

# Experience with PFAS as secondary component in pump-and-treat plants


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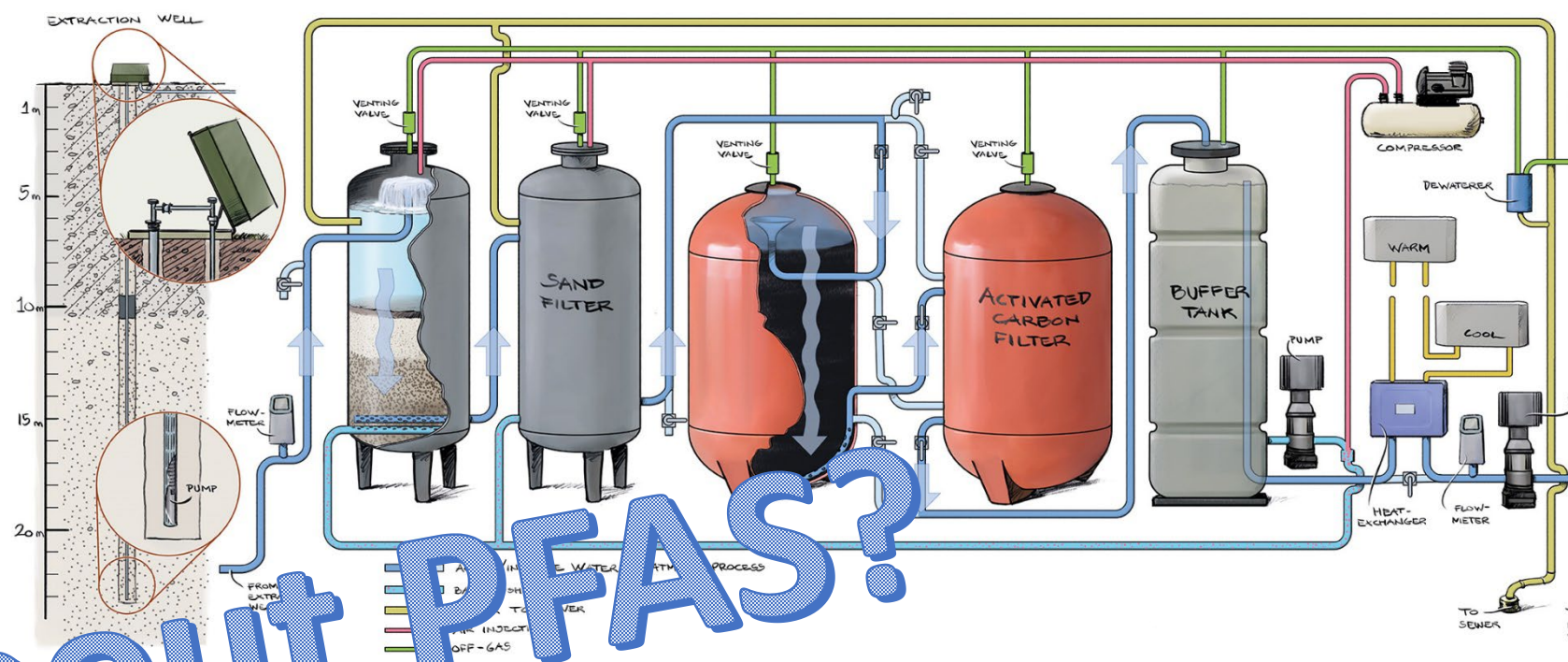
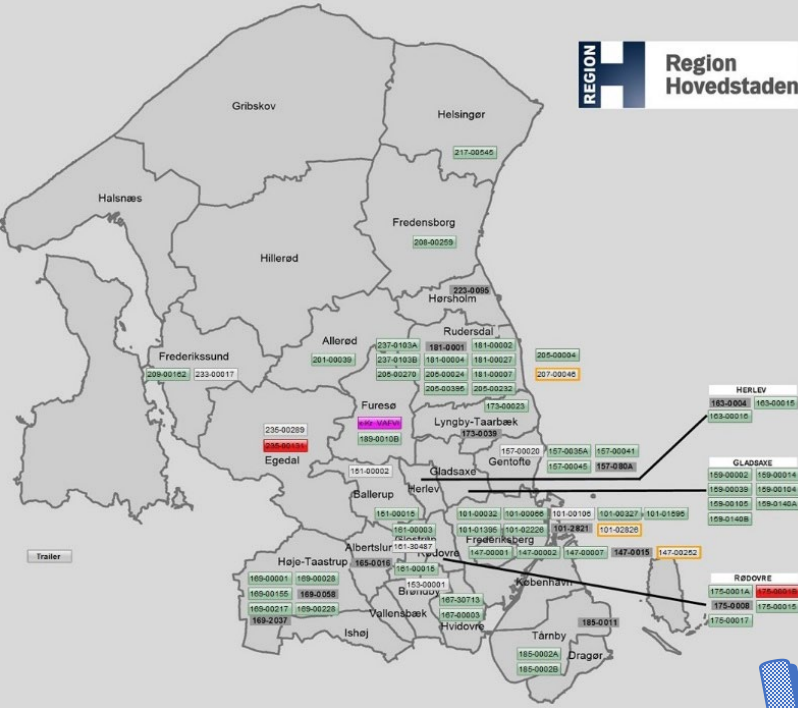
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What about PFAS?

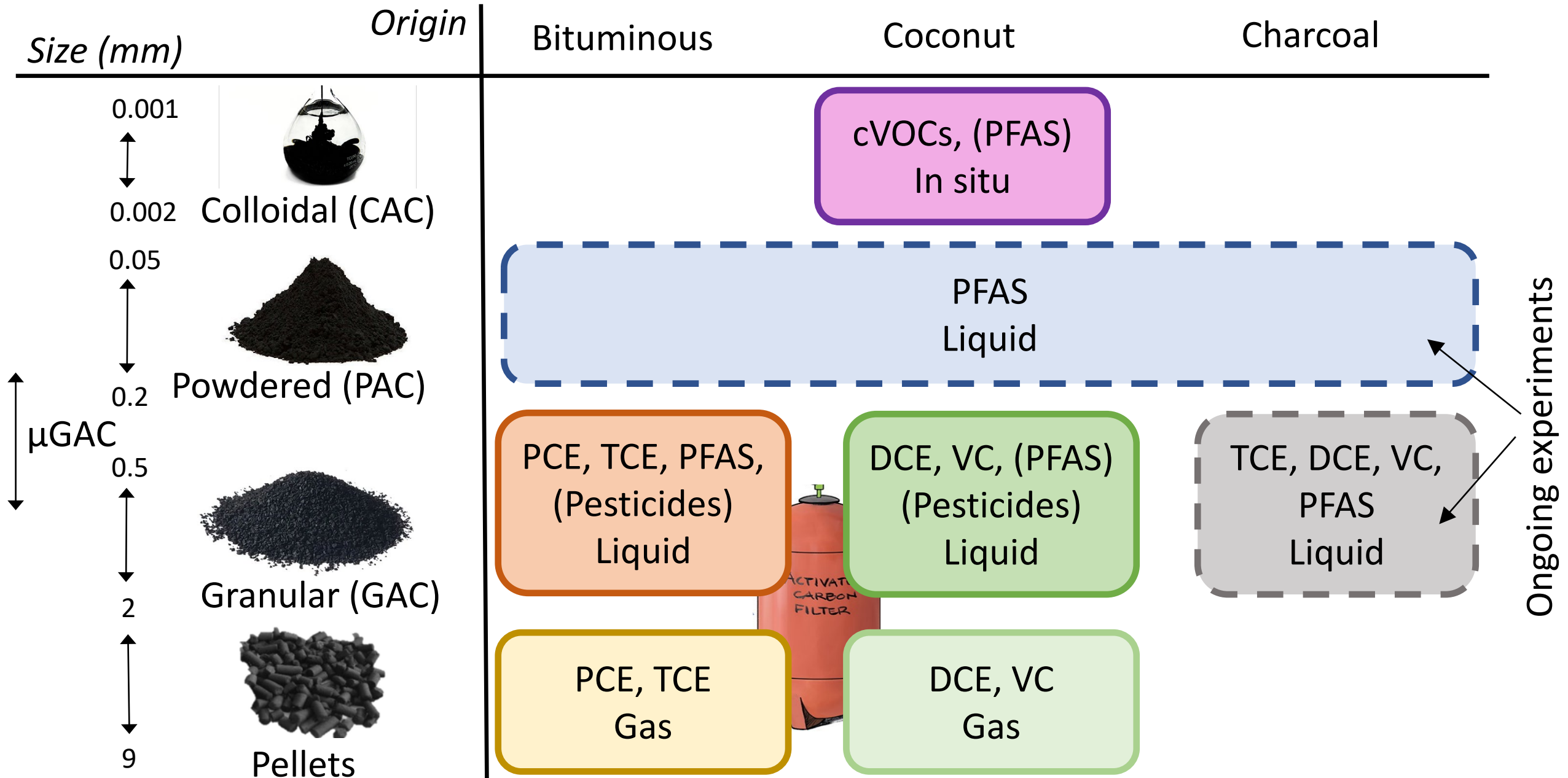


Capital Region of Denmark (CRD) P&T-plant at Nærum Industrial area

# Overview

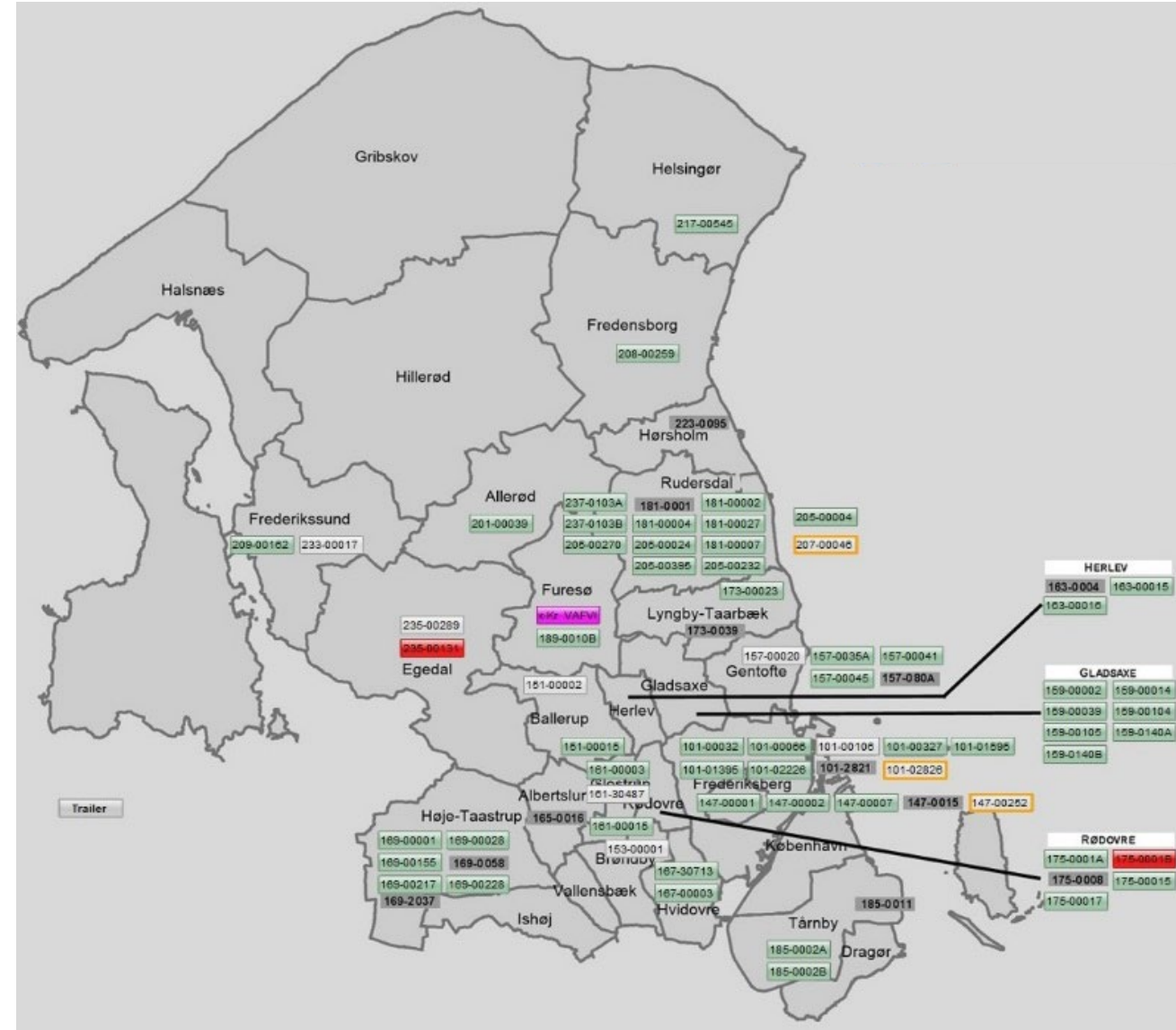
1. Experience with PFAS on activated carbon
2. Experience with ion exchange resins
3. Development work

# AC types and typical remediation use in Denmark

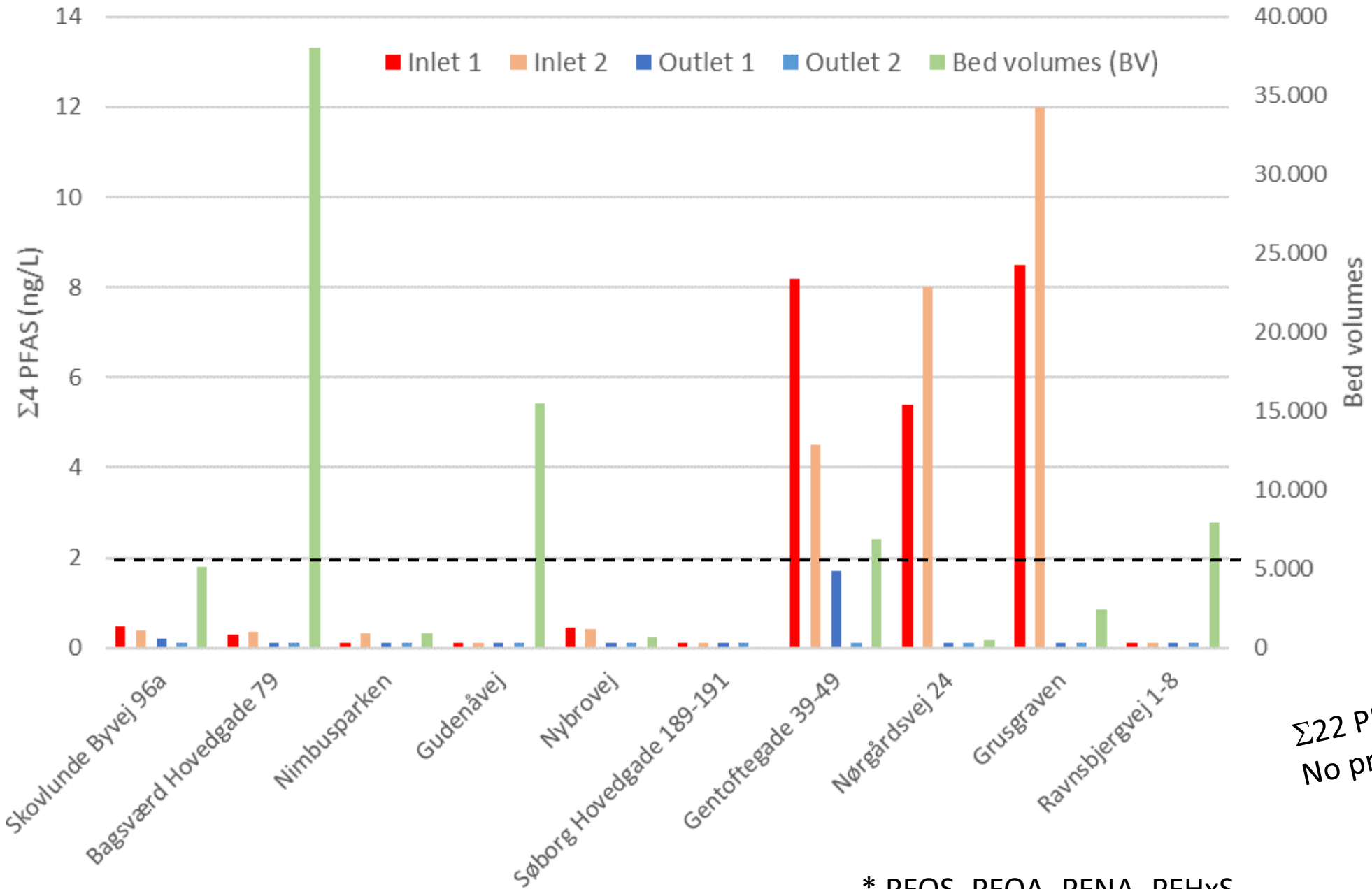


# PFAS as secondary component

- Analyses at 47 P&T plants
- Duplicate sampling separated by a month
- **Outlet criteria:**
- To fresh surface water
  - PFOS: 0,65 ng/l
- To groundwater
  - $\Sigma$  PFOS, PFOA, PFNA, PFHxS: 2 ng/l
  - $\Sigma$  22 PFAS: 100 ng/l
- To sewers (not shown)
  - Varying criteria



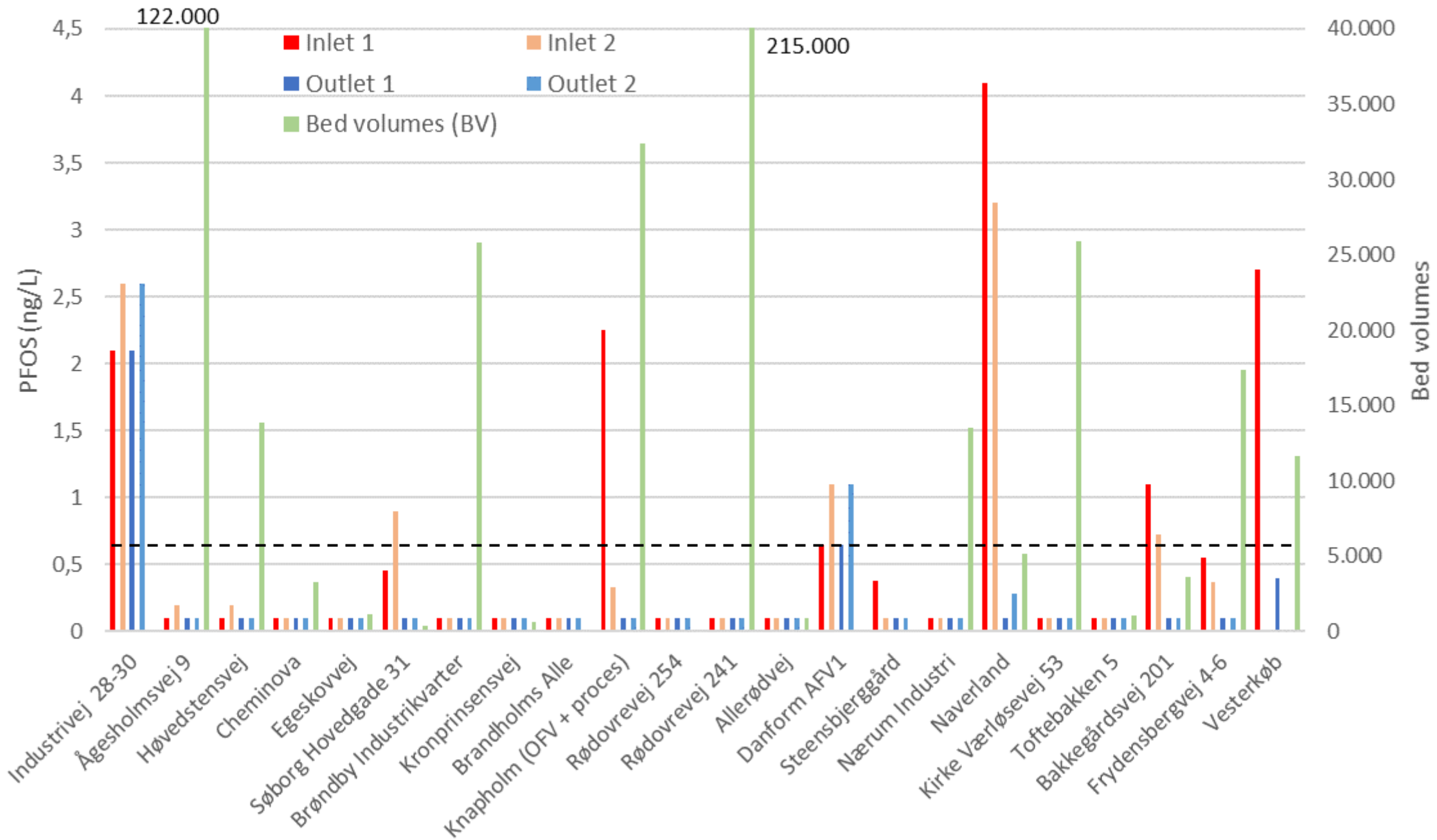
# $\Sigma 4$ PFAS\* at P&T plants with discharge to groundwater



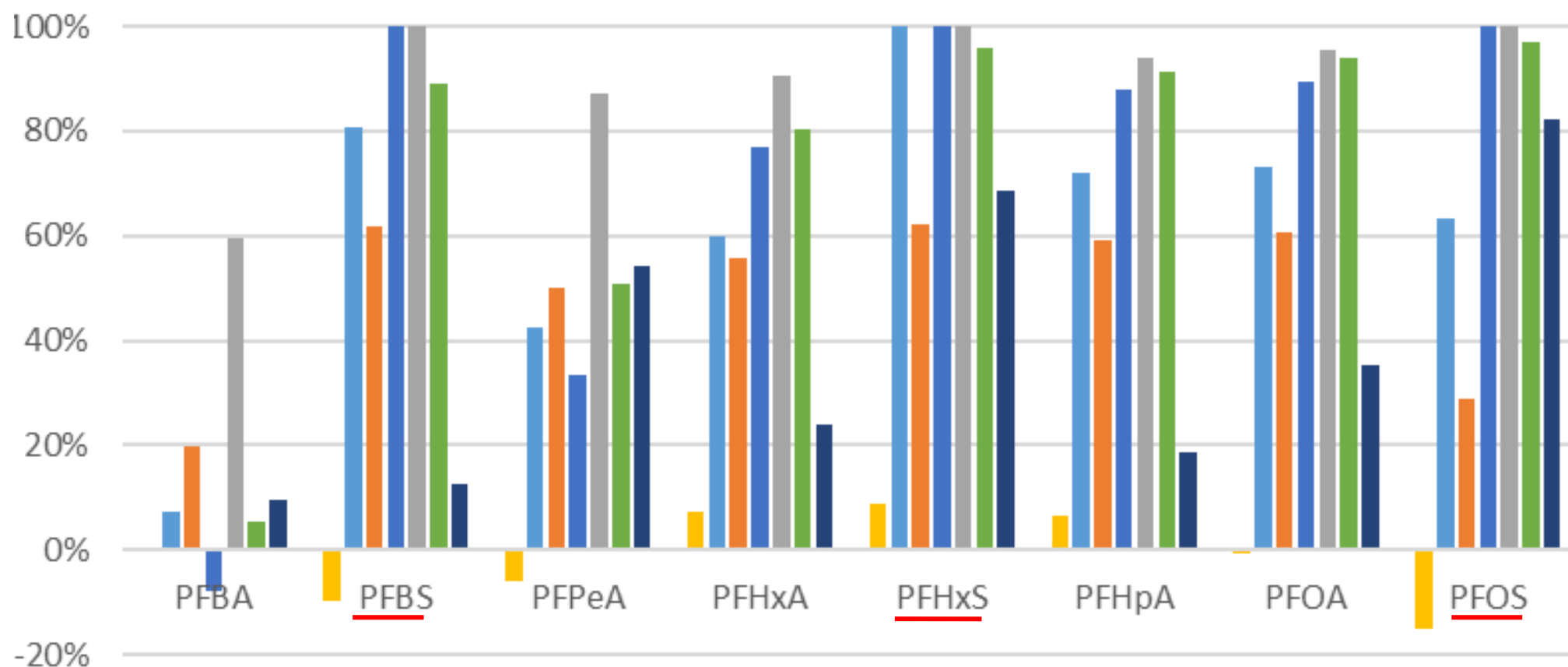
$\Sigma 22$  PFAS – 100 ng/l:  
No problem

\* PFOS, PFOA, PFNA, PFHxS

## PFOS at P&T plants with discharge to surface waters



## Reduction through GAC vessels



■ Ågesholmsvej (122400 BV, 20 min RT)

■ Marielundvej (7300 BV, 190 min RT)

■ Naverland (5200 BV, 70 min RT)

■ Glostrup Regnv.bassin (600 BV, 310 min RT)

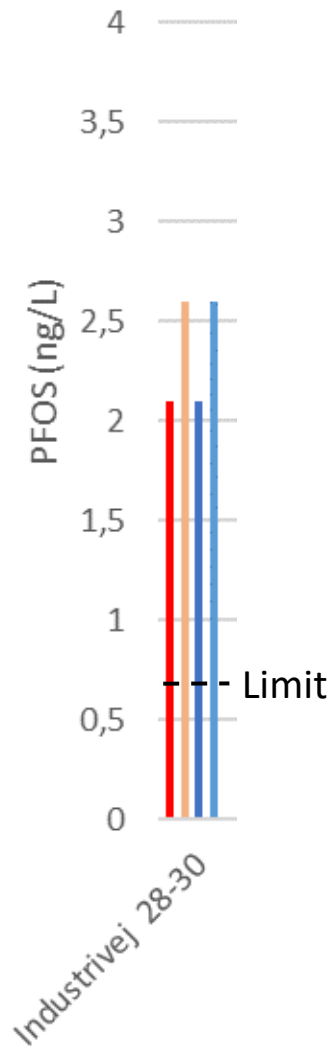
■ Åboulevard (8500 BV, 360 min RT)

■ Gentoftegade 39-49 (6900 BV, 140 min RT)

■ Rosenkæret 17 (1900 BV, 770 min RT)

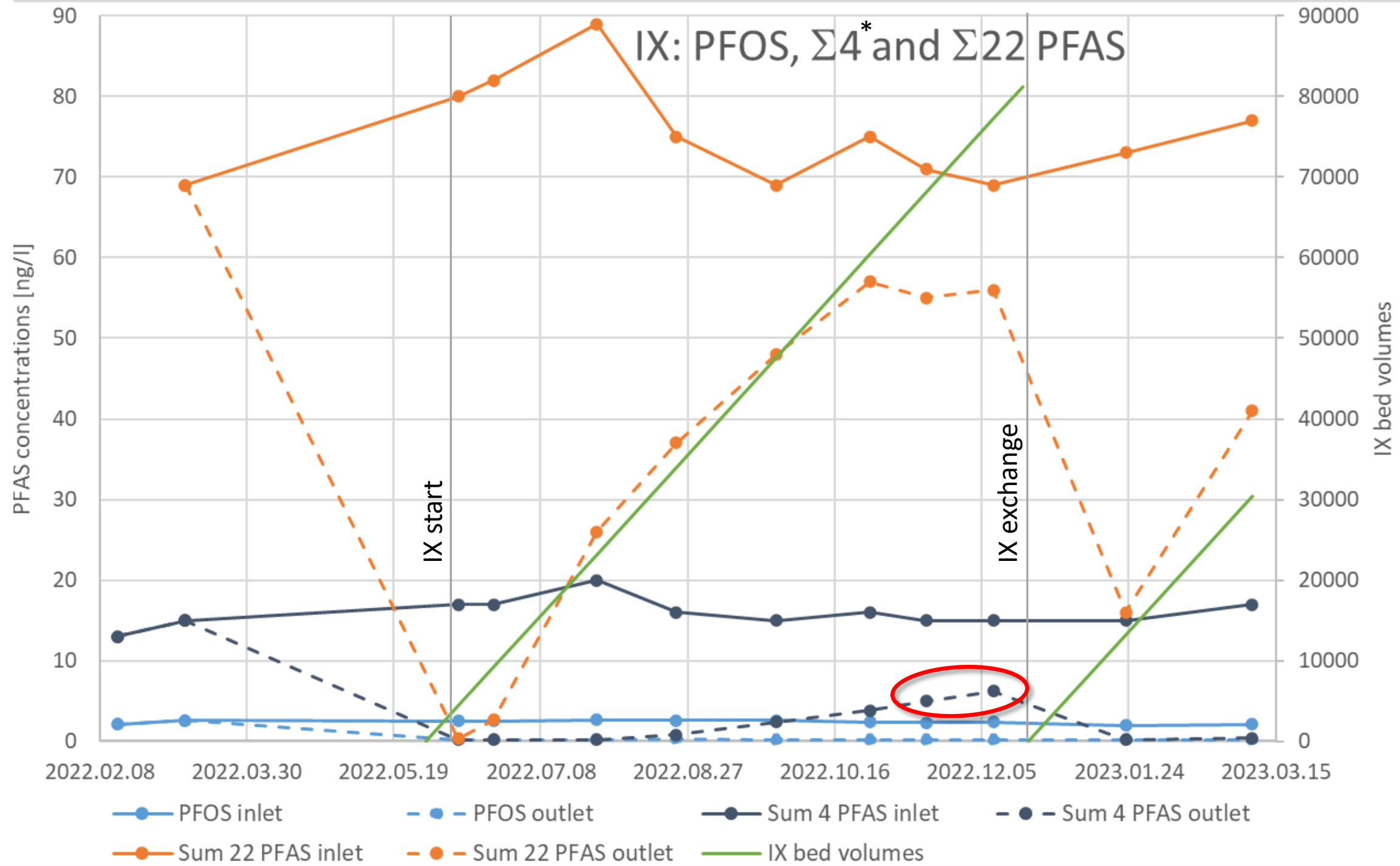


# Industrivej 28-30 site Ion exchange (IX) resins



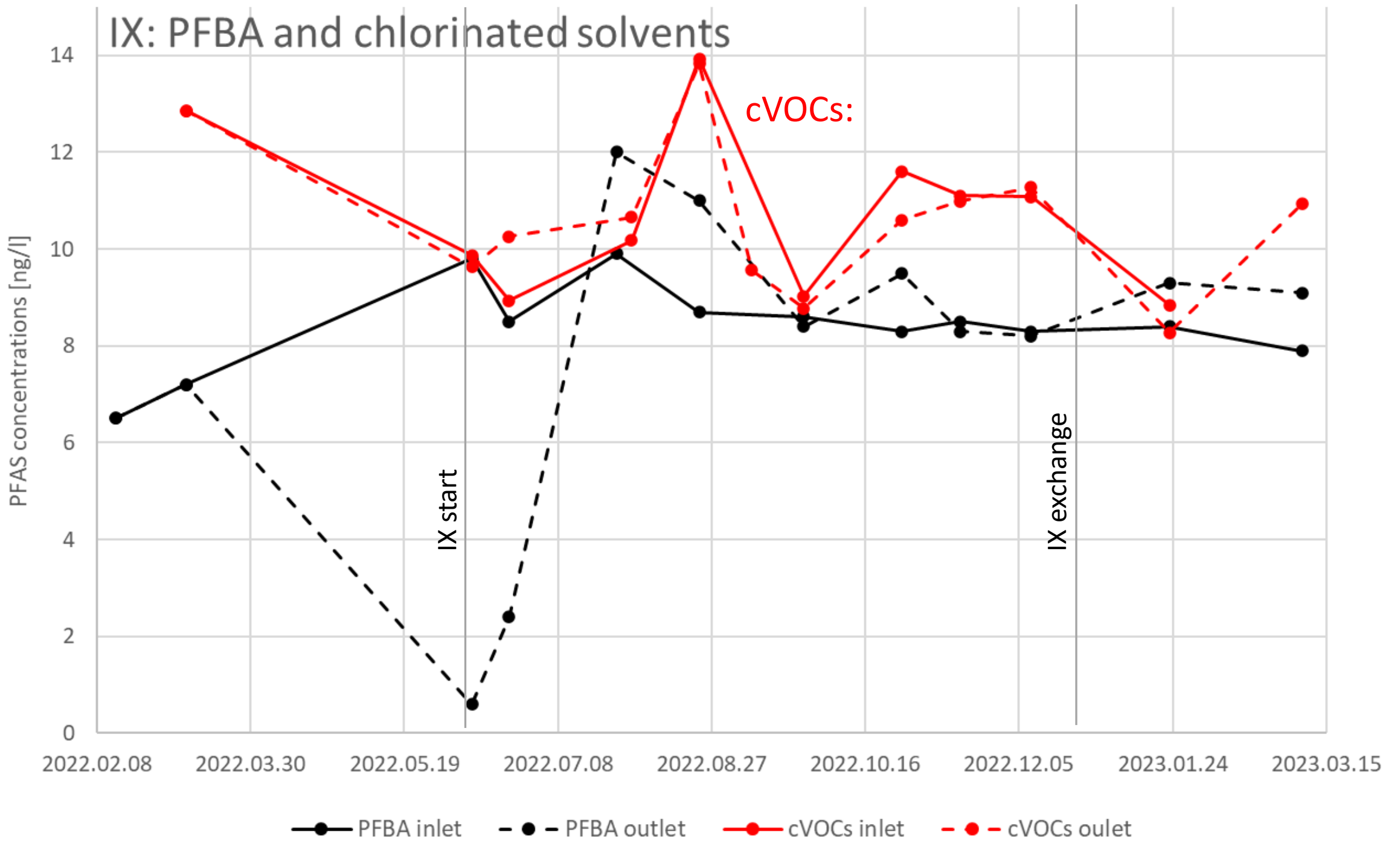
- No prior treatment
- Suspended solids were estimated to be low...
- Purofine PFA694E polystyrene based resins
- Surface water: PFOS 0,65 ng/l
- Vulnerable GW catchment
  - GW limits are also observed
  - $\Sigma 4$  PFAS: 2 ng/l
  - $\Sigma 22$  PFAS: 100 ng/l





\* PFOS, PFOA, PFNA, PFHxS

# IX: PFBA and chlorinated solvents



# Pre-treatment not optimal (i.e. non-existing)

Sep. 2022



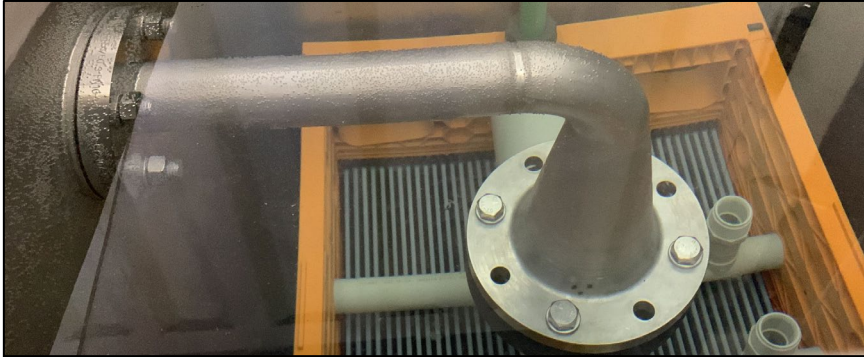
Dec. 2022



Development work



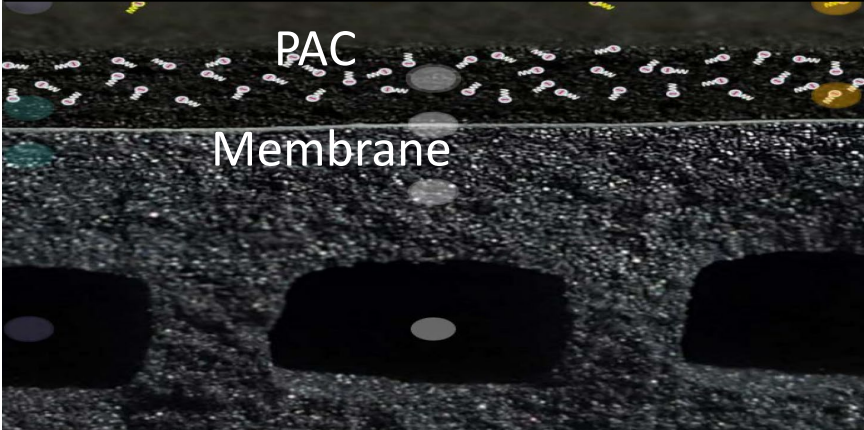
# PAC + ceramic membranes



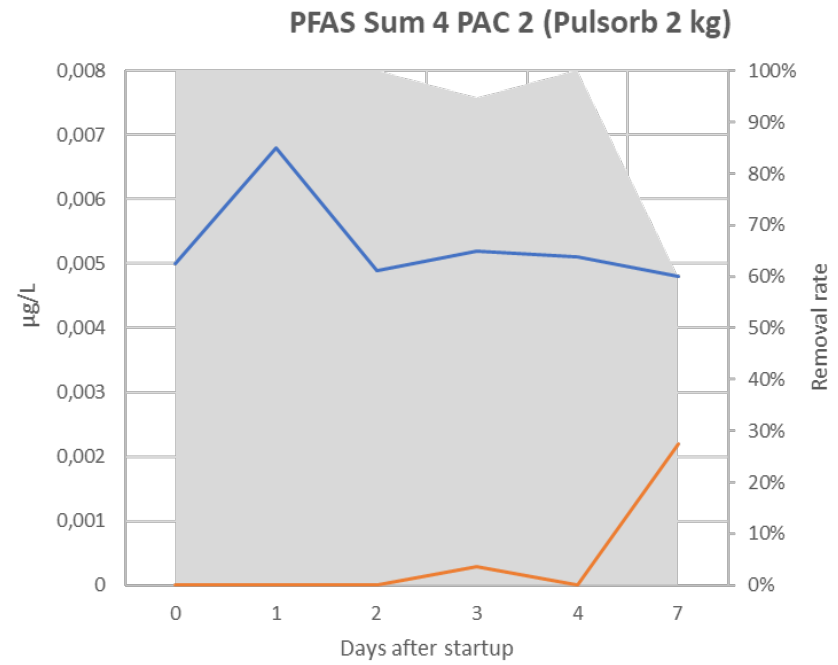
Without PAC



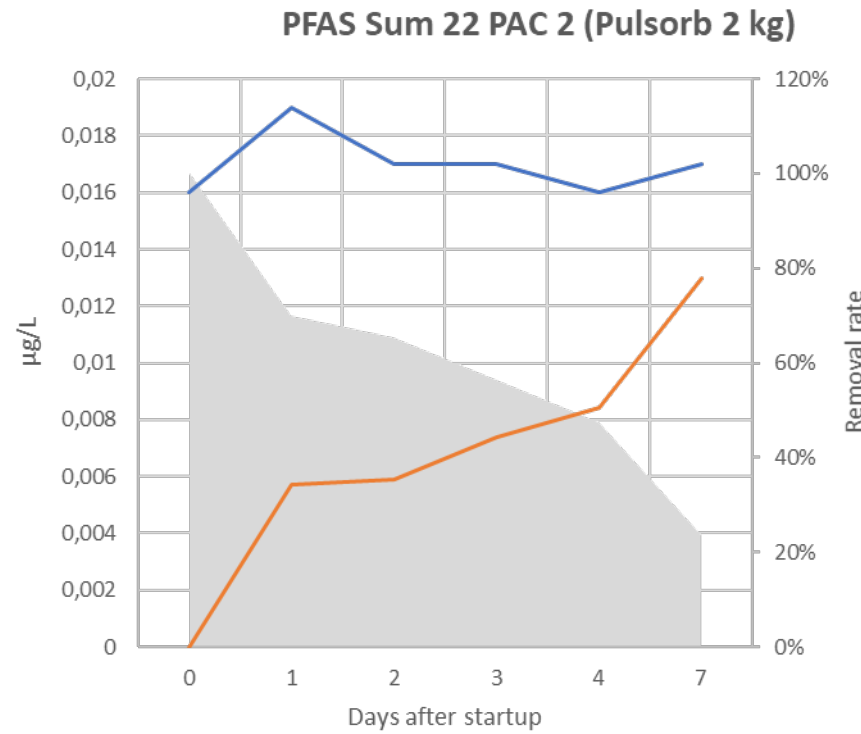
With PAC



## Preliminary results



**Carbon use:  
5,6 g/m<sup>3</sup>**



**GAC:  
10-50 g/m<sup>3</sup>**



# Conclusions

- Widespread load of PFAS in secondary groundwater
- Analyses at P&T plants are reproducible
- Filtration on GAC is efficient at low PFAS levels
- Short-chain carboxyl acids are tough – saved by  $\Sigma 22$ -limit
- PFAS as secondary components are not decisive for carbon exchange in our study
- Load capacity depends on concentrations
- Ion exchange materials work, but are no silver bullet
  - Cost comparable to GAC, less space
- PAC appears promising, longer-term studies underway



# Thank you for your attention

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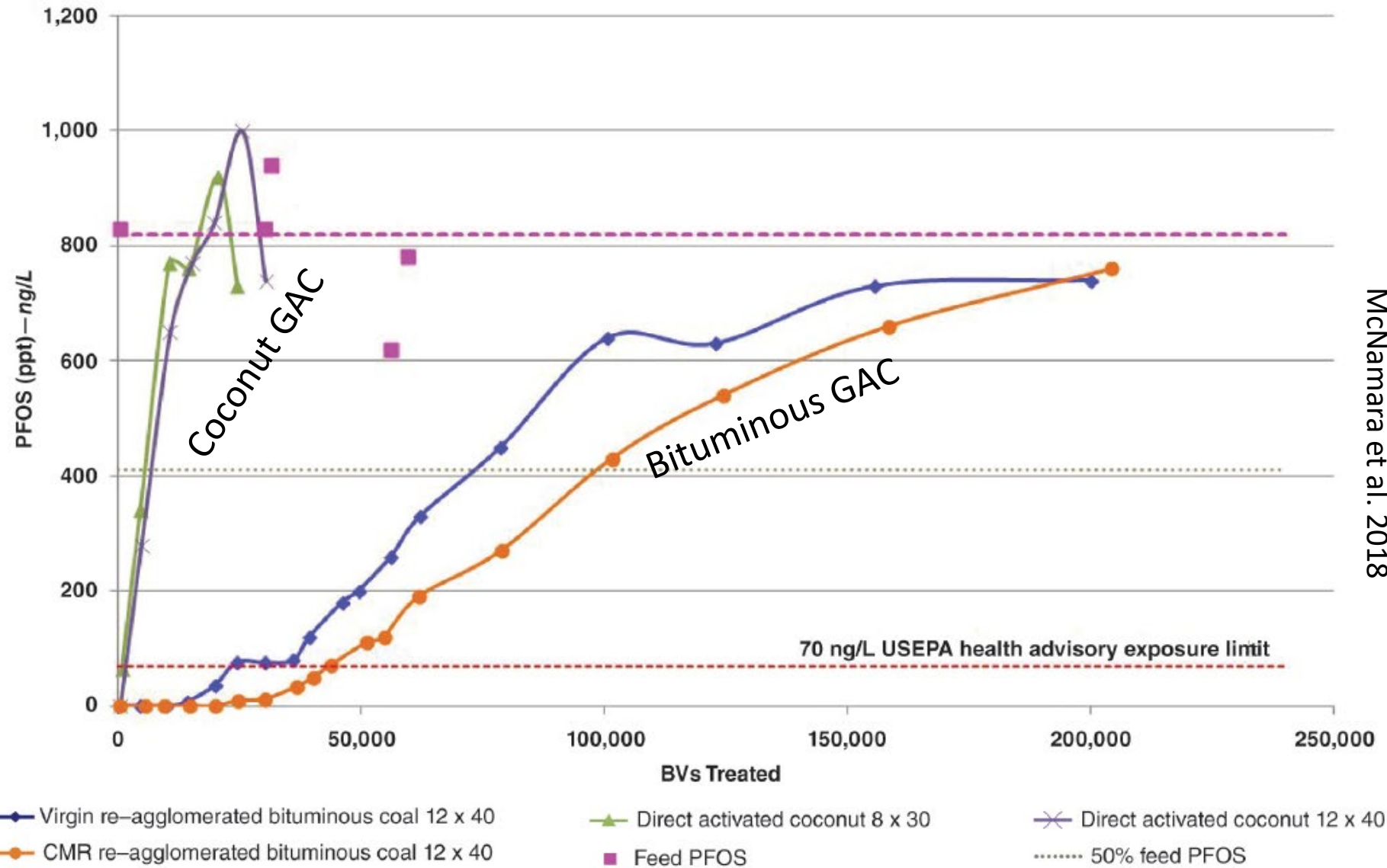


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Extras

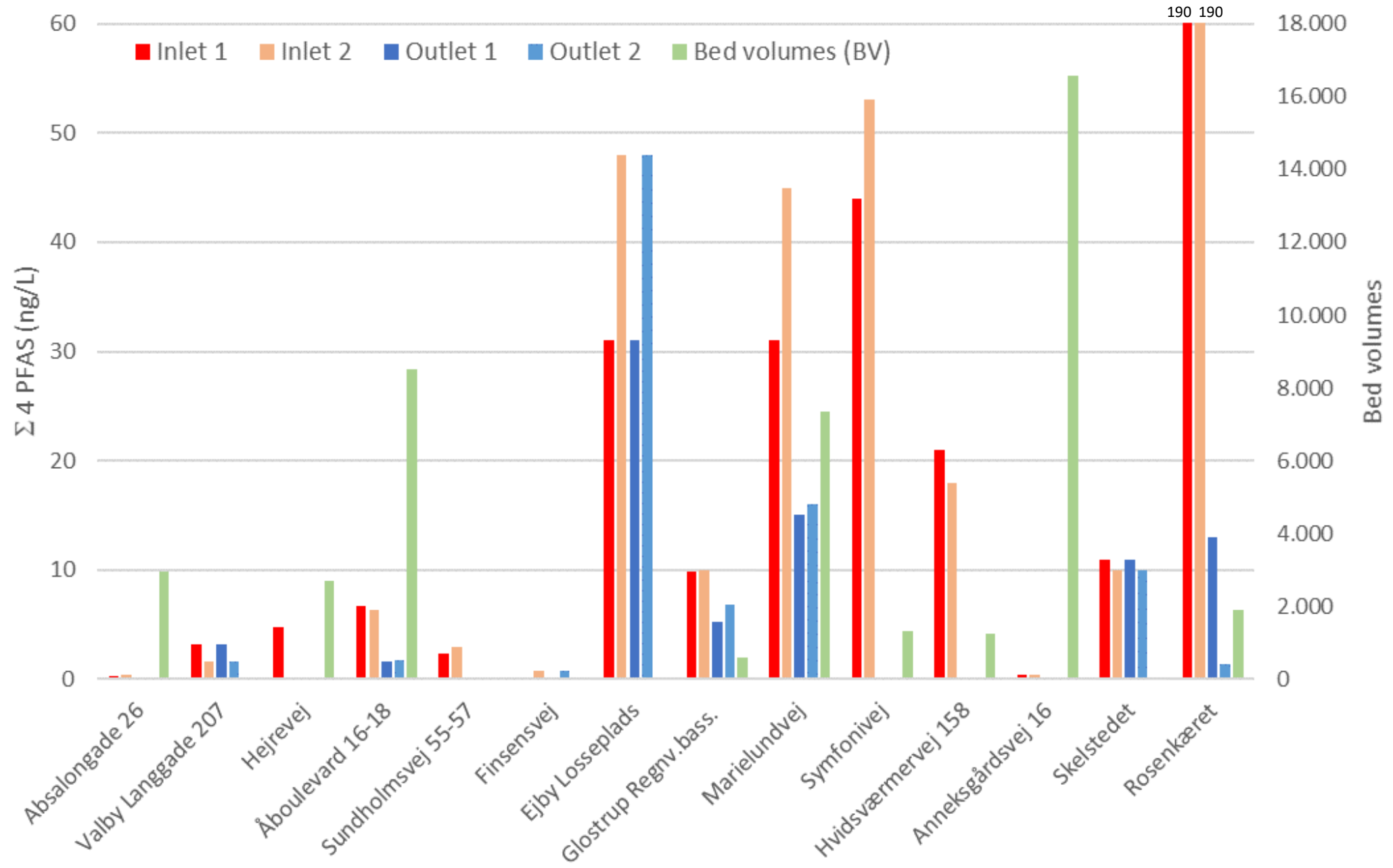
**FIGURE 4** RSSCT breakthrough curves of PFOS



McNamara et al. 2018

BV—bed volume, CMR—custom municipal reactivated, PFOS—perfluorooctane sulfonate, RSSCT—rapid small-scale column test, USEPA—US Environmental Protection Agency

## Σ4 PFAS at P&T plants with discharge to sewer



# Source tracking in WWTP-catchment

