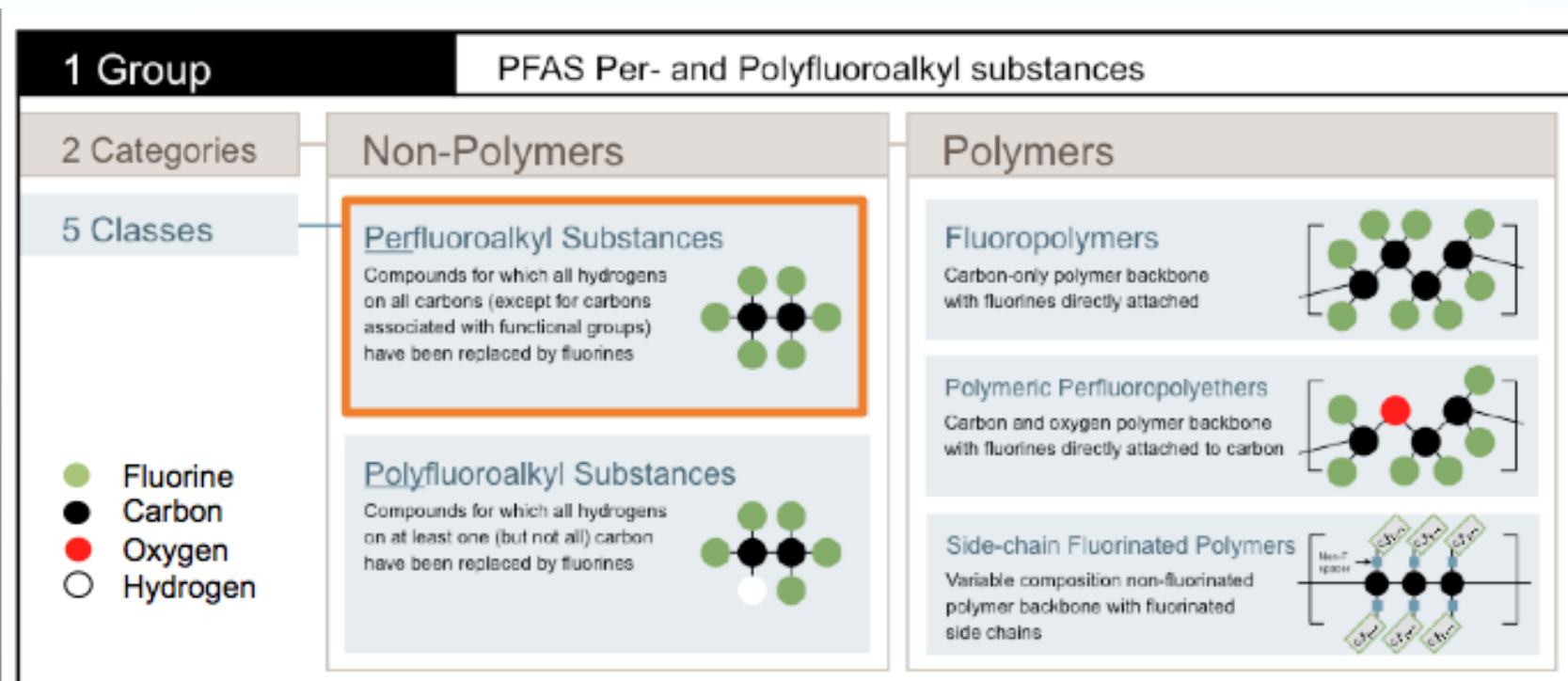


Perfluoroalkyl Substances: Risk and Toxicity

May 10, 2018

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Collaborative Risk Solutions LLC**

Perfluoroalkyl Substances



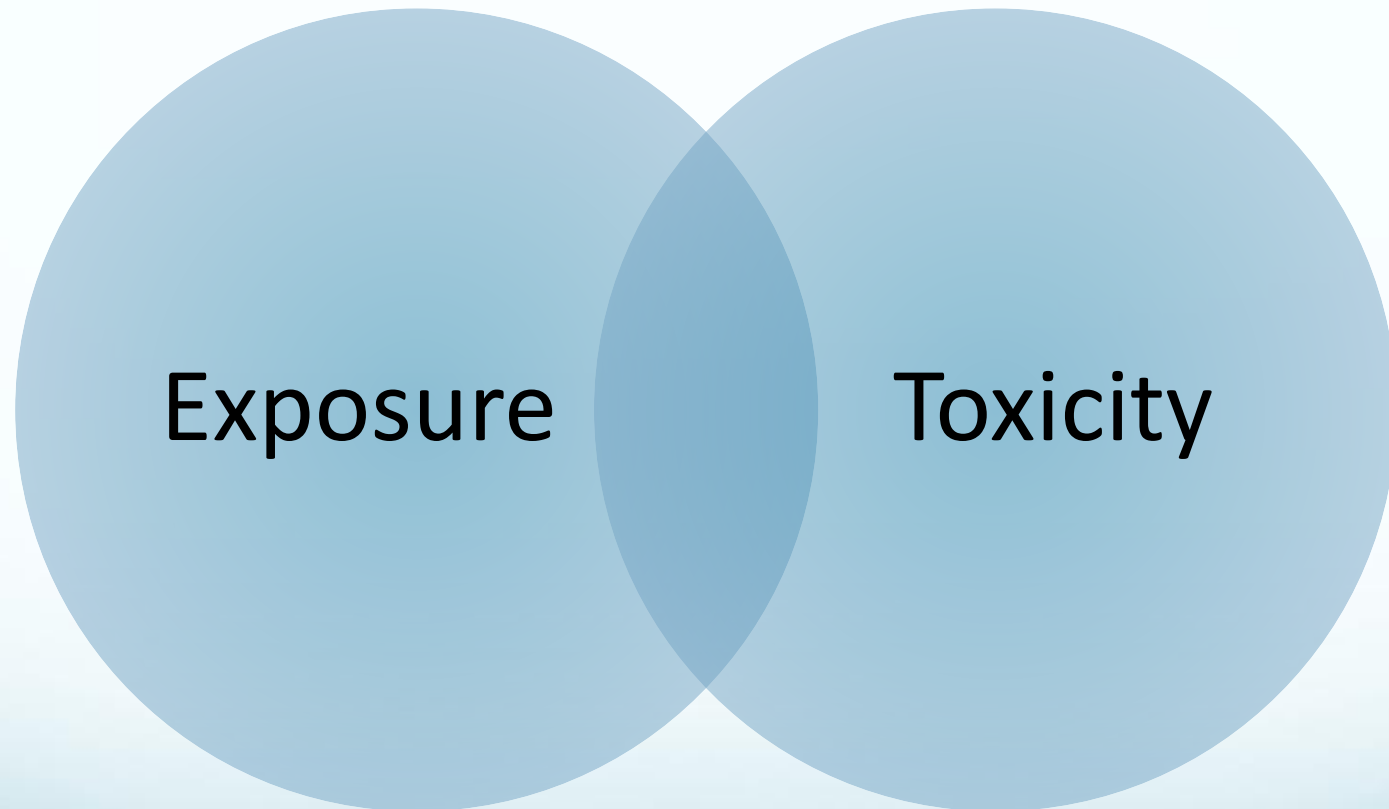
Adapted from Buck et al. 2011.

Integrated Environmental Assessment and Management 7:513.

Overview

- Introduction to Risk
- Basis of EPA Drinking Water Health Advisories
 - PFOS – Perfluorooctane Sulfonate
 - PFOA – Perfluorooctanoic Acid
- Massachusetts Department of Environmental Protection (MassDEP) Considerations for PFAS Compounds of Interest
- Toxic Use Reduction Institute (TURI) PFAS Compound of Interest

How is Risk Determined?

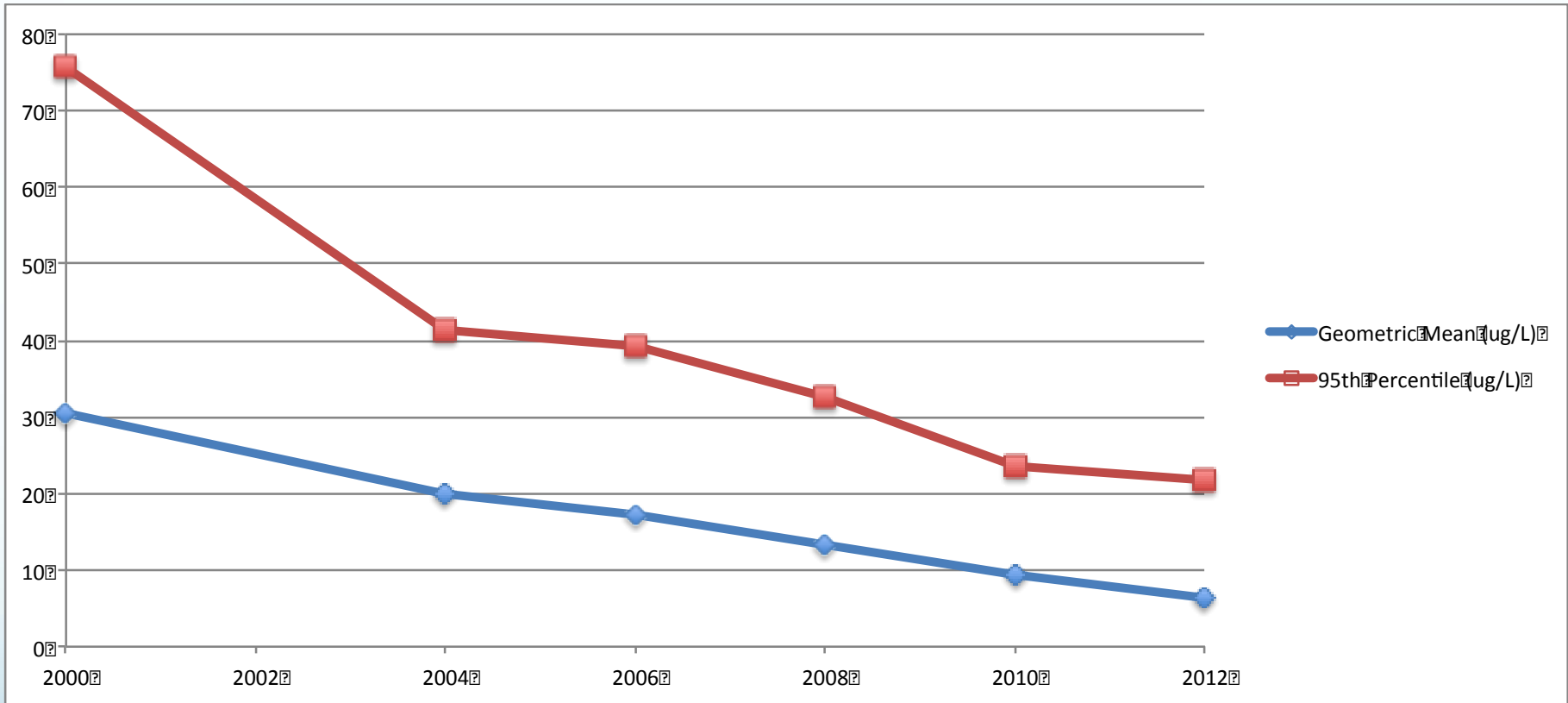


Sources of PFAS Exposure

- Food
- Indoor Dust
- Occupational
- Consumer Products
- Drinking Water
- Soil
- Air

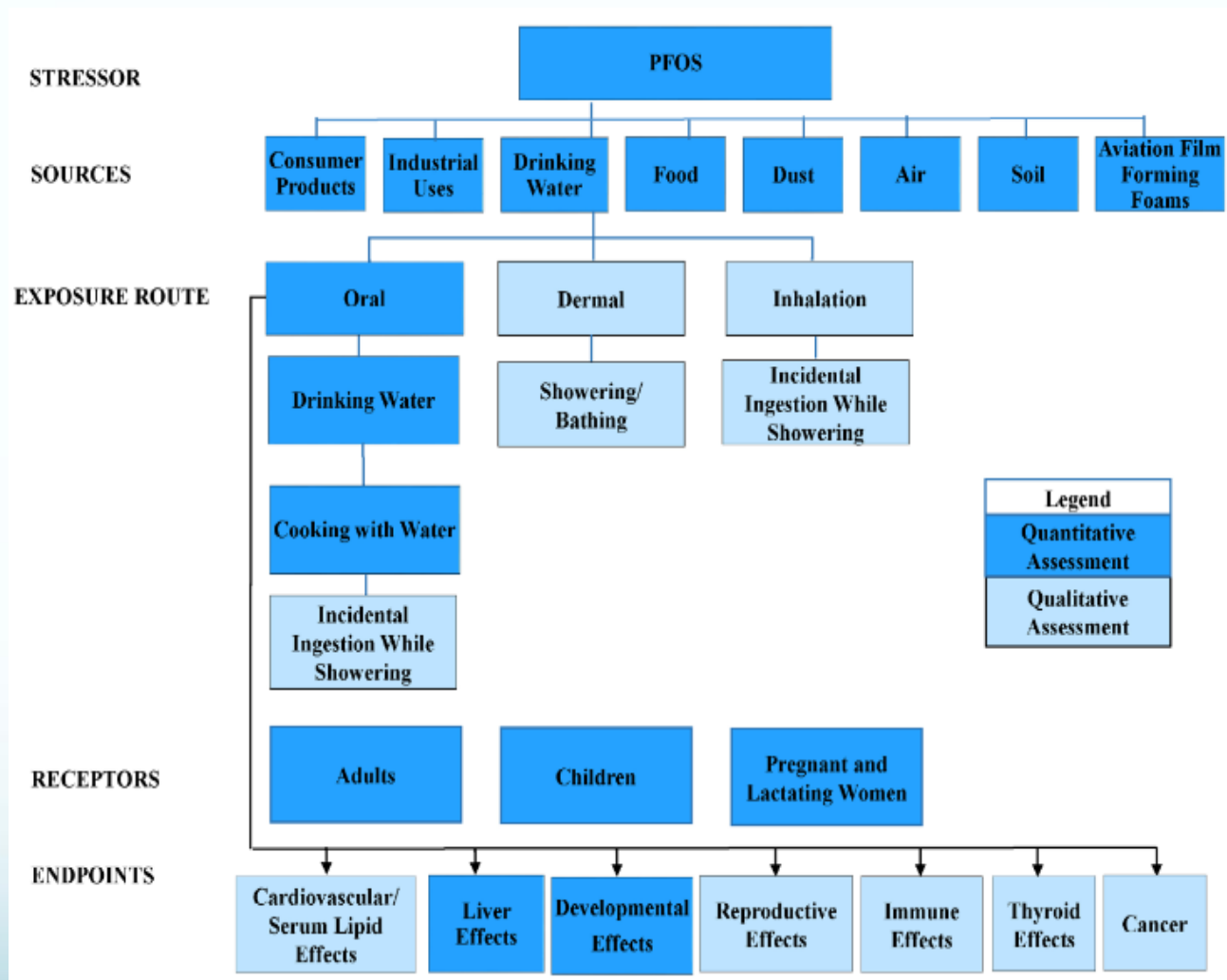


U.S. Serum PFOS Levels



U.S Department of Health and Human Services, Centers for Disease Control and Prevention, Fourth National Report on Human Exposure to Environmental Chemicals, Updated Tables, March 2018, Volume 1.

PFOS Conceptual Model



Source: USEPA Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS), May, 2016

Toxicity – USEPA

- Toxicity evaluated and quantified by numerous agencies
- USEPA issued Health Advisories in 2016
 - PFOS
 - PFOA
- Quantified dose-response (toxicity) and exposure

PFOS – Non-cancer Effects

- Non-cancer endpoints identified in animals
 - Developmental effects
 - Nervous
 - Liver
 - Serum Lipids*
 - Immune*
 - Thyroid*
- * USEPA also notes supported by human studies
- Non-cancer endpoints identified in humans
 - Reproductive, fertility

PFOS Health Advisory

- The Health Advisory equals 70 ppt (0.07 µg/L)
- Based on Developmental effect endpoint – reduced pup weight in rats
- Assessed drinking water intake and body weight for a lactating woman
- Assumes a 20% Relative Source Contribution Factor
 - Other sources include food, dust, air, consumer and industrial product (textiles, rugs), soils, surface water

PFOA – Non-cancer Effects

- Non-cancer endpoints identified in animals
 - Liver*
 - Low birth weight*
 - Immune effects*
 - Developmental effects
 - Liver
 - Kidney
 - Thyroid
 - Fertility
 - Serum lipids
- * USEPA also notes supported by human studies

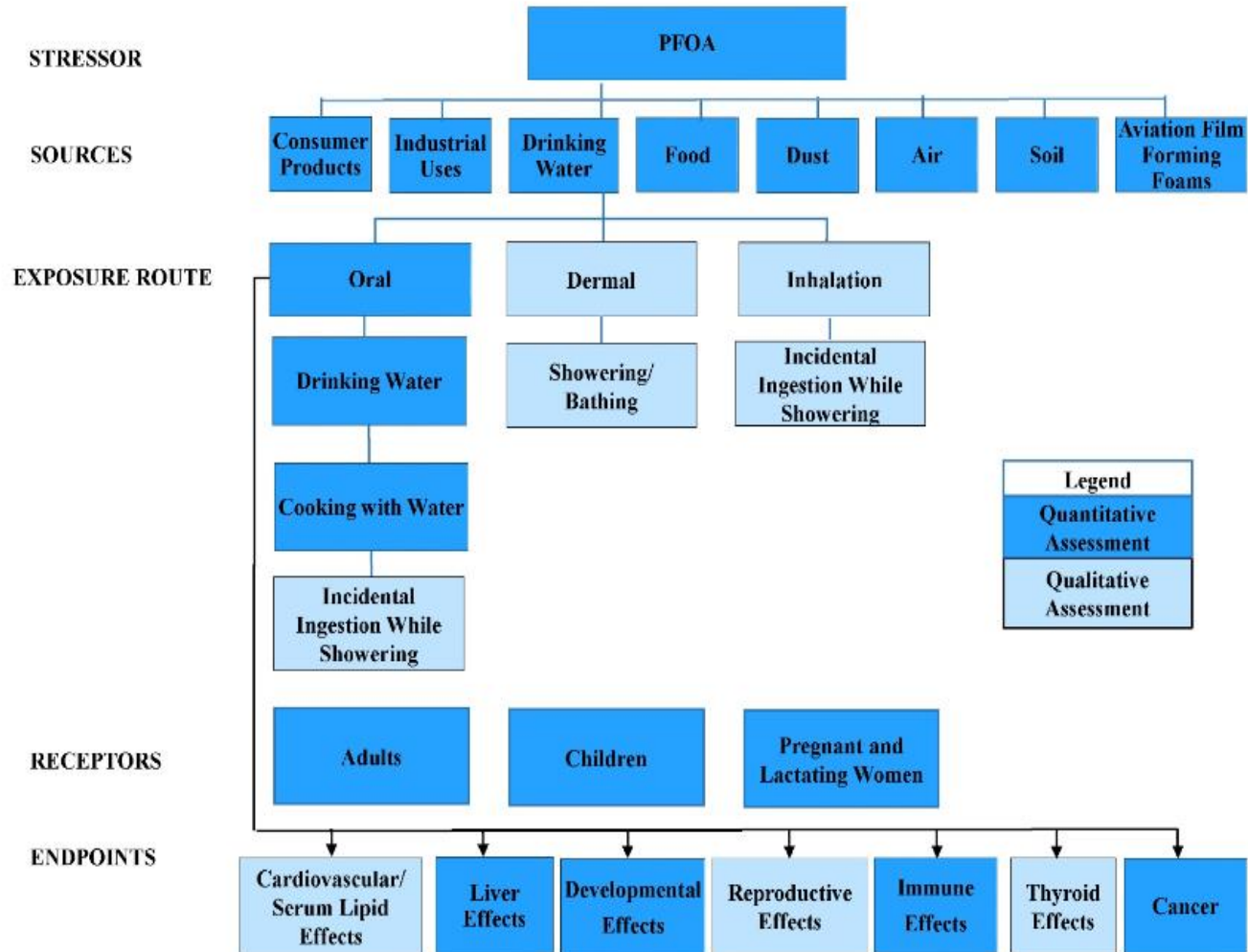


PFOA – Cancer Endpoints

- Cancer endpoints identified in animals
 - Testicular*
 - Liver

*USEPA also notes supported by epidemiology

PFOA Conceptual Model



Source: USEPA Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA), May, 2016

PFOA Health Advisory

- The Health Advisory equals 70 ppt
- Based on Developmental and Immune endpoints
- Protective of potential cancer risk
- Assessed drinking water intake and body weight for a lactating woman
- Assumes a 20% Relative Source Contribution Factor
 - Other sources include food, air, dust, (incinerators, carpets, paint, textiles, furniture, other consumer products, precursors), soils, surface water

PFOA and PFOS

- Similar effects noted for both compounds
- Effects that serve as the basis of the Health Advisories are developmental
- Health Advisories are identical
- Because both RfDs based on development effects, where two chemicals co-occur, EPA recommends summing the concentrations for comparison to the Health Advisory of 70 ppt

MassDEP Considerations

Compound	Carbon chain length	<i>In vivo</i> toxicity vs. PFOA	<i>In vitro</i> toxicity vs. PFOA	Half-life (days)
PFOA	8	1	1	1280
PFOS	8	1		1750
PFNA	9	≥ 1	1.2	NA
PFHpA	7		0.8	NA
PFHxS	6	≥ 1		2670
PFBS	4		<0.3	30

Source: Locke, P. (2017) 'PFAS Regulator's Perspective' [PowerPoint Presentation], MassDEP/LSPA Course: Per- and Polyfluoroalkyl Substances (PFAS): The Latest Information, November 29, 2017.

New England Drinking Water Health-Based Values

State	Value	Application	Comment
Connecticut	70 ppt	ΣPFOA, PFOS, PFNA, PFHpA, PFHxS	Long half-lives, emerging toxicity
Rhode Island	70 ppt	ΣPFOA, PFOS	USEPA HA
Massachusetts	Pending	PFOA, PFOS, PFNA, PFHpA, PFHxS	
Vermont	20 ppt	ΣPFOA, PFOS	Based on 0-1 year old
New Hampshire	70 ppt	ΣPFOA, PFOS	USEPA HA
Maine	100 ppt	PFOA	Different RfD (liver), RSC = 60%

Toxic Use Reduction Institute

- PFOA/PFOS groundwater concerns
- Alternatives or their breakdown products may have similar properties
- TURI Science Advisory Board has been reviewing scientific literature for specific perfluoroalkyl substances:
 - PFOA – C8 – Perfluorooctanoic acid
 - PFOS – C8 – Perfluorooctane sulfonic acid
 - PFHxA – C6 - Perfluorohexanoic acid
 - PFHxS – C6 - Perfluorohexane sulfonic acid
 - PFBA – C4 - Perfluorobutyric acid
 - PFBS – C4 - Perfluorobutane sulfonic acid
- Tasked to evaluate hazard

TURI SAB – Mammalian Toxicity Endpoints

Organ or System	PFHxA	PFHxS	PFBA	PFBS
Developmental	*		*	✓
Thyroid	✓	✓	*	✓
Liver	✓	✓	✓	
Immune				*
Kidney	*			
Nervous				*
Blood			*	
Reproductive				*

✓ = identified mammalian toxic effect; * = some concerns for effect

Conclusions

- Exposure is an important aspect in determining risk and health-based concentrations
- Toxicity has been demonstrated, though results are mixed and selected endpoints and health-based drinking water concentrations vary
- Summing risk across compounds will reduce health-based concentrations

Questions?

Thank you!

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