

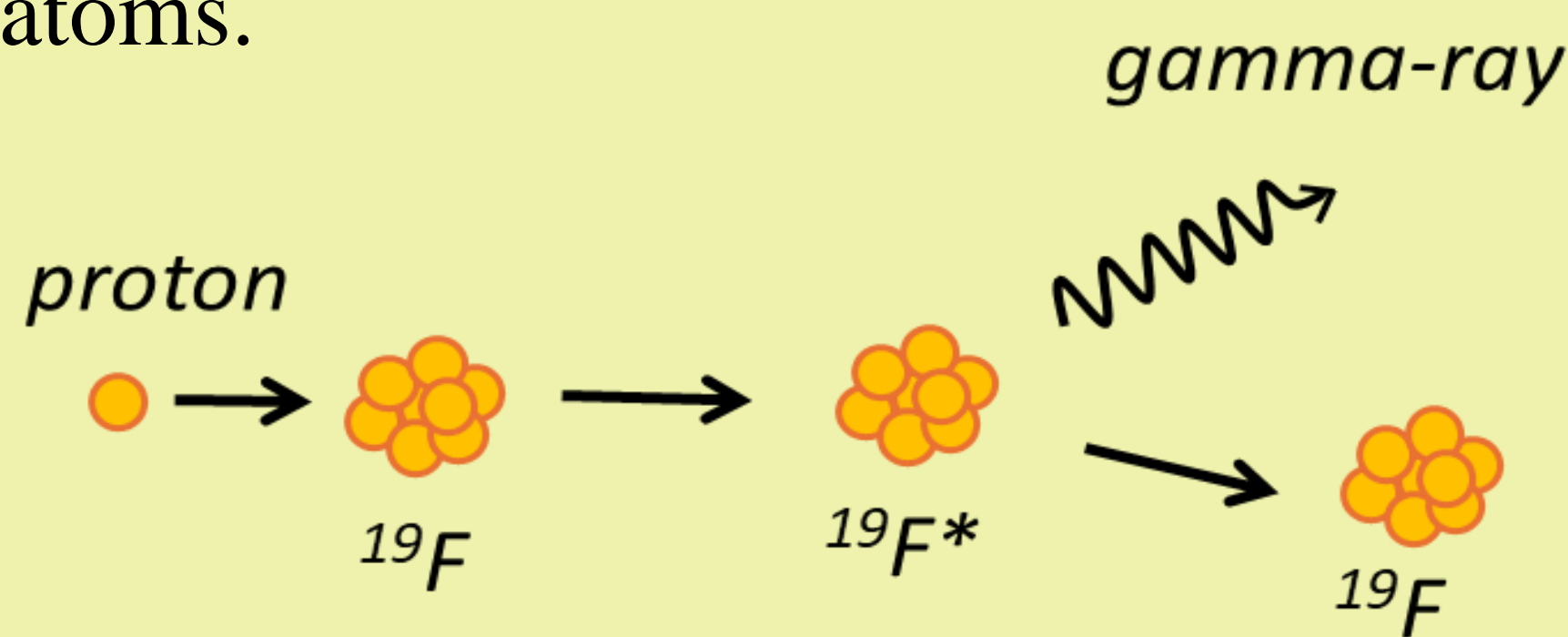
# Total PFAS Screening

## Summary

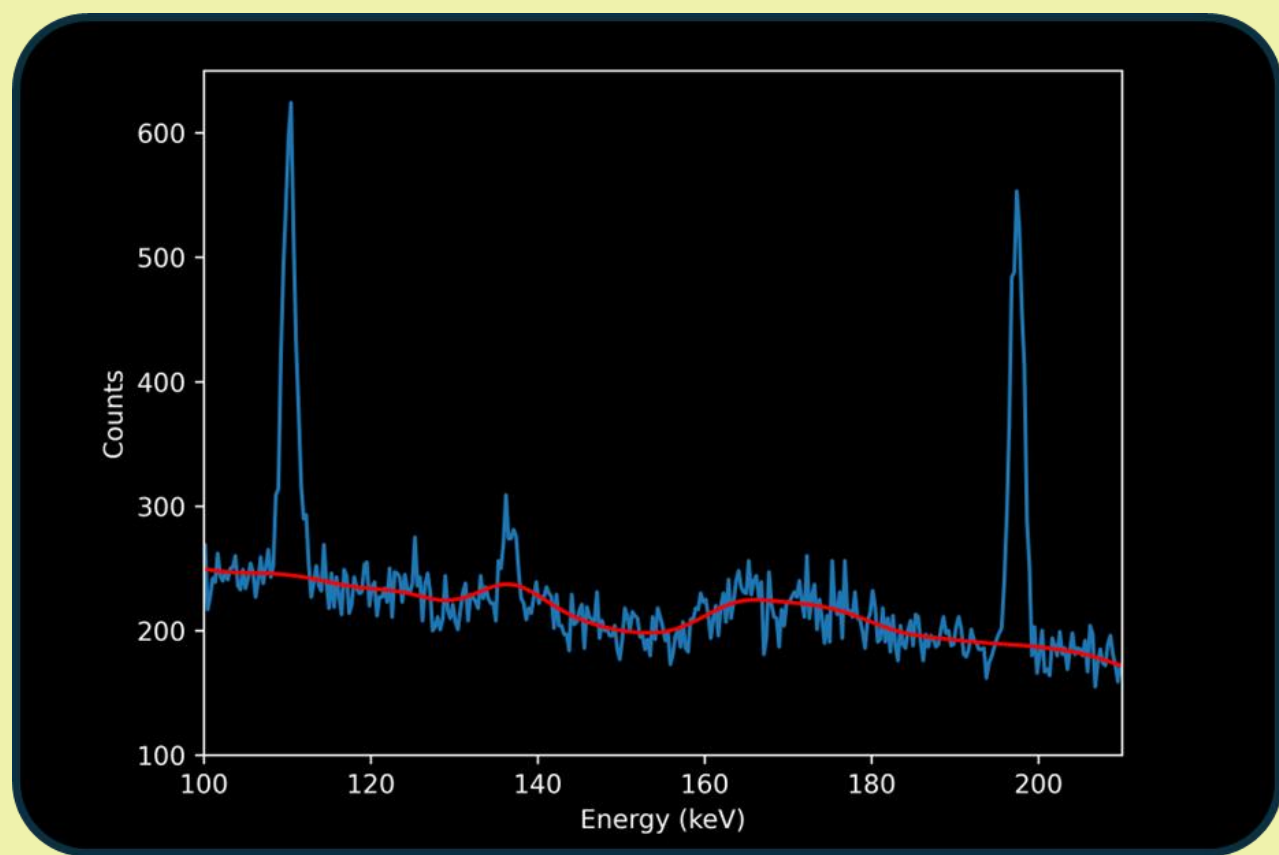
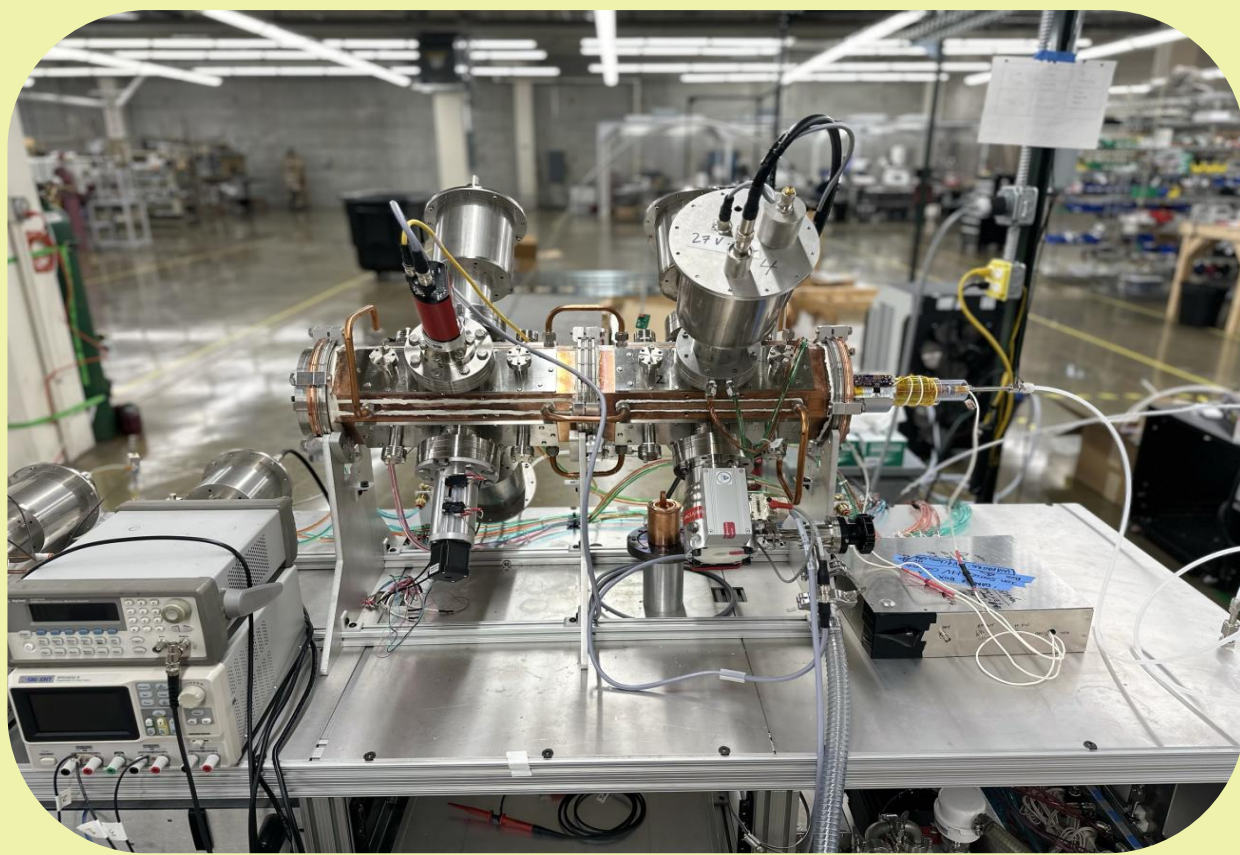
- Current methods to measure PFAS are expensive, take a long time and typically only cover a small percentage of all types of PFAS.
- Forever Analytical has developed a new measuring technique for **total PFAS** based on **Particle-Induced Gamma-ray Emission (PIGE)** Spectroscopy.
- The method combines a **simple extraction method** or **direct measurement** of various types of samples: water, soil, air, concrete, products such as clothing, toys, cosmetics and food preparation.
- The technique is **fast** (1-3 minutes), very **sensitive** (4 ppt), **accurate** (5-10%), **simple** (no lab required) and **cheap**. It can also be used for inline PFAS measurements.

## Particle-Induced Gamma-ray Emission

- Nuclear interactions are used to determine atomic composition of materials. Here, protons are accelerated and interact with fluorine atoms.



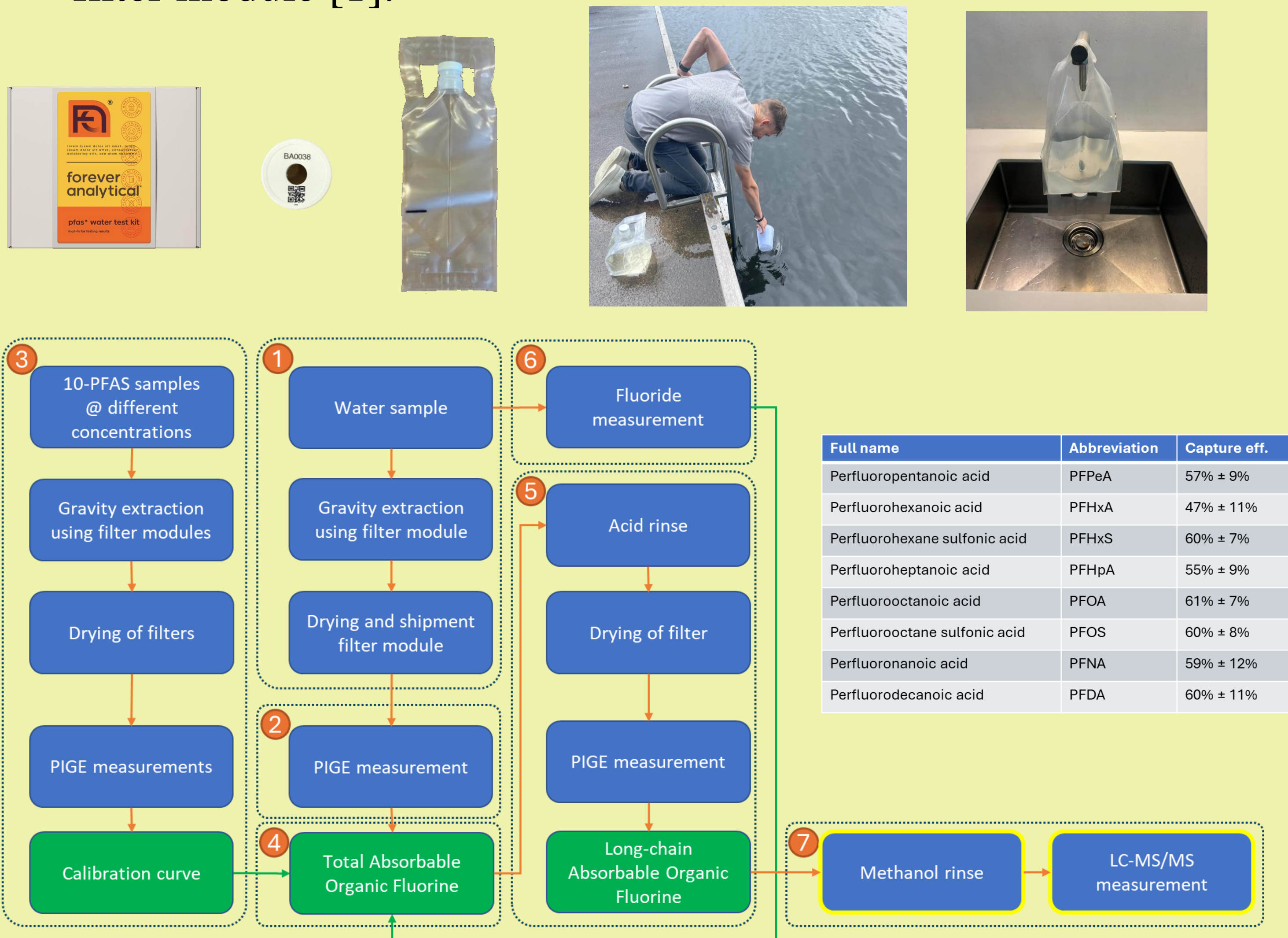
- A unique compact particle accelerator is used to generate an intense 2 MeV proton beam. A high-quality detector is used to create spectra of the emitted gamma-rays.



- Reference samples are used for calibration, which allows us to determine PFAS concentration from fluorine.
- Limit of Detection down to 4 ppt for water samples.

## PFAS extraction & measurement

- For water samples, a sample kit is shared with customer, containing a filter module, water bag and instructions.
- PFAS is extracted using an activated carbon fiber felt (ACFF) filter module [1].



- Distinction between long and ultra-short chain PFAS through acid rinse and second measurement.

## (Selected) Use cases

### Drinking water samples

Location	Total AOF (pre-rinse)	Total AOF (post-rinse)	Reverse Osmosis (pre-rinse)	Reverse Osmosis (post-rinse)	GAC (pre-rinse)	GAC (post-rinse)
Amsterdam	36,1 ± 10,9	21,8 ± 10,9	16,5 ± 9,8	7,0 ± 9,8		
Oostwoud	108,7 ± 16,1	57,3 ± 16,1	12,8 ± 11,1	17,2 ± 11,1	50,8 ± 13,7	22,2 ± 13,7
Edam	85,3 ± 16,3	33,4 ± 16,3				

All values are in ng/liter (ppt)



### Waste water samples

Location	AOF (pre-rinse)	AOF (post-rinse)
Location 1 (RWZI - effluent)	1212 ± 223	1250 ± 227
Location 2 (RWZI - effluent)	2178 ± 440	2071 ± 431
Location 3 (RWZI - effluent)	1046 ± 197	963 ± 191
Location 4 (RWZI - effluent)	1586 ± 317	1230 ± 287
Location 5 (RWZI - effluent)	1194 ± 215	1086 ± 204
Location 6 (RWZI - effluent)	9545 ± 962	10128 ± 997
Location 7 (RWZI - influent)	1312 ± 98	n.a.
Location 7 (RWZI - effluent)	815 ± 58	n.a.

All values are in ng/liter (ppt)



### Surface water samples

Location	Decant (pre-rinse)	Decant (post-rinse)	Residual (pre-rinse)	Residual (post-rinse)
Location 1 (farmers area)	61 ± 8	56 ± 8	2923 ± 124	2741 ± 124
Location 2 (farmers area)	278 ± 16	58 ± 8	2940 ± 118	1123 ± 117
Location 3 (farmers area)*	12876 ± 538	2015 ± 537		
Location 4 (sea water)*	1252 ± 97	n.a.		
Location 5 (river - Dommel)	268 ± 109	236 ± 88	1449 ± 209	1458 ± 209
Location 6 (Eindhoven airport)	831 ± 126	434 ± 86	1669 ± 278	1297 ± 263
Location 7 (recreational area)*	714 ± 41	708 ± 39		
Location 8 (swimming water)	146 ± 45	95 ± 38	421 ± 93	206 ± 89

All values are in ng/liter (ppt), \* samples were not decanted



### Other types of samples

- Fire fighting gear contains up to 2% PFAS [2].
- Up to 50% of food packaging contains PFAS [3].
- Baby car seats contain PFAS [4].
- Cosmetics contains PFAS, foundations, mascaras, and lip products have the highest proportion [5].

## References

[1] Screening for Per- and Polyfluoroalkyl Substances in Water with Particle Induced Gamma-Ray Emission Spectroscopy, M. Tighe et al. ACS EST Water 2021, 1, 2477–2484.  
[2] Another Pathway for Firefighter Exposure to Per- and Polyfluoroalkyl Substances: Firefighter Textiles, G. Peaslee et al. Environ. Sci. Technol. Lett. 2020, 7, 8, 594–599  
[3] Fluorinated Compounds in U.S. Fast Food Packaging, Schaidt et al. Environ. Sci. Technol. Lett. 2017, 4, 105–111  
[4] Side-chain fluorotelomer-based polymers in children car seats, Environmental Pollution, Volume 268, Part B, 1 January 2021, 115477  
[5] Fluorinated Compounds in North American Cosmetics, Environ. Sci. Technol. Lett. 2021, 8, 538–544

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