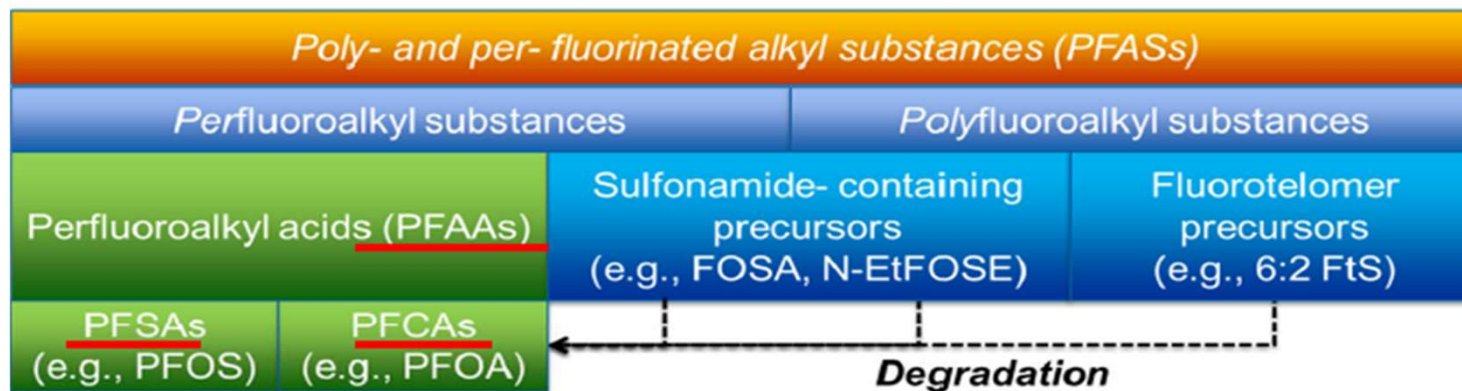


Poly and per fluorinated alkyl substances and Wastewater treatment plants



PFAS: Re-introduction

Alphabet Soup



- 3,000 man made compounds but we analyse for less than 30.
- So far 455 different PFAS in Fluorosurfacant based foams
- PFOS, PFHxS and PFOA

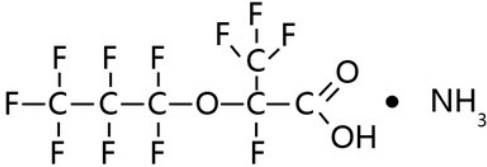
Ref: Wang et al, 2017, ES & T, 51, 5, pp 2508-2518

Dauchy et al, 2017, Chemosphere, 183, pp 53-61



Emerging PFAS Compounds

perfluorobutanesulfonic acid (PFBS)



GenX Chemical Structure

Gen X - [2,3,3,3-tetrafluoro-2-\(heptafluoropropoxy\)propanoic acid](#)



F-35B

ADONA

PFECHS

Fluorotelomers



Where is PFAS found?

- AFFF class B ~ 1970s (≈ 5% volume of use)
- Industrial/commercial facilities.
 - Textile manufacturers
 - Chromium electroplaters
 - Car wash
 - Aviation facilities
- Food packing/paper recycling.
- Landfill leachate.
- Household products (detergents, carpet cleaners, dental floss, etc.).
- Human effluent.



Compound	NZ (2 WWTP)	Australia	United States
PFBS	2.2 - 63	-	-
PFHxS	3.1 – 10	20	>310
PFOS	3.9 – 22	25	>790
PFHxA	7.3 – 50	18	>29
PFOA	8.2 - 17	22	>8170
6:2 FTS	59	-	-

Ref: Gallen *et al.*, 2018
Rayne & Forest, 2009



Tradewaste Bylaws



Disposal of PFAS containing wastewater to trade waste

Prepared by Dr Peter Dawson, Principal Scientist, Environmental Protection Authority

Reviewed by Dr Grant Northcott, Director, Northcott Research Consultants Limited; Honorary Associate, Plant & Food Research; Adjunct Senior Lecturer, School of Environmental & Rural Sciences, University of New England, Armidale, NSW

<http://www.mfe.govt.nz/sites/default/files/media/Land/PFOS-disposal-to-trade-waste-guidance.pdf>

Trade waste Limits

- NZS 9201 – No limits
- PFOS – 0.1 µg/L
- PFOA - 0.1 µg/L
- PFAS(total) - 1µg/L

Receiving Water Limits

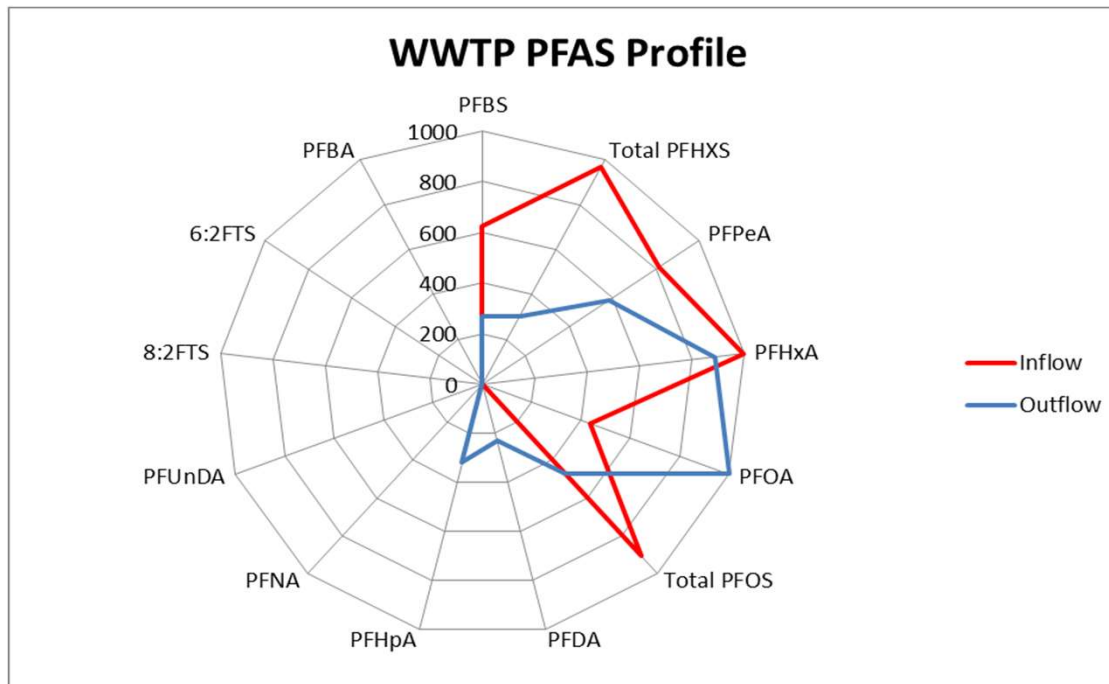
Draft ANZECC (95%) - 0.130 µg/L

Onset effects – 0.001 - 0.010 µg/L

Bioaccumulation/secondary poisoning -????

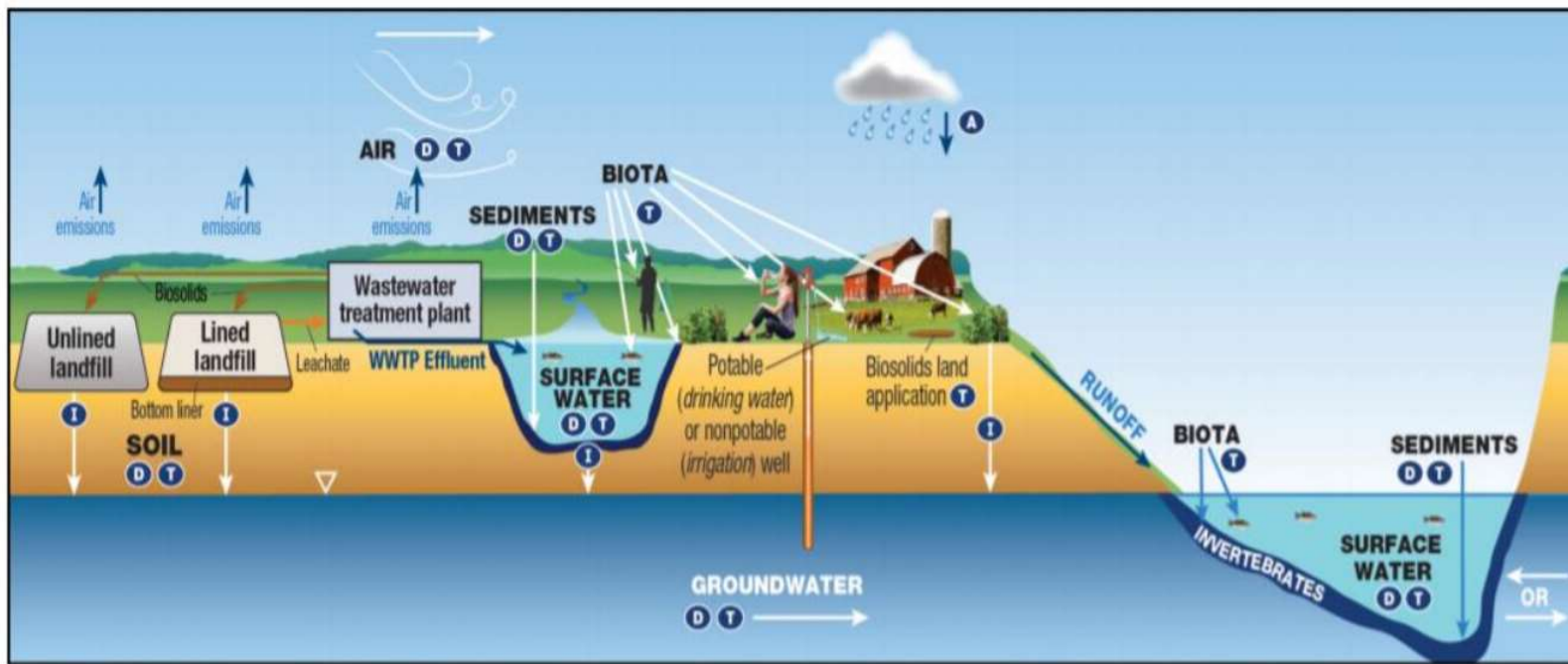


Transformation of Precursor Compounds inside WWTP



- Between 60-90% PFAS entering – unquantified.
- Abiotic/biotic process increase PFCA.
- Biosolids removal – short chain compounds less than 1%.
- C10 + compounds do accumulate in biosolids.





KEY A Atmospheric Deposition D Diffusion/Dispersion/Advection I Infiltration T Transformation of precursors (abiotic/biotic)

Bioaccumulation in Biota

Biota Sampling Results - Per- and Poly-Fluoroalkyl Substances (PFAS) - Freshwater Fish ^{1,2}								
Sample Results ⁴	Tissue Residues				Bioconcentration Factor ³			
	Species							
	Carp	Shortfin Eels	Longfin Eel ⁵	Bully	Carp	Shortfin Eels	Longfin Eel ⁵	Bully
PFSA Compounds								
PFBS	<LOR	<LOR	<LOR	<LOR	NC	NC	NC	NC
Sum of Total PFHxS+PFOS ^{6,7}	23 - 81	19 - 1600	30	13 - 17	NC	9 - 727	40	23 - 591
PFNS	<LOR	<LOR - 20	<LOR	<LOR	NC	NC - 12500	NC	NC
PFCA Compounds								
PFBA	<LOR	<LOR - 0.56	<LOR	<LOR	NC	NC	NC	NC
PFHxA	<LOR	0.25 - 0.45	<LOR	<LOR	NC	1 - NC	NC	NC
PFOA	<LOR	0.37 - 0.69	0.35	<LOR	NC	9 - 69	4	NC
PFNA	0.31 - 0.96	<LOR - 4.3	0.5	<LOR - 0.4	NC	NC - 123	25	NC - 20

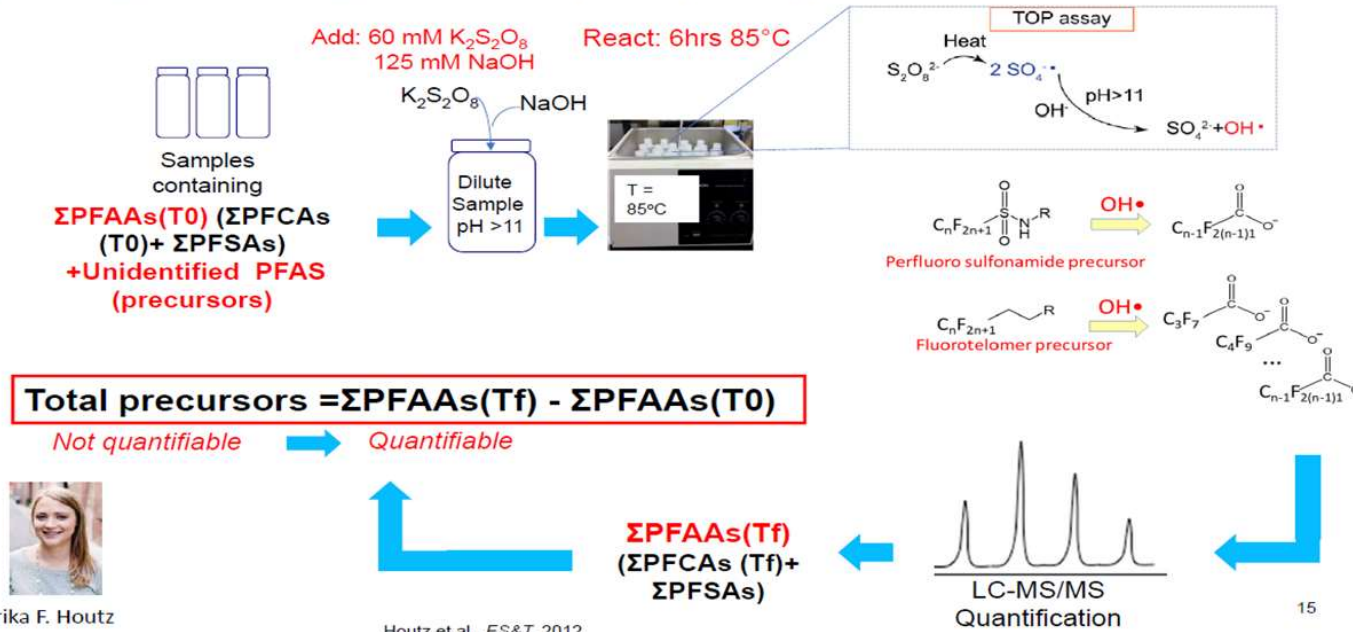
- Significant accumulation in some biota including eels and watercress.
- Long chain accumulate more than short chains.
- Long chain PFNS, PFNA, PFNDA can be below 0.1 ppt but still have significant BCF. (ANZECC 99% no protection).
- Some PFAS compounds are very bio-persistent. Need to consider for HRA.

Ref: Cervený *et al.* (2018) *Water Research*



Is TOPA the Answer?

Total Oxidative Precursor (TOP) assay



Shan Yi (2018) TOP for analysing PFAS
Houtz et al, 2013



Conclusions

- **PFAS sources include domestic and industrial inputs.**
- **NZ WWTP likely to be similar to Australian WWTP.**
- **Most trade waste consents probably do not have PFAS limited. NZ EPA has set limits for PFAS.**
- **Effluent can contain more PFCA than influent.**
- **Bioaccumulation potential should be considered when consenting WWTPs.**

