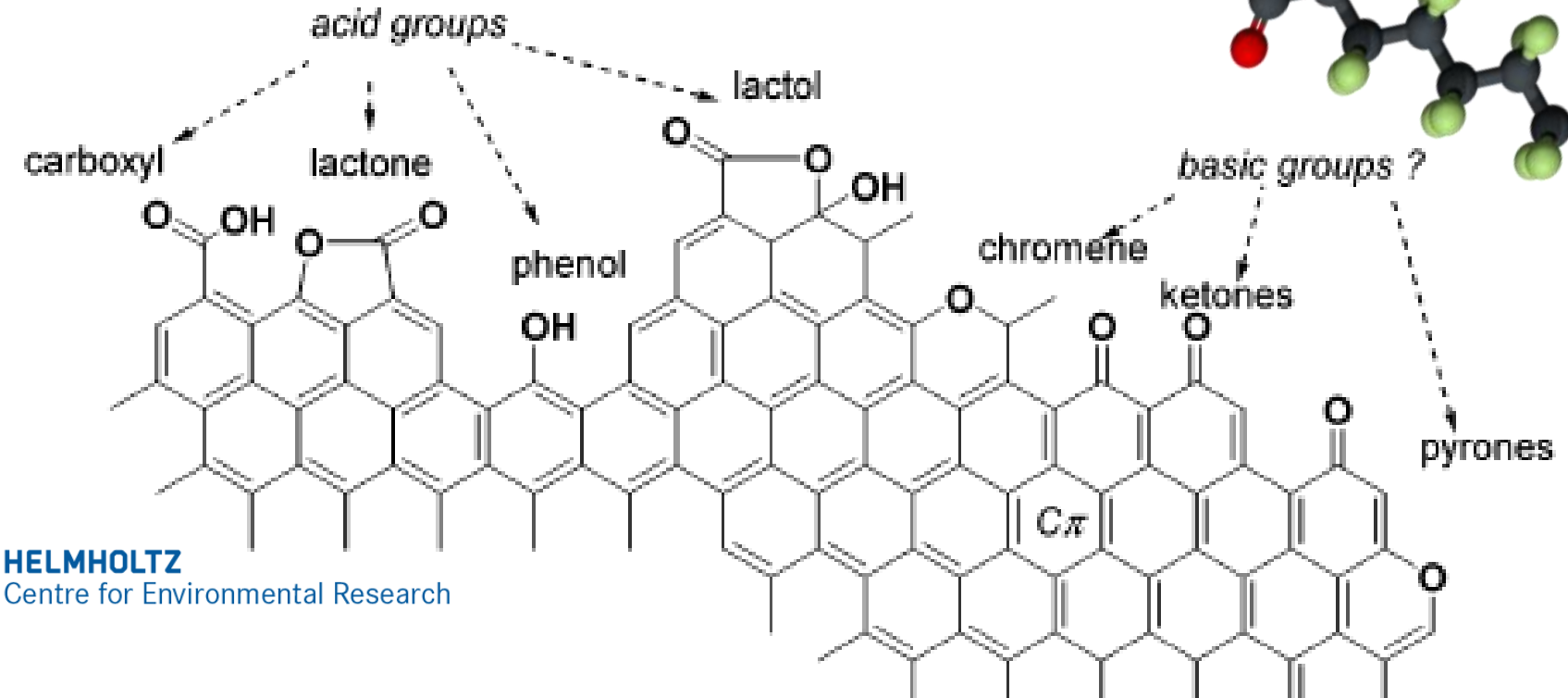
- ✓ 10-slot screen = 256 µ
- ✓ 200-mesh sieve (clay) = 75 µ
- ✓ Bacteria = 0.5 - 2 µ
- ✓ Pore throats (*Nelson, AAPG Bull., 3/09*):
  sand >2 µ *silt* 0.03 – 2 µ *clay* 0.005 – 0.1 µ
- ✓ Mesopore = 0.05 µ; Micropore = 0.002 µ
- ✓ BTEX molecules = 7 Angstroms (Å) = 0.0007 µ
- ✓ ➢Water molecule = 3 Angstroms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





UFZ HELMHOLTZ Centre for Environmental Research

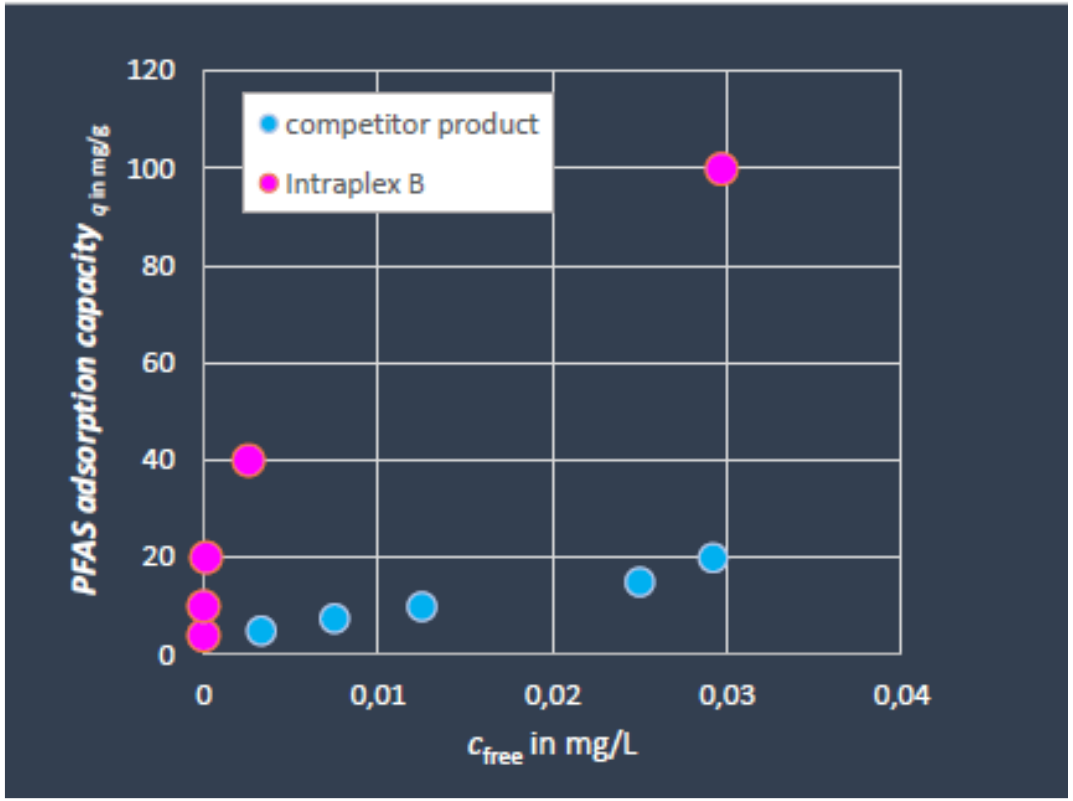
intrapore

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

chemco ENVIRONMENT

Intraplex B®- Independent scientific comparison:

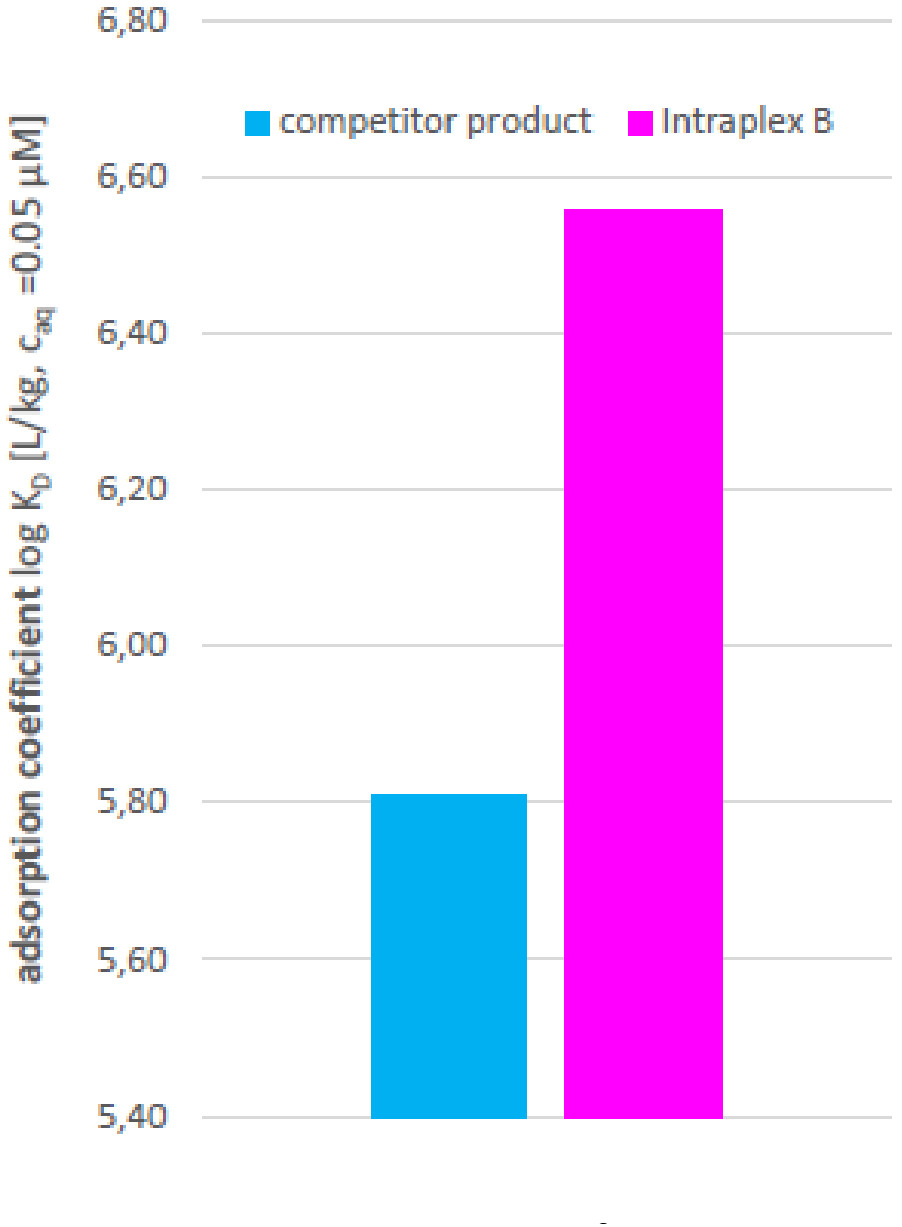
PFAS adsorption capacity

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.



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

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.**

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,**
  - ❑ **stabililizer (in situ), water**

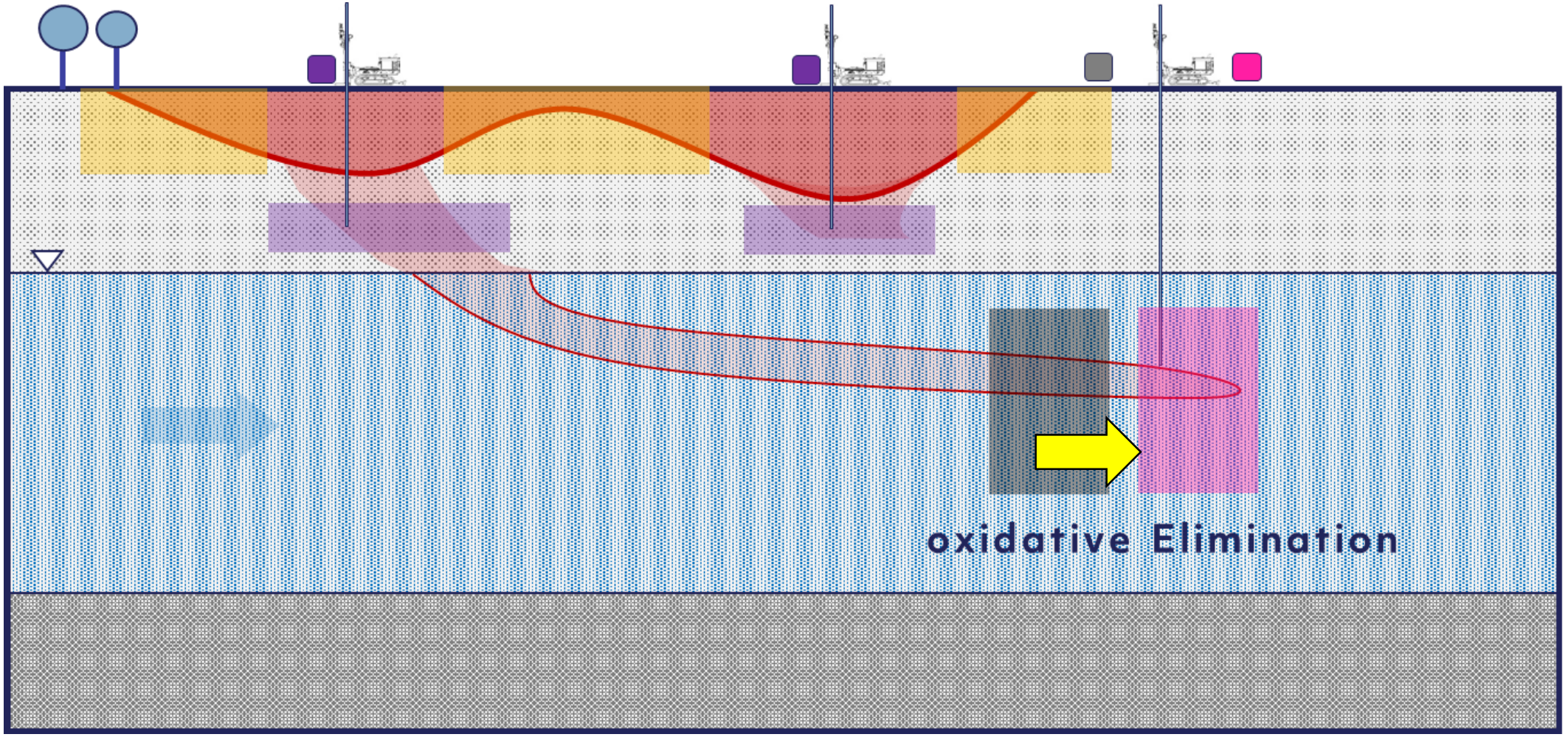
To be deployed for :

- 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 plume and source remediation

Intraplex B carbon ®

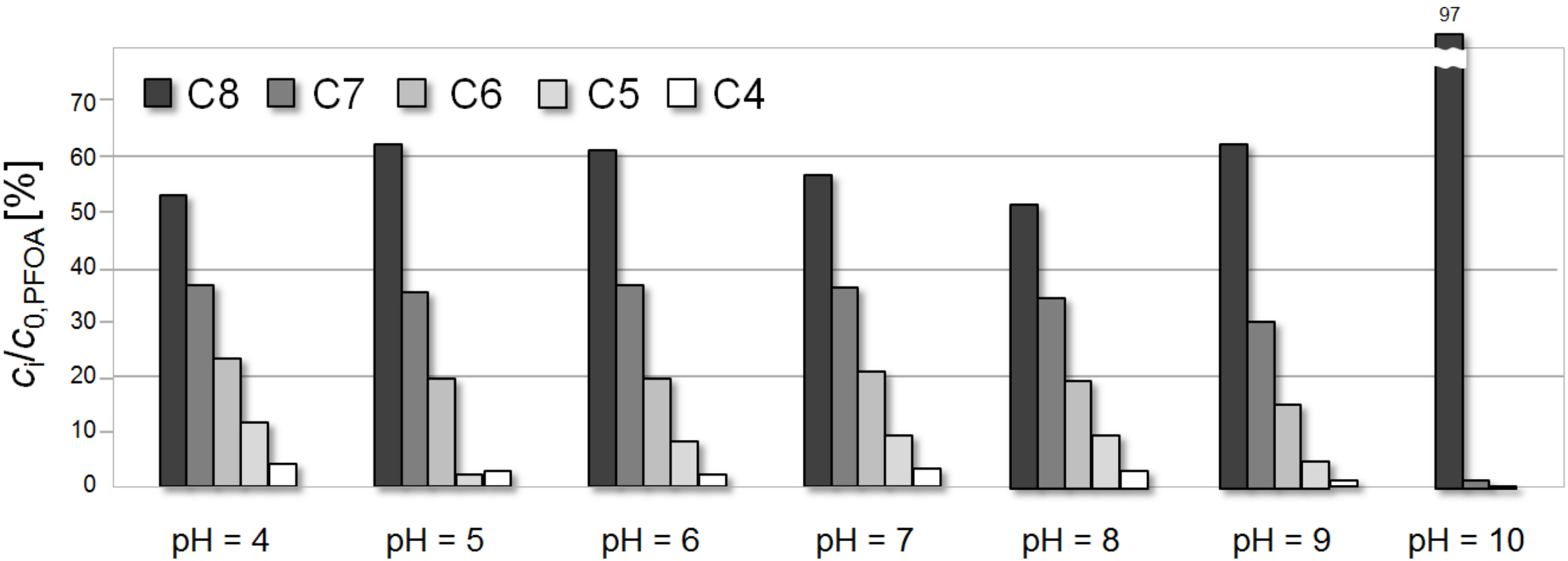
- **Optimized for PFAS**
- **Independent Lab study shows highest quality**
- **Intraplex successful in field applications**
- **Application is straightforward & cost efficient**
- **Eco- and climate friendly**
- **Go to solution to cut off PFAS plumes**

Intraplex® C (under developement)

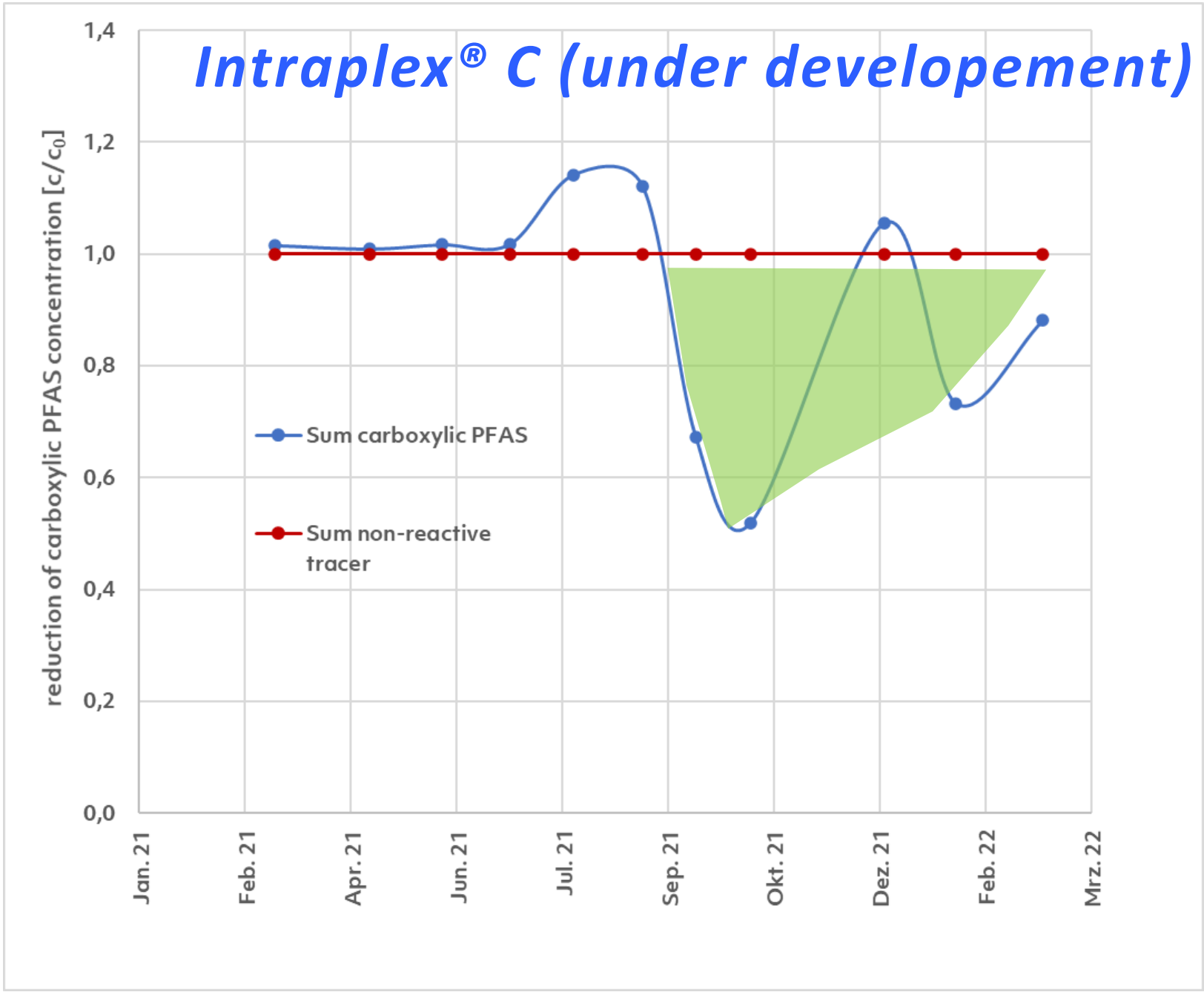


intrapore

Intraplex® C (under developement)

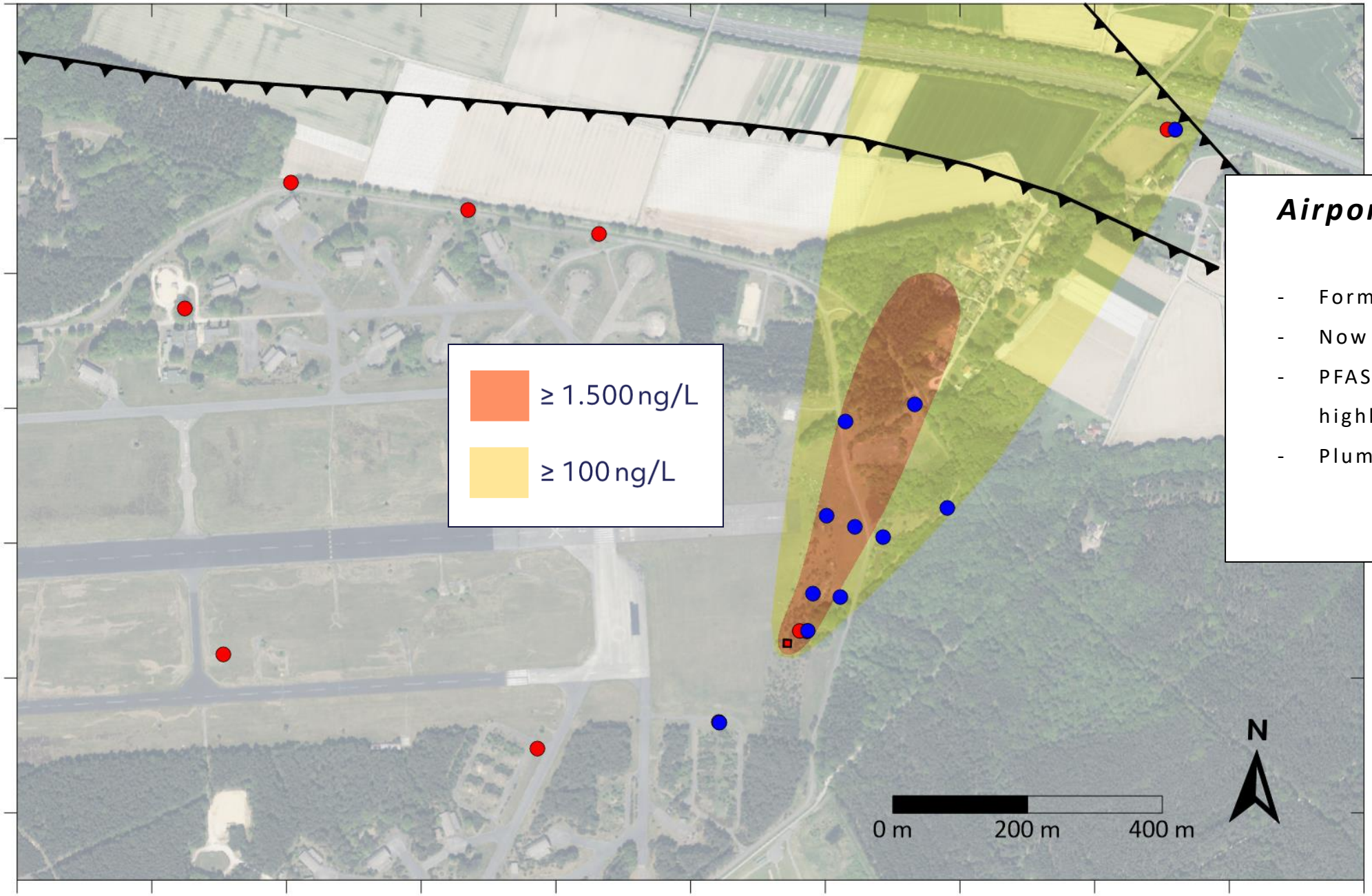


Intraplex® C (under developement)



intrapore

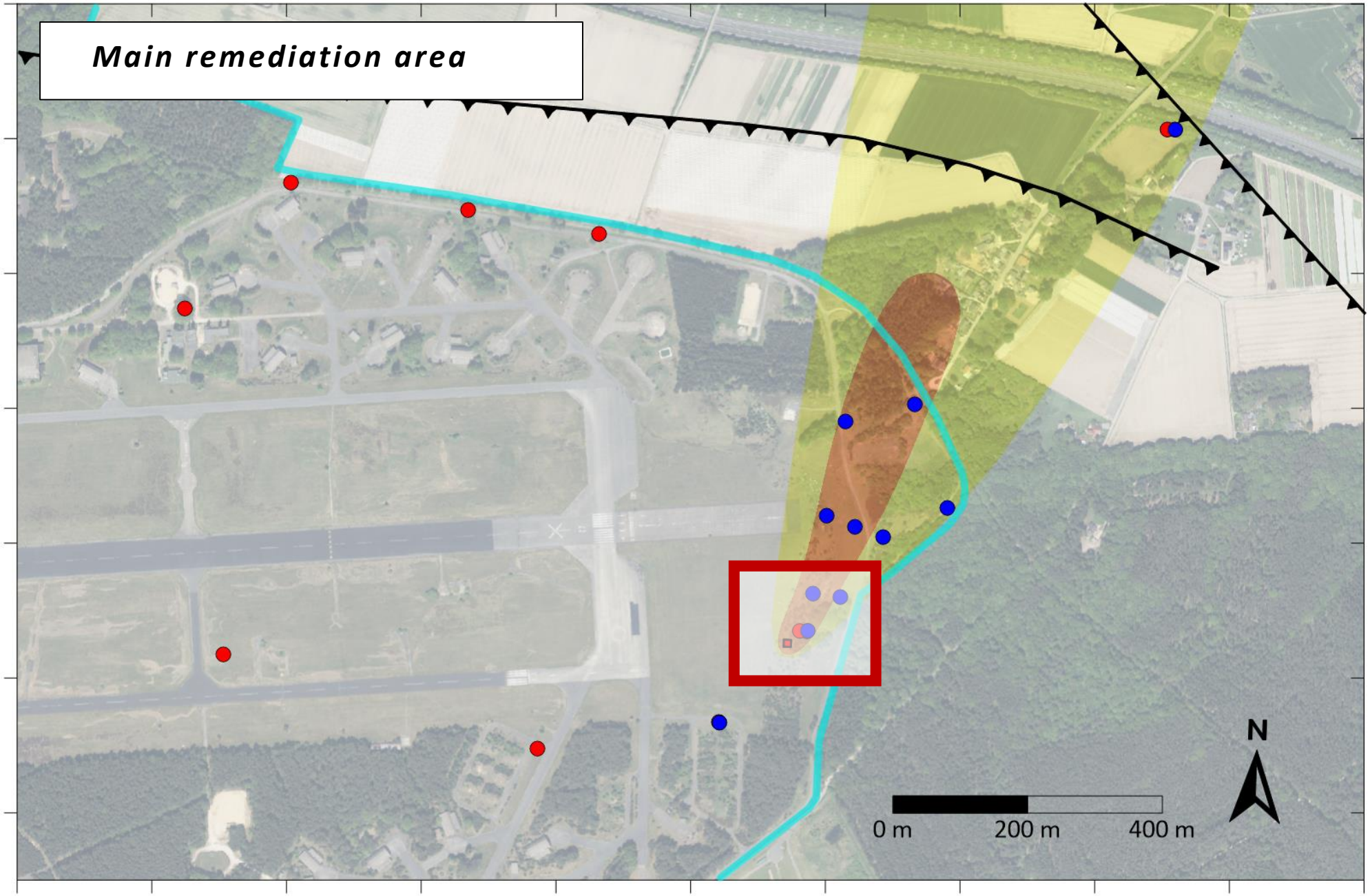
Intraplex B Case studies



Airport reference site

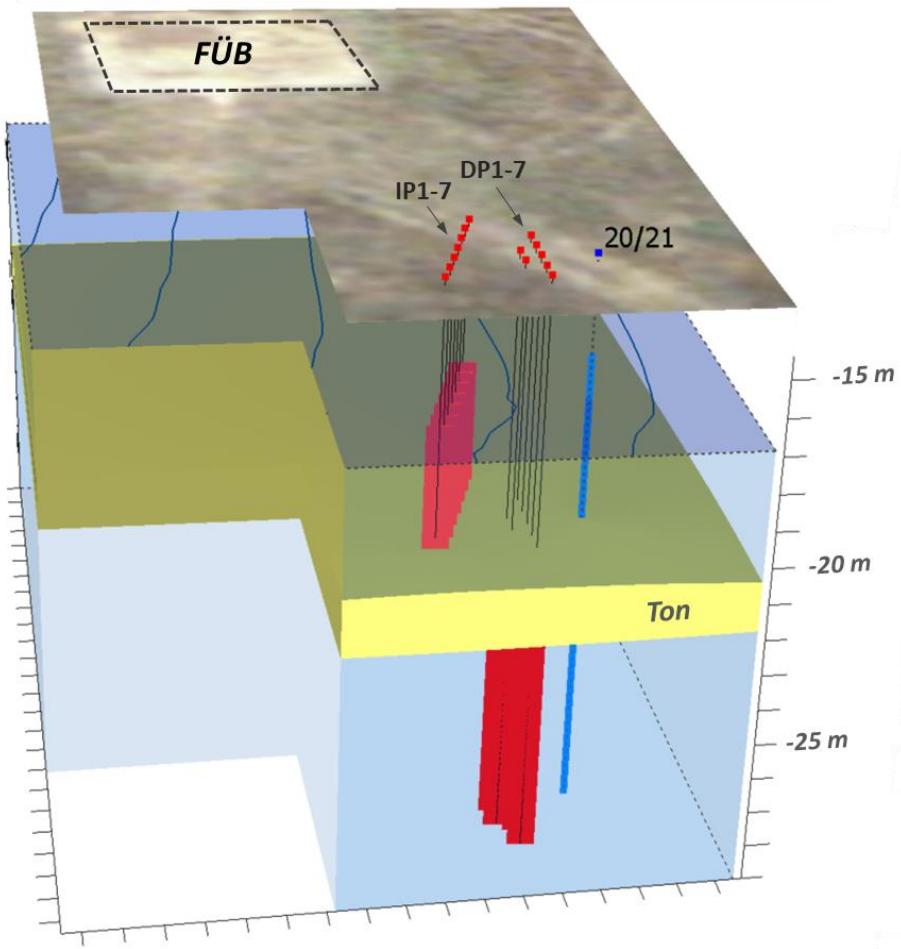
- Former NATO airport
- Now under federal management
- PFAS fire fighting training area highly contaminated
- Plume needed containment

intrapore

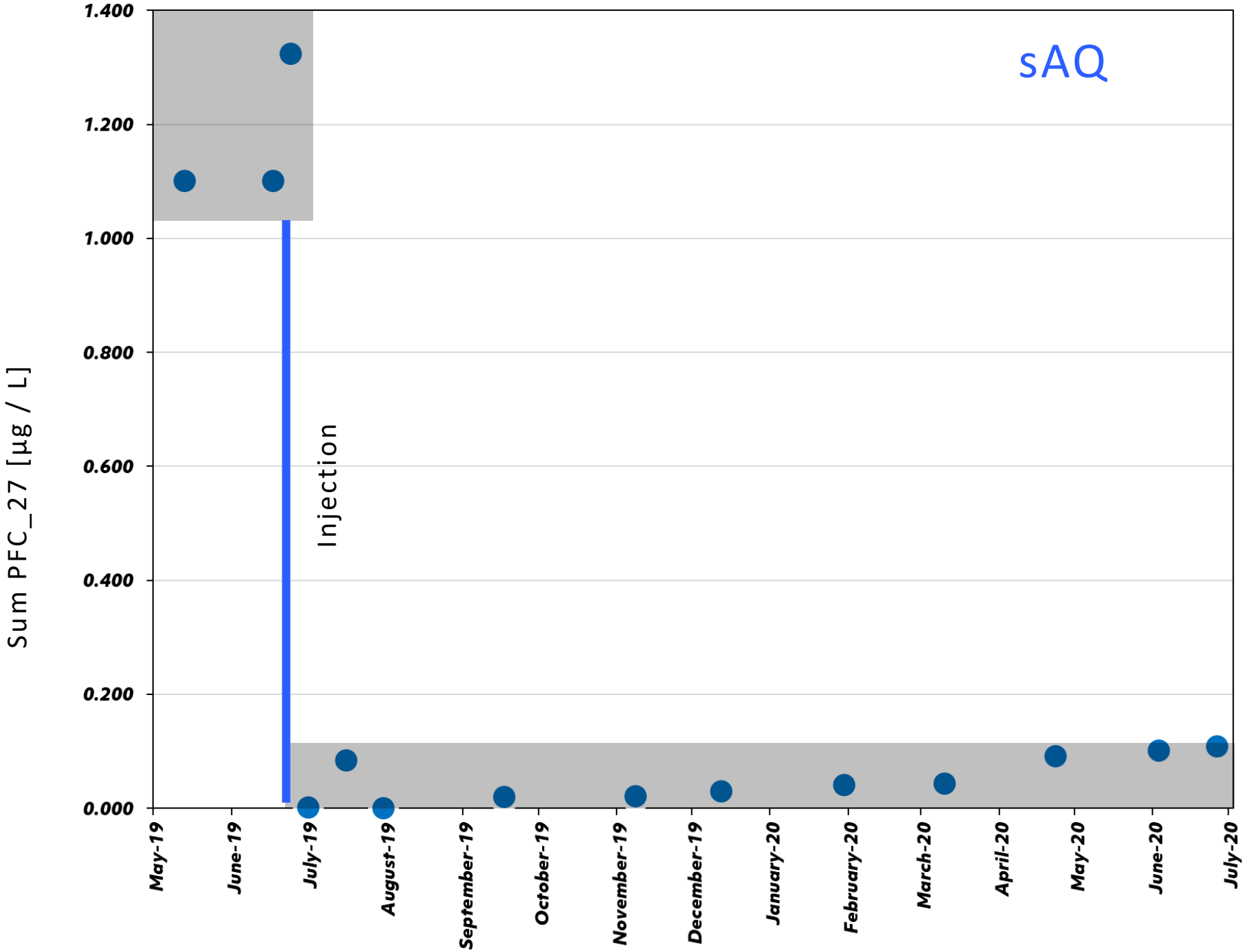

Main remediation area
N
0 m
200 m
400 m

oGWL

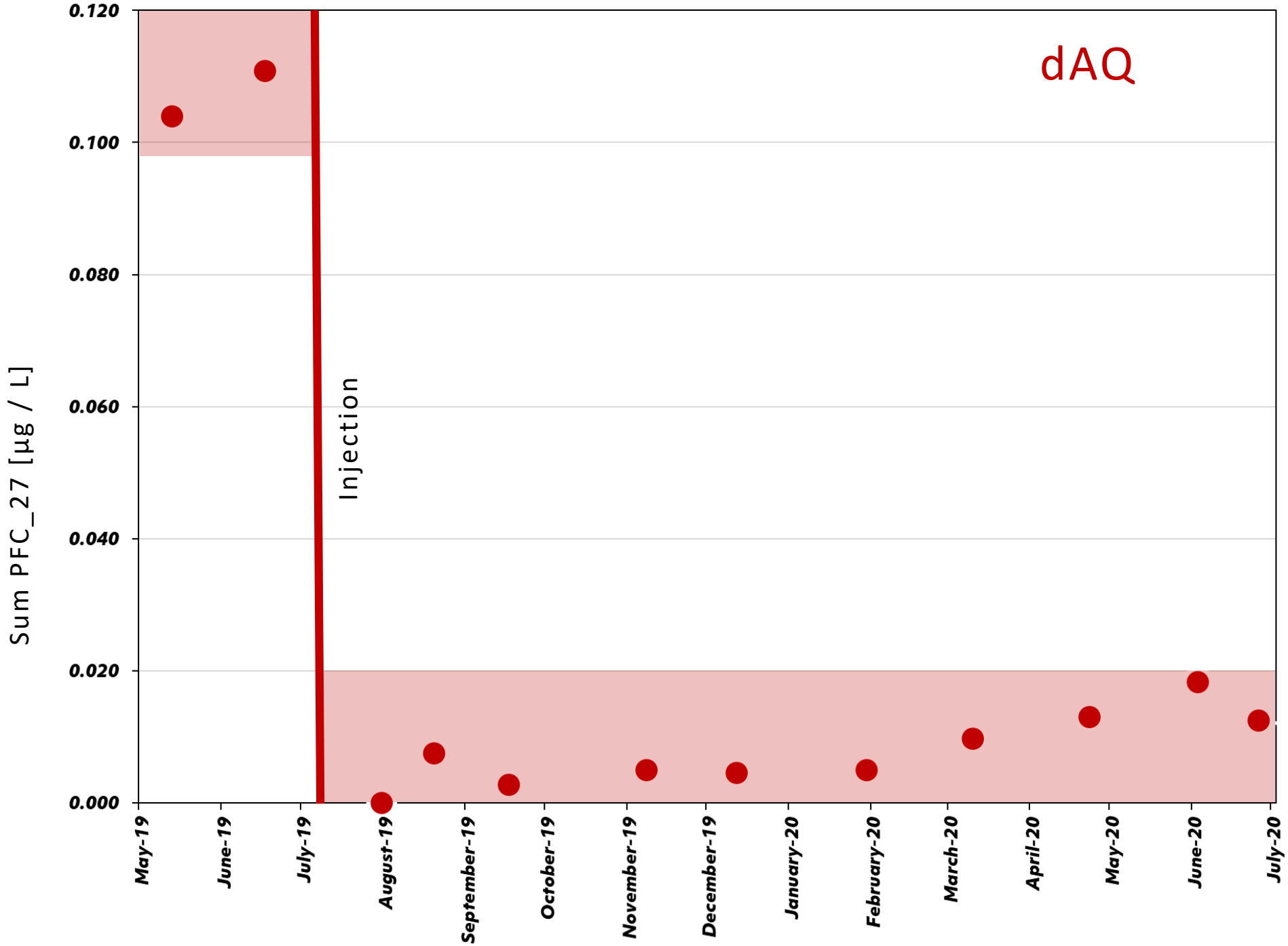
uGWL



intrapore

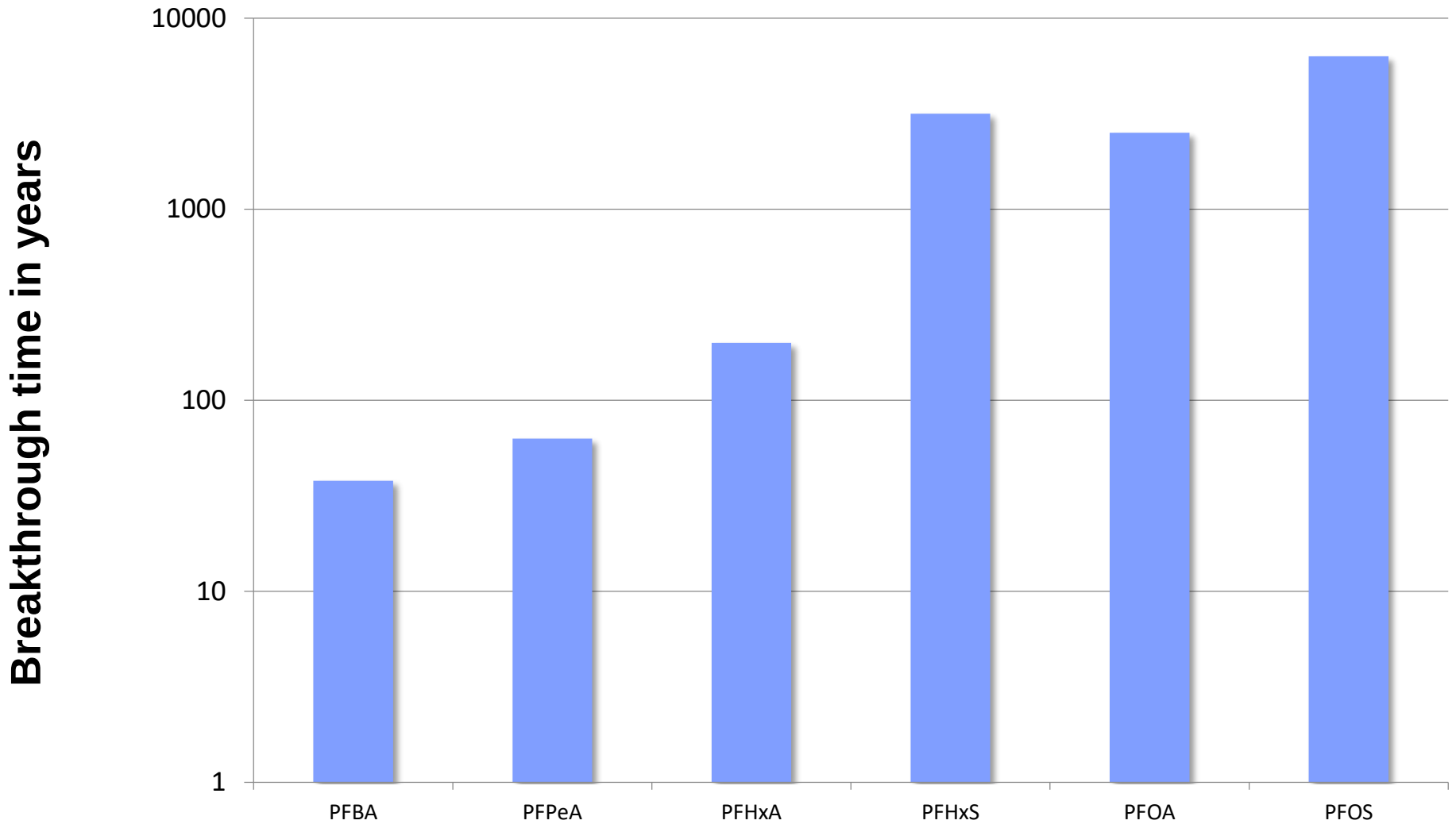

sAQ
Sum PFC_27 [µg / L]
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Injection
May-19
June-19
July-19
August-19
September-19
October-19
November-19
December-19
January-20
February-20
March-20
April-20
May-20
June-20
July-20

intrapore

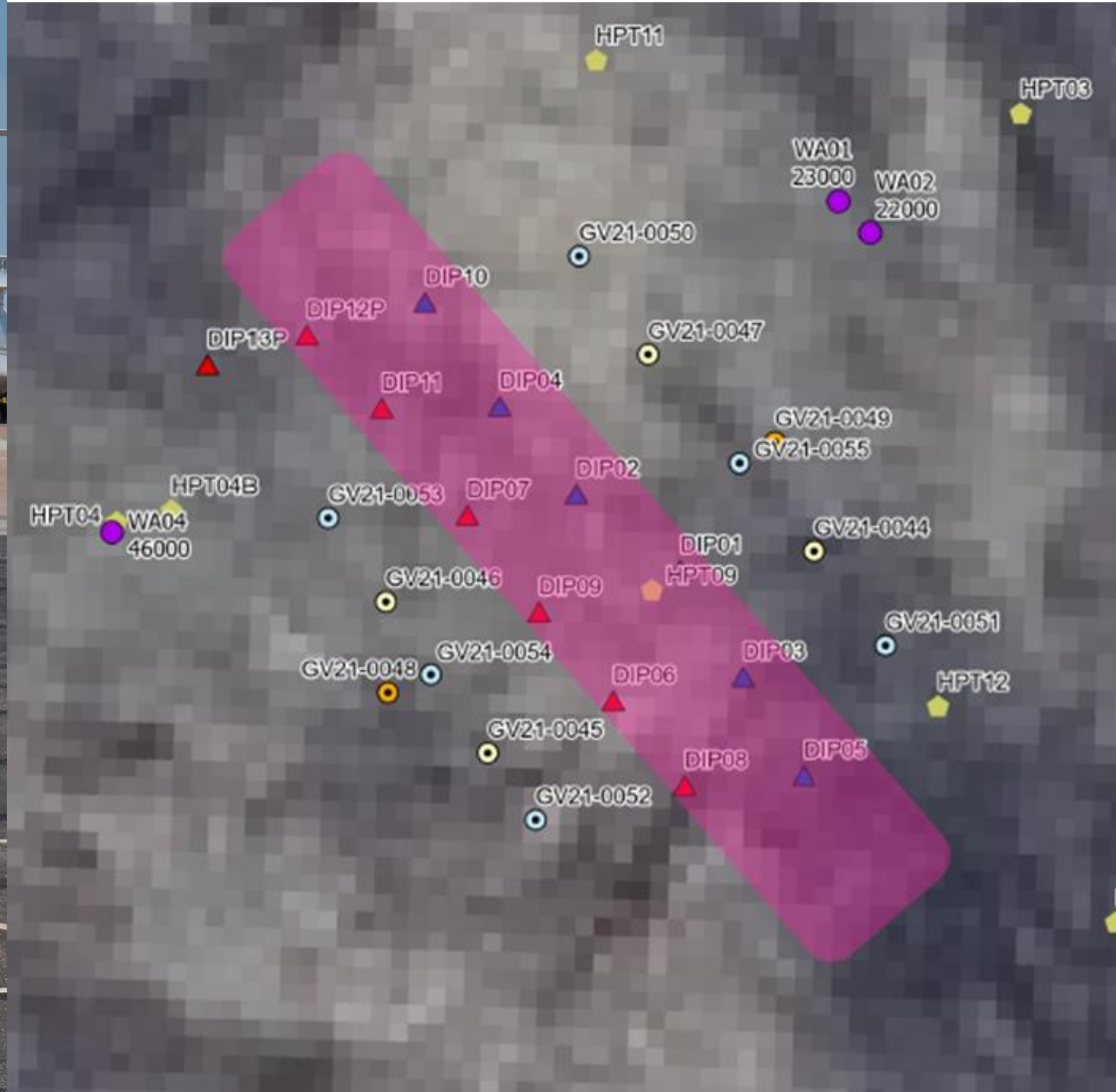

dAQ
Sum PFC_27 [µg / L]
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Injection
May-19
June-19
July-19
August-19
September-19
October-19
November-19
December-19
January-20
February-20
March-20
April-20
May-20
June-20
July-20

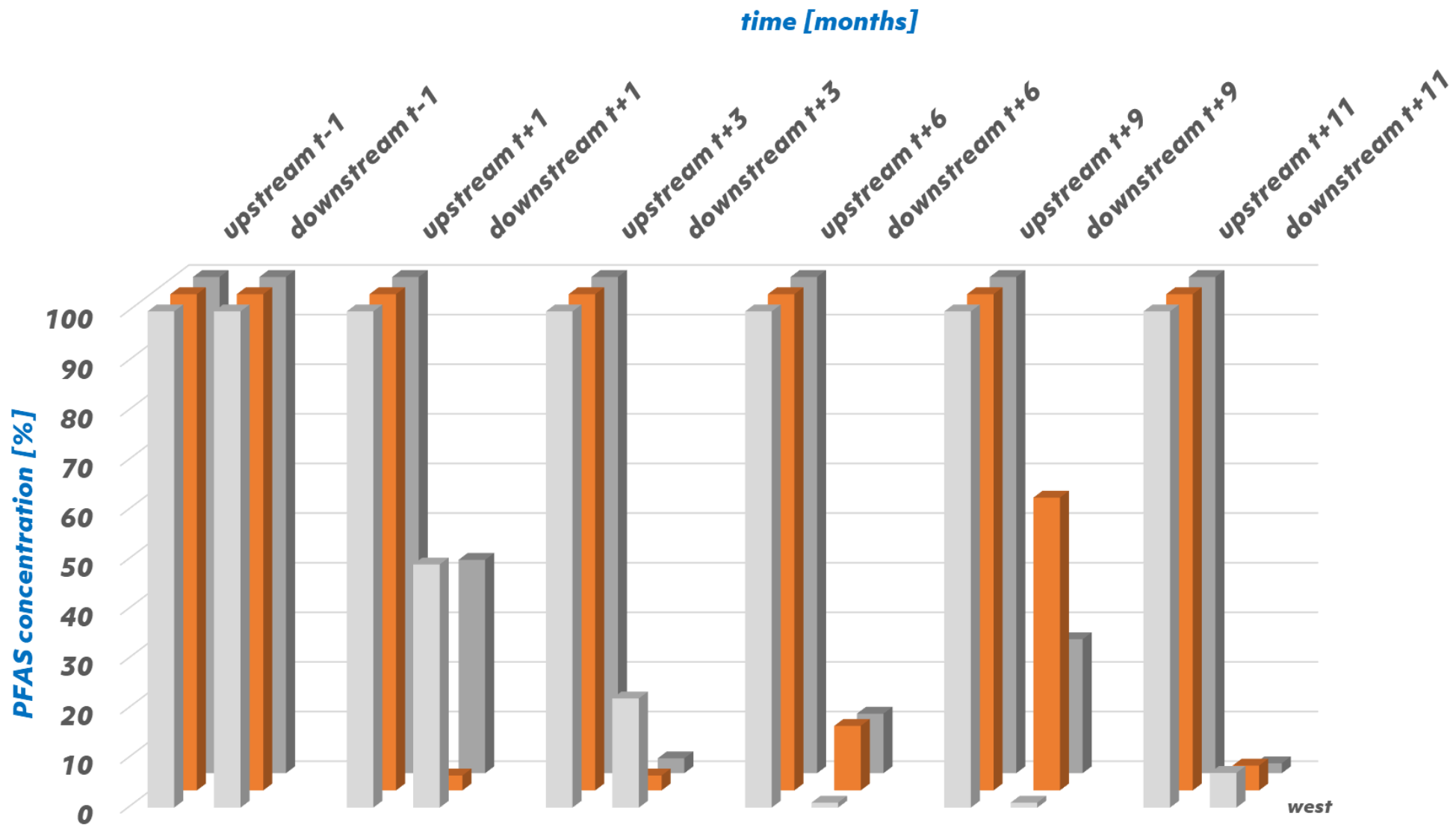
intrapore

Estimate operation time of in-situ AC barriers



Case study 2 - Stockholm Airport




time [months]
upstream t-1
downstream t-1
upstream t+1
downstream t+1
upstream t+3
downstream t+3
upstream t+6
downstream t+6
upstream t+9
downstream t+9
upstream t+11
downstream t+11
PFAS concentration [%]
100
90
80
70
60
50
40
30
20
10
0
west

Thank you for your attention !!
Questions ?!?

April 2023

Contact info:

Jean Paré, P. ENG.
M: 418-953-3480 // jean.pare@chemco-inc.com

T: 800-575-5422

Chemco-inc.com