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PFAS IN CANADIAN MUNICIPAL WASTEWATER TREATMENT SYSTEMS: 12 years of monitoring by ECCC

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OUTLINE

- The Chemicals Management Plan (CMP)
- Wastewater monitoring program
- PFAS as a chemical family of concern
- Study objectives
- Methods
- Results & discussion
  - Fate of PFAS through liquid and solids trains of typical treatment types used in Canada
  - Time trends of PFAS in wastewater influent, effluent, and biosolids between 2009 and 2021
- Conclusions

THE CHEMICALS MANAGEMENT PLAN (CMP)

- Under the Canadian Environmental Protection Act (CEPA 1999)
- Co-led by Health Canada and Environment and Climate Change Canada (ECCC)
- 2006 to 2024 so far
- Designed to:
  - Take action on the highest priority substances
  - Provide transparency and predictability
  - Invest in research and monitoring

WASTEWATER MONITORING PROGRAM

- Wastewater effluents and biosolids are important pathways to the environment for many chemicals, through consumer products
- Wastewater sector has no control over chemicals entering its treatment systems.
- Field data to inform model predictions for removal and fate (risk assessment)
- Field data to evaluate upstream control measures (risk management)

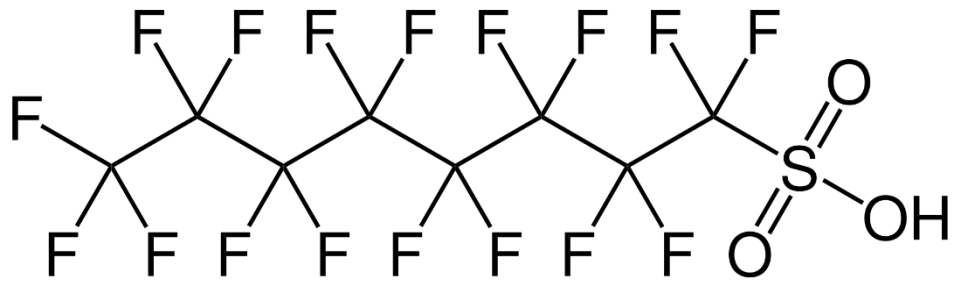
WASTEWATER SCIENCE UNIT

Environment and Climate Change Canada

- Wastewater monitoring program established under CMP in 2009
- 14 – 16 plants monitored across Canada once per year
- Monitor inputs (influent) and outputs (effluent and biosolids) in the wastewater sector
- WWTPs participate anonymously
- Representative of treatment types and geography

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

- Used in a wide variety of industrial and consumer products
- Over 4,700 PFAS known to exist
- Some PFAS are highly persistent (e.g., PFOS, PFOA)
- Some PFAS are not persistent but transform to PFAS that are persistent



Adhesives
Food packaging
Non-stick cookware
Outdoor clothing
Cleaning products

Cosmetics
Carpets
Upholstery
AFFF

WHY IS EVERYONE FREAKING OUT ABOUT PFAS?

- Exposure to certain levels of PFAS may lead to:
  - Reproductive effects such as decreased fertility
  - Developmental effects or delays in children
  - Reduced ability of the body's immune system to fight infections
  - Interference with the body's natural hormones
  - Increased cholesterol levels and/or risk of obesity
  - Increased risk of kidney or testicular cancer
  - Effects to wildlife at environmentally realistic concentrations

Sources: ECCC & Health Canada, US EPA, ATSDR, ITRC

PFAS – REGULATIONS AND PHASE-OUTS

- PFAS not manufactured in Canada (to our knowledge)
- Phased-out by major US manufacturers:
  - Early 2000s – PFOS + precursors
  - Late 2000s/early 2010s – PFOA + precursors
  - By 2025 - 3M will stop manufacture and use of PFAS
- 2009: PFOS regulated in Canada
- 2016: PFOA, and long-chain perfluorocarboxylic acids (LC-PFCAs) regulated in Canada
- 2021: Government of Canada published a notice of intent to move forward with activities to address the broad class of PFAS
- 2023: Government of Canada will publish a State of PFAS report to inform discussions on addressing PFAS as a class

OUR STUDY OBJECTIVES

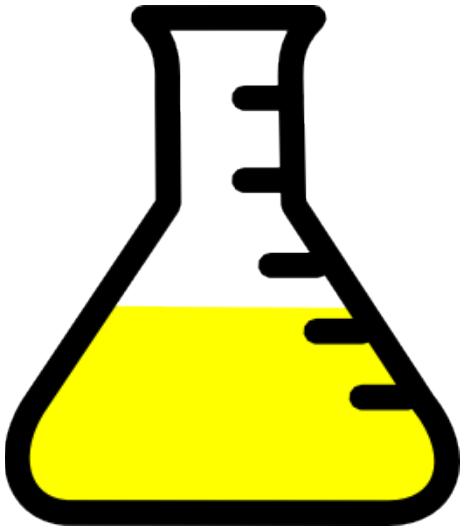
- Concentrations and removals of PFAS through liquid and solids trains of typical treatment types used in Canada
- Assess time trends of PFAS in wastewater influent, effluent, and biosolids between 2009 and 2021

SAMPLING METHODS

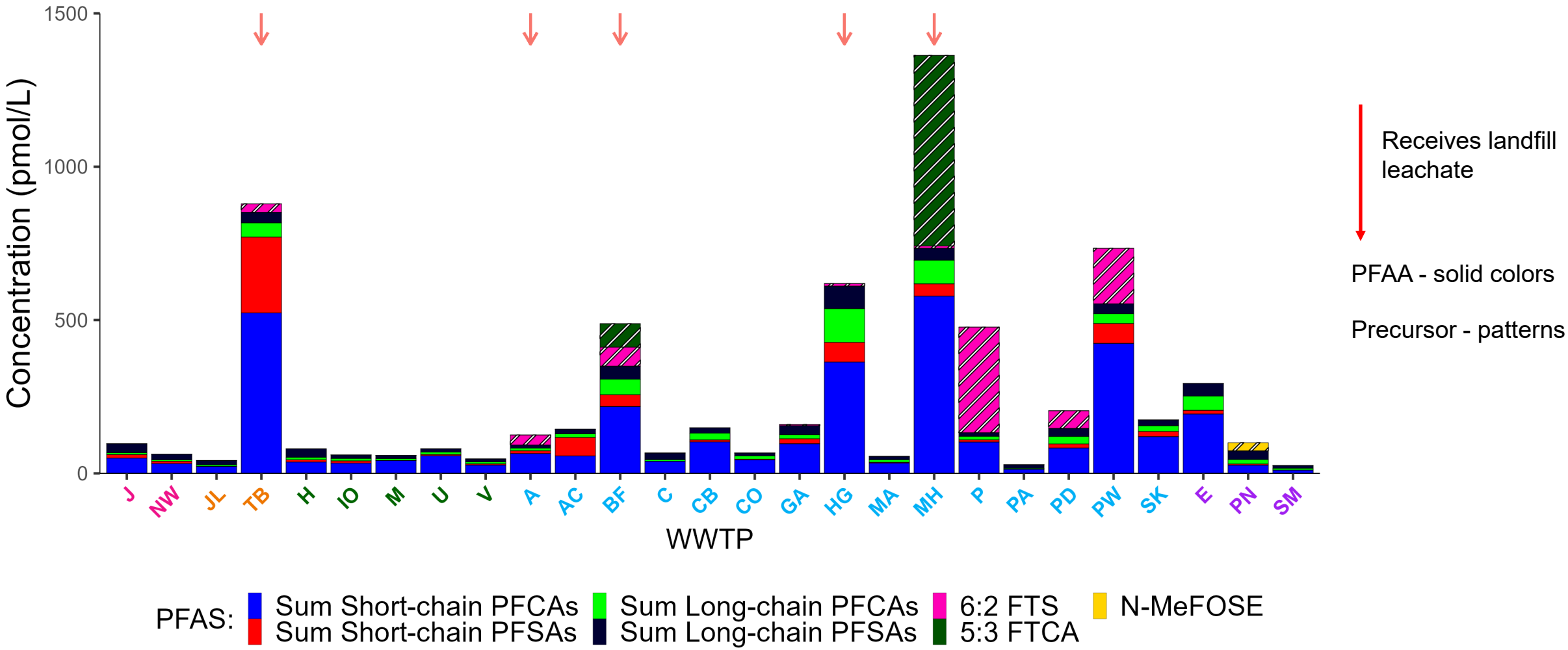
- 10 to 20 WWTPs
- 3 consecutive weekdays
- 2009, 2010, 2011, 2013, 2014, 2015, 2016 (biosolids only), 2018, 2019, 2021
- Raw influent & final effluent (24-hour composite)
- Treated biosolids (Grab)

CHEMICAL ANALYSIS

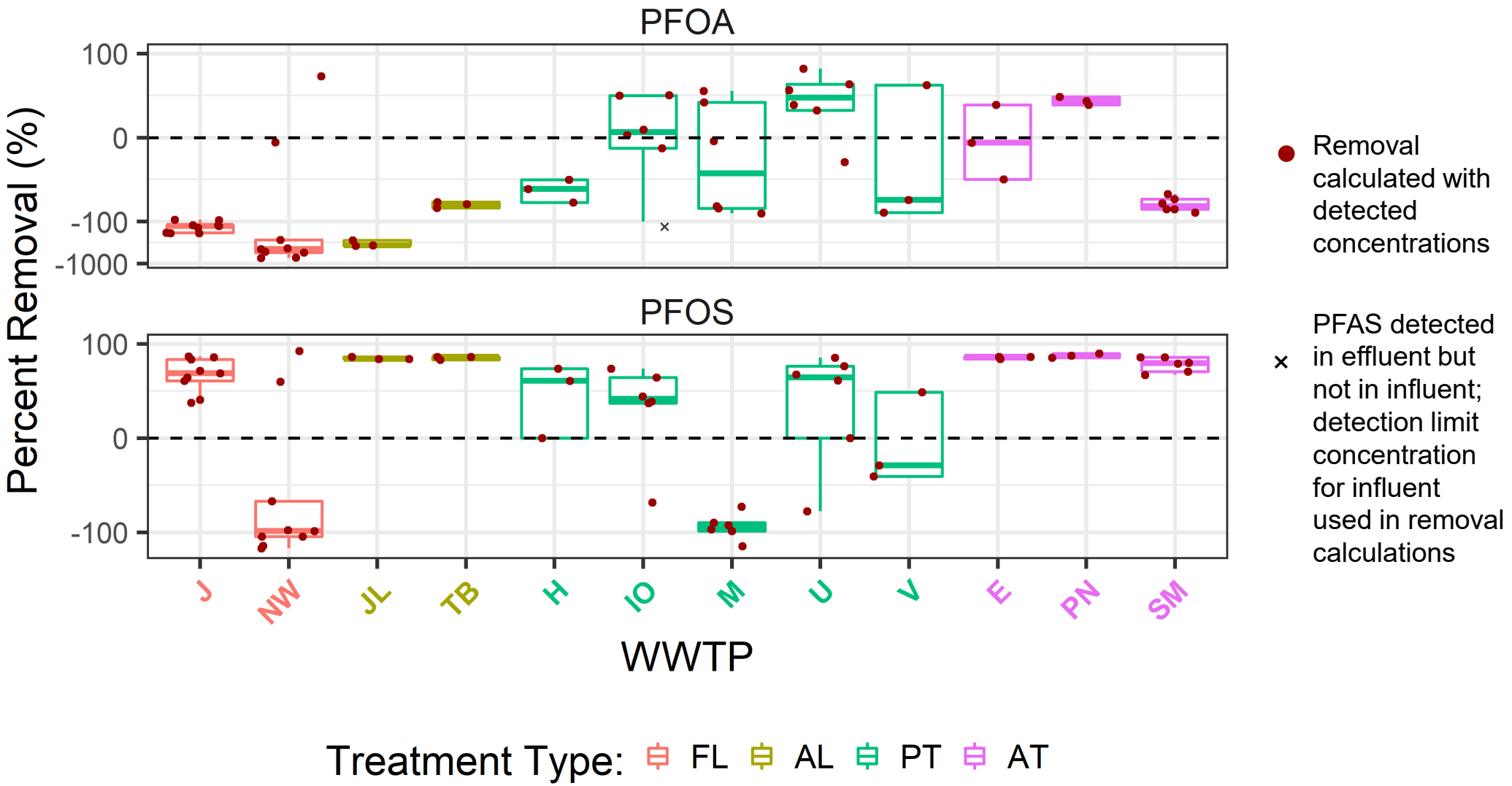
- SGS AXYS Analytical Services Limited
- Developed U.S. EPA Method 1633 draft
- Number of PFAS analyzed increased over years (13 to 40)



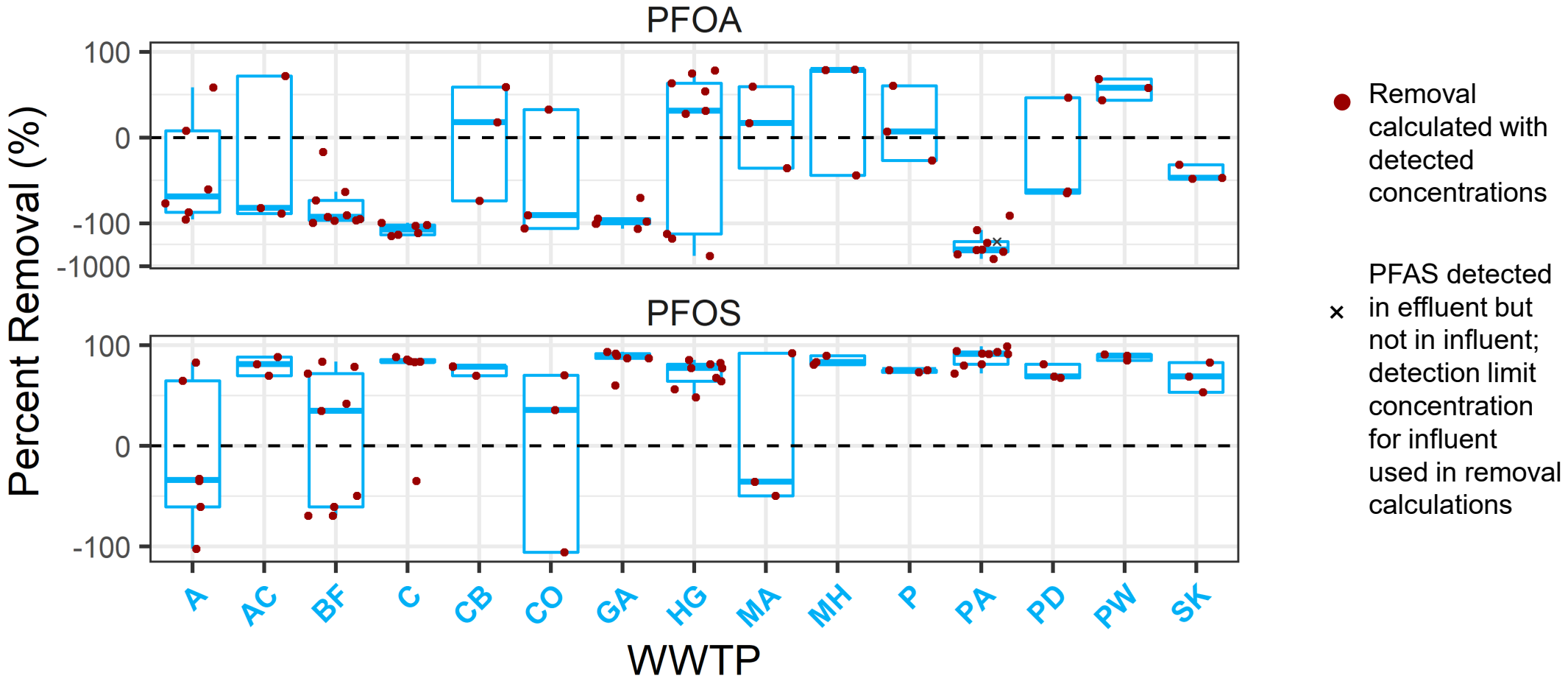
INFLUENT CONCENTRATIONS 2018, 2019, 2021



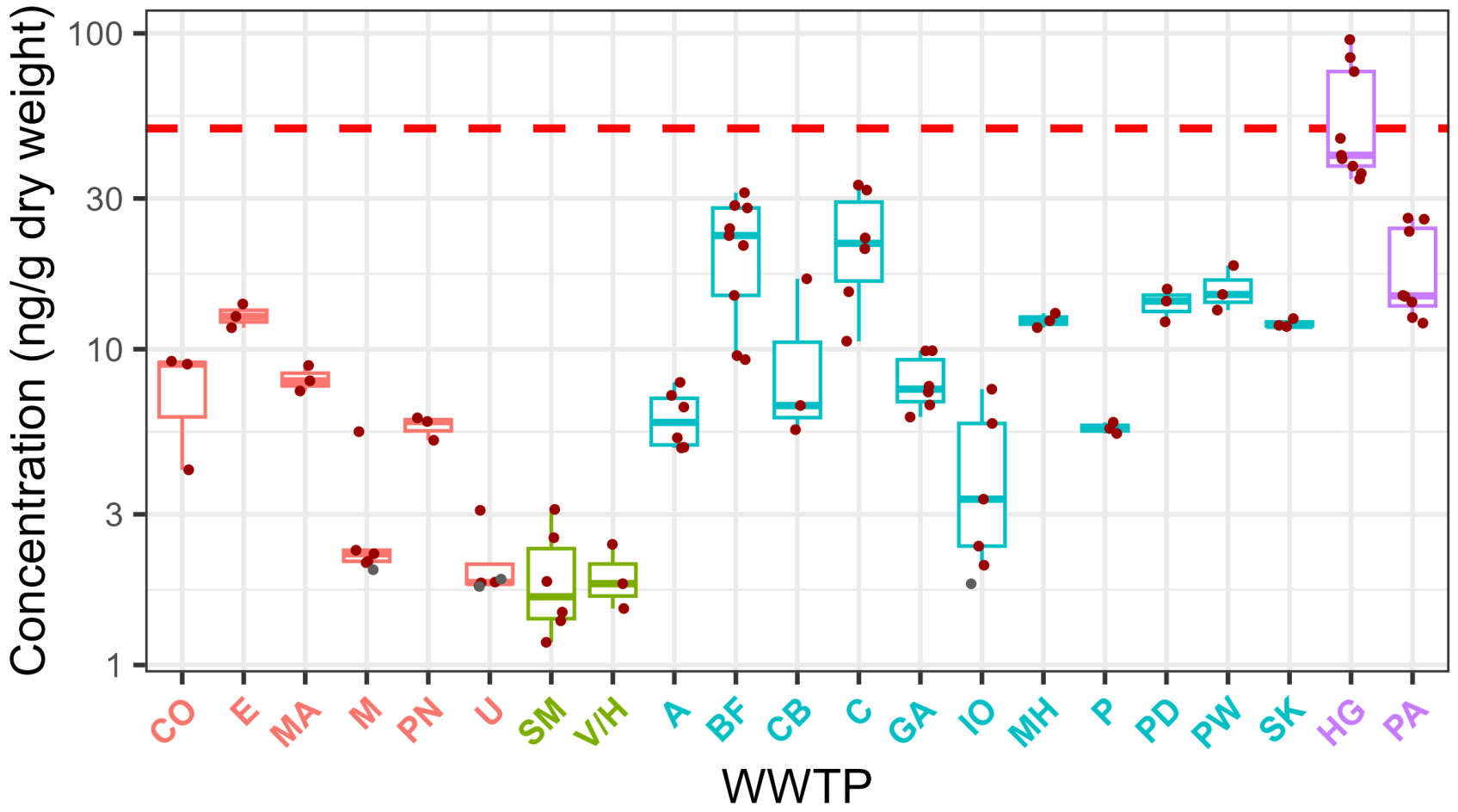
PERCENT REMOVAL 2018, 2019, 2021



PERCENT REMOVAL 2018, 2019, 2021 ST

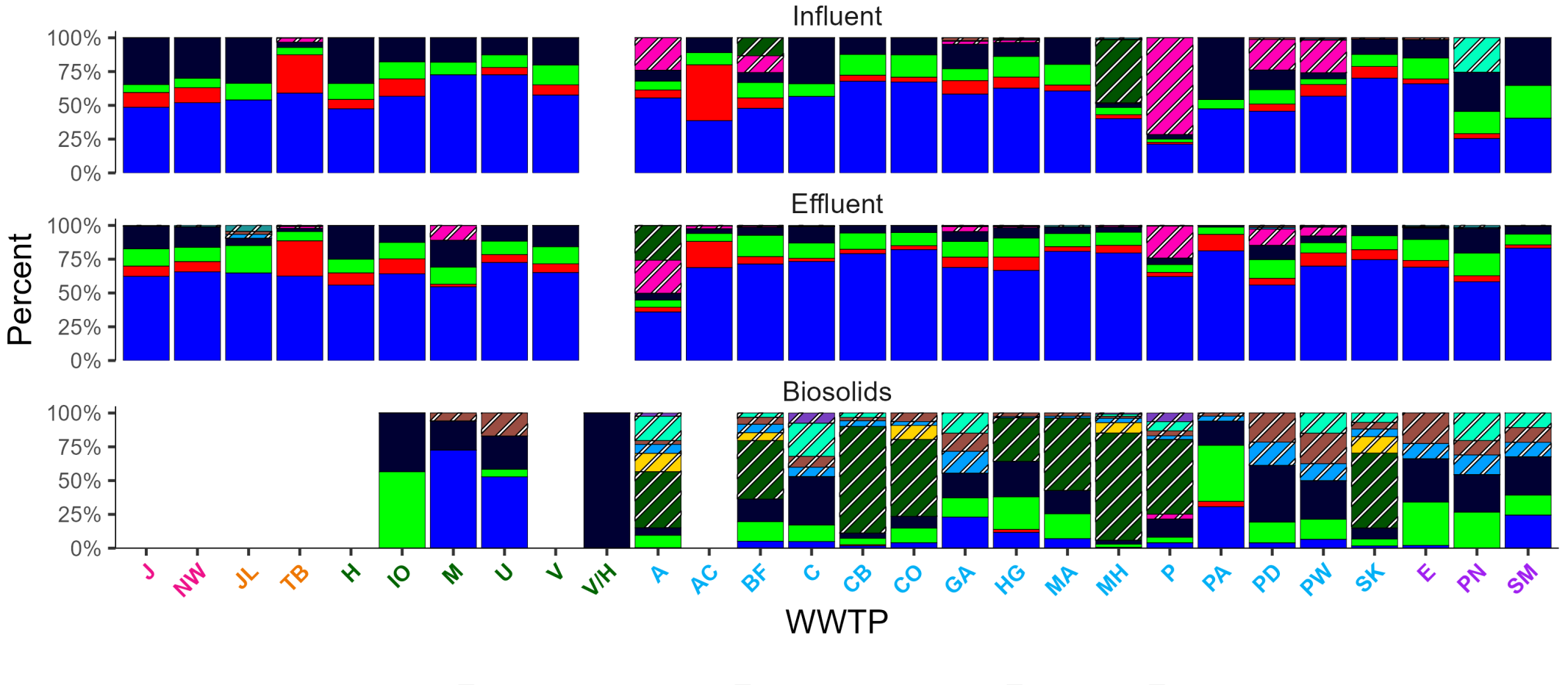


PFOS IN BIOSOLIDS 2018, 2019, 2021



Canadian Food Inspection Agency (CFIA) interim standard = 50 ng/g

WIDE VARIETY OF PFAS DETECTED IN WASTEWATER MATRICES 2018 TO 2021



PFAA - solid colors

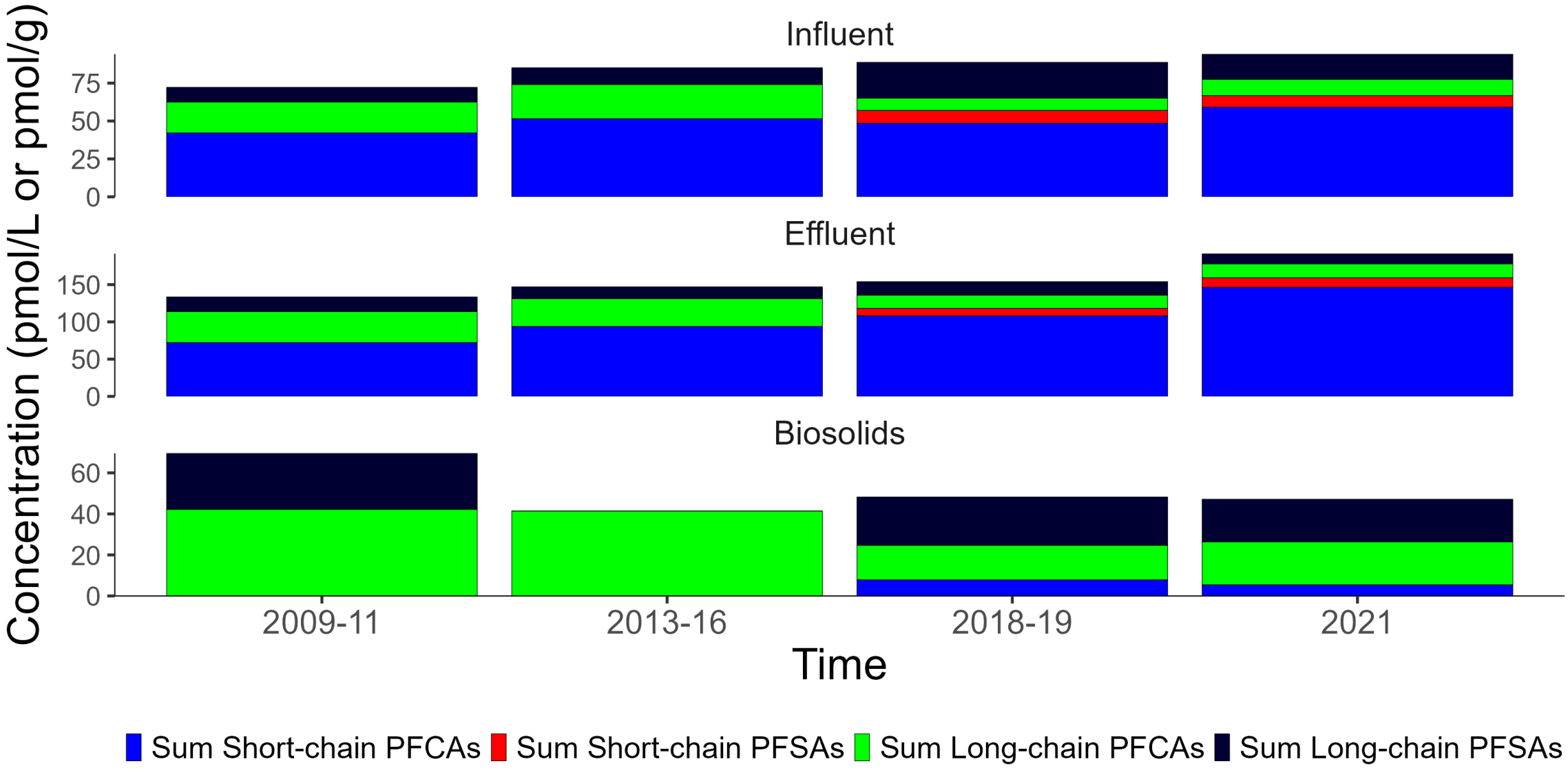
Precursor - patterns

Facultative lagoons | Aerated lagoons | Primary WWTP | Secondary WWTP | Advanced WWTP

WHAT ABOUT “EMERGING” PFAS?

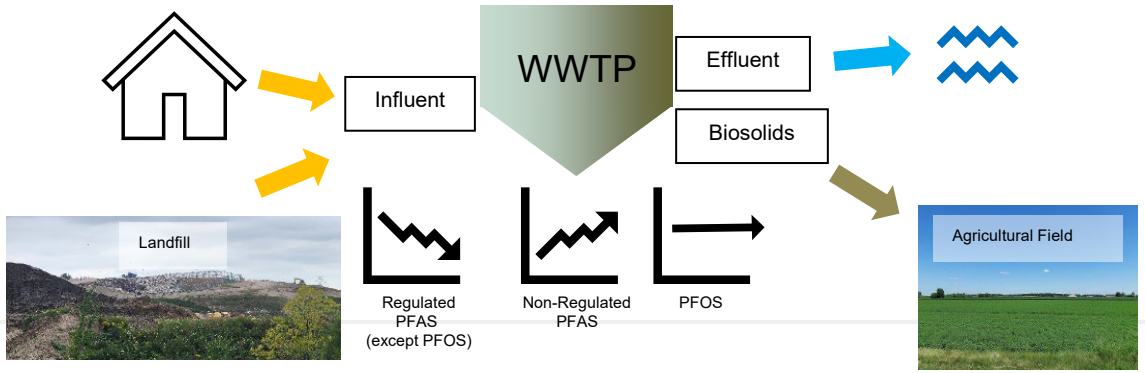
- Several emerging PFAS analyzed but not detected in WWTPs including:
  - GenX
  - ADONA
- They are detected at high concentrations at WWTPs in other countries impacted by industrial sources
- Indicates not being released to municipal wastewater in Canada

TIME TRENDS


Influent
Effluent
Biosolids
Concentration (pmol/L or pmol/g)
75
50
25
0
150
100
50
0
60
40
20
0
2009-11
2013-16
2018-19
2021
Time
Sum Short-chain PFCAs
Sum Short-chain PFSAs
Sum Long-chain PFCAs
Sum Long-chain PFSAs

CONCLUSIONS

- Data provides baseline as Government of Canada intends to address broad class of PFAS
- PFAS formation through WWTPs sometimes observed
- Regulatory action and industrial phase-outs *mostly* reflected in wastewater and biosolids
- Continued monitoring of PFAS in wastewater as indicator of progress



THANK YOU!

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- Operators
- ECCC and academic colleagues

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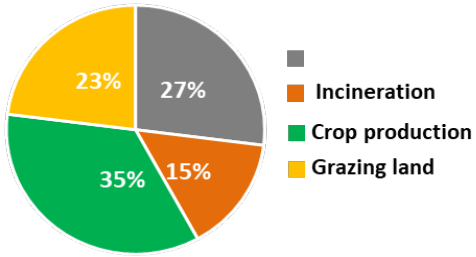
Open data

Search: *Chemicals Management Plan Wastewater Monitoring Program*
(https://open.canada.ca/data/en/dataset/c6bbdf52-e5e4-43db-b1be-813bb4651ba3)

CFIA Interim standard for PFAS in domestic and imported biosolids

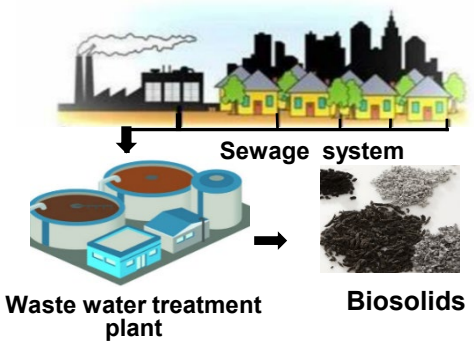


End uses for biosolids produced in Canada (estimated at 989,000 tonnes total) (M&M, 2023)

- Municipal biosolids (wastewater solids imported or sold as commercial fertilizers) are regulated by the Canadian Food Inspection Agency (CFIA) under the *Fertilizers Act*.

- All fertilizers must be safe for humans, plants, animals, and the environment when used as directed and cannot leave toxic residues in crops when spread on agricultural or grazing land.

★ PFAS are not *intentionally* added or used in the treatment of municipal wastewater; the level of contamination largely depends on the "***source***" = ***rate of discharge***

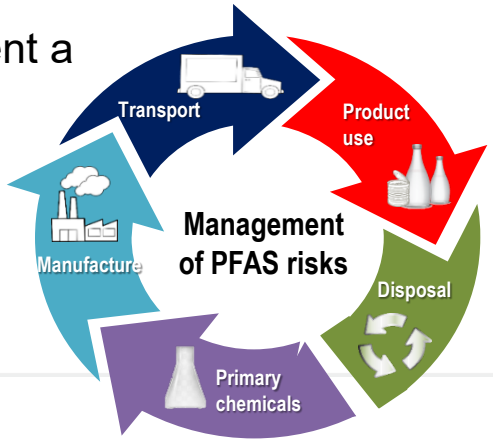


★ On May 19th, 2023, the CFIA announced its intent to adopt an interim standard of **< 50 ppb of PFOS** (used as an indicator) for domestic and imported biosolids represented as fertilizers

➢ According to the proposal, biosolids that contain levels of PFOS (indicator) ≥ 50 ppb **will be prohibited** for import or sale as a fertilizer in Canada

➢ Importers and domestic manufacturers will be required to test their products and present a certificate of analysis [CoA] to show compliance

The CFIA's interim standard is part of the GoC (ECCC, HC, CFIA) coordinated response to PFAS; it is a *life cycle approach* where risks are managed from their **source ➡ disposal.**



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