



PILOT SCALE DEMONSTRATION OF PFAS IMMOBILIZATION IN SOIL AND GROUNDWATER

PIGGS project

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KIS Kenniscentrum
Innovatieve
Saneringstechnieken

D|N JAN DE NUL

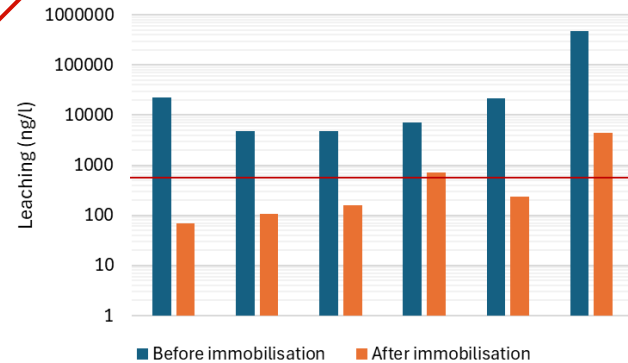

UNIVERSITEIT
GENT

 **SOETAERT**


anteagroup

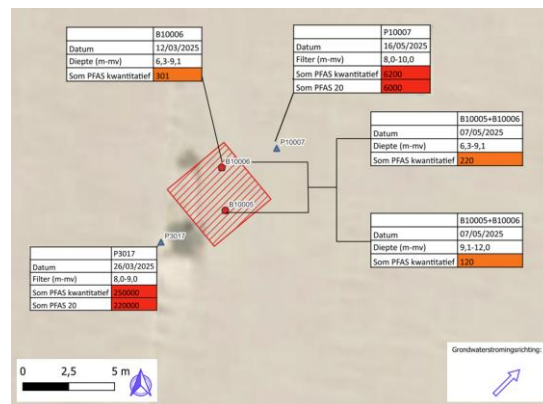
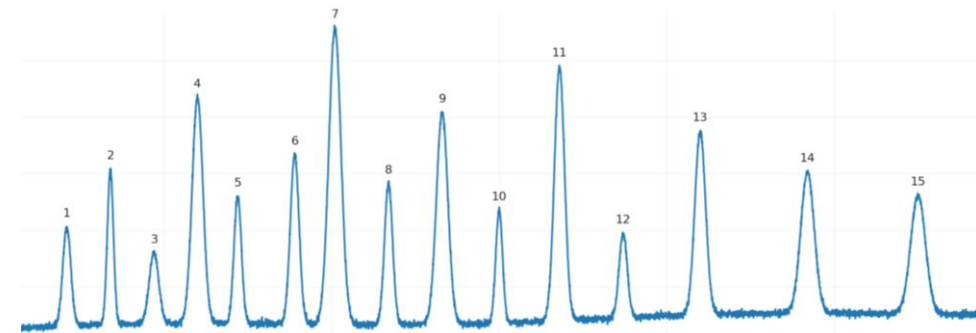
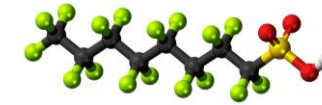
 **Port of
Antwerp
Bruges**

Solution provider



University

PFAS screening



Engineering office



PFAS concentrations
 Soil: up to **300 µg/kg DM**
 Groundwater: up to **250000 ng/l**

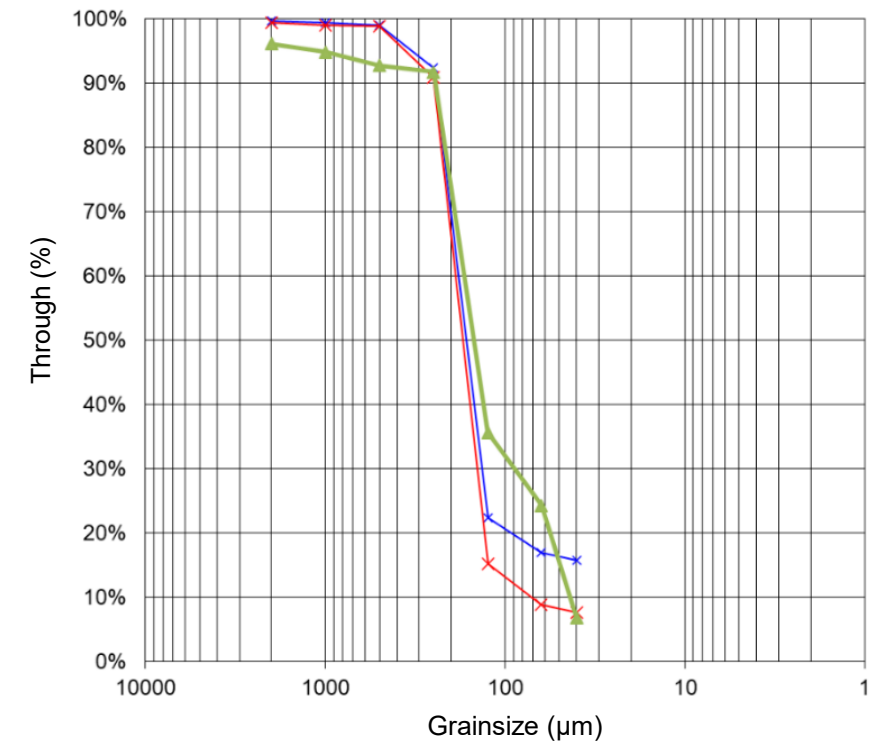
Problem owner

FORMER OPEL CAR ASSEMBLY INDUSTRIAL SITE

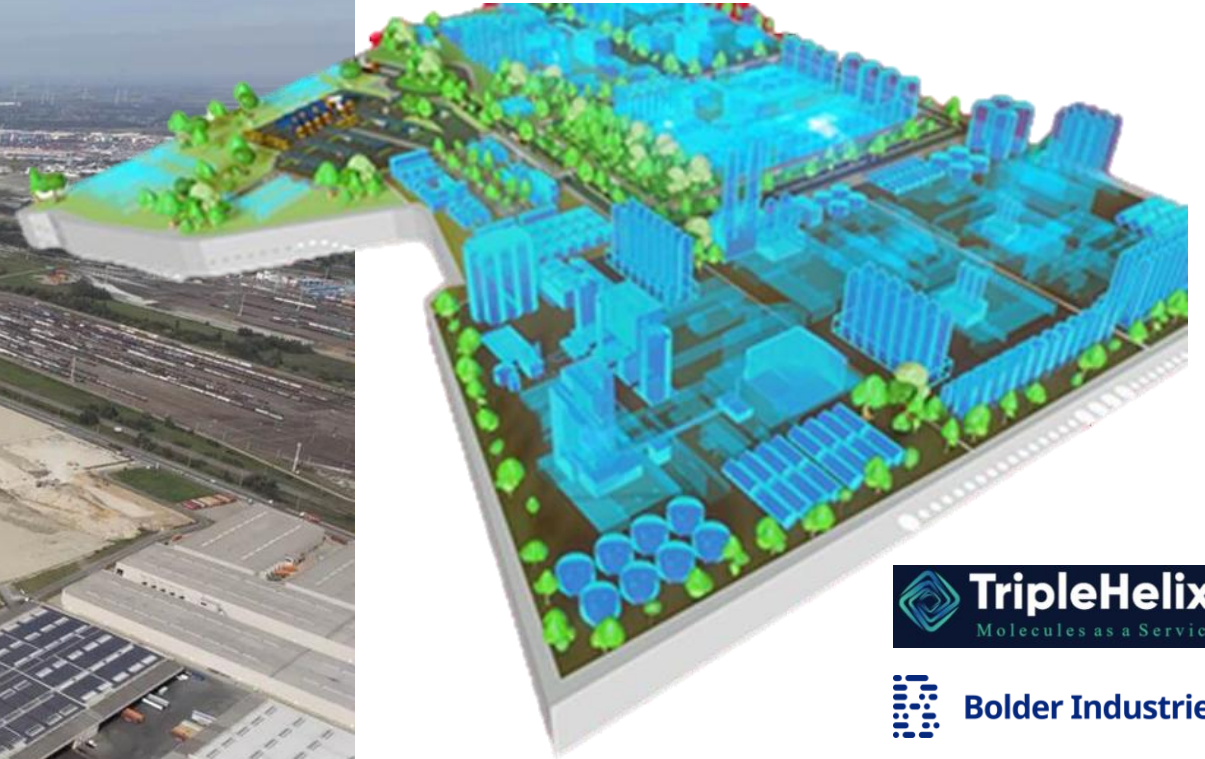


- 1 Fire department training ground
- 2 Storage of chemicals

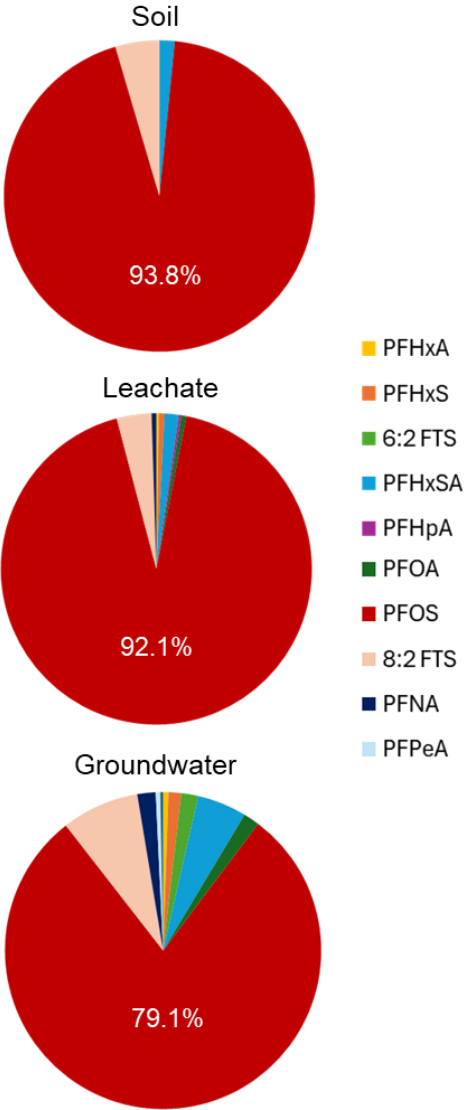
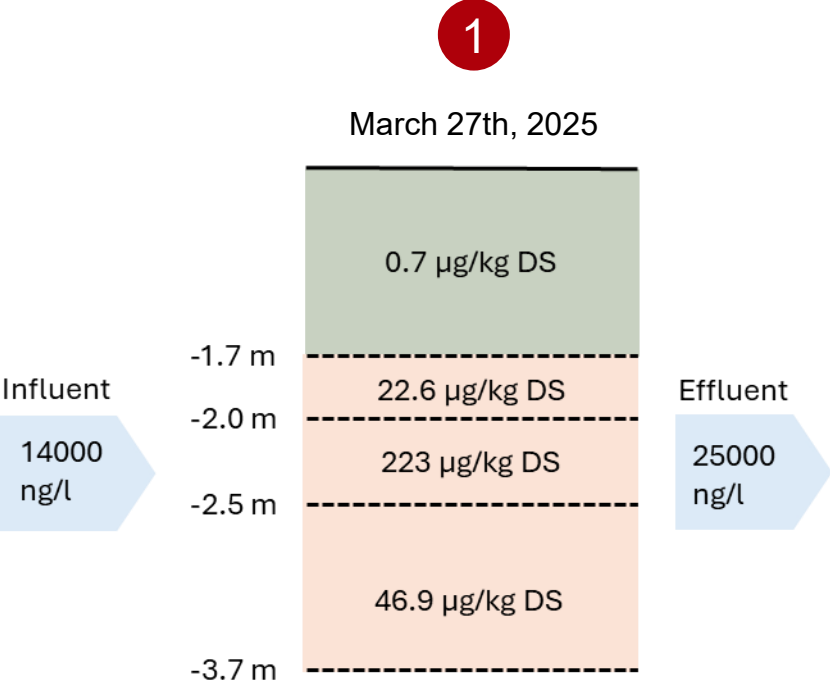
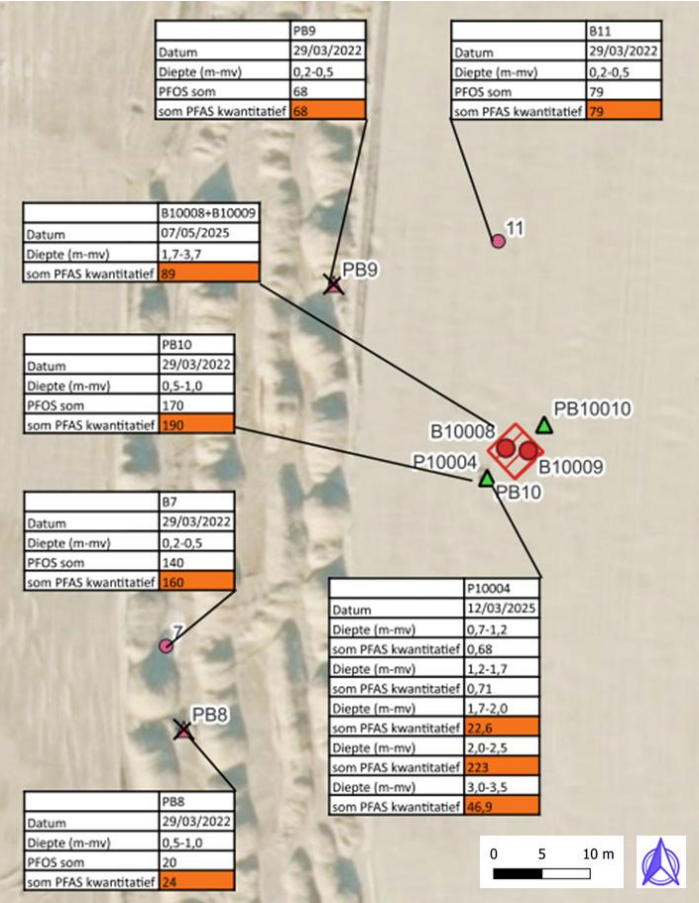
FORMER OPEL CAR ASSEMBLY INDUSTRIAL SITE



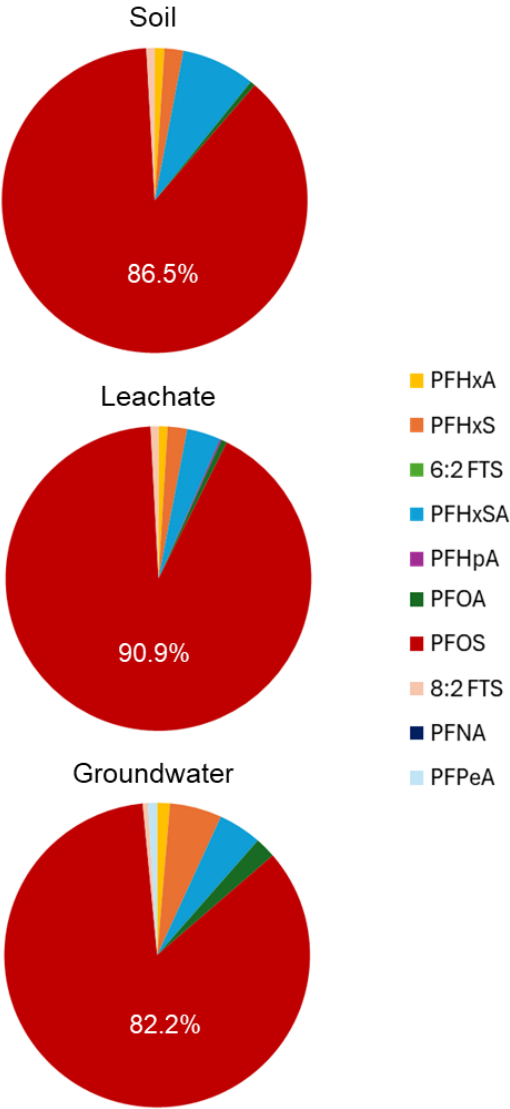
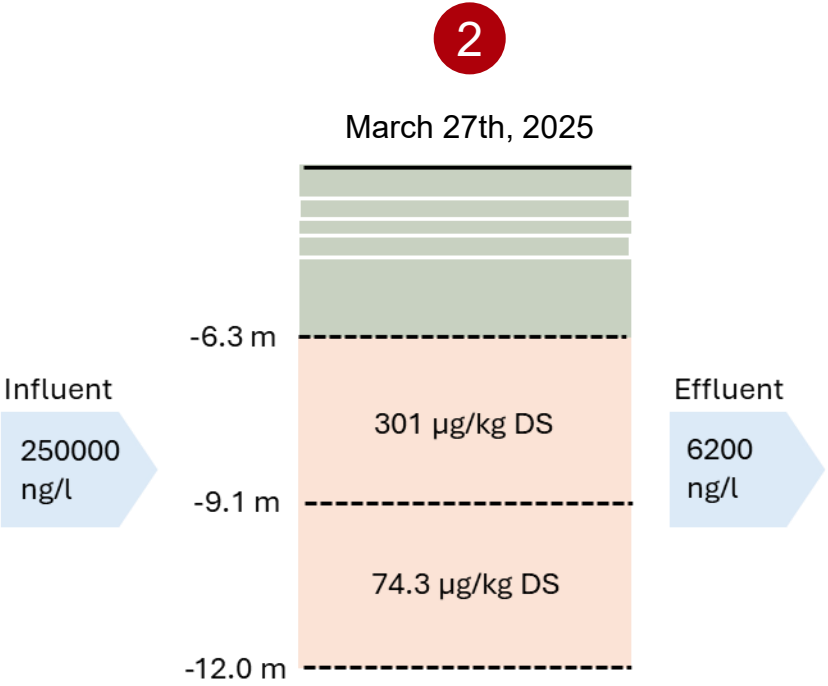
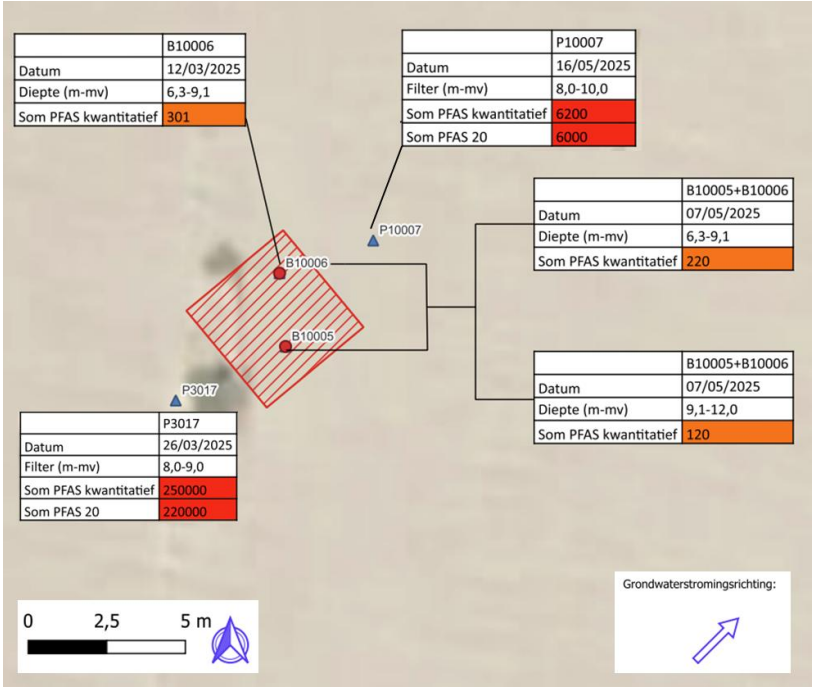
NEXT GEN DISTRICT – HOTSPOT FOR CIRCULAR ECONOMY



SUPERFICIAL PFAS CONTAMINATION – SOIL MIX



DEEP PFAS CONTAMINATION – INJECTION



SOIL MIX



Cutter Soil Mix equipment
(RG19T)



Step 1

Excavation of
PFAS-free soil up
to 1.7 m bgs



Step 2

Mixing phase
1.5 m² per mix



Step 3

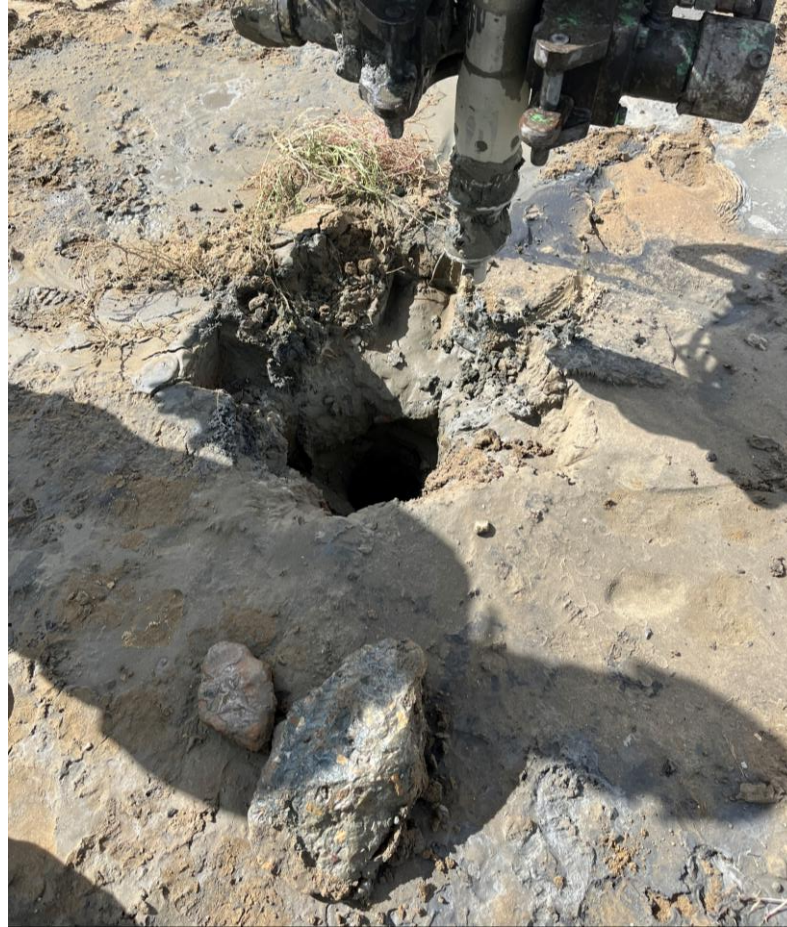
Infiltration phase
(± 2 days)



INJECTION



Deepflow™ equipment



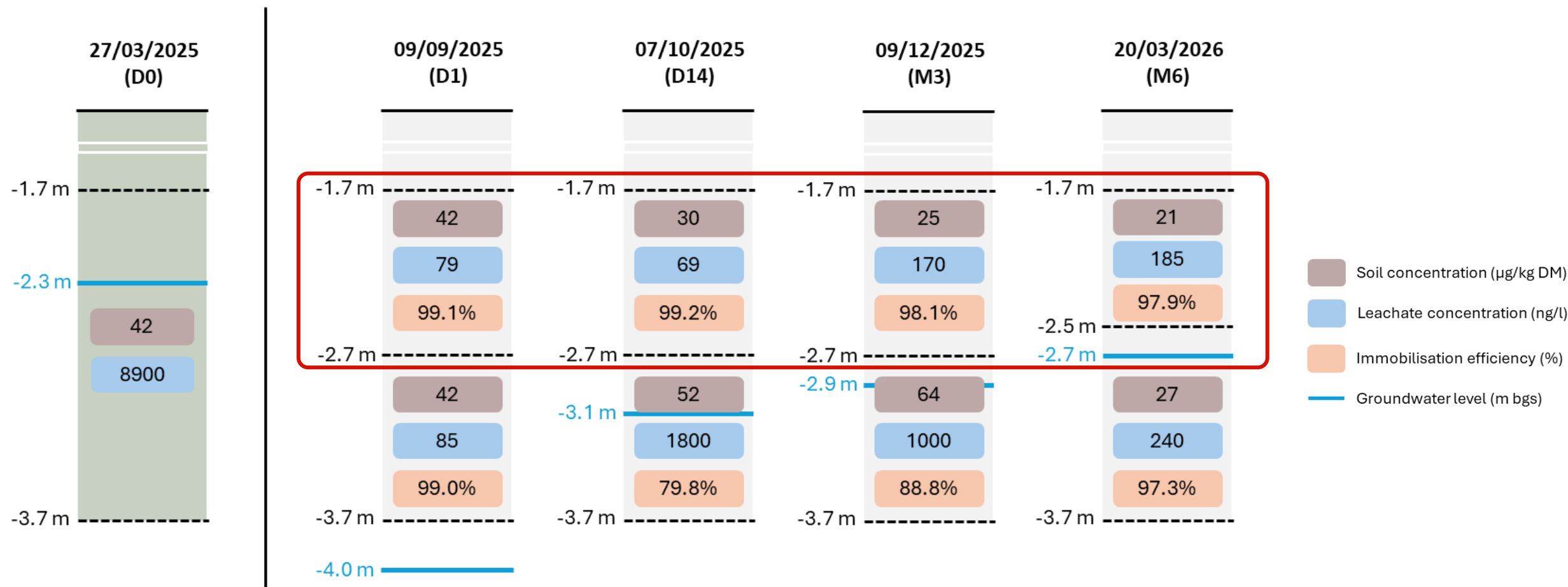
Unfavorable geological parameters:

- Compacted, fine sand
- Large stones and debris



Unsuccessful injection due to the limiting geological parameters

PILOT SCALE FOLLOW-UP



Stable PFAS immobilisation of 98% - 99% in the pilot test (current follow-up of 6 months).

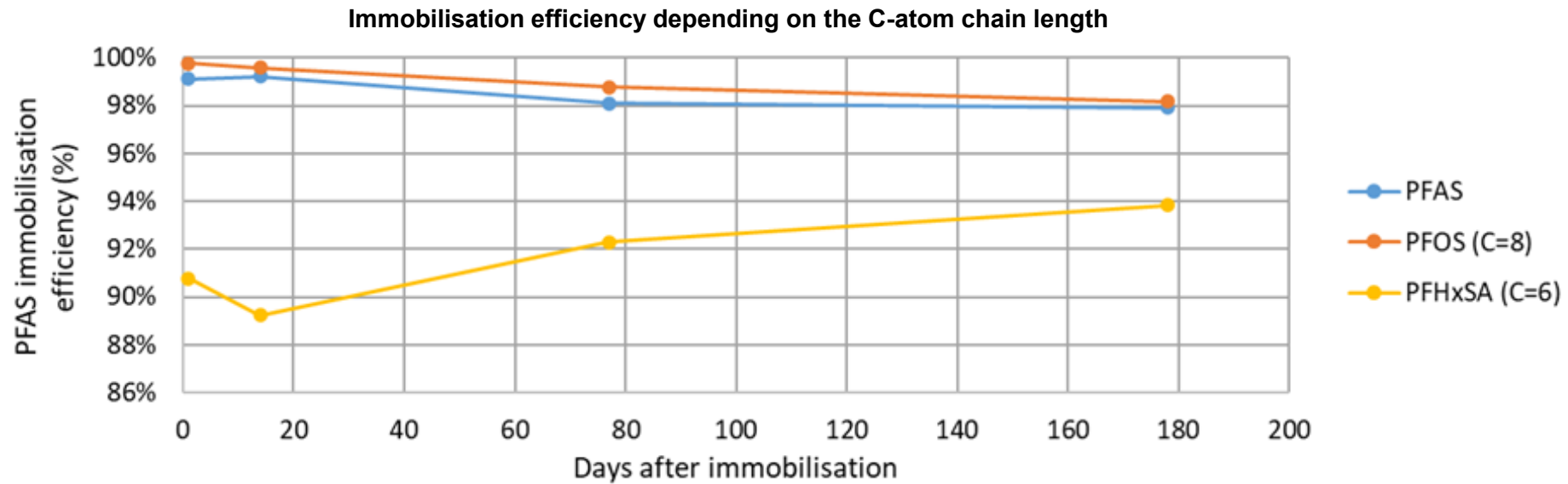
PILOT SCALE FOLLOW-UP

Immobilisation efficiency depending on the C-atom chain length:

PFAS 98.6%

PFOS (C=8) 99.1%

PFHxSA (C=6) 91.5%



Effective immobilization of short-chain PFAS, despite their high leachability.

PILOT SCALE VERSUS LAB SCALE RESULTS

Laboratory scale results

1% dosage → Immobilisation efficiency

99.1% PFAS

99.9% PFOS

2% dosage → Immobilisation efficiency

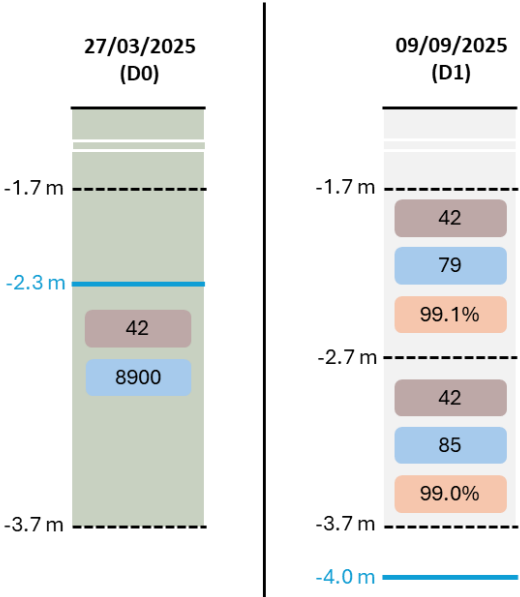
99.6% PFAS

99.9% PFOS

Pilot scale results

1% dosage → immobilisation efficiency

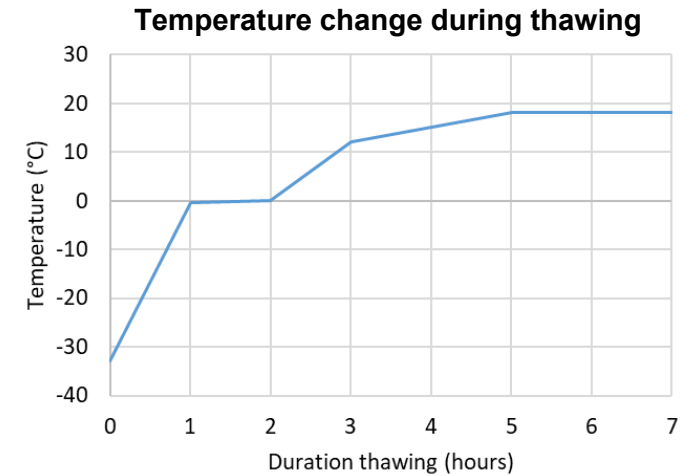
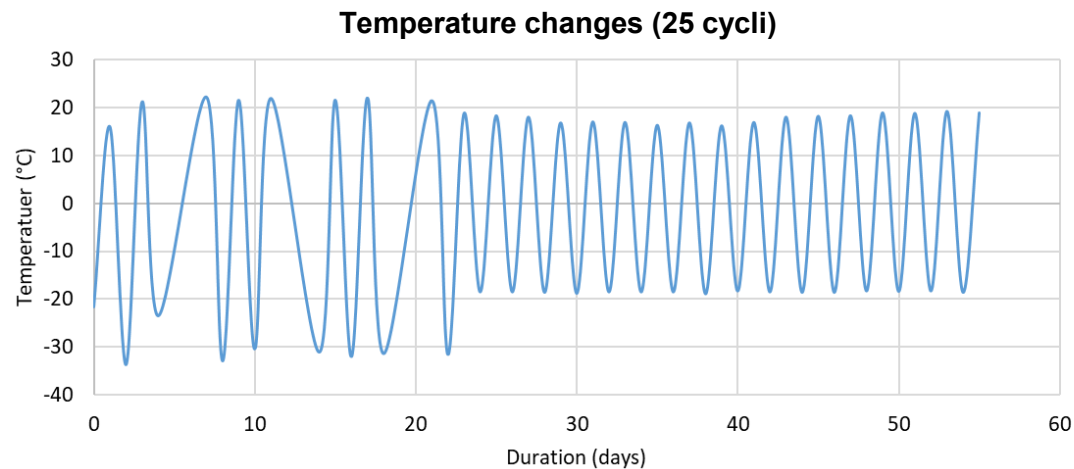
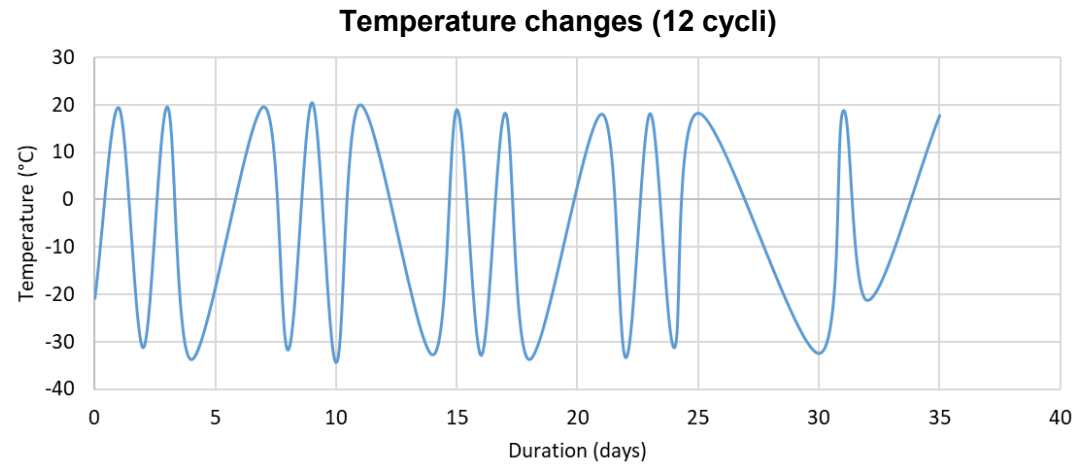
99.1% PFAS



Laboratory-scale and pilot-scale results are aligned.

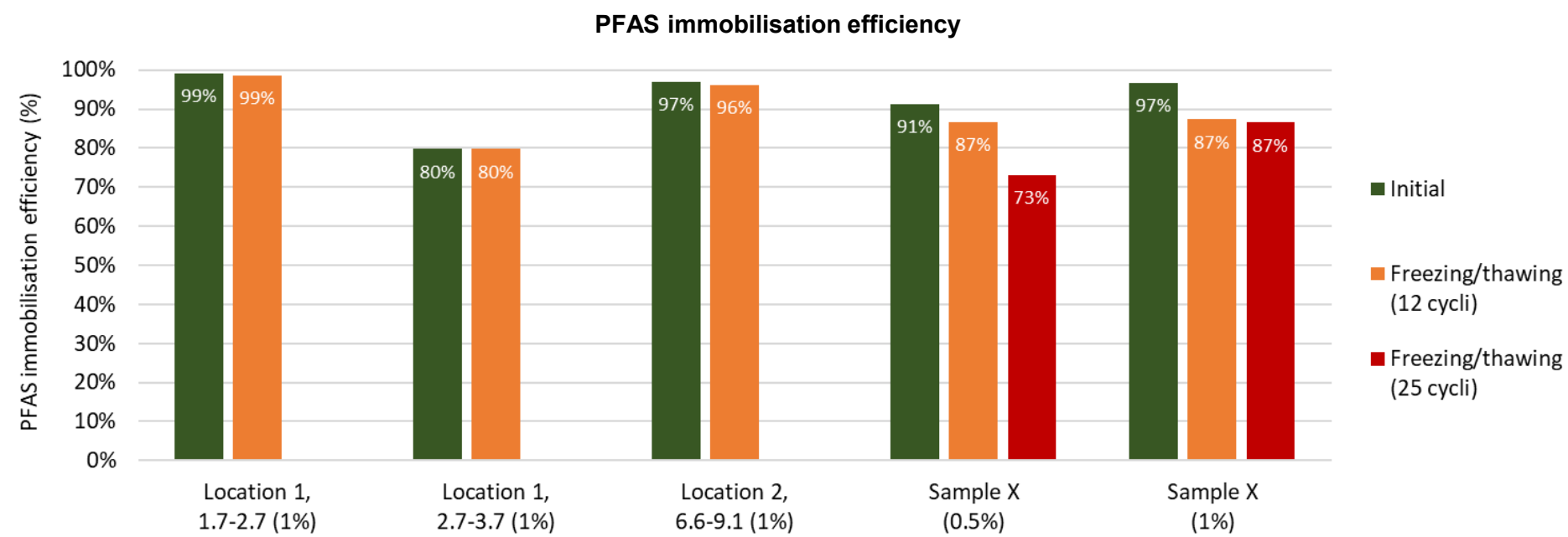
DURABILITY ASSESSMENT (LAB SCALE)

A Resistance to freezing and thawing (ASTM D4942-90)



DURABILITY ASSESSMENT (LAB SCALE)

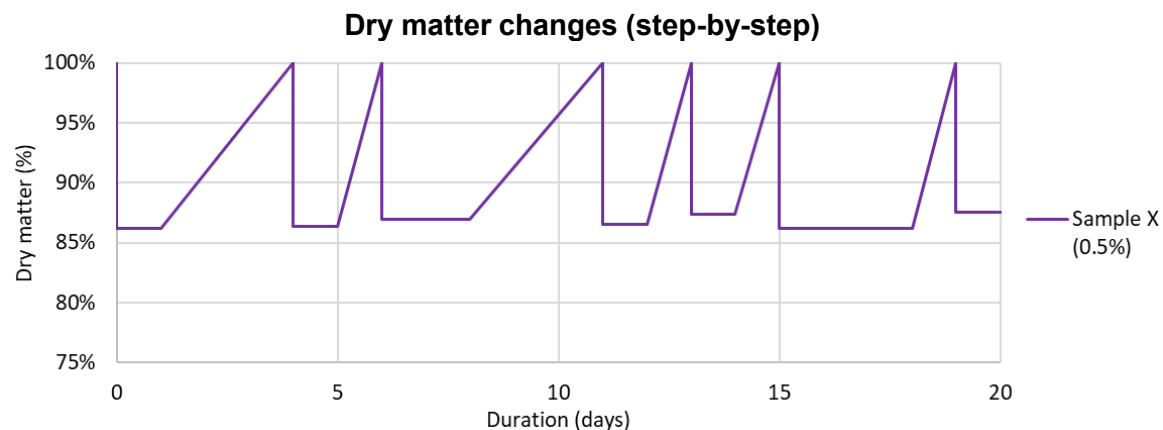
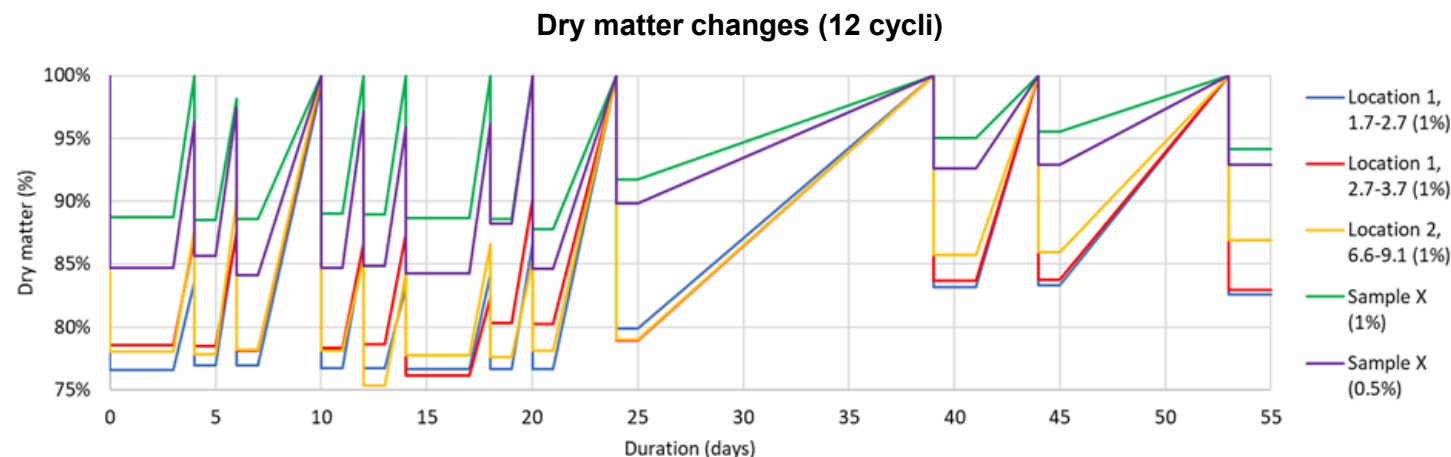
A Resistance to freezing and thawing (ASTM D4942-90)



Durable binding between PFAS and the immobilization additive during thawing and freezing.

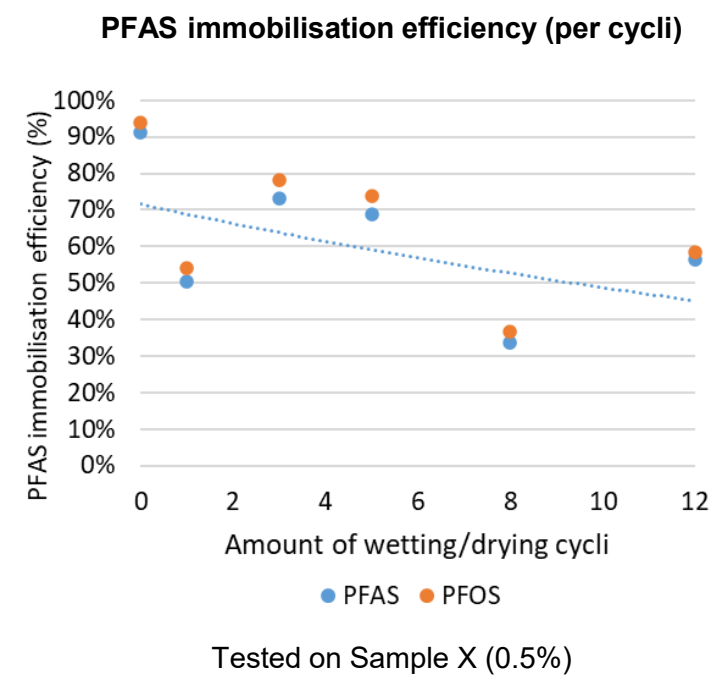
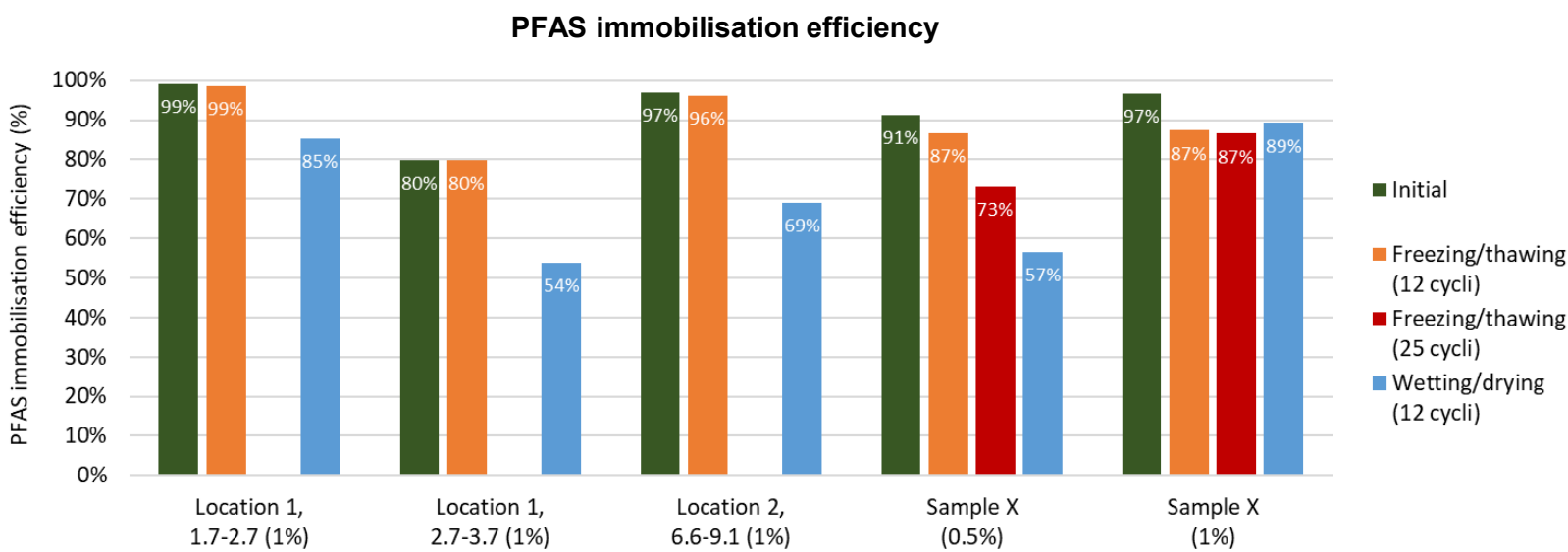
DURABILITY ASSESSMENT (LAB SCALE)

B Resistance to wetting and drying (ASTM D4843-88)



DURABILITY ASSESSMENT (LAB SCALE)

B Resistance to wetting and drying (ASTM D4843-88)



**Durable PFAS binding is possible.
More research is needed on the factors that ensure this long-term binding.**

CONCLUSIONS

- Successful long-term PFAS immobilization on a full scale is possible.
- Stable PFAS immobilisation of 98% - 99% in the pilot test (current follow-up of 6 months).
- Laboratory-scale and pilot-scale results are aligned.
- Soil mixing is a robust technique; injection requires a certain level of soil permeability.
- Collecting more long-term data (both laboratory-scale and full-scale) is necessary to define the parameters for successful long-term immobilization.
- Laboratory-scale and pilot-scale tests using various immobilization additives can be conducted by Jan de Nul.