Testimony of R. Thomas Zoeller, Emeritus Professor of Biology, University of Massachusetts Amherst.

Thank you, Senator Muth, Senator Collett, Representatives Scott and Monroe and members of the Joint Policy Committee, for giving me the opportunity to speak today. My name is R. Thomas Zoeller. I am an Emeritus Professor of Biology at the University of Massachusetts Amherst and a Visiting Professor in the School of Science and Technology at the University of Örebro in Sweden.

I trained in the field of Neuroendocrinology – the study of how the brain controls our hormone systems – with a specific focus on the role of thyroid hormone on brain development. In the mid 1990s, I was a member of the US EPA's Endocrine Disruptor Screening Advisory Committee where I became interested in the way manufactured chemicals can interfere with hormone systems and how regulatory agencies go about assembling and interpreting scientific evidence to determine what is safe for the human population.

Since then, I have been very actively involved in this field of toxicology. I have served as a member of the Science Advisory Board of EPA, have served on several other advisory committees for EPA, including risk assessments for individual per- and polyfluroalkyl substances (PFAS), for European agencies such as the European Food Safety Authority, and for the UN and WHO. I was also a co-chair of the Endocrine Disruptor task force for the Endocrine Society – a society of over 18,000 members in 120 countries who care for endocrine diseases and acquire new knowledge about how hormones work and what they do.

Given my experiences over the last 25 years, I fully support a legislative approach to limit human exposures to PFAS including that represented by House Bill 2238. There are several reasons for this.

1. **PFAS are toxic.** There are an estimated 12,000 PFAS chemicals that have been produced and only a few have been studied well. PFOS and PFOA are two of the most familiar, but data are accumulating for several others. These chemicals are known to affect many human health outcomes (below).
    - **a.** Various PFAS have been shown to reduce the efficacy of the immune system (i.e., "immunotoxic"). In addition, people are not exposed to a single PFAS molecule, but rather a mixture of PFAS. This mixture produces a more potent effect on the immune system than each individual PFAS [1].
    - **b.** PFAS have also been shown to affect the thyroid hormone system in a complex way that is not fully understood. Thyroid hormone is critical for brain development in the human fetus and neonate [2-4]. Interfering with thyroid hormone action during this time robs the individual – and society – of human potential by reducing IQ as well as increasing the risk of autism and ADHD [5].
    - **c.** In addition, thyroid cancer is among the most common cancers, increasing in incidence at a rate of about 3% per 100,000 per year. PFAS have also been implicated in the development of thyroid cancer [6, 7].
    - **d.** Chronic diseases of the liver and kidney diminish the quality of life and exact huge costs on the individual and society. Several large systematic analysis of the

scientific literature highlight the importance of PFAS in these adverse human health outcomes [8, 9].

2. **PFAS are "forever".**
    - **a.** It is well-known now that these chemicals do not degrade in the environment. This has two important implications for public health.
        - **i.** First, it means that the only way to reduce human exposure – or even to reduce the rate of increase in exposure – is to reduce production. Prohibiting the use of PFAS in certain consumer products in the Commonwealth is the equivalent of reducing "production".
        - **ii.** PFAS readily get into the blood from contaminated food, water and consumer products, and once in the blood, they are taken up into tissues where they reside for long periods. As a result, they accumulate in the body over time [10].
3. **PFAS are not alone.**
    - **a.** We humans are not exposed to single chemicals. We are exposed to a mixture of many chemicals every day. But hazard and risk calculations are traditionally based on an approach that considers the exposure to each chemical in isolation, which is not how people are exposed.
    - **b.** Experimental studies in animals – for example, studies required by the EPA or FDA or by OECD and other regulatory agencies – go to great pains to perform toxicological experiments on a single chemical without incidental contamination by other chemicals. Epidemiological studies -- studies of how often diseases occur in different groups of people and why -- similarly go to great pains to factor out the contribution to adverse health effects by the mixture of other chemicals that people are in contact with on a regular basis in daily life.
    - **c.** However, a recent study by the Dutch risk assessment agency in collaboration with scientists at Brunel University, showed that the mixture of chemicals to which Europeans are exposed is much more potent on reducing IQ in children than what would be expected based on individual chemical estimates of risk [11].
    - **d.** The consequence of the combination of these observations is that risk estimates by industry and by government regulators is likely underestimating the current harm of these exposures.
4. **We must turn off the Tap**
    - **a.** The confluence of these issues means clearly that the only way to protect Americans from the harm of PFAS is to reduce exposure. Because the Federal government is slow to act in this regard, it is right and just that the Commonwealth take action.
        - **i.** An ancillary issue is whether it is reasonable to view the hazard of PFAS chemicals as a class based on data obtained from a relative few. There are varying estimates of the number of PFAS molecules in the environment, but the estimates are above 10,000. My answer to the question of regulating PFAS as a class is "absolutely yes". PFAS chemicals

have been around since the 1950s, and yet we still have only limited data on a relative few. Moreover, as a ProPublica article recently revealed, the 3M company knew of the toxicity of PFAS and concealed it. If we wait for scientific studies to approach this class in a one-by-one manner, it will be too late to do anything about it.

ii. One common trend is that as time goes on and data accumulate, our estimate of risk increases. Consider the recent analysis by the European Commission leading to a reduction in the estimate of a safe level for bisphenol A (or BPA) by 20,000 [12]. In fact, since 2006, various regulatory agencies have identified "safe" levels of BPA that vary by 250,000-fold.

iii. As a result, it is important to turn off the tap of PFAS rather than try to limit exposures for a chemical that won't go away and will only build up.

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