Williamtown & Surrounds Residents Action Group Inc.

To: PFAS Expert Panel, by email: PFAS@allenandclarke.com

7 November 2017

Dear Sir / Madam

PFAS Consultation Process by Department of Health's Expert Panel: Submission

1. For the benefit of the recently established Expert Health Panel we enclose a submission on behalf of the Williamtown & Surrounds Residents Action Group, Fullerton Cove Residents Action Group and Salt Ash Community First. Our three action groups represent the interests of the three local communities suffering from the contamination emanating from RAAF Base Williamtown, NSW.

2. Whilst in principle we welcome the creation of a genuinely independent panel to consider the health issues caused by PFAS, there have been previous "expert panels" and "taskforces" created to respond to this crisis which have contributed very little to date. What is needed is proper research and direct consultation on actual solutions. Online consultation does not go far enough to capture the views and evidence needed. We invite the Panel members to come and visit our communities, meet with us and gather evidence first hand.

3. In addition to this submission, we are encouraging individual submissions from members of our communities, many of whom:

    - Are suffering from health issues linked to PFAS exposure, such as impacts to the immune system function, reproductive functions, endocrine functions such as thyroid functions, liver functions, and cancers including prostate, kidney, testicular and breast.
    - Have seen the value of their assets disintegrate as a result of living in a contamination zone.
    - Have been forced daily to live with the stress and anxiety caused by having their lives turned upside down by a disaster which is no fault of their own.

Preliminary Remarks

4. As a preliminary remark, our communities are surprised and disappointed that the Department of Health has commenced this public consultation without making any attempt to give notice to the affected communities. This is particularly concerning given that the public consultation is set to last 16 days only. The impression given is a consultation arranged in a hurry without any proper thought being given to the people who should be the key stakeholders in your process, i.e. those people whose health has been placed at

risk. We encourage you to extend the consultation period and provide proper notice to key stakeholders.

5. Secondly, we are concerned that the Expert Panel website contains a number of statements which are inaccurate and misleading. In particular:

   - 'there is currently no consistent evidence that exposure to perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) causes adverse human health effects' (enHealth, 2016)
   - 'recent reviews conducted by regulatory bodies have concluded that there is no compelling evidence that PFAS at the concentrations found in these areas are harmful to health.'

6. It is not clear to us which 'recent reviews' you are referring to, or why the outcome of an investigation by an "Expert Panel" is apparently being pre-judged before any work has been commenced. As the affected communities being forced to live through this crisis, we have done our own research including contacting leading scientific experts - the vast majority of whom we note are located overseas and not in Australia.

Factual Background and Relevant Scientific Studies

7. As the chronology set out in the Schedule to this letter demonstrates, there is a significant and compelling body of evidence which has linked these chemicals to adverse health effects in humans. This evidence is in addition to evidence confirming the damaging effects that PFAS has on the environment and on animals, both of which are accepted by scientists beyond any debate. The body of human health evidence includes findings by:

   - the OECD, which as early as 2000 acknowledged that PFOS was "persistent, bioaccumulative and toxic to mammalian species"
   - the US Federal EPA ("overall, the toxicity studies available for PFOS demonstrate that the developing fetus is particularly sensitive to PFOS induced toxicity. Human epidemiology data report associations between PFOS exposure and high cholesterol, thyroid disease, immune suppression, and some reproductive and developmental parameters, including reduced fertility and fecundity")
   - various State EPAs including Vermont and Minnesota
   - the US Agency for Toxic Substances and Disease Registry
   - the US National Toxicology Program
   - the United Nations Environment Program
   - the European Union
   - the Stockholm Convention on Persistent Organic Pollutants
   - the International Agency on Research on Cancer (IARC)

- the C8 Science Panel which in 2012 concluded an independent epidemiological study of PFAS exposure across 69,000 people in the Ohio Valley and determined probable links to at least 6 serious human diseases. This remains the most extensive and authoritative PFAS human health study to date.

8. The Expert Health Panel will note that these agencies are independent and objective, being concerned with identifying potential risks to human health. By contrast, a number of the scientific studies conducted into PFAS have been sponsored by the manufacturers of the products in question, 3M and DuPont.

9. 3M (manufacturer of Lightwater and Scotchguard) and DuPont (manufacturer of Teflon) have generated billions of dollars from selling these products and have a vested interest and bias towards downplaying any public health risks which might interfere with their profitability. In litigation in the USA, DuPont was compelled by court order to disclose internal documentation concerning its level of knowledge of how harmful PFAS chemicals were. These internal documents indicate that for many years, both 3M and DuPont were aware that PFAS were potentially harmful (as a result of extensive internal testing), but chose to keep these matters secret from the public.

   - Workers at DuPont's Washington Works first raised concerns that PFOA might be toxic in 1954.
   - DuPont's head chemist, in an internal memo to executives when launching the company's best selling "Happy Pan" in 1961, stated that PFOA should be "handled with extreme care" on the basis of an internal study which had found enlarged livers in rats and rabbits exposed to PFOA.
   - In both 1968 and 1976, 3M were made aware of studies showing that PFAS chemicals had entered the plasma of the general population in the US (including blood banks), but elected not to investigate the causes and effects any further.
   - In 1978, 3M informed DuPont that PFAS was potentially hazardous to its workers, and DuPont began monitoring the abnormally high blood levels of its workers.
   - Also in 1978, 3M discovered that PFAS were immunotoxic following a study of monkeys in which many of the monkeys died.
   - In 1981, following secret monitoring, DuPont discovered a "statistically significant" rate of birth defects in female workers exposed to PFOA. DuPont's studies also confirmed birth defects in rats.
   - By 1984, DuPont was aware that PFOA was present in the drinking water at levels which exceeded levels then thought to be safe, in some cases by 100 times.
   - In 1993, in the first significant peer reviewed epidemiological study into PFAS, a study by Professors Gilliland and Mandel of 3000 male workers exposed to C-8 at a 3M plant in Minnesota (Cottage Grove) reported those workers were 3.3 times more

likely to have contracted prostate cancer. Consequently, as early as 1993 the manufacturers of these chemicals were aware of the cancer risk in humans.

- The above information was kept confidential by 3M and DuPont and was not disclosed to the US EPA until 2000, following a disclosure order against DuPont granted to Wilbur Tennant, a farmer whose water supply and cattle had been poisoned by PFOA. In response, Bernard J. Reilly, in house lawyer at DuPont, wrote to his colleagues: "The shit is about to hit the fan in [West Virginia]. The lawyer for the farmer finally realizes the surfactant [C8] issue … Fuck him."
- In 2001, Mr Reilly described PFOA as a chemical "we poop to the river and into drinking water along the Ohio River […] I can't blame people if they don't want to drink our chemicals. The compound … is very persistent in the environment, and on top of that, loves to travel in water and if ingested or breathed wants to stay in the blood, the body thinks it is food, so pulls it from the intestine, the liver then dumps it back to the stomach because it can't break it down, then the intestines puts it right back into the blood […] Too bad the business wants to hunker down as though everything will not come out in the litigation, god knows how they could be so clueless, don't they read the paper or go to the movies?"
- In 2002, Mr Reilly acknowledged that the "EPA better buckle their seat belts… We are exceeding the levels we set as our own guideline." At this point, DuPont persuaded the West Virginia EPA, who was receiving funding from DuPont, to make a public announcement that PFOA was safe to drink at concentrations of 150 parts per billion—150 times higher than DuPont's internal safety guideline of 1 part per billion, which had never been made public.

10. This list could go on and on. The Expert Health Panel will be aware that the C8 Science Panel (www.c8sciencepanel.org) was set up as a result of the multidistrict litigation involving DuPont. Between 2005 and 2012, at a cost of more than US$30m, three independent epidemiologists – Dr Tony Fletcher (London School of Hygiene and Tropical Medicine), Dr David Savitz (Brown University), and Dr Kyle Steenland (Rollins School of Public Health, Emory University) – took blood samples from 69,000 people in the Ohio River Valley. Their study – the most comprehensive PFAS study ever to occur by some margin – identified at least 6 serious diseases which were probably linked to PFOA exposure:

    - Kidney cancer
    - Testicular cancer
    - Thyroid disease
    - Ulcerative colitis
    - Pregnancy-induced hypertension (pre-eclampsia)
    - High cholestorol

11. The first-of-its-kind medical monitoring program set up by the C8 Science Panel has been made publicly available at www.C-8medicalmonitoringprogram.com

12. The Expert Health Panel will also be aware that in 2015/2016, DuPont was found by US courts to have deliberately (acting with actual malice) caused personal injury to the residents through its PFOA contamination of the Ohio River Valley. In February 2017, DuPont settled with its 3,500 plaintiffs for US$670m. At least two major litigations are underway in the USA against 3M alleging that 3M also knew that its products were toxic – one brought by the State of Minnesota (where Lightwater was manufactured at 3M's Washington Works), and the other by residents of Decatur Alabama concerning PFAS dumped by 3M into the Tennessee River.

13. The key properties of the two chemicals PFOA and PFOS are considered to be similar (biopersistent, bioaccumulative, toxic to mammalian species). However of the two, PFOS (the main PFAS chemical present in Lightwater as used by the Department of Defence in Australia) has been considered by scientists to be higher risk. Hence, PFOS was nominated to the Stockholm Convention in 2009 whereas PFOA was nominated in 2015. PFOS is also considered to have a longer half life in the human body (5 years) compared to PFOA (3 years); note that the half life for both in the environment is closer to 70 years.

14. A third chemical, PFHxS, has been detected in significant quantities in the environment around RAAF Williamtown. Little is publicly known about the effects of PFHxS, though we understand that (i) its half life in human blood is even longer (9 years) and (ii) it is commonly detected in organs such as brain, kidney and lung and less readily in blood, meaning many of its effects may be hidden. Undoubtedly though, its manufacturer will know much more.

Recommendations

15. From the above we make the following observations and recommendations.

16. First, in respect of the methodology the Expert Health Panel should apply. If the Panel wishes to achieve a proper, thorough and genuinely independent analysis of the public health risks of PFAS chemicals, and in particular those caused to communities around Australia such as Williamtown, Fullerton Cove and Salt Ash by the Department of Defence's AFFF usage, it is imperative that the Panel:

    (1) Identify and distinguish in its literature review studies which have been sponsored by "industry" (meaning PFAS manufacturers and promoters of such industries in general). Such studies will distinguish a strong bias towards the "nil hypothesis".
    (2) Demand from 3M (and also DuPont) full copies of the internal correspondence, data and test results concerning the toxicity of PFAS (including 'new' PFAS such as

PFHxS). The Expert Panel will learn far more about the real risks of PFAS from the manufacturers' internal documents than it will from those they choose to publish. This is the critical source data that must be requested and reviewed.

(3) Cooperate fully with other regulatory authorities overseas who have conducted similar research into these chemicals, including the US Federal EPA and National Toxicology Program. Similarly to point (2) above, the Panel should seek to share in the source data disclosed by manufacturers to these authorities.

(4) Extend the Department of Health's proposed epidemiological study beyond simply the communities of Williamtown and Oakey (which number only a few thousand people). The study (including free blood testing) should include ALL persons living in areas of Australia affected by PFAS contamination, including firefighters exposed through their occupation as well as residents near Defence Bases and civil airports.

(5) Reconsider the "safe" exposure limits (TDIs, recreational and drinking water) set by FSANZ in light of ALL available science. Australia's limits remain many times higher than the USA and Germany, to name two examples, and this inconsistency amongst regulators is a major concern to affected communities who struggle - in circumstances where health advice is coming from the polluter - to know who to trust.

17. Second, we comment on the effects observed within our own communities.

(1) Test results showing PFOS levels in our waterways 1900 times higher than the Government's "safe" drinking water limits.

(2) A contamination plume which is reported by AECOM, contractor to the Department of Defence, to be 5km long by 5km wide.

(3) Cancer clustering within the local population. To give one example, 39 residents within one 5km stretch of road were reported to have suffered some form of cancer in the last 15 years alone; that number has now increased to 50 upon further investigation. Nor is Cabbage Tree Road by any means alone. There are many other streets in our communities which have been similarly blighted by illnesses which we now know are consistent with the type of issues caused by long term PFAS exposure.

(4) Some cancers have been diagnosed in the last 2 years, despite those individuals having followed the Government's health precautions.

(5) Blood testing has shown some residents, particularly elderly residents who have worked the land around the RAAF Base, have serum levels over eleven times the national average for their age.

(6) Blood testing has also shown that babies are being born with levels many times those of their parents, despite their parents following the Government's health precautions.

(7) The number of our residents who have suffered from liver disorder, thyroid issues, and high cholesterol is too numerous to count.

(8) Similarly the stress, anxiety and other mental health issues caused by the contamination are too widespread for us to begin to count.

18. Third, in light of our experience, we have reached the following observation about the risks posed by these chemicals. At the very least, whatever the causal links to illness may be, PFAS are unnatural, man made substances composed of complex long chain carbon atoms which persist in the body, reduce white blood cells and undermine the body's immune system. Babies and unborn children are most at risk. In the manufacturer's own words:

> "[PFOA] if ingested or breathed wants to stay in the blood, the body thinks it is food, so pulls it from the intestine, the liver then dumps it back to the stomach because it can't break it down, then the intestines put it right back into the blood."

19. Why should any person accept any level of such chemicals in their body against their will? How can any panel of scientists with a genuine concern for public health say that any amount is "safe"? Surely it is a basic human right that our drinking water contains not a trace of any such chemicals? In our view, the only truly "safe" amount is ZERO and the regulatory authorities in Australia should be doing everything within their power to eliminate these chemicals from our ecosystems altogether.

20. Fourth and finally, a comment looking to the future. In a sense, this investigation by the Expert Health Panel comes too late for the many of us who have already fallen sick. It is fundamentally wrong that companies can sell industrial chemicals without first having to prove that those chemicals are safe. Instead of the victims, it is the manufacturers who should bear the burden of proof. The present system means that unscrupulous companies can generate vast profits selling products they know to be harmful, and then put the victims to the massive burden of having to prove their cases in a court of law.

Conclusion

21. The people within our communities, and the people of Australia generally, deserve to be fully and properly informed of the risks associated with these chemicals. Rigorous, independent and thorough research by this Panel must include reviewing source data from the manufacturers as well as field visits to affected areas. The risk assessments of industrial chemicals should be carried out BEFORE the products are sold, and not after they have caused years of harm to people who are treated like guinea pigs.

22. We trust the Expert Health Panel will deliver in its objectives, and we reiterate our invitation to the Panel members to come and visit our communities and see for themselves how PFAS affect human lives.

Yours faithfully

Williamtown & Surrounds Residents Action Group, Fullerton Cove Residents Action Group and Salt Ash Community First

Copy to:

Senator James McGrath, head of PFAS Taskforce

Hon. Marise Payne, Minister for Defence

Michael Lysewycz, Defence Legal Counsel

Prof. Mary O'Kane, Chief Scientist NSW

SCHEDULE – CHRONOLOGY OF PFAS STUDIES

1951	Kauck & Diesslin, "Some Properties of Perfluorocarboxlic Acids" – Industrial & Engineering Chemistry 1951, 43(10)
1961	In an internal memo to executives as part of the Happy Pan roll out, DuPont head chemist Dorothy Head concluded that PFOA (C-8) should be "handled with extreme care". She explained that a new study had found enlarged livers in rats and rabbits exposed to C8, which suggested the chemical was toxic.
1968	Dr Donald Taves (University of Rochester), "Evidence that there are two forms of fluoride in human serum". Published in *Nature* 1968, 217, 1050-1051 First evidence that PFAS were entering human blood.
1974	LeFebvre E and Inman R, "Biodegradability and Toxicity of Lightwater FC-206 AFFF", Report no. EHL (K) 74-26, USAF Environmental Health Laboratory, Kelly Air Force Base
1976	Taves DR & ors, "Organic Fluorocompounds in human plasma – prevalence and characterization" – ACS Symposium Series, 1976 (28). Demonstrated that PFAS were present in blood banks.
1978	Goldenthal et al, "Final Report, Ninety Day Subacute Rhesus Monkey Toxicity Study", International Research and Development Corporation Study No. 137-090 Monkeys were given 0, 3, 10, 30 and 100 mg/kg per day of PFOA. All monkeys at the 100 dosage and 3 out of 4 at the 30 dosage died. Adverse effects were noted in the adrenals, bone marrows, spleen and lymph nodes.

1980	Ubel FA, Sorenson SD and Roach DE: "Health status of plant workers exposed to fluorochemicals – a preliminary report". Published in *Am Ind Hyg Assoc*, 1980, 41: 584-589 Recorded high concentrations of PFAS in blood of exposed workers.
1981	DuPont monitoring of female employees who had been exposed to C8 revealed two of the seven pregnant workers exposed to the chemical had given birth to babies with eye and nostril deformities. The researchers concluded that this was a "statistically significant" increase over the two-in-1,000 birth-defect rate in the general population.
1980	Griffith FD and Long JE: "Animal toxicity studies with ammonium perfluoroocatanoate" Showed that lab animals readily absorbed PFAS after oral or inhalation exposure
1985	Salazar S, "Toxicity of AFFF to Marine Organisms: Literature Review and Biological Assessment" for the US Navy
1993	Gilliland F and Mandel J, "Mortality among employees of a perfluorooctanoic acid production plant", J Occup Med 1993, 35(9) Study of 3000 male 3M workers exposed to C-8 at a 3M plant in Minnesota (Cottage Grove) reported "ten years of employment in exposed jobs was associated with a 3.3 fold increase… in prostate cancer mortality compared to no employment in [C-8] production"
1996	McDonald and others, "Acute Toxicity of Fire Control Chemicals" – published in Ecotoxicology and Environment Safety 33(1):62-72
1998	Olsen GW, Gilliland FD, Burlew MM et al: "An epidemiologic investigation of reproductive hormones in men with occupational exposure to perfluorooctanoic acid", published in *J Occup Environ Med* 1998, 40: 614-622
2000	US EPA press release following disclosures by 3M: "3M data supplied to EPA indicated that these chemicals are very persistent in the environment, have a strong tendency to accumulate in human and animal tissues and could potentially pose a risk to human health and the environment over the long term"
2000	Draft report by OECD Environmental Directorate first published. Final OECD report (November 2002) concluded that PFOS is "persistent, bioaccumulative and toxic to mammalian species" https://www.oecd.org/env/ehs/risk-assessment/2382880.pdf
2006	Mueller et al, "Levels of 12 PFCs in pooled Australian serum, collected 2002-2003" – Enviro Sci Technol 2006, 40(12) 3800 Australians sampled, confirmed that PFAS concentrations in Australian blood were higher than average in the USA
2006	Persistent Organic Pollutants Review Committee of the Stockholm Convention found that: "PFOS is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted"
2009	PFOS added to Annex B of the Stockholm Convention
2011	Lindstrom et al, "Polyfuorinated compounds: past, present, and future" – Environ Sci Technol 2011, 45(19).

2012	Bonefeld Jorgensen EC & Fredslund SO, "Breast cancer in the Arctic – changes over the past decades" Int J Circumpolar Health 2012, 71
2012	Kyle Steenland and Susan Woskie, "Cohort Mortality Study of Workers Exposed to Perfluorooctanoic Acid" – based on 5,791 workers at DuPont factory in West Viriginia
2012	Grandjean P and Heilmann C: "Perfluorinated Compounds and immunotoxicity in children" – JAMA 2012, 307 First of three studies into immunotoxicity in children in the Faroe Islands. 656 births, 587 children followed through to age 7: found a doubling in exposure to PFOS and PFOA was associated with an overall decrease by about 50% in the antibody concentration, such that "a substantial number of children at age 7 had such a low antibody concentration that they had no long term protection against the targeted diseases despite a total of four vaccinations"
2013	Vieira, VM et al, "Perfluorooctanoic acid exposure and cancer outcomes in a contaminated community: a geographical analysis" "Our results suggest that higher PFOA serum levels may be associated with testicular, kidney, prostate, and ovarian cancers and non-Hodgkin lymphoma. Strengths of this study include near-complete case ascertainment for state residents and well-characterized contrasts in predicted PFOA serum levels from six contaminated water supplies."
2013	Barry V, Winquist A and Steenland K, "Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers among Adults living near a Chemical Plant" Environ Health Perspect 2013 Nov-Dec
2014	Watkins, Wellenius et al, "Associations between serum perfluoroalkyl acids and LINE-1 DNA methylation" Environ Int 2014 Feb
2014	"Polyfluoroalkyl chemicals and menopause among women 20-65 years of age (NHANES)", by Taylor KW et al
2014	International Agency for Research on Cancer (IARC) in Lyon, France publishes a report on the health impacts of PFOA. Classified PFOA as a class 2B carcinogen – which means "possible human carcinogen". Results published in *The Lancet* vol 15 Aug 2014
2014	Monash University publish a study into the cancer risk of Fiskville firefighters – "Fiskville Firefighters' Health Study" 69 firefighters out of 606 had cancer; 16 cancer deaths identified as possibly linked to chemicals at Fiskville http://www.coeh.monash.org/assets/fiskvillereport1.pdf
2014	Phillipe Grandjean and Richard Clapp, "Changing Interpretation of Human Health Risks from Perfuorinated Compounds" http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4187289/
2015	Velez et al, "Maternal Exposure to Perfluorinated Chemicals and Reduced Fecundity: the MIREC Study" – Hum Reprod 2015, 30(3) Canadian study of over 1700 women which concluded that increased concentrations of PFAS in serum were associated with reduced fecundity (measured by greater time to pregnancy, 11% down) and infertility (31% increase)
2015	200 scientists sign the Madrid Statement expressing concern about usage of PFC chemicals.

	http://greensciencepolicy.org/madrid-statement/ Summary: PFOA and its replacements are suspected to belong to a large class of artificial compounds called endocrine-disrupting chemicals; these compounds, which include chemicals used in the production of pesticides, plastics and gasoline, interfere with human reproduction and metabolism and cause cancer, thyroid problems and nervous-system disorders.
2015	UN POPs Review Committee nominates PFOA for inclusion in the Stockholm Convention due to its dangerous toxicity, extreme persistence, bioaccumulation and long-range transport Experts agreed that for PFOA "there was epidemiological evidence for kidney and testicular cancer, disruption of thyroid function and endocrine disruption in women"
2015	Brown University (Prof Joseph Braun) study of 204 mothers living near Ohio River: PFOA exposure in utero linked to child adiposity and faster BMI gain
2016	"Prenatal Exposure to Perfluorocarboxylic Acids (PFCAs) and Fetal and Postnatal Growth in the Taiwan Maternal and Infant Cohort Study", by Yan Wang et al Study of 223 Taiwanese mothers and their infants, which concluded prenatal exposure to long-chain PFCAs may interfere with fetal and childhood growth in girls, and childhood growth in boys.
2016	US EPA Office of Water, Drinking Water Health Advisory for PFOS "For PFOS, oral animal studies of short-term and subchronic duration are available in multiple species including monkeys, rats and mice. These studies report developmental effects (decreased body weight, survival, and increased serum glucose levels and insulin resistance in adult offspring), reproductive (mating behaviour), liver toxicity (liver weight co-occurring with decreased cholesterol, hepatic steatosis), developmental neurotoxicity (altered spatial learning and memory), immune effects, and cancer (thyroid and liver). Overall, the toxicity studies available for PFOS demonstrate that the developing fetus is particularly sensitive to PFOS induced toxicity. Human epidemiology data report associations between PFOS exposure and high cholesterol, thyroid disease, immune suppression, and some reproductive and developmental parameters, including reduced fertility and fecundity." https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos
2016	National Toxics Network (Dr Mariann Lloyd Smith), "The Persistence and Toxicity of Perfluorinated Compounds in Australia" http://www.ntn.org.au/wp/wp-content/uploads/2016/06/NTN-Perfluoros-in-Australia-June-2016.pdf
2016	National Toxicology Program Report into immunotoxicity of PFOS "The NTP concludes that PFOS is presumed to be an immune hazard to humans based on a high level of evidence that PFOS suppressed the antibody response from animal studies and a moderate level of evidence from studies in humans. Although the strongest evidence for an effect of PFOS on the immune system is for suppression of the antibody response, there is additional, although weaker, evidence that is primarily from studies in experimental animals that PFOS suppresses disease resistance and natural killer (NK) cell activity. The evidence indicating that PFOS suppresses multiple aspects of the immune system supports the overall conclusion that PFOS alters immune function in humans. Although the mechanism(s) of PFOS-associated immunotoxicity is

	unknown, suppression of the antibody response and NK cell function are both potential mechanisms by which PFOS may reduce disease resistance." https://ntp.niehs.nih.gov/pubhealth/hat/noms/pfoa/index.html