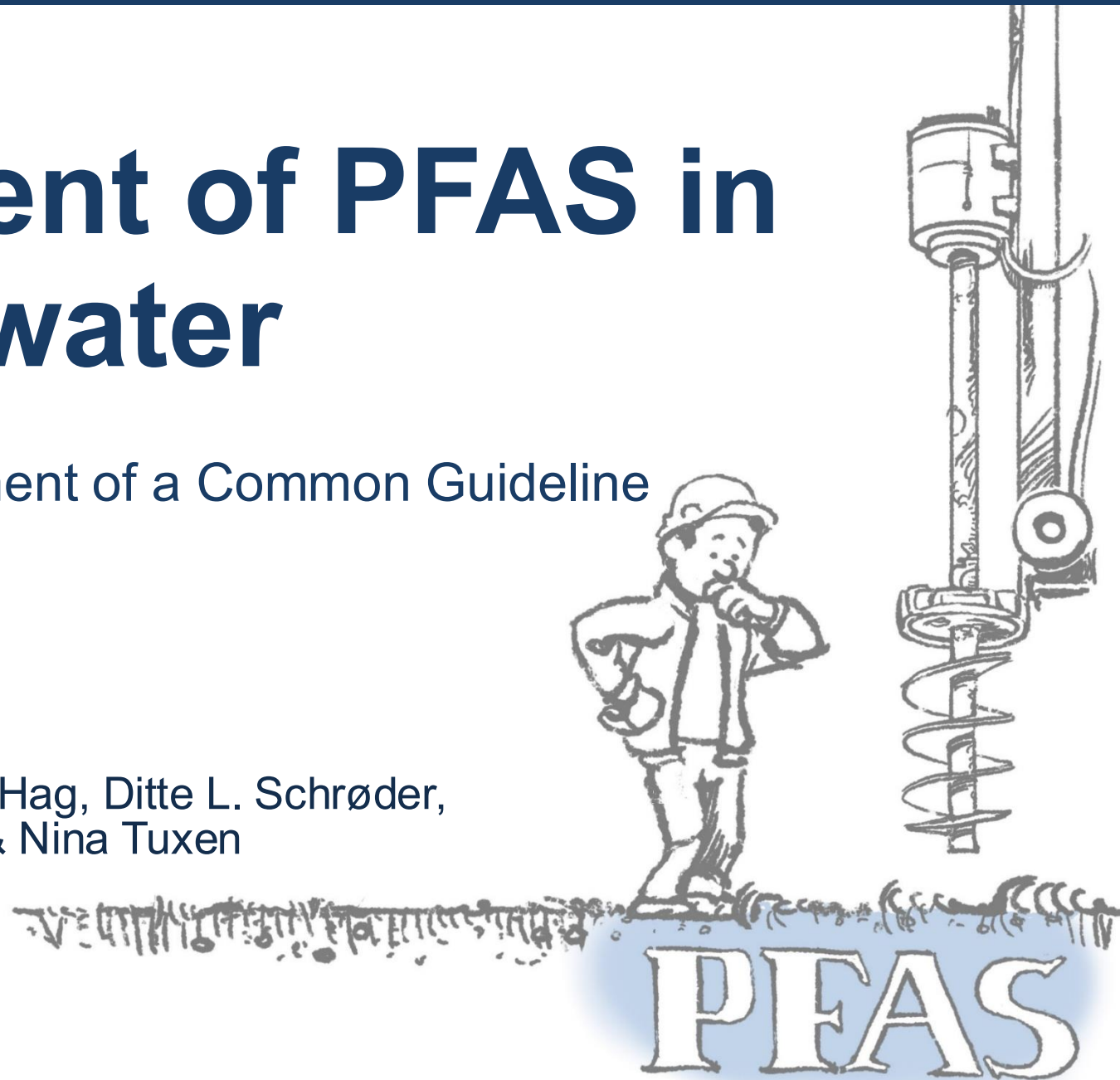


# Risk Assessment of PFAS in Soil & Groundwater

Knowledge Upgrade and Development of a Common Guideline  
Across an Environmental Authority

Ane LaBianca, Louise Rosenberg, Maria Hag, Ditte L. Schrøder,  
Lærke Brabæk Ildvedsen, Rikke Howitz & Nina Tuxen



RAMBOLL

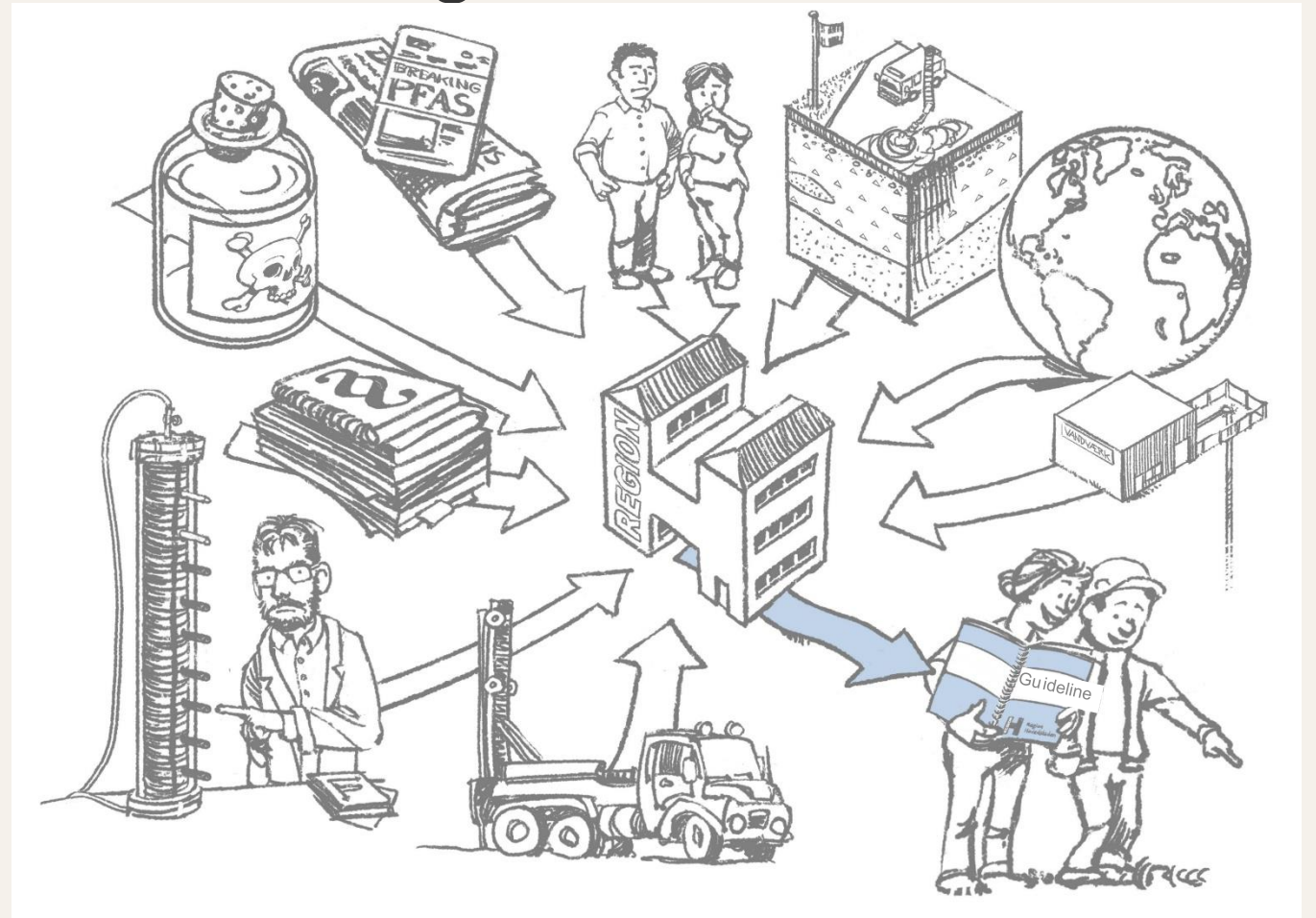
NIRAS

DTU

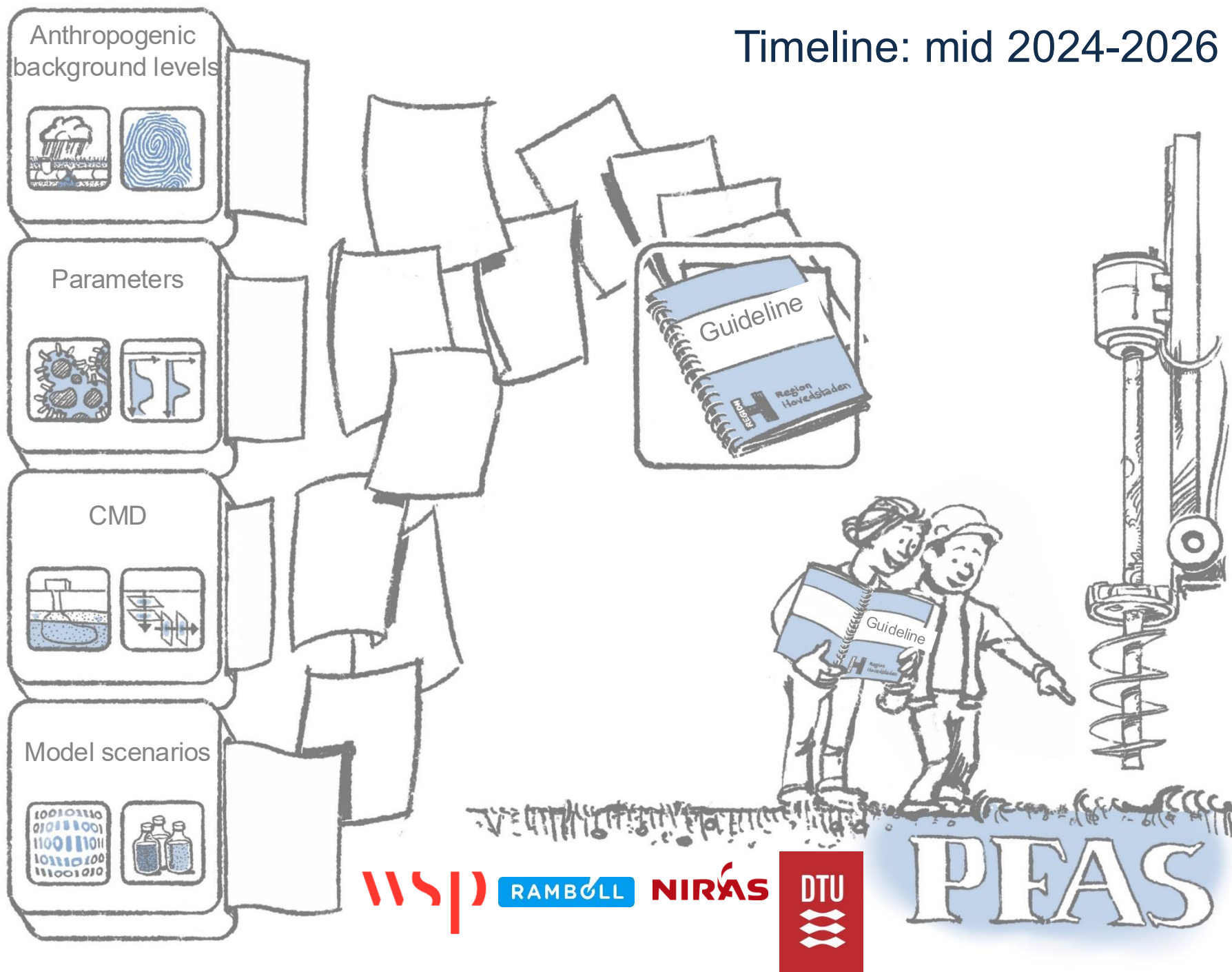
# Technical and Administrative Challenges

Lower PFAS criteria in 2021:

|                                 |                         |
|---------------------------------|-------------------------|
| $\Sigma 4$ PFAS in groundwater  | 2 ng/l                  |
| $\Sigma 22$ PFAS in groundwater | 100 ng/l                |
| $\Sigma 4$ PFAS in soil         | 10 $\mu\text{g/kg DM}$  |
| $\Sigma 22$ PFAS in soil        | 400 $\mu\text{g/kg DM}$ |



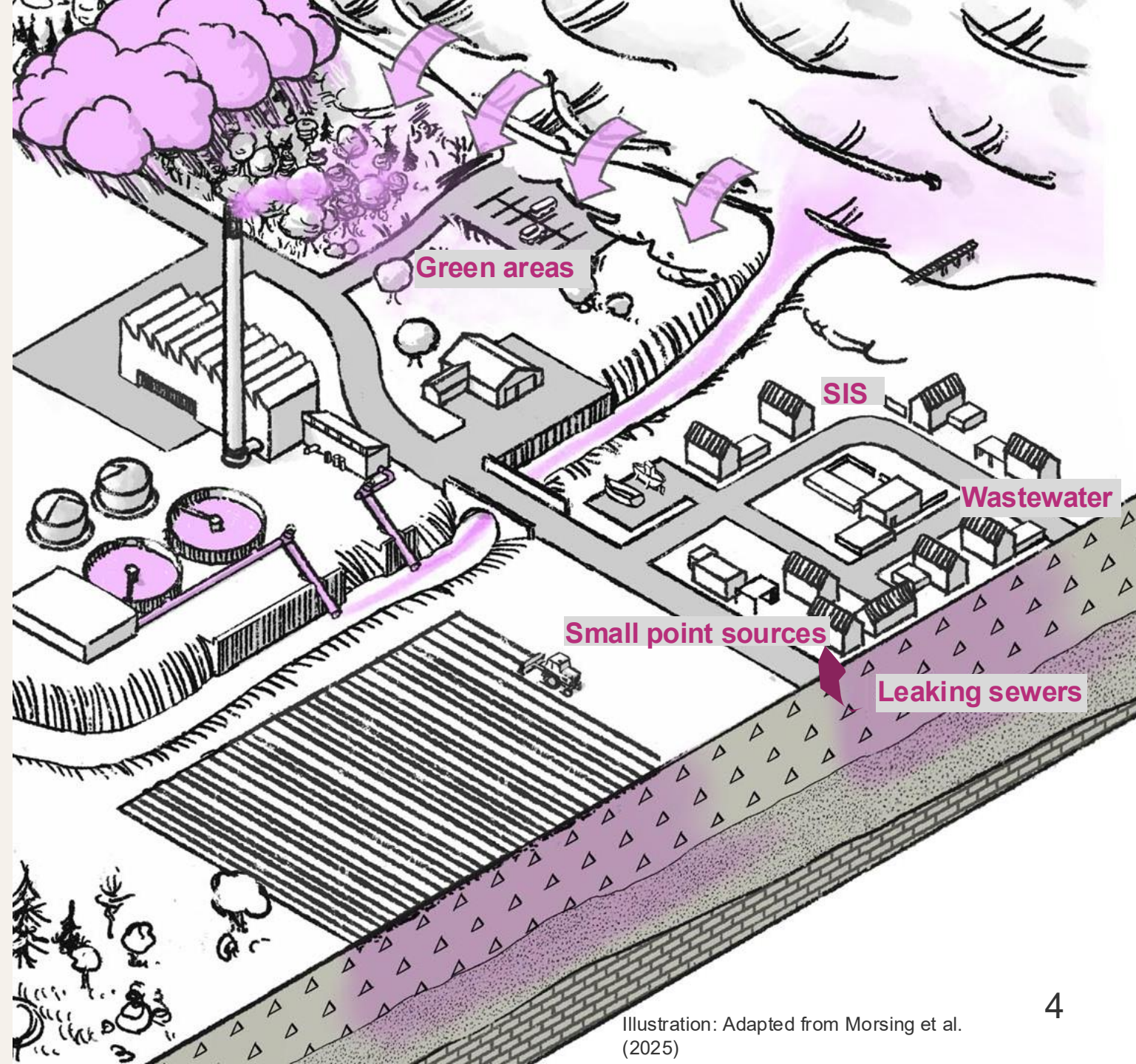
Timeline: mid 2024-2026



## Anthropogenic background levels

Background levels are close to threshold values

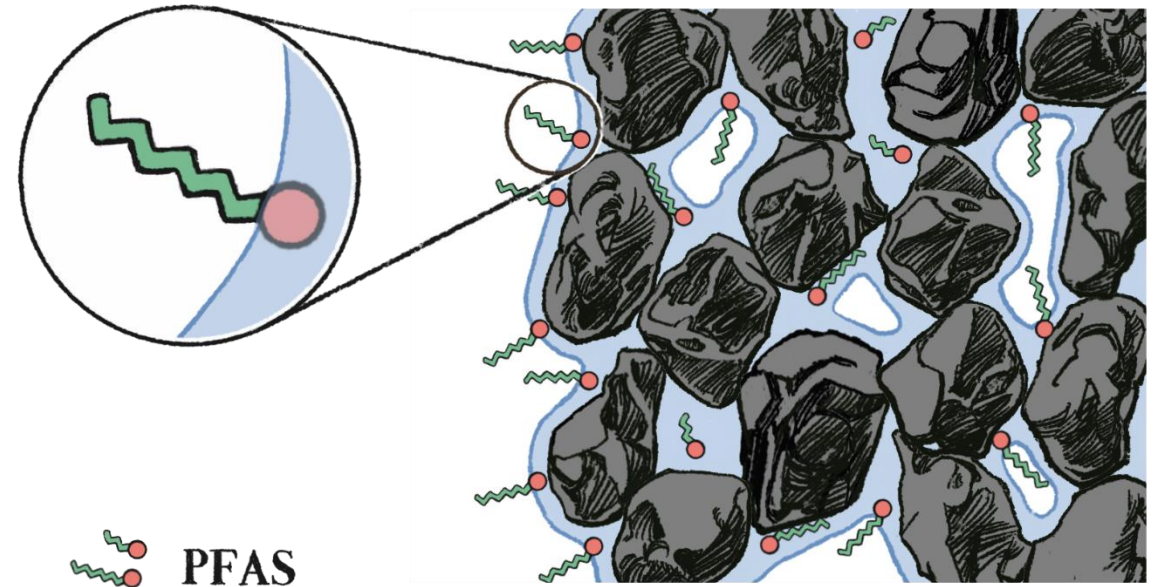
Cluster analysis can potentially identify the diffuse source



# Key parameters for PFAS Transportation

Parameter value ranges

Test and evaluate methods



Morsing et al. (2025)

$$R = 1 + \frac{K_d \cdot \rho_b}{\theta_w} + \frac{K_{ia} \cdot A_{ia}}{\theta_w}$$

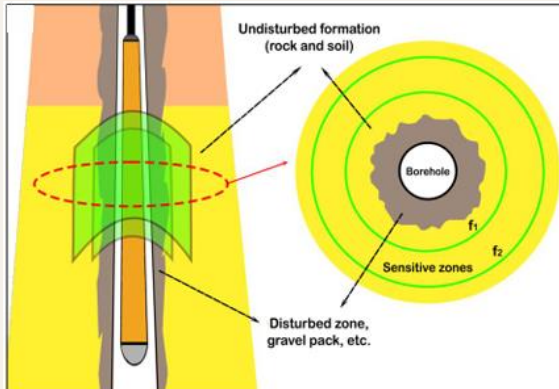
*Sorption to soil*      *Adsorption to air-water interface*

- R Retardation factor in the unsaturated zone for the specific substance
- $K_d$  Partition coefficient between soil and water
- $\rho_b$  Bulk density of dry soil
- $\theta_w$  Water content
- $K_{ia}$  Adsorption coefficient at the air-water interface
- $A_{ia}$  Specific surface area of the air-water interface

# Field campaigns

## Water content measurements

### Nuclear Magnetic Resonance



Photos and illustrations of NMR from Almpanis et al. 2026

### Time-domain reflectometry

#### Weather station and online transmitters

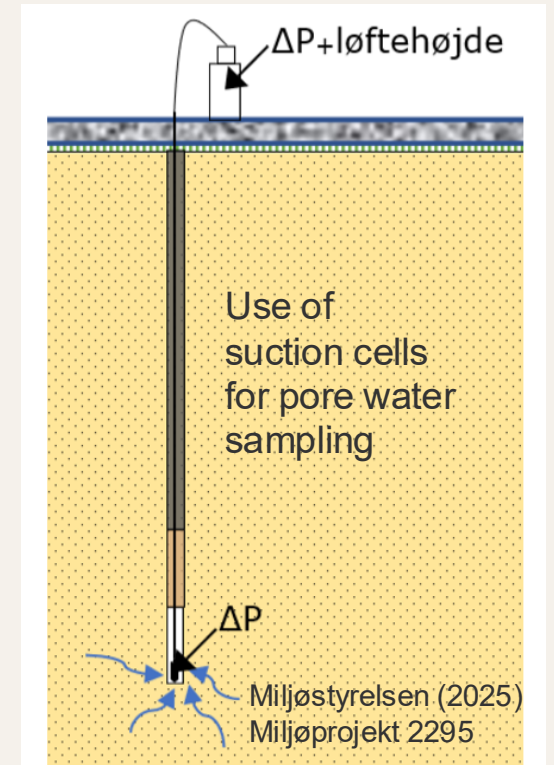


Photos of TDR and Weather station from Rambøll, 2025

### Porewater sampling

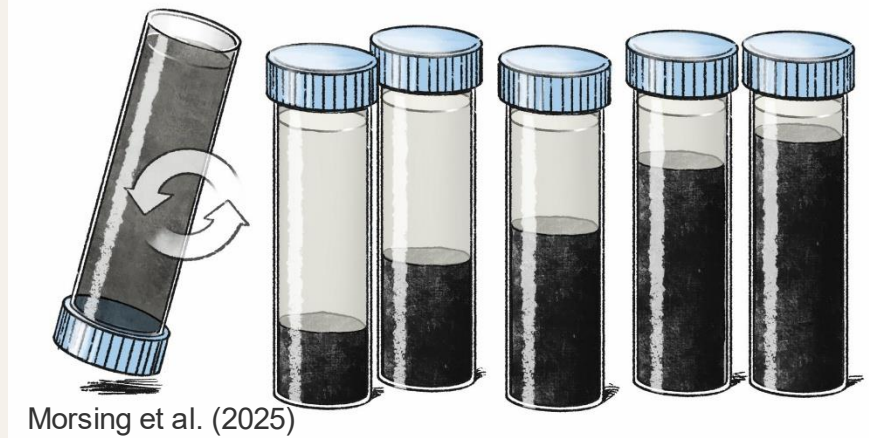


Photos of suction cells from Niras, 2025

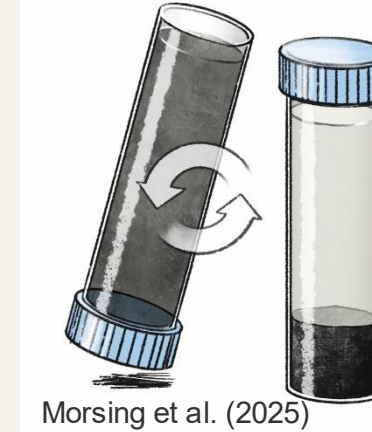


# Laboratory work

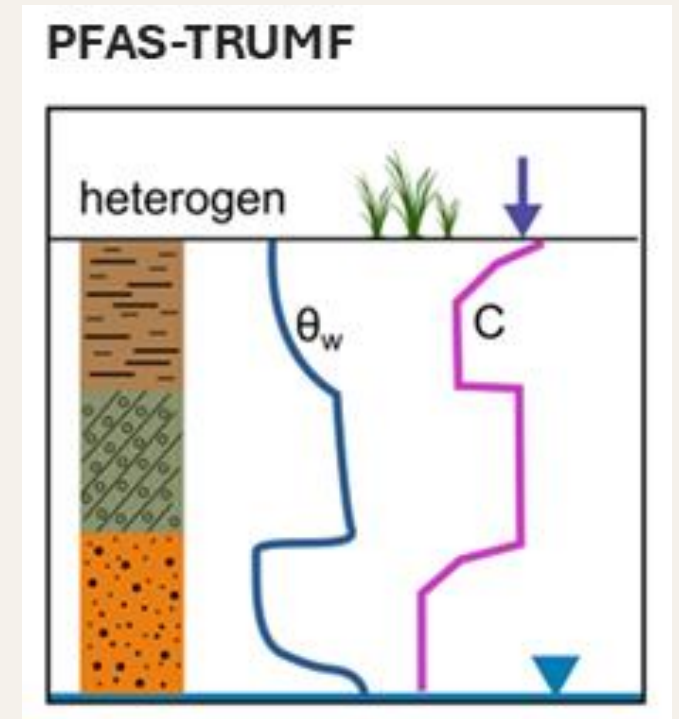
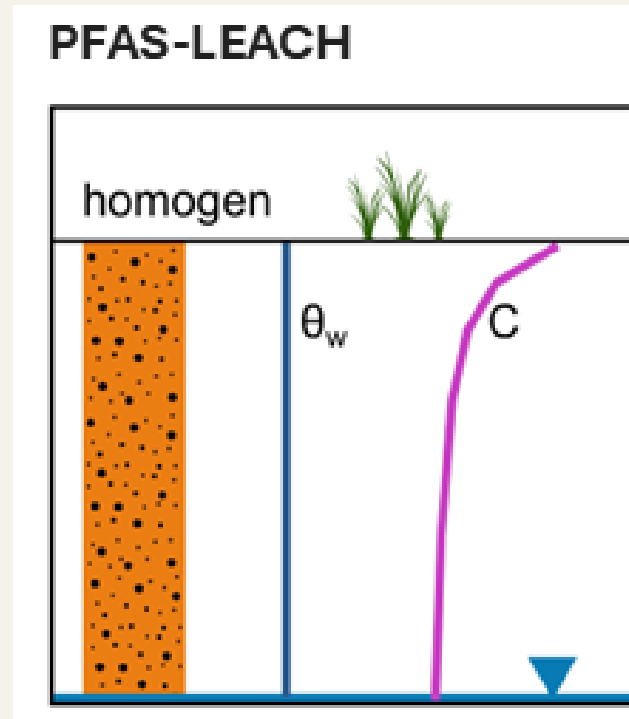
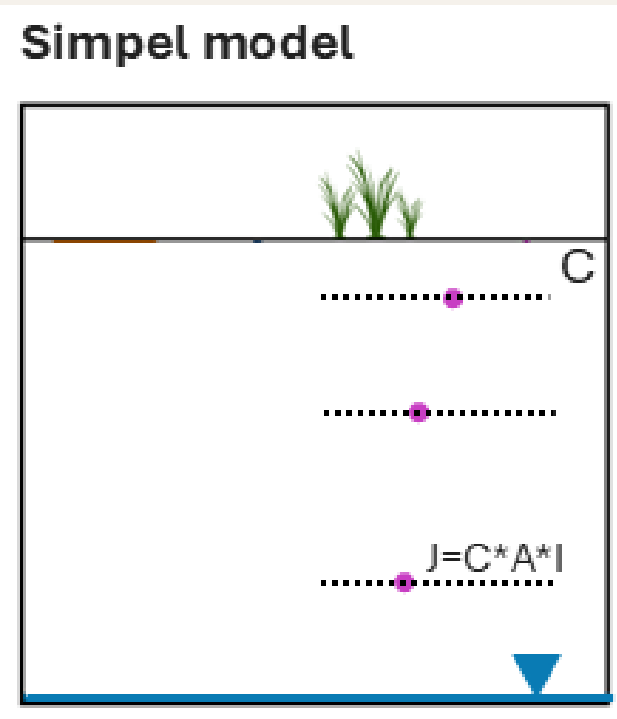
## Sorption tests



## Leaching tests



# How can modeling be used for risk assessment?



# Highlights of input to the Guideline

"PFAS is everywhere" .... In significant concentrations

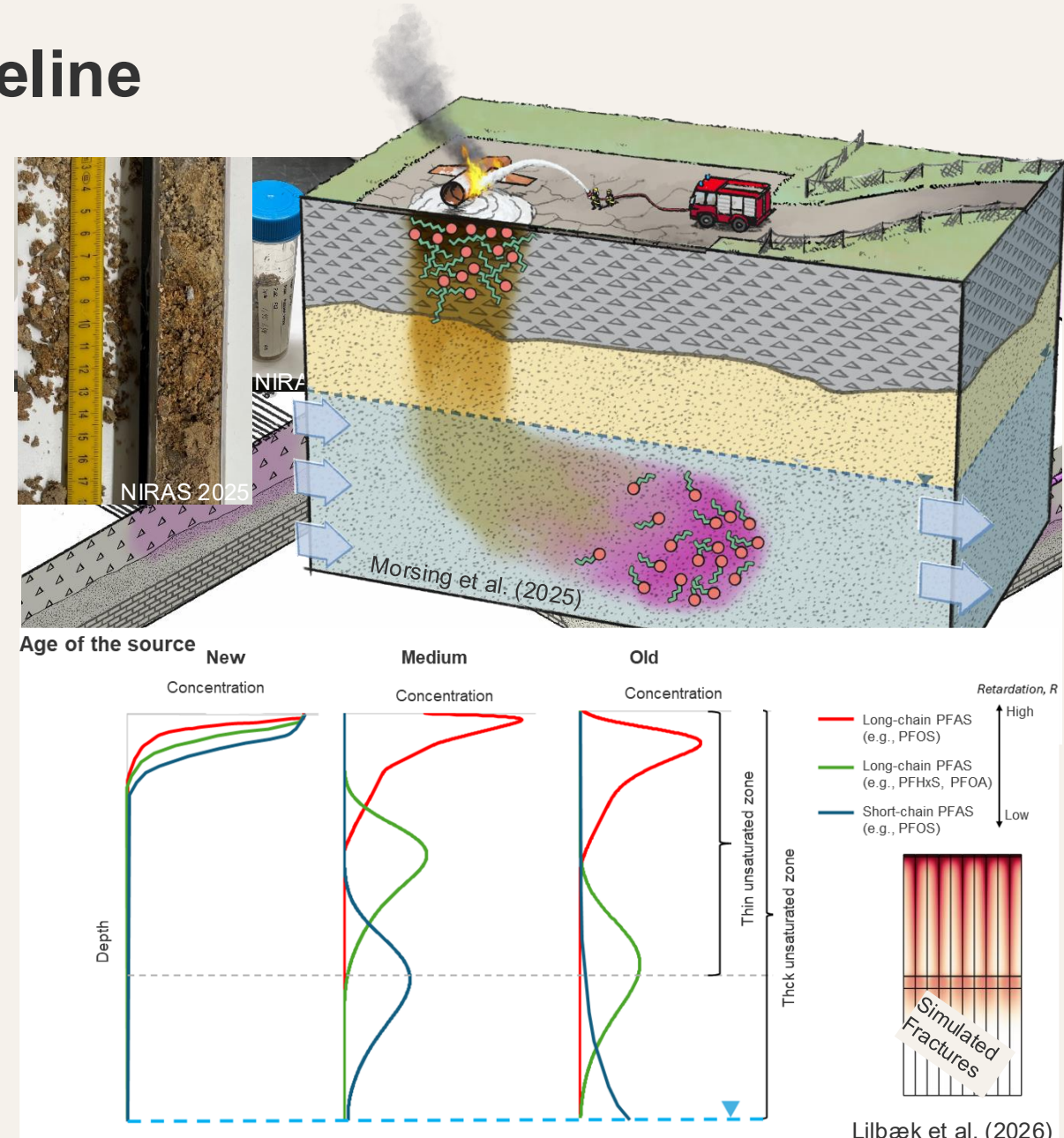
Handle the soil samples with care

Get a systematic and detailed description of geological conditions

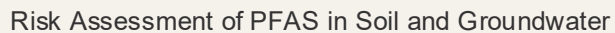
Understand the composition of PFAS at various depths in the unsaturated zone

Develop a robust conceptual model

Open fractures may dominate transport



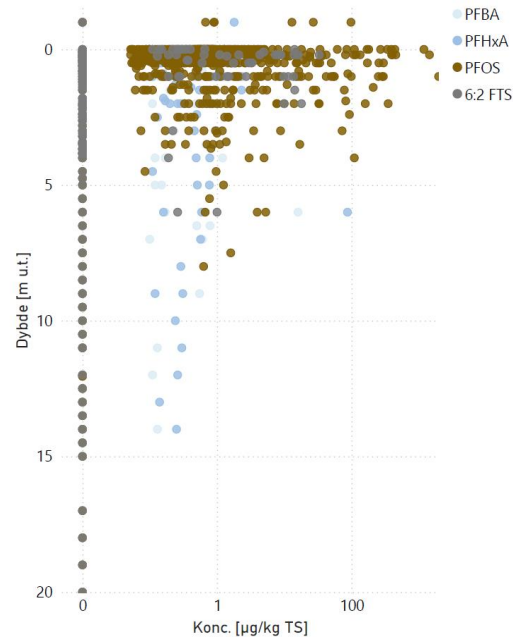
## A photograph of a carefully balanced stack of smooth, rounded stones on a dark, textured rock. The stones are arranged in a tiered, triangular shape, with the largest stones at the base and smaller ones on top. The stones have various shades of grey, brown, and tan. The background shows a calm sea under a cloudy sky.



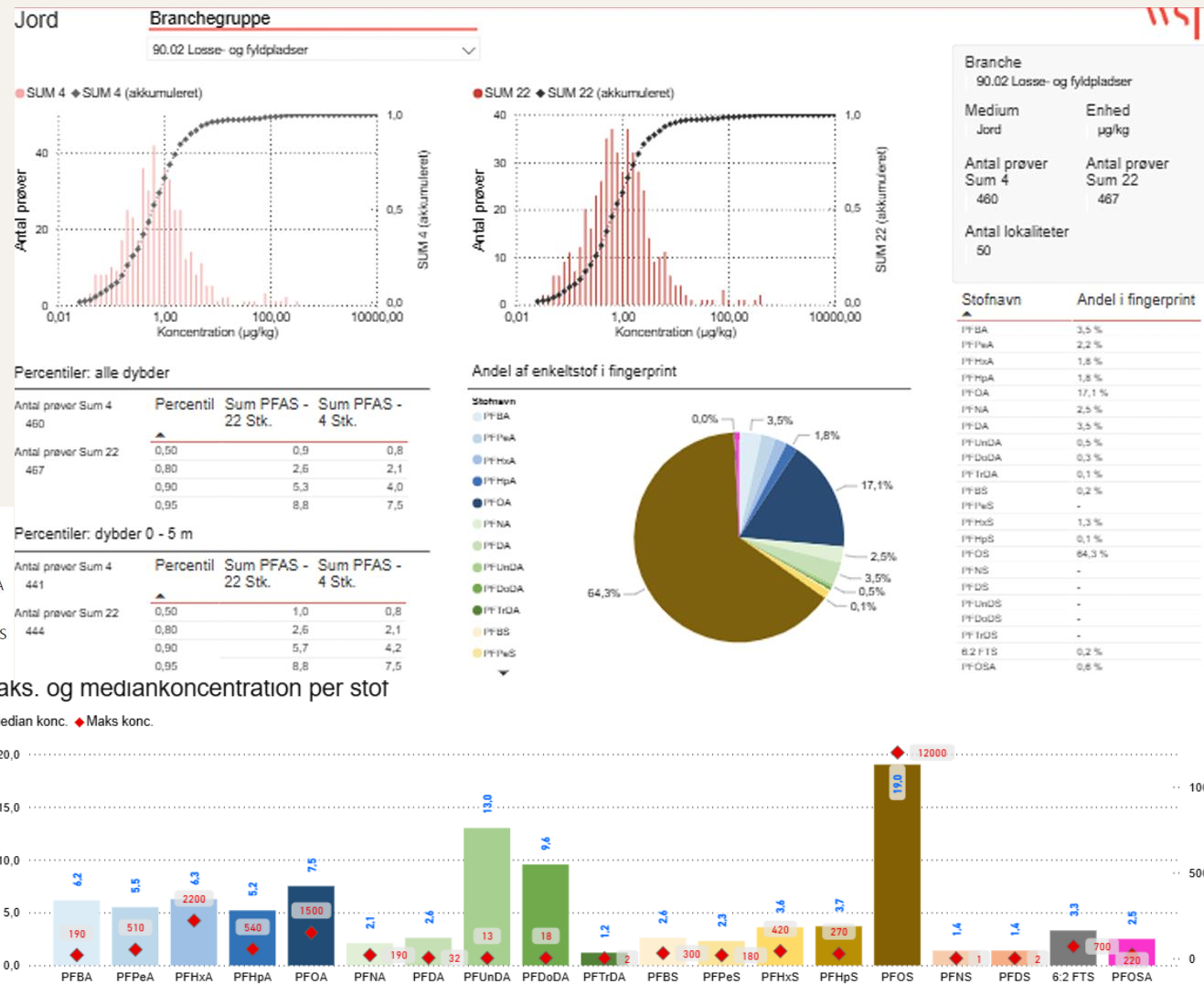
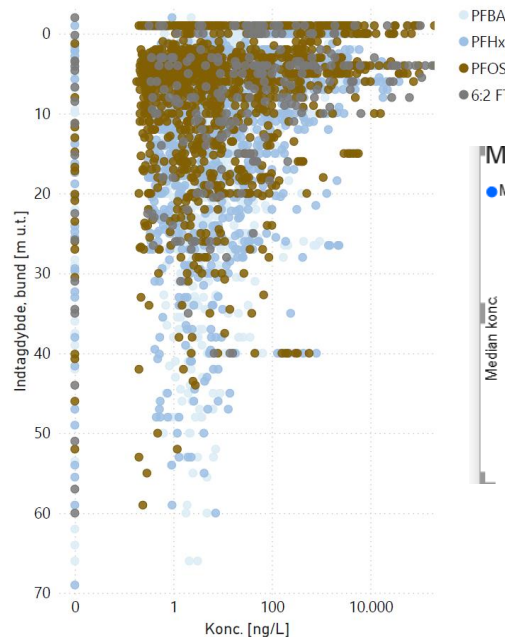
# Tools

## PFAS database in Power BI

### Soil samples



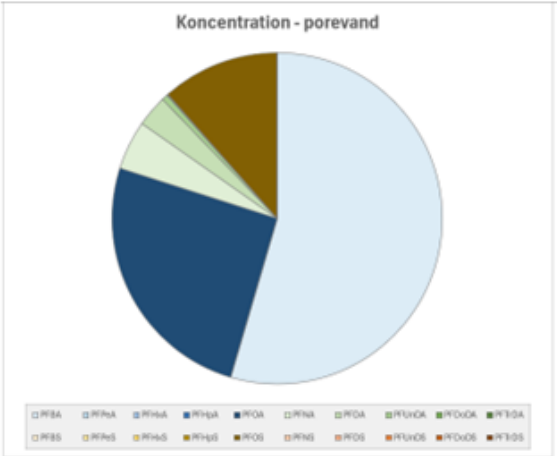
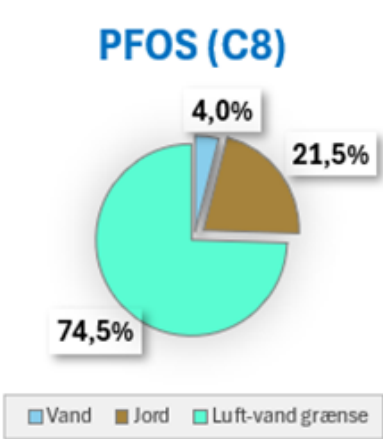
### Water samples



# Tools

A phase distribution calculator  
→ “PFASen”

| Analyseresultater          |                       |             | Fra jordprøve                              | Fra vandprøve                          | Estimerede resultater (afrundede) |                           |                       |
|----------------------------|-----------------------|-------------|--------------------------------------------|----------------------------------------|-----------------------------------|---------------------------|-----------------------|
|                            |                       |             | Koncentration (C <sub>t</sub> ) (µg/kg TS) | Koncentration (C <sub>w</sub> ) (ng/l) |                                   |                           |                       |
| Trivialnavn                | # fluorerede C-atomer | Forkortelse |                                            |                                        | Forkortelse                       | C <sub>t</sub> (µg/kg TS) | C <sub>w</sub> (ng/l) |
| Perfluorbutansyre          | 3                     | PFBA        | 0,111                                      |                                        | PFBA                              | 0,111                     | 966                   |
| Perfluorbutansulfonsyre    | 4                     | PFBS        | <0,10                                      |                                        | PFBS                              |                           |                       |
| Perfluorpentansyre         | 4                     | PFPeA       | <0,20                                      |                                        | PFPeA                             |                           |                       |
| Perfluorhexansyre          | 5                     | PFHxA       | <0,20                                      |                                        | PFHxA                             |                           |                       |
| Perfluorpentansulfonsyre   | 5                     | PFPeS       | <0,050                                     |                                        | PFPeS                             |                           |                       |
| Perfluorheptansyre         | 6                     | PFHpA       | <0,20                                      |                                        | PFHpA                             |                           |                       |
| Perfluorhexansulfonsyre    | 6                     | PFHxS       | <0,10                                      |                                        | PFHxS                             |                           |                       |
| 6:2 fluortelomersulfonsyre | 6                     | 6:2 FTS     | <0,050                                     |                                        | 6:2 FTS                           |                           |                       |
| Perfluoroctansyre          | 7                     | PFOA        | 0,233                                      |                                        | PFOA                              | 0,233                     | 449                   |
| Perfluorheptansulfonsyre   | 7                     | PFHpS       | <0,10                                      |                                        | PFHpS                             |                           |                       |
| Perfluoroctansulfonamid    | 8                     | PFOSA       | <0,050                                     |                                        | PFOSA                             |                           |                       |
| Perfluornonansyre          | 8                     | PFNA        | 0,128                                      |                                        | PFNA                              | 0,128                     | 85,0                  |
| Perfluoroctansulfonsyre    | 8                     | PFOS        | 0,443                                      |                                        | PFOS                              | 0,443                     | 204                   |



Værktøjet er udarbejdet af DMR for Region Hovedstaden, med faglig input og sparring fra DTU Sustain.

September 2025

Version: PFASen (Ver. 2.3) - 2025-09-04

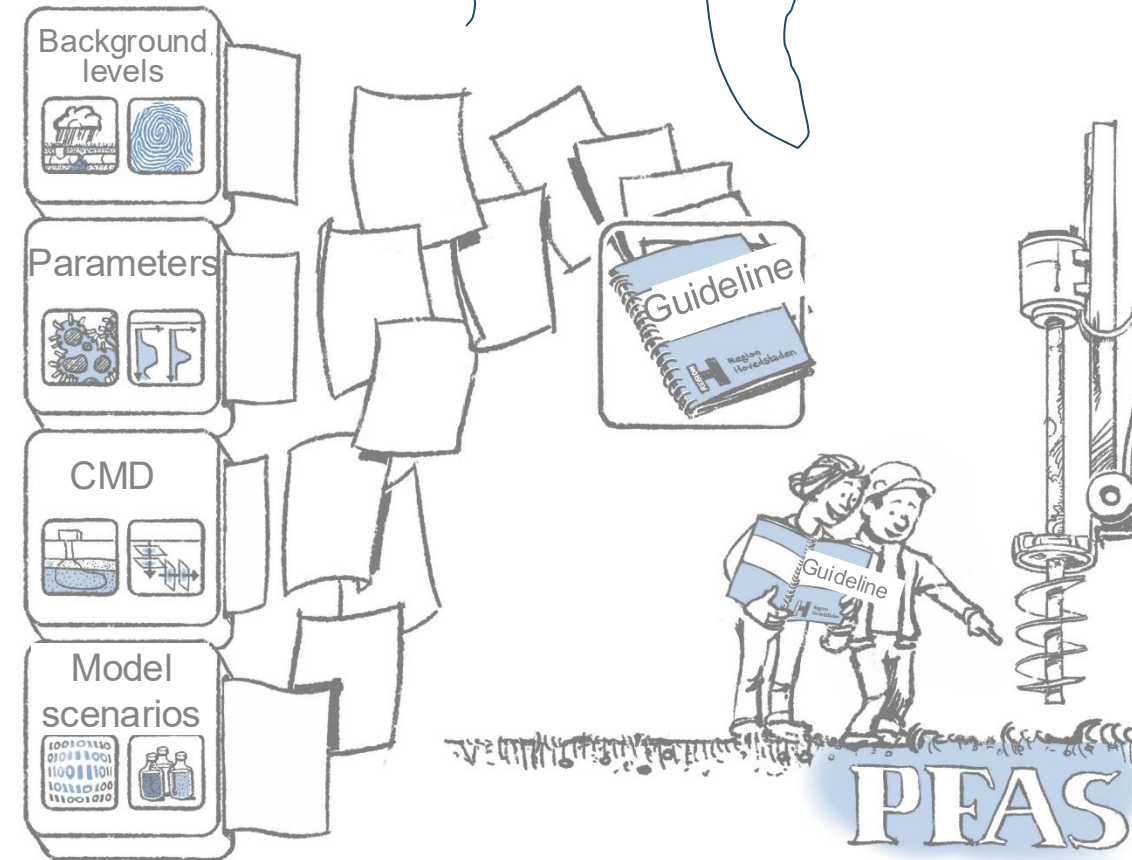
# Reflections on project design



Picture of the working group at the kick-off in June 2024  
- many more great colleagues and partners are involved!



Difficult to align perceptions





Picture of the working group at the kick-off in June 2024  
- many more great colleagues and partners are involved!

## Get in touch

**Ane LaBianca**

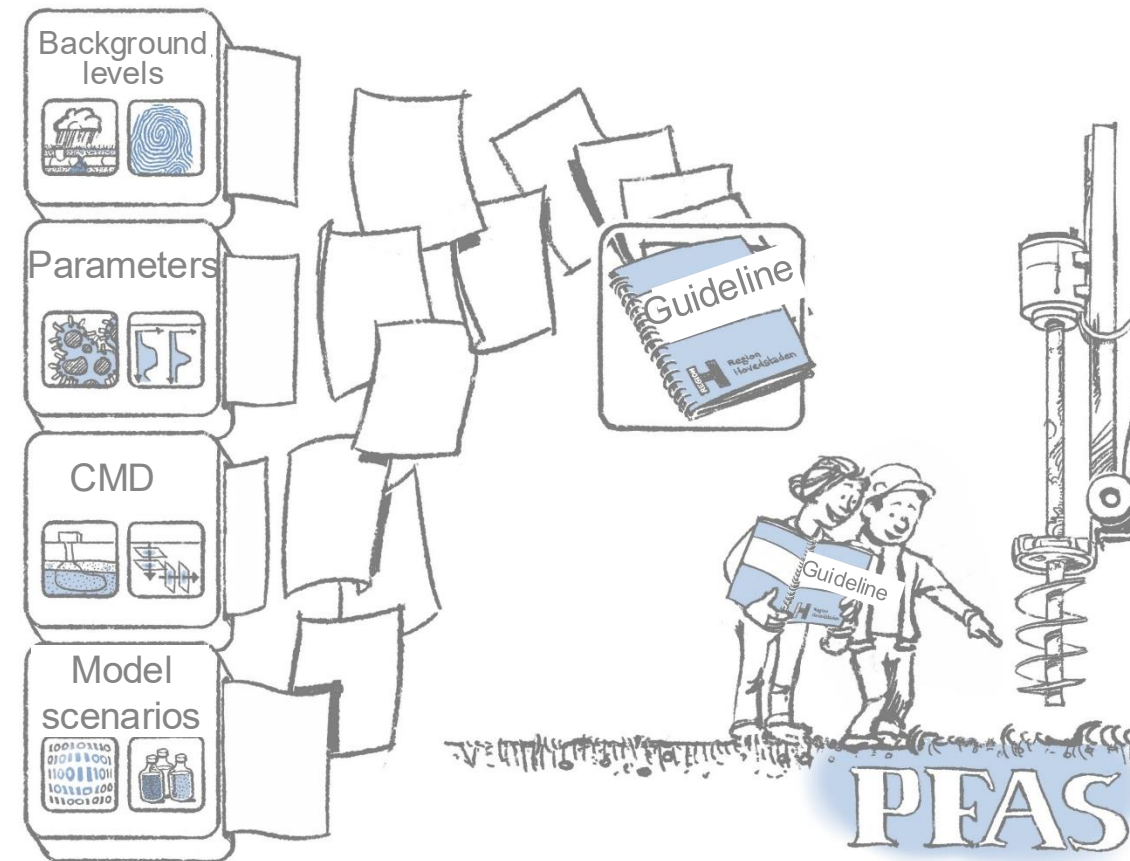
Mail: [ane.labianca@regionh.dk](mailto:ane.labianca@regionh.dk)

## Capital Region of Denmark

Center for Regional Development - Environment

Mail: [regionaludvikling@regionh.dk](mailto:regionaludvikling@regionh.dk)

Web: [www.regionh.dk](http://www.regionh.dk)



# Tools for PFAS Risk Assessment

## Power BI PFAS Database

PFASen – English version is under development

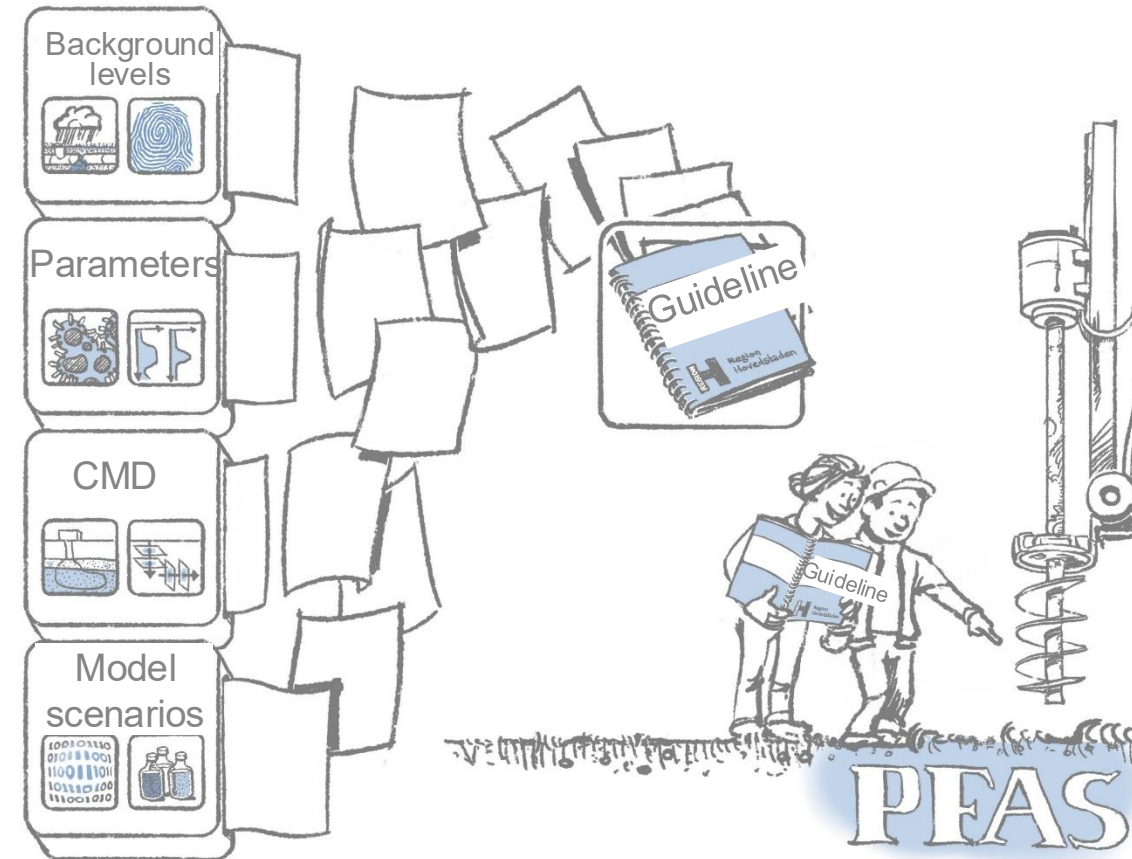
## PFAS-LEACH

## PFAS-TRUMF

Contact:

Henning Wienkenjohann, [henwie@dtu.dk](mailto:henwie@dtu.dk)

Klaus Mosthaf, [klmos@dtu.dk](mailto:klmos@dtu.dk)



## References

- Almpanis, A., Grombacher, D., Pedersen, J., Griffiths, M. and Zamora-Luria, J. C. (2006), Measuring Soil Water content – NMR insights and other perspectives, ATV Vintermøde 2006, Aarhus University
- Lilbæk, G., Petersen, T. E., Dyreborg, S., Christensen, A. G., Wienkenjohann, H., Mostaf, K. and Bjerg, P. L. (2006) Hovedrapport, Risikovurdering af PFAS i jord og grundvand, delprojekt 3 og 5. Region Hovedstaden
- Morsing, L., Tsitonaki, K., Dyreborg, S., Mosthaf, K., Fjordbøge, A. S., Hjorth, R., Jensen, B. B., Baun, A. & Bjerg, P. L., 2025, Konceptuel model for transport og skæbne af PFAS ved forurenede grunde, Miljøstyrelsen. 96 p. (Miljøprojekt; No. 2286)
- Tsitonaki, K., Hurst, P., Andersen, C., Andreasen, K. and Smith, K. (2026). Antropogene baggrunds niveauer af PFAS – betydning for jord- og grundvandsundersøgelser. Region Hovedstaden