Submission
Select Committee on PFAS (per and polyfluoroalkyl substances)
November 2024
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Dr Lloyd-Smith has worked in the area of chemicals policy and waste management for over three decades with clients as diverse as the United Nations Environment Program (UNEP), the Organisation for Economic Cooperation and Development (OECD), Australian and Pacific Island governments and community organisations. Mariann was a long-term member of the Technical Advisory Group for Australia's industrial chemical regulator assessing confidential chemical information and helped develop Australia's National Pollutant Inventory providing community right to know about industries' chemical emissions. Mariann is currently Senior Advisor to the International Pollutants Elimination Network (IPEN) a global network, committed to the United Nation's Sustainable Development Goals and the goal of a toxic free future.

From 2004, Mariann participated in the Stockholm Convention's Technical Working Groups for the assessment of PFOS, PFOA and PFHxS, which are now all listed on the convention, and was a guest presenter at the 'OECD Workshop on Perfluorocarboxylic acids (PFCAs) and Precursors. Mariann was a member of the UN Expert Group on Climate Change and Chemicals.

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In 2000, the US EPA warned the Australian government that PFOS was a serious hazard to human health and the environment. The warning was sent to a range of high level chemical regulators and Worksafe Australia stating that PFOS *"appears to combine persistence, bioaccumulation, and toxicity properties to an extraordinary degree."* The email urged the Australian government to eliminate the use of the chemical, perfluorooctane sulfonate (PFOS). Yet, despite evidence of Australian's high levels of PFOS and PFOA in blood and breast milk, no action was taken and no public information was provided on either the impacts or the probably exposure routes. This meant those worst affected were unable to take action to reduce exposure. Since then successive Australian governments have played down the risks and failed to implement the essential principles of sound chemical management.[1] Consequently, Australia, despite having no history of PFAS production or manufacture, has emerged as a global PFAS hotspot, akin to regions in China, Europe, and North America.

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[1] To uphold Australian's right to a healthy environment, public policy regarding hazardous chemicals needs to be grounded in internationally recognized principles of sound chemical management.
- *Intergenerational Equity:* consider long-term impacts and ensure sustainability for future generations.
- *Precaution:* respond to serious or irreversible harm even when complete information is unavailable.
- *Substitution:* replace harmful chemicals with safer alternatives, avoiding regrettable substitution.
- *Polluter Pays:* hold polluting industries accountable for the true costs of their products and activities.
- *No Data, No Market:* prohibit market access for chemicals lacking sufficient data.
- *Right to Know*: ensure public access to information on chemical-related harms to health and environment.
- *Liability:* establish responsibility and compensation for injury or harm.
- *Good Governance*: promote transparency and accountability

Summary of Concerns

The dangers of PFAS chemicals are numerous and varied affecting human health; both current and future generations as well as the environment, wildlife, oceans and fish stocks, and the world's climate. The endocrine impacts of the thousands of PFAS in circulation may influence not only our ability to fight disease but ours and wildlife's ability to reproduce. PFAS are a multifaceted problem and require urgent multidisciplinary responses.

1. Persistence of PFAS:
Per- and poly-fluoroalkyl substances (PFAS), often referred to as "forever chemicals" due to their stable carbon-fluorine bonds, do not degrade in the environment. Australia like others has ignored this fundamental chemical property which has led to approximately 9-14,000 PFAS in commercial use today. This has resulted in widespread environmental and human contamination with chemicals that do not breakdown.

2. Global Contamination:
PFAS travel globally through air and water, contaminating oceans and ecosystems, even in remote areas. As global transboundary pollutants, PFAS bioaccumulate in living organisms; humans, aquatic and terrestrial wildlife. Once released into the environment, PFAS inevitably build-up and regardless of regulatory statutes and limits, are unmanageable. Some PFAS have been included in the Stockholm Convention on Persistent Organic Pollutants (POPs) due to these harmful and uncontrollable characteristics.

3. Trifluoroacetic acid (TFA) levels of are increasing "exponentially" across the globe, (e.g., 6-17 fold in a decade). In a case of 'regrettable substitution', fluorinated gases introduced in the 1990s as a replacement for chlorofluorocarbons in air-conditioning and refrigeration have seen emissions of TFA soar. Releases from wastewater plants, firefighting foam and pesticides also contribute to the accumulation of TFA in drinking water, household dust, plant-based drinks, rain and oceans and in human blood. Levels are already high and predicted to continue to rise. At high temperatures TFA can be converted to a potent greenhouse gas fluoroform; of relevance as destruction options for the stockpiles of PFAS fire fighting foam are considered.

4. Health Impacts:
Research has found that PFAS can damage the endocrine, reproductive, and immune systems of both humans and wildlife. U.S. National Toxicology Program concluded both PFOA and PFOS are an immune hazard to humans. Perfluorooctanoic acid (PFOA) is classified as a human carcinogen by the International Agency for Research on Cancer (IARC). ANU community health studies found that cancer outcomes in three Australian PFAS affected communities were higher than the general population. Exposed communities also had higher levels in their blood of both PFOS and PFHxs.

PFAS are endocrine disrupting chemicals and exposure has been linked to increased cholesterol levels, immune suppression, hormonal interference and developmental issues in children. Certain PFAS have shown potential for intergenerational harm. Yet, the Australian government continues to assert that there is *"limited to no evidence of human disease or other clinically significant harm resulting from PFAS exposure at this time."*

5. Children's Exposure:
"Children are not little adults: they have special vulnerabilities to the toxic effects of chemicals. Children's exposure to chemicals at critical stages in their physical and cognitive development may have severe long-term consequences for health." *- WHO, ILO, UNEP*

Current discussions regarding acceptable levels of PFAS lifetime exposure do not protect Australian children. Children are born pre-exposed to PFAS in utero and already at heightened risk of epigenetic harm due to maternal exposure. Babies and children also experience "windows of susceptibility" in their development. If exposure occurs during critical times, it may contribute to health problems much later in life. The incidence of childhood cancer in Australia continues to rise with the most common childhood cancer groups being leukaemia, cancer of the central nervous system (including the brain) and lymphoma. Cancer Australian has stated that cancers in children can be caused by DNA (epigenetic) changes in cells that occur very early in life, sometimes even before birth. The regulatory reliance on risk assessment and tolerable daily intakes based on an adult's lifetime exposure are outdated and cannot protect Australian children from exposure to PFAS.

5. Widespread Use:
PFAS are found in a variety of building, consumer and children products, including plastics, paints, stain and water repellent materials, carpets, textiles (including, baby textile products, school uniforms), non-stick cookware, cosmetics (like mascara), dental floss, and food packaging (including moulded fibre, paper bags, and teabags). Exposure occurs via direct skin absorption (up to 38% of PFOA dose), oral routes (e.g., through lipstick and children's behaviours), and through household dust and indoor air. There is minimal monitoring, assessment or control of PFAS in imported products.

6. Contamination of Waste Streams:
The presence of PFAS in products leads to contamination of the waste stream, including recycled plastic goods. Sewage treatment plants are unable to completely remove PFAS, releasing their waste water into waterways and through the reuse of biosolids—a byproduct of wastewater treatment. In Australia, nearly 400,000 dry tonnes of biosolids are produced annually, much of which is applied to agricultural lands. In a Victorian study the vast majority of biosolids exceeded Victorian EPA Guideline levels and required *"dilution"* to achieve compliance. This is unsustainable management option for chemicals that do not break down.

7. Historical Use in Firefighting Foams:
PFAS were used in aqueous film-forming foams (AFFF) long after their extreme persistency was recognized, leading to contamination of Australian soil, surface water and groundwater. Testing of drinking water in 2011 revealed extensive PFAS contamination, yet there was no effective management or policy response.

8. Pesticide Regulations:
Under changes to the definition in 2021, certain pesticides containing PFAS including as an active ingredient are used in Australian agriculture. Studies by the U.S. Environmental Protection Agency (USEPA) have shown that plastic pesticide containers can also leach PFAS into products but have also identified the presence of PFAS in some pesticides which appeared to have been added intentionally.[i] There has been no regulatory action in response to this issue in Australia. Three pesticides cited recently as major contributors to TFA emissions are registered and used in Australia - flufenacet, diflufenican, fluazinam.

9. Destruction of PFAS:
Currently, there are no facilities in Australia that have successfully conducted trials to destroy PFAS through incineration.

10. Lack of Support for Affected Residents:
Residents impacted by PFAS contamination have received minimal government support, often forcing them to pursue costly legal action against the Department of Defence for contaminating their properties. In many cases, this legal recourse has not provide sufficient financial means for residents to relocate from their contaminated homes.

11. Inadequate Policy Responses:
Australia's policy responses to PFAS have been insufficient, characterized by:

- A narrow focus on a limited number of PFAS chemicals, rather than the whole PFAS class.
-Guidelines for drinking water and tolerable daily intakes that do not acknowledge the possibility of "no safe level of exposure."
- Failure to monitor national PFAS levels in blood and breast milk.
- Inadequate environmental monitoring and lack of response to PFAS in drinking water.
- Regulatory allowances for PFAS-contaminated biosolids used in agriculture and the use of PFAS in pesticides.
- Reliance on voluntary industry agreements rather than mandatory removal of PFAS from food contact packaging.
- Insufficient attention to imported consumer products as multiple sources of PFAS exposure, particularly in cosmetics and children's clothing.
- A failure to ensure community access to information as required by Australia's ratification of the Stockholm Convention on POPs.
- Lack of a financial model (e.g., Superfund) for PFAS site remediation and pursuing redress from 3M, a major PFAS producer.

Addressing the Terms of reference

(c) the health, environmental, social, cultural and economic impacts of PFAS;

PFAS Health Impacts and Australian Government's Denial

Successive Australian governments have downplayed the dangers of PFAS exposure. A 2021, international review of epidemiological studies[ii] confirmed associations between exposure to specific PFAS and a variety of health effects, including altered immune and thyroid function, liver disease, lipid and insulin dysregulation, kidney disease, adverse reproductive and developmental outcomes, and cancer. These findings were supported by experimental animal data for many of these effects. They also noted that health effects data existed for a relatively few PFAS compounds, while hundreds are used in commerce lacking any toxicity data.

Their findings were consistent with many international research bodies including the U.S. National Toxicology Program whose evaluation[iii] of PFAS exposure and immune-related health effects concluded both PFOA and PFOS are an immune hazard to humans. PFAS exposure were linked with worse COVID-19 outcomes.[iv] People with elevated blood levels of perfluorobutanoic acid (PFBA) had an increased risk of a more severe course of COVID-19 (e.g., hospitalisation, death). PFAS exposure is increasingly being linked to neurological damage as well including the exacerbation of autism spectrum disorder (ASD) and Parkinson's disease.[v]

In 2023 the International Agency for Research on Cancer (IARC), classified PFOA as *carcinogenic to humans* (Group 1) and PFOS as *possibly carcinogenic to humans* (Group 2B).[vi]

Yet, Australian governments continue to claim that there is *"limited to no evidence of human disease or other clinically significant harm resulting from PFAS exposure at this time."* [vii] Australian Red Cross Lifeblood cite this claim as reason for it not to have a specific deferral for PFOS or PFOA ,[viii] supporting the continuing use of fire fighters PFAS contaminated blood.

Endocrine Disruptors and Intergenerational Equity

Both long- and short-chain PFASs are endocrine disrupting chemicals. [ix] [x] and the impacts of their endocrine disruption may vary according to gender and age of development. Both long- and short-chain PFASs exhibit potential impacts on steroid hormone precursors. PFASs have been shown to bind to estrogen receptors, androgen receptor and thyroid hormone receptor and can alter steroidogenesis [xi] (the processes by which cholesterol is converted to steroid hormones).

For children, exposures are associated with altered pubertal timing and interference with several critical biological processes including the metabolism of fats and amino acids in adolescents and young adults. The disruption of these processes can increase susceptibility to a variety of illnesses, including developmental disorders, cardiovascular disease, cancer and metabolic diseases like diabetes.[xii] PFAS can also affect the learning and behavior in children, [xiii] and some PFAS have been associated with an increase in autism spectrum disorder (ASD). [xiv]

While much of the current discussion in Australia focuses on acceptable levels of exposure, ‘how much is too much’ and the risk assessment processes for deciding this, the focus needs a priority shift to the intergenerational effects of PFAS, and their impact on our children.

Children today are born pre-polluted

Children today are born pre-exposed to PFAS. PFAS remain in the human body for many years, and for women, these chemical contaminants can be passed onto their babies in utero and via breast milk. Mothers with higher blood levels of PFAS in pregnancy are 1.5-times more likely to have a baby that is three weeks before their due date or earlier, i.e., ‘preterm’. In this 2023 study, specific biological signals detected in the newborn babies' blood upon birth showed PFAS chemicals may have disrupted the balance of certain processes in the newborns, such as the growth of tissues and the functioning of hormones. [xv] Early 2007 animal studies already demonstrated that mice exposed to PFOA during pregnancy developed problems with milk production. Their daughters, exposed during gestation, had stunted mammary gland development. [xvi]

Some PFAS may also affect future generations via germ cells, the precursors to sperm and ova. When exposure occurs in a pregnant woman, her developing fetus is exposed, as are the germ cells within the fetus that become the next generation. Changes in germ cells can result in epigenetic changes that alter the way DNA is regulated. These changes can be inherited over one or more generations.[xvii],[xviii] There has been growing evidence of PFAS impacts and epigenetic changes in highly exposed adults but researchers have now demonstrated these changes in newborns exposed to their mothers PFAS residues. A 2022 paper[xix] critically reviewed current evidence from human epidemiological, in vitro, and animal studies, including mammalian and aquatic model organisms. The studies identified the associations between PFOS or PFOA exposure and epigenetic changes in both adult populations and birth cohorts.

If exposure is occurring prior to birth in utero, current considerations regarding acceptable levels of PFAS lifetime exposure are obsolete. Children born pre-exposed are already at heightened risk of harm due to maternal exposure. Babies and children then experience “windows of susceptibility” in their development. When exposure occurs during critical times, it may contribute to health problems much later in life.[xx] The incidence of childhood cancer in Australia continues to rise with the most common childhood cancer groups being leukaemia, cancer of the central nervous system (including the brain) and lymphoma. Cancer Australia has stated that cancers in children can be caused by DNA (epigenetic) changes in cells that occur very early in life, sometimes even before birth.[xxi]

The regulatory reliance on risk assessment and tolerable daily intakes based on an adult's lifetime exposure are outdated and does not protect Australian children from exposure to PFAS.

Australian National University (ANU) PFAS Health Study

The ANU studies [xxii] into community health effects of PFAS although limited by lack of exposure data and other factors found that cancer incidence in the three PFAS affected communities was higher than the general population. Between 1983-2017, Katherine in the Northern Territory had estimated higher-than-expected rate of prostate cancer while Oakey in Queensland had a higher incidence of laryngeal cancer and Williamtown in NSW had a higher incidence of kidney and lung cancers.

In the ANU Blood Serum Study blood, exposed communities had higher levels in their blood of both PFOS and PFHxs; 29% to 42% of participants from the exposed communities had an elevated serum PFOS concentration and 48% to 55% had an elevated serum PFHxS concentration.

Exposed communities measured PFOS at 4.9 to 6.6 nanograms per millilitre (ng/mL), PFHxS 2.9 to 3.7 ng/mL and PFOA 1.3 to 1.8 ng/mL. While comparison communities returned blood levels of PFOS 2.5 to 3.3 ng/mL, PFHxS 0.7 to 1.2 ng/mL and PFOA 1.2 to 1.4 ng/mL.

The large body of health data sourced from both independent researchers and regulators married with the ANU studies demonstrating both incidence of PFAS contamination of affected community members and probable harm from PFAS, makes the Australian governments ongoing dismissal of the health impacts of PFAS incomprehensible.

Australian Wildlife contaminated

PFAS also accumulate in the blood, liver and kidney of terrestrial and marine wildlife.[xxiii] Sampling associated with defence base contamination at HMAS Albatross, on the south coast of NSW, found high levels of PFAS in yabbies, mosquito fish, Australian bass and cattle serum.[xxiv] Elevated levels of PFAS have also been found in fish, eels and ducks from a Gippsland wetland in eastern Victoria connected to the East Sale RAAF base.[xxv]

Eight wild platypuses collected from NSW waterways from 2022-2024 returned PFAS results with concentrations ranging from 4 to 1,200 µg/kg - some of the highest concentrations of any species in the world.[xxvi] The study noted there were currently no concentrations considered safe for platypus health, but added that draft Australian government guidelines suggest that exposure directly from their diet should not exceed 3.1 µg/kg of wet weight.

<u>(b) sources of exposure to PFAS, including through environmental contamination, food systems and consumer goods;</u>

Sources of exposure

While exposure to PFAS in Australia has focused on drinking water and to some extent food, exposure routes such as household dust and indoor air, skin absorption and other oral routes, have received little attention.

Skin Absorption of PFAS

PFAS are used in a wide variety of consumer products including adult and children's clothing, baby products, make-up (lipstick, mascara) and creams and cleansers. Researchers using 17 different PFAS compounds were able to measure the proportion of the chemicals that were absorbed by the skin. [xxvii] They found human skin took in "substantial" amounts of 15 PFAS, including 13.5% of PFOA, one of the most toxic PFAS. With a longer application, skin absorbed a further 38% of the PFOA dose.

Industry is replacing long chain PFAS like PFOA with smaller "short-chain" PFAS which are now more commonly used. These were absorbed at higher levels with nearly 60% of one short chain compound dose absorbed by the skin. Of the shortest carbon chain compounds examined, PFPeA (58.9 %) and PFBS (48.7 %) had the highest absorbed fractions of PFCAs and PFSAs respectively, with absorbed fractions of PFAS decreasing with increasing carbon chain length. These findings indicate the need for an immediate response to remove PFAS from consumer products, particularly children's products as a priority.

Food Contact packaging

In 2022, a joint study by Planet Ark and Australian Packaging Covenant Organisation (APCO) found that a significant proportion of fibre based, food contact packaging samples in Australia contained PFAS, while 54% of samples either contained no detectable levels of PFAS or very low detectable levels. Of the 74 samples tested, 21 samples (28%) had high total fluorine concentrations.[xxviii] Alternative treatments for food packaging are available, and grease proof paper can be manufactured essentially PFAS-free.

The Australian Packaging Covenant Organisation published an action plan for phasing out PFAS in fibre-based food-contact packaging, designed to support businesses to voluntarily phase out intentionally added PFAS in fibre-based food contact packaging by 31 December 2023, with provision for a stock run-out period within a reasonable timeframe (approximately 6 to 8 months). To track industry's progress in achieving the phase out, a reporting mechanism was to be set up to be collated February 2023 and December 2024, to allow for monitoring of the phase out. However, at this time there is no publicly available data on the progress of the phase out.

This initiative is a voluntary approach with little oversight and does not represent an appropriate response to a serious pathway to PFAS exposure.

Plastics contain PFAS

Many plastics utilise PFAS, e.g., fluoropolymers like PTFE (Polytetrafluoroethylene) used in non-stick coatings, gaskets, seals, and linings; PVDF (Polyvinylidene fluoride) found in coatings, wire insulations, piping and membrane technology; fluorinated ethylene propylene used in wire insulation, tubing, and some types of films; and PFA (Perfluoroalkoxy alkane) used in high-performance plastic coatings and films.

PFAS are also used as surfactants or processing aids in polyurethane manufacturing, particularly in coatings, foams, and adhesives, while some PFAS are applied to nylon and similar fibres to enhance water or stain resistance, especially in textiles and fabrics. PFAS are also present in plastics that have surface coatings or treatments, such as packaging materials and some food contact plastics.

The use of fluorine gas to treat polyethylene food-contact articles has led to high levels of PFAS exposure for consumers. In one study[xxix] water was stored in fluorinated bottles for a year and then tested for PFAS. The average total PFAS in the water was 188 ppb (ug/L) and were predominantly short chain PFAS.

Fish Consumption

Fish consumption is a major source of human PFAS exposure. [xxx] In Australia, frequent consumption of wild fish could pose health risks to some local populations. In the 27th Australian Total Diet Study, PFOS was found in canned tuna (0.070 µg/kg), prawns (0.018 µg/kg), saltwater fish fillets (0.011 µg/kg) [xxxi] Cooking seafood does not reduce PFAS concentrations and in some cases can increase dietary exposure. PFOS, PFHxS and PFOA concentrations in school prawn effectively doubled after boiling while baking some fish also increased PFOS concentrations.[xxxii] [2]

A review of PFAS concentrations in wild fish from the Norwegian mainland, Svalbard, the Netherlands, the USA, the North Sea, English Channel and the Atlantic Ocean found that even limited fish consumption would lead to exceedance of the European Food Safety Authority Tolerable Weekly Intake (4.4 ng kg-1b.w. per week).

This was despite most concentrations falling below the EU environmental quality standard and would not be defined as polluted in the EU. In addition to traditional PFASs, (e.g., PFOS, PFOA, PFHxS, PFBS), over 330 other fluorinated chemicals have been detected in fish livers.[xxxiii]

NSW EPA Investigations[xxxiv] found varying levels of PFAS in multiple fish species in Botany Bay and the Georges River and set dietary guidelines that restrict the consumption of Mulloway, Estuary Perch, Dusky Flathead, Silver Trevally, Tailor, Luderick, Sea Mullet.

Due to the elevated levels of PFAS in Australian Salmon (Arripis Trutta) caught in Botany Bay, it is recommended that this species is catch and release only. Numerous other fish advisories exist for other areas in NSW Including the Shoalhaven River, Saltwater Creek South West Rocks, Lake Macquarie, [xxxv] , Hunter River, Fullerton Cove and Tilligerry Creek[xxxvi]

Currently EPA Victoria warns not to eat the fish or eels from the Gippsland area's Lake Kernot, Heart Morass Wetland, and areas of the Skeleton Creek Lower Catchment and Maribyrnong River catchment . [xxxvii]

PFAS in Australian Drinking Water

In 2011, PFAS was found in drinking water collected from Australian capital cities and regional centres. PFOS and PFOA were the most commonly detected; 49% and 44% of all samples respectively. While the maximum concentration in any sample was for PFOS with a concentration of 16 ng /l, the second highest maximums were for PFHxS and PFOA measured at 13 and 9.7 ng/l.[xxxviii] There was no follow up monitoring or official response to the extensive contamination of drinking water. The highest levels were found at Glenunga in inner-city Adelaide, where PFOS was nearly quadruple the US four ppt enforceable limit. Yet, even Glenunga's water supply was not subject to ongoing monitoring for PFAS.

[2] Note : PFOA and PFOS can be generated from precursor compounds in chemical and biological processes.

In 2024, there was further evidence of widespread PFAS contamination of drinking water across parts of Sydney, Newcastle, Canberra, Victoria, Queensland and the tourist destinations of Rottnest and Norfolk islands.[xxxix]. Even drinking water sourced from desalination plants e.g., Rottnest Island was contaminated with PFAS. Polyvinylidene fluoride (PVDF) ultrafiltration membranes are one the most common material used in the membrane industry for water treatment. The European Union is banning the use of PVDF as it is produced from PFAS monomers. [xl]

Testing by Sydney Water in August 2024, detected PFOS (0.0155 micrograms per litre (μg/L) and PFHxS (0.0136 μg/L) at Blackheath Water Filtration Plant. at The Cascade Water Filtration Plant which supplies drinking water to 49,500 people in the Blue Mountains has also shown to be contaminated with PFAS at levels above US standards. Medlow Dam situated near Katoomba Airfield was disconnected from the regions water supply when PFOS /PFHxS was detected above the Australian guideline of 0.07 micrograms per litre. Adam's Creek which feeds into the dam was found to have high PFOS levels in the sediment.

In Port Hedland, Western Australia PFAS concentrations in groundwater have been found less than 2 km from homes. In these dry areas many households have a private well or bore in their backyard for use on private vegetable gardens and watering domestic animals, leading to a real risk of PFAS contamination of homegrown fruit and vegetables and domestic chicken eggs.

Ultrashort-chain PFASs in Australian drinking tap water

A 2024 study[xli] examined the distribution of Ultrashort-chain per- and polyfluoroalkyl substances (PFASs) in Australian drinking tap water, environmental waters, and wastewaters. Thirteen were identified, including perfluoroalkane sulfinate (PFPSi), hydrogen-substituted perfluoroalkyl carboxylate (H-PFCA), chloro-perfluoroalkanesulfonate (Cl-PFSA), and bis-perfluoroalkyl sulfonamide (bis-FASIs)).

The most prevalent Perfluoropropanesulfonic acid (PFPrS) was detected in 83% of surface, groundwater and wastewater samples, and in 67% of tap water samples from major Australian cities. Concentrations of PFPrS and perfluoroethanesulfonic acid (PFEtS) ranged from <0.02 to 8000 ng/L. These findings require the scope of drinking water monitoring to expand to include a full suite of short and ultrashort chain PFAS.

Environmental contamination – Releasing the Unmanageable

As evident by the detection of PFAS in drinking water sources across the country, once released from waste sites, sewerage treatment works, fire-fighting operations and from the use of fluorinated pesticides, PFAS are extremely persistent in the environment and mobile, travelling via air and water currents. PFAS also migrate out of consumer products such as all-weather clothing, carpets and camping gear into the air and household dust.

In the air, volatile PFAS (eg polyfluorinated fluorotelomer alcohol (FTOH) and sulfonates) are transported thousands of kilometres and others are carried by suspended particulate matter, which is eventually washed out and deposited in rain and snow.

In Australia, PFAS has been found in soil, groundwater, surface water associated with airports, defence bases, fire fighting practices and waste facilities. Australian researchers collated PFAS concentration data for over 45,000 surface and groundwater samples from around the world. The data suggests Australia, China, Europe and North America are hotspots relative to the world. Unlike other global hotspots, Australia has no PFAS manufacturing sites.[xlii]

Trifluoroacetic acid (TFA) and Climate - Regrettable Substitution

Trifluoroacetic acid (TFA) levels of are increasing "exponentially" across the globe, (e.g., 6-17 fold in a decade). In a potent case of 'regrettable substitution', fluorinated gases introduced in the 1990s as a replacement for chlorofluorocarbons in air-conditioning and refrigeration have seen emissions of TFA soar. Releases from wastewater plants, firefighting foam and pesticides also contribute to the accumulation of TFA in drinking water, household dust, plant-based drinks, rain and oceans and in human blood. Levels are already high and predicted to continue to rise. In plant uptake experiments, there was no indication of a steady state concentration being reached. Amid the dismal lack of data on TFA impacts on human health and the environment, a 2021 industry study reported adverse effects on embryo foetal developmental in rabbits. TFA plays a role in climate change as well. At high temperatures TFA can be converted to a potent greenhouse gas fluoroform; of relevance as destruction options for the stockpiles of PFAS fire fighting foam are considered.

Discharges from Australian Wastewater Treatment Plants

Discharges from wastewater treatment plants (WWTPs) include PFAS as they are often the final destination for forever chemicals waste from consumer products and industry processes. WWTPs are only partially effective at removing PFAS from wastewater, which is then released back into the environment risking further contamination of the food chain and drinking water supplies.[xliii] National loads of PFOA and PFOS in effluent were estimated at 65 kg and 26 kg per annum respectively.[xliv] PFAS in waste streams have also been shown to increase the toxicity of other compounds such as with microplastics. Waste water treatment effluent contains both microplastics and PFAS.[xlv]

PFOA and PFOS Generated from Precursor Compounds

In chemical and biological processes such as used in wastewater treatment plants, legacy PFAS are generated from precursor compounds. Significant increases (up to 1,200%) were observed in concentrations of perfluorohexanoic acid (PFHxA) and PFOA. Similar increases have been seen during drinking-water disinfection processes. Landfill leachate treatment processes, designed to improve water quality are also generating PFOA and PFOS. In the UK, approximately 80% of locations tested showed an increase in PFOS, with an increase of 1,335% in one sample.[xlvi]

Contaminated Biosolids in Australian Agriculture

PFAS also exit the WWTP via biosolids (sludge), which are a by-product of the wastewater treatment facilities. While treatment reduces pathogens, it does not remove all PFAS chemicals. Australia produces almost 400,000 dry tonnes of biosolids per year, [xlvii] the majority of which is applied to agricultural land or used in landscaping and land rehabilitation. Melbourne Water alone provides biosolids that are used on 30,000ha of farmland per year.A 2022 Victorian Friends of the Earth Freedom of Information request [xlviii] revealed that the vast majority of biosolids in Victoria exceeded Victorian EPA Guideline levels and would require *"dilution"* to achieve compliance. The highest PFOA levels were detected in a 2016 biosolid sample at 550 times over the 0.004mg/kg EPA Guideline level. PFOS was found at 250 times.

The results of degradation tests and field monitoring data support the conclusion that no biodegradation of PFOA or PFOS occurs, and do not undergo any abiotic or biotic degradation under any relevant environmental conditions. Any release of PFAS can only add to the current unsustainable burden of PFAS environmental contamination. Biosolids contaminated with PFAS have no place in agriculture.

PFAS in Australian Waste Facilities

Waste management plays a major role in the spread of PFAS into the environment through disposal (i.e., landfill and incineration) and through the recycling and downcycling of recovered waste resources. Waste disposal facilities in Wellesley, Vasse, Tamala Perk and Red Hill in Western Australia have contaminated their associated groundwater.[xlix] PFAS are not being monitored in the Australian waste streams nor consideration given to the many downstream uses of waste materials containing PFAS. In effect PFAS is concentrated into new products involving recycled textiles, plastic products and electronic waste.

In addition, incineration of PFAS waste has shown to generate PFAS contaminated waste ash and air emissions. The reuse of such ash has potential to be a major route of PFAS to the environment.[l]

PFAS Contaminated Sites in Australia and Community Right To Know

By 2018, more than 90 high priority sites were being investigated for PFAS contamination in Australia including 26 Defence sites.[li] By 2024, NSWEPA had identified 51 contaminated sites in NSW alone.

The highly contaminated firefighting training centre at Fiskville in Victoria was the first PFAS-contaminated site to be publicly identified. In 2015, it was permanently shut down due to tests showing high PFOS levels in water. A farmer adjacent to the site was forced to cease selling animal produce after PFOS was found in the soil and sheep. High levels were also found in the farmer's blood and that of his children.[lii]

Other PFAS-contaminated sites included metropolitan and regional airports, rural and urban firefighting stations, landfills and industrial sites.

Airservices Australia is responsible for airport firefighting and used 3M Light Water firefighting foam containing PFOS between the 1980s and 2000s. In 2003, Airservices switched to another foam, Ansulite, wrongly arguing it did not contain PFAS. In 2008 it began a program of preliminary site assessments for contamination. Areas around airports including Sydney, Melbourne, Perth, Gold Coast, Tamworth, Darwin are highly contaminated. Airservices moved to a PFAS-free alternative, Solberg RF6, at most airports in 2010. Queensland and South Australia have restricted the use of certain PFAS in firefighting foams while South Australia was the first state to ban all fluorinated (PFAS-containing) fire-fighting foams January 2018. New South Wales has also recently implemented a progressive ban on the use of firefighting foam containing PFAS, which came into effect on 1 April 2021.

While, serious contamination issues at the Gold Coast Airport became apparent as early as 2008, the public were not informed until nearly a decade later. Sampling in 2016 of groundwater at the airport detected very high concentrations for PFOS ranging from 17.9 to 527 µg/L and PFOA concentration of 2.23- 37.1 µg/L. [liii]

Australia has ratified the Stockholm Convention and is bound by Articles 9 and 10 ensuring the community has ready access to information on POPs chemicals and their impact on human health and the environment. Nevertheless, Australians are kept ignorant about PFAS contamination in their communities and surrounding environment.

Managing PFAS waste in Australia

In 2019, the destruction of solid and liquid wastes containing PFASs, PFOS and PFOA was trialed in a high temperature hazardous waste incinerator in South Australia.[liv] During a representative trial burning liquid PFASs waste, PFBA, PFOA and PFPeA were detected in the stack. Some PFAS were also detected in the bottom ash and leached into the quench waters. The trial failed the destruction requirements of the Stockholm and Basel Conventions. During the solid waste burning trial, PFAS (PFBA and PFPeA) were found in the stack emissions and a high number of PFAS compounds were found in the bottom ash.

In trials of PFAS destruction in cement kilns, relatively low destruction and removal efficiency for some of PFASs suggest that significant quantities of PFAS compounds were released to atmosphere. On this basis, the trial was not successful.

Australia currently has no effective destruction method for PFAS.

This needs to be addressed as a priority with a focus on non-combustion technology, which will not produce further PFAS contamination.

e) the effectiveness of current and proposed federal and state and territory regulatory frameworks, including the adequacy of health based guidance values, public sector resourcing and coordination amongst relevant agencies in preventing, controlling and managing the risks of PFAS to human health and the environment;

Conflicting Standards and Guidelines – Australia 'out of step'

In 2020, the European Food Safety Authority (EFSA) based on decreased immune responses observed in children, set a tolerable weekly intake (TWI) threshold for the sum of PFOA, PFOS, perfluorononanoic acid (PFNA), and perfluorohexanesulfonate (PFHxS) of 4.4 nanograms per kilogram of body weight per week.[lv]

Australians supposedly can tolerate far more PFAS in their bodies, in fact approximately 280 times more or 1260ng/ nanograms per kilogram of body weight per week[lvi] - based on the extraordinary claim by the National Health & Medical Research Centre that *"PFAS has not been shown to cause disease in humans."* [lvii]

U.S. regulators in July 2022, responding to human epidemiology data concluded that for PFOA and PFOS, *some negative health effects may occur at concentrations that are near zero and below our ability to detect at this time*. [lviii]

In 2024, the US EPA significantly reduced Health Advisory levels for PFAS in drinking water to: [lix]

- 4 parts per trillion (ppt) for PFOA
- 4 ppt for PFOS
- A standard based on the hazard of a mixture of four PFAS chemicals: PFNA, PFHxS, PFBS, and HFPO-DA (commonly known as Gen X)
- 10 ppt for PFNA
- 10 ppt for PFHxS
- 10 ppt for HFPO-DA

- 2000 ppt PFBS

In Europe, the EU Drinking Water Directive, which took effect on 12 January 2021, includes a limit of 0.5 µg/l (500ppt) for all PFAS. [lx] One of the most protective recommendation for drinking water is Health Canada's objective value of 30 ng/L (30ppt for the sum total of 25 specific PFAS) [lxi]

Revised Australian drinking water guidelines

Australia is revising its drinking water guidelines and has proposed reducing PFOS from 70 ng/L to 4ng/L and PFOA from 560 ng /L to 200 ng/L [lxii] PFHxS was set at 30ng/L and PFBS at 1000ng/L.

Australia's recommended guideline values for PFAS in recreational water are for the sum of PFOS and PFHxS at 2 µg/L (2000 ng/L) and PFOA at 10 µg/L (10,000 ng/L).

The EU restrict PFOS in inland surface water to 0.65ng/L as an annual average value and 36 mg/L as the maximum allowable concentration.[lxiii]

Over the last decades PFAS standards and guidelines have seen 'acceptable' levels drop dramatically; reflecting the growing evidence of harm and acknowledging that harm may occur at levels *'near zero and below our ability to detect at this time.'* Australian governments need to accept the growing evidence and respond far more proactively to the threats posed by PFAS, with particular attention to the intergenerational impacts of PFAS that affect our children and generations to come.

(f) the role, liability and responsibility of government agencies and industry in the production, distribution, contamination and remediation of PFAS, including obligations under the Stockholm Convention on Persistent Organic Pollutants and other relevant principles and international conventions;

Expanding Definition of PFAS

The 2021 OECD criteria defined PFAS as '*fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), that is, with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS.'*

The OECD criteria highlighted the many PFAS in commerce today, estimated between 9-14,000 which includes up to 200 fluorinated pesticides. While Australian regulations have focused primarily on a handful of historical PFAS; *perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) perfluorohexane sulfonate (PFHxS), and their direct and indirect precursors,* there is a growing awareness of short chain PFAS eg perfluorobutane sulfonate (PFBS) and the broader group of perfluoroalkyl carboxylic acids (PFCAs)

The three PFOS, PFOA and PFHxS are listed on the *Stockholm Convention on Persistent Organic Pollutants* 2001. Australian government has not ratified their inclusion but will ban their import, manufacture and use by July 2025. How this will provide oversight and regulation of imported consumer products is not clear.

The next PFAS POPs

Long chain perfluoroalkyl carboxylic acids (PFCAs) have been assessed as a class by the POPs Review Committee of the Stockholm Convention and recommended for elimination. In 2018, PFCAs were detected in more than 80% of the 30 surface seawater samples from the North Pacific to Arctic Ocean.[lxiv] Perfluoroalkyl ether carboxylic and sulfonic acids (PFECAs and PFESAs) have been found in surface waters in China, US, UK, Sweden, Germany, Netherlands and Korea, indicating ubiquitous dispersal and distribution in global surface waters.[lxv] The detection of high levels of ultra short chain PFAS in surface, ground and drinking water in Australia demonstrates the urgent need to take action on the whole class of PFAS chemicals. As short-chain PFAS rapidly replace long-chain PFAS and are increasingly detected in groundwater, surface water, ocean and snow melt, [lxvi] concern grows regarding the many PFAS in use today with little or no toxicology or eco-toxicology data.

Production of some fluoropolymers, used extensively in consumer products are also linked to the emissions of legacy and novel PFAS used as polymer processing aids. The production and use of fluropolymers is increasing and there are serious concerns regarding the impacts of the fluorinated processing aids on humans and the environment.[lxvii]

PFAS Must be Addressed as a Class.

The huge numbers of PFAS mean it impossible to effectively assess, restrict or ban individual PFAS chemicals in a realistic time frame. PFAS must be addressed as a class. Five European national authorities have called for a ban on production, use and placement on the EU market of all per and polyfluoroalkyl substances.[lxviii] In February 2023, the European Chemicals Agency published a proposal put forward by environmental agencies in five countries; Denmark, Germany, the Kingdom of the Netherlands, Norway and Sweden, which would heavily restrict the manufacture of more than 12,000 PFAS. Some US States have also progressed legislation around PFAS bans as a class, e.g., Maine [lxix]. Australian governments should support these initiatives and start the process immediately to eliminate PFAS from Australian commerce.

(h) the adequacy and effectiveness of government engagement with and support for communities disproportionately affected by PFAS contamination, including fair and appropriate compensation schemes;

PFAS litigation – Australia, United States, Sweden

In Australia, residents who homes were affected by Department of Defence's past use of PFAS fire fighting foams had no option but to take legal action against the department claiming loss of house and land value. In 2020, residents in Katherine, Williamtown and Oakey settled for $215.5m and in 2023 a settlement was concluded for $132.7m for the 30,000 residents located near Australian military bases including Royal Australian Air Force bases at Richmond and Wagga Wagga in NSW, Bullsbrook in Western Australia, Darwin in the Northern Territory, Edinburgh in South Australia, Townsville in Queensland and Wodonga in Victoria.[lxx] Also in May 2023, the federal Government reached a $22 million settlement with the Wreck Bay Aboriginal community.

These settlements do not cover personal injury claims and have not provide sufficient financial means for all affected residents to relocate and move on with their lives.

DuPont Pays

Since 1998, multiple lawsuits have been filed in US courts against chemical company DuPont in relation to PFOA used to produce Teflon. Local farmers, residents and company workers claimed illnesses linked to PFOA pollution from DuPont's Parkersburg plant in West Virginia.

In one class action lawsuit settled in 2005, DuPont agreed to provide up to $235 million for medical monitoring of over 70,000 people - the world's largest epidemiology study of people exposed to PFOA. The resultant C8 Science Panel, a joint initiative of the US government, affected communities and the PFAS industry concluded that there was a probable link to PFOA exposure for diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension.[lxxi] This resulted in numerous individual lawsuits from victims of PFOA-related diseases.

In February 2017, DuPont settled over 3,550 lawsuits for $671 million. In 2022, a US federal appeals court has upheld a $40 million verdict for a cancer survivor who sued E.I. du Pont de Nemours and Co after years of exposure to a toxic chemical that it manufactured.[lxxii]

3M Massive Settlement for PFAS Drinking Water Contamination

In June 2023, manufacturer of PFAS, 3M reached a US$10.3 (AUD19) billion settlement with several US public water system operators to test and treat PFAS contamination. [lxxiii] This provides a good example of polluter pays and cost recovery that Australia could emulate.

Swedish Residents sue over contaminated drinking water

In 2024, the Swedish Supreme Court ruled that residents who have high levels of PFAS in their blood as a result of PFAS-contaminated drinking water, have suffered personal injury within the meaning of their national Product Liability Act.[lxxiv] The drinking water from the Brantafors waterworks in Ronneby municipality contained very high levels of PFAS from the use of firefighting foam in fire drills. More than 150 residents filed a lawsuit against the municipal water company, for compensation for personal injury.

According to the Swedish Product Liability Act, damages must be paid for personal injury caused by a safety defect in a product, such as drinking water. The damages may relate to costs, loss of income and physical or mental suffering caused by the personal injury. The ramifications for drinking water providers and those that insure them could be significant.Australian communities affected by drinking water contamination are considering their legal options.

In order to pay for both compensation for those affected as well as huge expense of technology improvement and remediation, state and federal governments should initiate a legal case against PFAS current and past producers as a priority.

(k) areas for reform, including legislative, regulatory, public health and other policy measures to prevent, control and manage the risks of PFAS to human health and the environment, including the phasing out of these harmful substances;

Recommendations for Action :

Australian governments should:

1. Address PFAS as a class, aiming to restrict and eliminate all PFAS import, use and emissions.

2. Update Australian drinking water guidelines to reflect USEPA finding that there may be *"no safe level of PFAS exposure."*

3. Significantly improve water treatment at the point of distribution, ensuring all water providers employ best available technology (BAT) to limit PFAS contamination as close to zero as possible.

4. Cease the release and distribution of PFAS-contaminated biosolids, a byproduct of wastewater treatment plants, much of which is applied to agricultural lands.

5. Prioritize the mandatory removal of PFAS from all food contact packaging.

6. Proactively address PFAS in imported consumer products, with a focus on personal care items and children and baby products.

7. Eliminate PFAS from pesticides and pesticide containers.

8. Enhance environmental monitoring and community information regarding PFAS contamination.

9. Ratify the three Stockholm Convention PFAS and support the proposed global ban on perfluorocarboxylic acids (PFCAs) as recommended by the Persistent Organic Pollutants Review Committee (POPRC).

10. Assist in global efforts to rapidly replace refrigerants with non-fluorinated options.

11. Initiate a claim against 3M to help finance PFAS elimination, remediation, and compensation efforts.

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