MDHHS Role for PFAS Sites in Michigan

Bill Farrell

Toxicology and Response Section

Michigan Department of Health and Human Services

Presentation Overview

- Background on PFAS
- PFAS Challenges
- MDHHS Activities at PFAS Sites
- Overview of PFAS public health drinking water screening levels

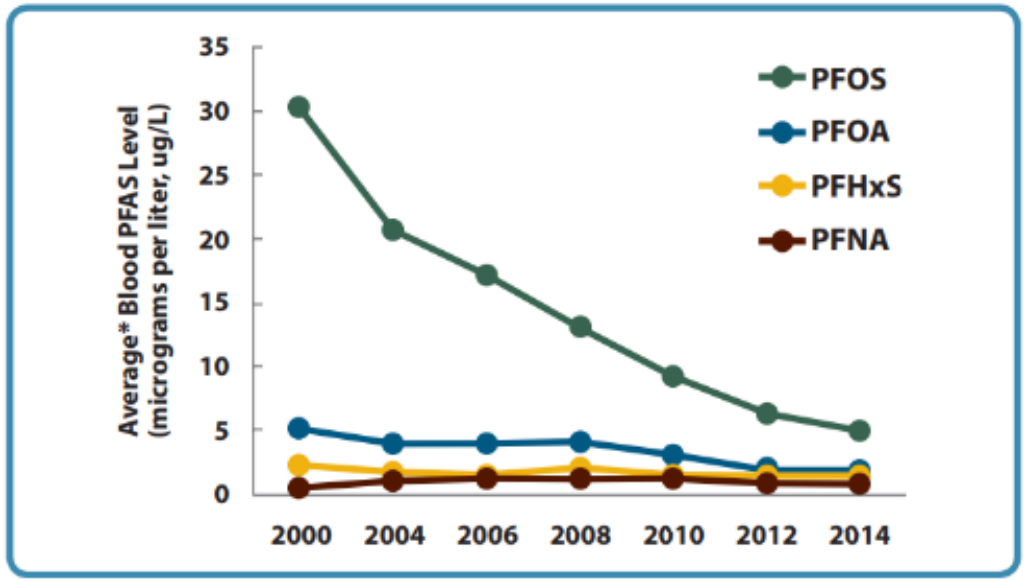
Sources of PFAS

- Drinking water, typically localized and associated with a specific facility (e.g., manufacturer, landfill, wastewater treatment plant, firefighter training facility).
- Food packaged in PFAS-containing materials, processed with equipment that used PFAS, or grown in PFAS-contaminated soil or water.
- Commercial household products, including stain- and water-repellent fabrics, nonstick products (e.g., Teflon), polishes, waxes, paints, cleaning products, and fire-fighting foams (a major source of groundwater contamination at airports and military bases where firefighting training occurs).
- Workplace, including production facilities or industries (e.g., chrome plating, electronics manufacturing or oil recovery) that use PFAS.
- Living organisms, including fish, animals and humans, where PFAS have the ability to build up and persist over time.

Human Exposure

- Ingestion is main pathway
  - Drinking contaminated water
  - Ingesting food contaminated with PFAS, such as certain types of fish and shellfish
  - Eating food packaged in materials containing PFAS (e.g., popcorn bags, fast food containers, etc.)
    - Until recently- PFAS now largely phased out of food packaging
- Hand-to-mouth transfer from surfaces treated with PFAS-containing chemicals

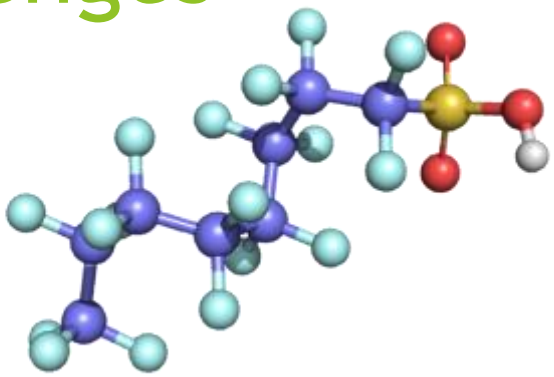
Blood Levels of the Most Common PFAS in People in the United States from 2000-2014



* Average = geometric mean

Data Source: Centers for Disease Control and Prevention. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables, (January 2017). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Emerging Contaminant Challenges



- Widely present in the environment
- Detected in drinking water and biota
- Evolving understanding of fate and transport
- Just now ID'ing new pathways and affected areas – creates sense the problem is "getting worse"
- Evolving analytical capabilities
- Expanding analytical lists and lowered detection limits – more detections and sense the problem is getting worse
- Evolving risk assessment
- Changing guidance values – public confusion
- Incomplete regulatory structure
- Limited remedial technologies

MDHHS supports communities impacted by PFAS by:

- Following federal guidance to evaluate PFAS data, identify hazards, and initiate public health protective actions (Fish and Deer consumption advisories, Provide filters, Foam advisories)
- Technical assistance to local public health, regulatory agencies, and residents regarding interpreting toxicological and epidemiologic data
- Public health assessments that document public health actions
- Surveillance data review – example, cancer incidence report
- Exposure Assessments and Biomonitoring – example North Kent County
- Community engagement and Health Education – example, town hall meetings

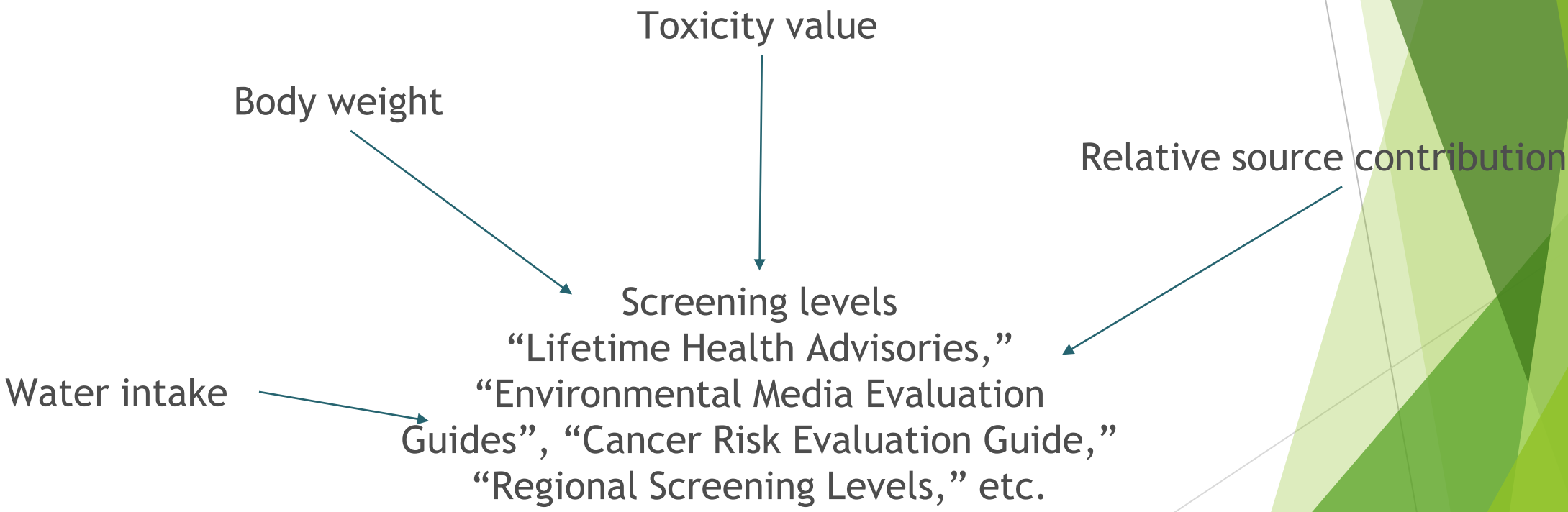
Multiple Lines of Consideration for Determining Public Health Response Actions

- USEPA Lifetime Health Advisory
- MDHHS Public Health Screening Levels
- Residential Well Results (individually and collectively)
- Site –specific information (e.g., known source, geology, etc.)

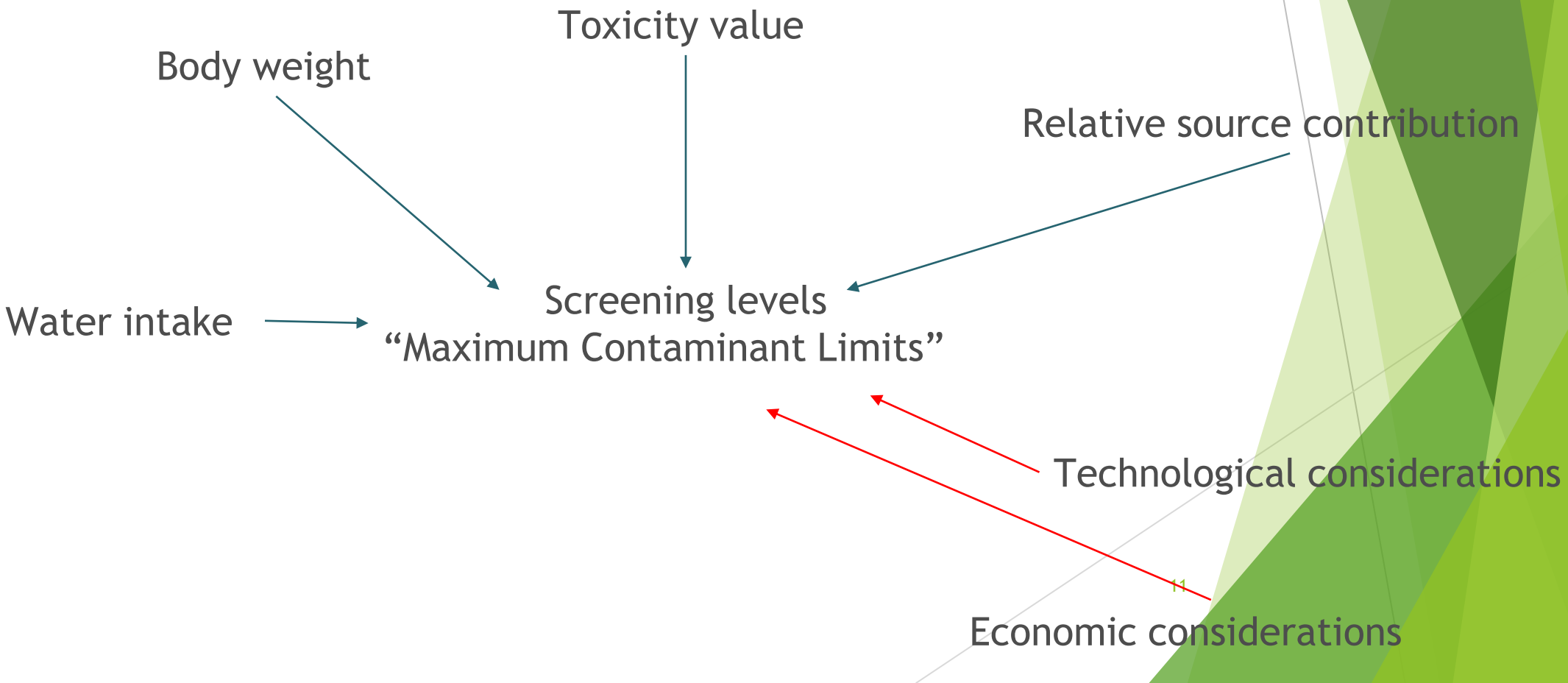
What are PFAS public health drinking water screening levels?

- PFAS public health drinking water screening levels
  - Health-based
    - Protective of fetus and breastfed infant
    - Also protective of formula fed infant and other ages
  - Used to determine if further evaluation of PFAS is needed
  - Used to determine if public health actions are needed
  - Non-regulatory

Development of screening levels

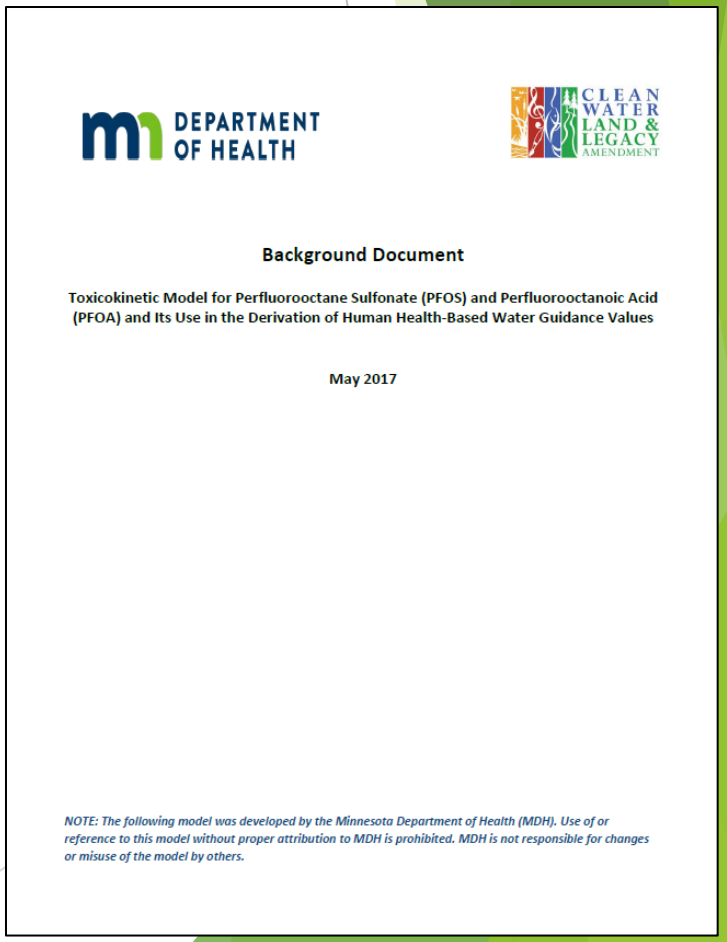


Development of regulatory levels



MDH Toxicokinetic Model

- "However, PFOS and PFOA have unique characteristics that are not adequately addressed when using this traditional approach."
- "PFOA and PFOS bioaccumulate in serum, cross the placenta, and are excreted into breastmilk."
- Reviewers of the model and recently published for PFOA



DEPARTMENT OF HEALTH

CLEAN WATER LAND & LEGACY AMENDMENT

Background Document

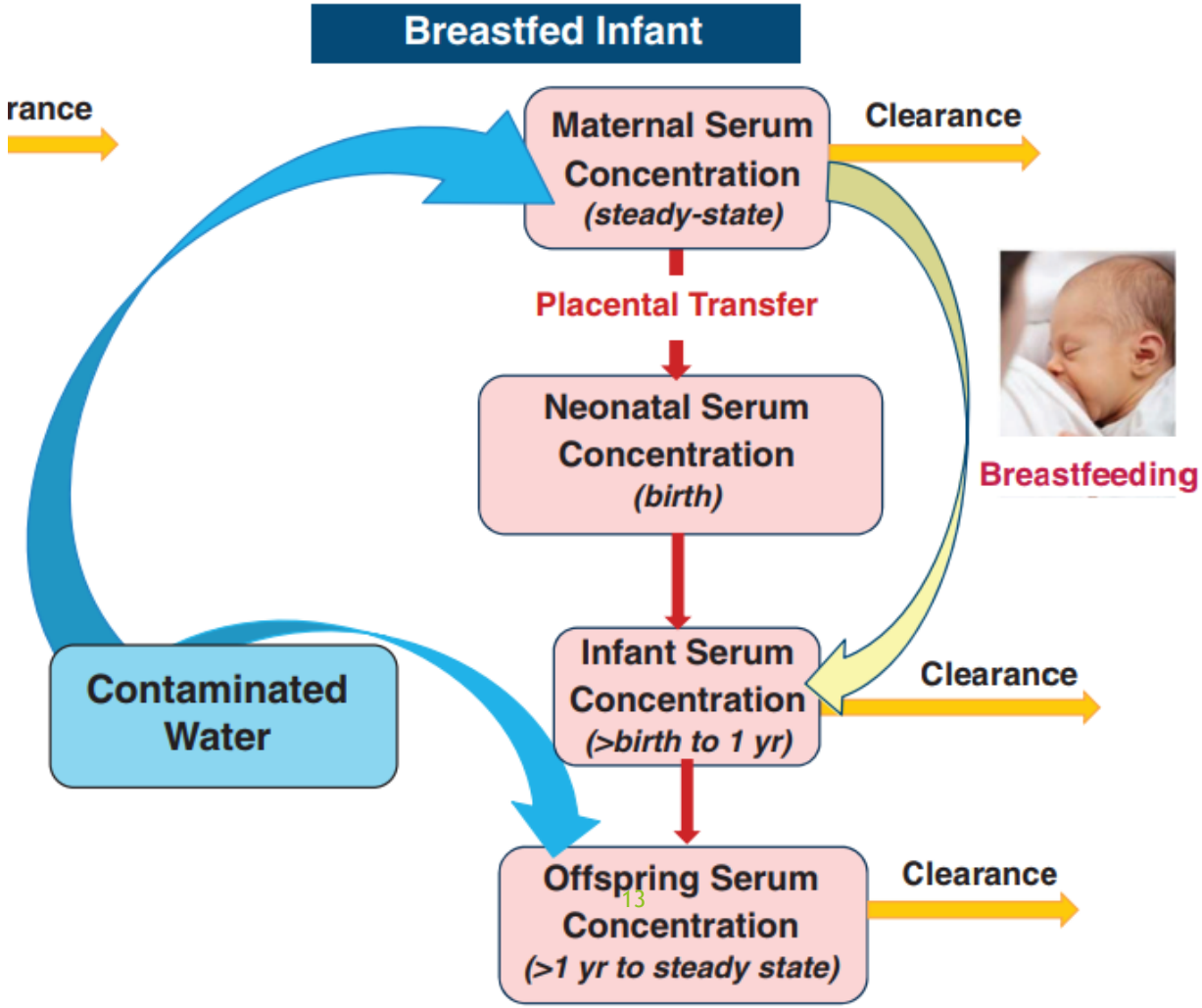
Toxicokinetic Model for Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) and Its Use in the Derivation of Human Health-Based Water Guidance Values

May 2017

NOTE: The following model was developed by the Minnesota Department of Health (MDH). Use of or reference to this model without proper attribution to MDH is prohibited. MDH is not responsible for changes or misuse of the model by others.

MDH Toxicokinetic Model

- One-compartment model predicts daily serum concentrations of PFOS and PFOA over a lifetime (i.e., from birth through attainment of steady-state conditions) of exposure to constant PFOA and PFOS concentrations in drinking water.
- Used to establish Screening Levels for PFOA,PFOS, PFHxS, and PFNA



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https://doi.org/10.1038/s41370-018-0110-5

ARTICLE

A transgenerational toxicokinetic model and its use in derivation of Minnesota PFOA water guidance

Helen M. Goeden[1] · Christopher W. Greene[1] · James A. Jacobus[1]

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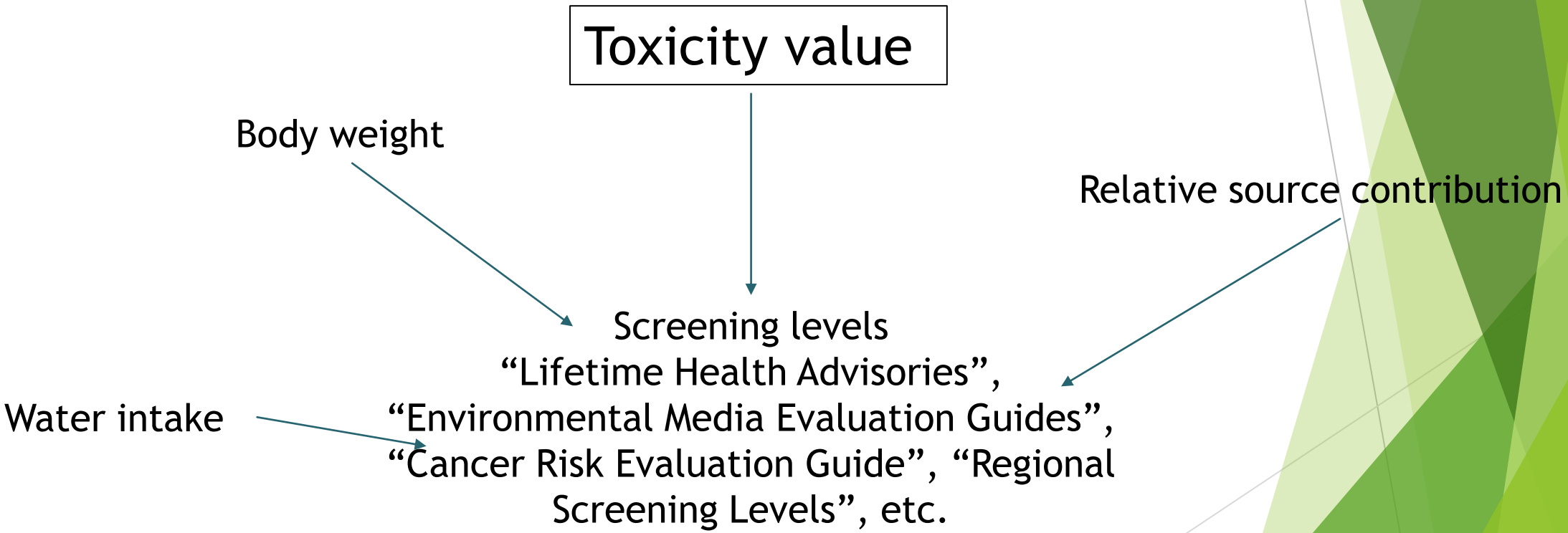
Abstract

Minnesota has been grappling with extensive per- and polyfluoroalkyl substances (PFASs) groundwater contamination since 2002, in a major metropolitan setting. As toxicological information has accumulated for these substances, the public health community has become increasingly aware of critically sensitive populations. The accumulation of some PFAS in women of childbearing age, and the placental and breastmilk transfer to their offspring, require new risk assessment methods to protect public health. The traditional water guidance paradigm is inadequate to address maternal-to-infant transfer of accumulated

https://www.nature.com/articles/s41370-018-0110-5.pdf

Development of screening levels



Toxicity values

- An amount of chemical (estimate with uncertainty) that is thought to cause minimal risk of harm for exposures lasting up to a lifetime
- For non-cancer health effects, called Reference Dose (US EPA and other agencies), Minimal Risk Levels (ATSDR)
- Often developed based on laboratory animal data (clear dosing levels, single chemical exposure)

Select PFAS Toxicity Values

	PFOA	PFOS	PFNA	PFHxS	PFBS
US EPA	20 ng/kg/day	20 ng/kg/day	NA	NA	20,000 ng/kg/day (chronic PPRTV) 10,000 ng/kg/day (DRAFT chronic)
ATSDR (Draft)	3 ng/kg/day	2 ng/kg/day	3 ng/kg/day	20 ng/kg/day	NA
Minnesota Dept of Health (MDH)	18 ng/kg/day	3.1 ng/kg/day	NA	9.7 ng/kg/day	430 ng/kg/day
NJ DEP	2 ng/kg/day	1.8 ng/kg/day (draft)	4.9 ng/ml (Serum level, not dose; draft)	NA	NA
NH DES	5.2 ng/kg/day	8 ng/kg/day	2.5 ng/kg/day	9.3 ng/kg/day	NA

NA = not available

Translating animal dose to human equivalent dose

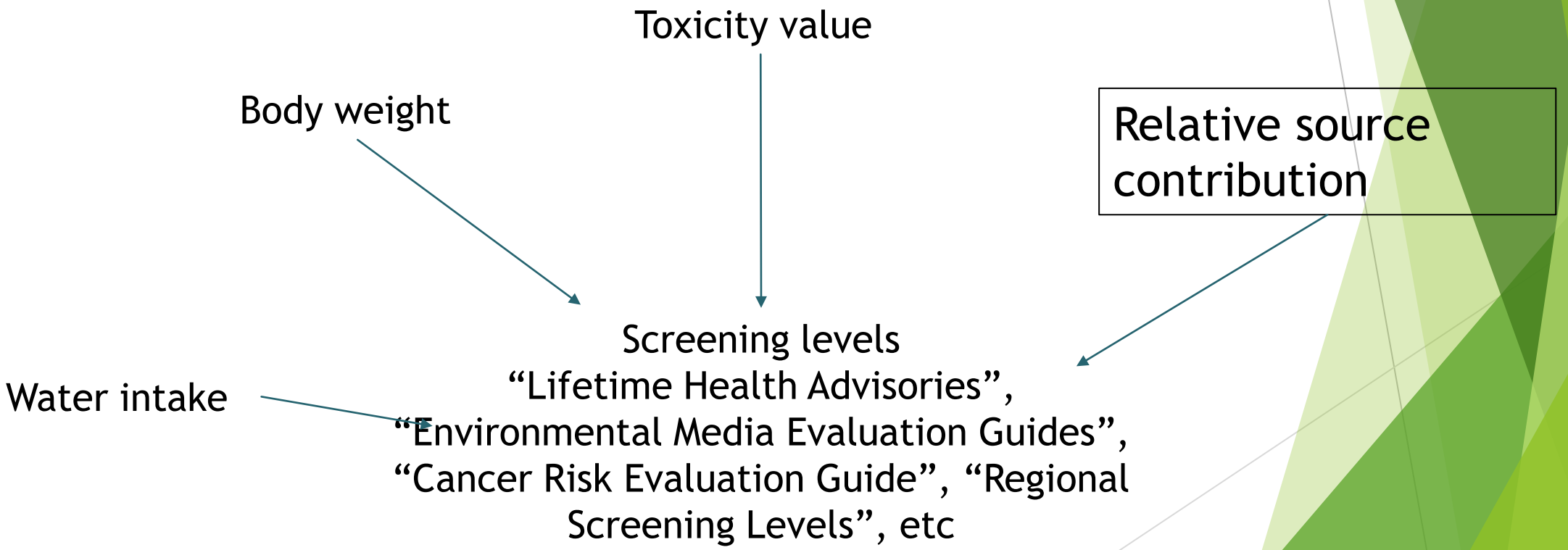
- Laboratory animal dose or serum level is converted to a human equivalent dose or serum level
  - Uses toxicokinetic information, animals and humans
  - Dosimetric adjustment factors (animal and human half-life)
  - Human-specific information on clearance rates (occupational and non-occupational)

- Know that there are differences in animal and human half-lives/elimination not covered by body weight scaling

Toxicity value used in the toxicokinetic model

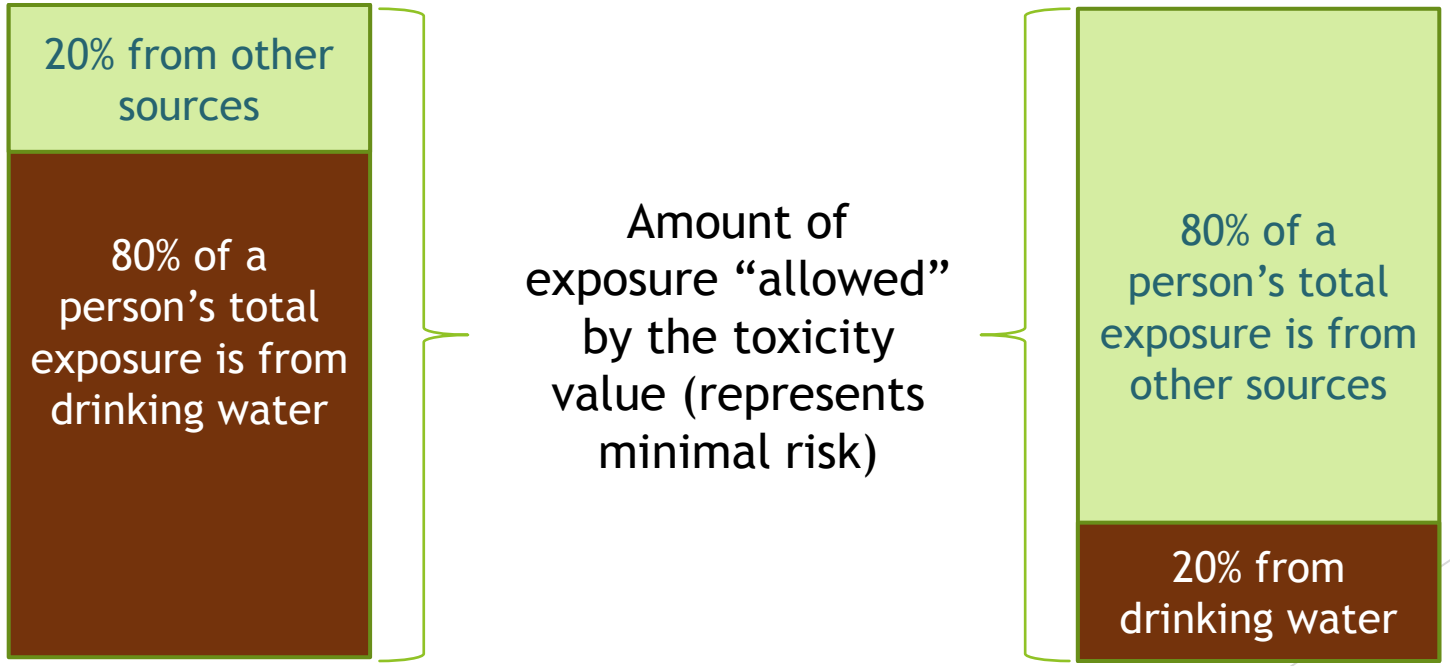
- Serum PFOA, PFOS, PFHxS, and PFNA levels (average levels calculated by ATSDR) divided by the uncertainty and modifying factors
- Results in serum level associated with the toxicity value
- Serum levels used in development of these screening levels are not meant to indicate a level where health effects are likely. These serum levels are calculated to be at a point where no or minimal risk exists for people drinking water with a certain PFAS.

Development of screening levels



Relative Source Contribution

Not many other sources of the chemical



Higher drinking water screening level

Lower drinking water screening level

Many other sources of the chemical

Relative Source Contribution – Subtraction method

- Subtract all non-drinking water exposures (i.e. background) from the Toxicity value to determine the amount of the Toxicity value available for drinking water exposure
- Determine what percentage of the Toxicity value that remainder represents

- NHANES or local biomonitoring information (if available)

NHANES – National Fourth Report

Serum Perfluorooctane sulfonic acid (PFOS) (2011 – 2016)‡

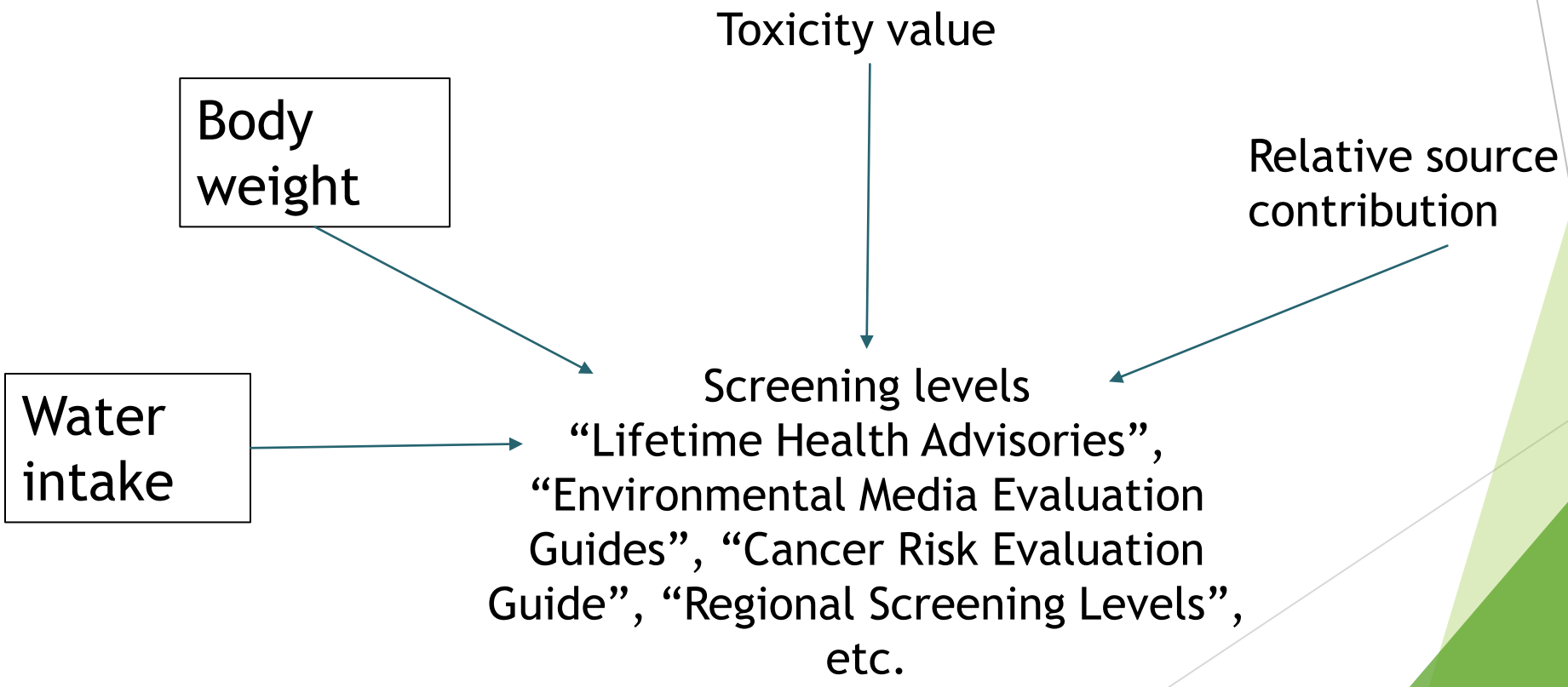
CAS Number 1763-23-1

Geometric mean and selected percentiles of serum concentrations (in µg/L) for the U.S. population from the National Health and Nutrition Examination Survey.

Categories (Survey Years)	Geometric Mean (95% conf. interval)	50th Percentile (95% conf. interval)	75th Percentile (95% conf. interval)	90th Percentile (95% conf. interval)	95th Percentile (95% conf. interval)	Sample Size
Total population (2011 - 2012)	6.31 (5.84-6.82)	6.53 (5.99-7.13)	10.5 (9.78-11.1)	15.7 (14.7-17.5)	21.7 (19.3-23.9)	1904
Total population (2013 - 2014)	4.99 (4.50-5.52)	5.20 (4.80-5.70)	8.70 (7.90-9.40)	13.9 (11.9-15.5)	18.5 (15.4-22.0)	2165
Total population (2015 - 2016)	4.72 (4.40-5.07)	4.80 (4.40-5.30)	8.10 (7.30-9.40)	13.2 (11.4-15.6)	18.3 (15.5-22.7)	1993
Age 12-19 years (2011 - 2012)	4.16 (3.70-4.68)	4.11 (3.48-4.65)	5.90 (5.14-7.25)	9.05 (6.49-10.8)	10.8 (8.52-14.2)	344
Age 12-19 years (2013 - 2014)	3.54 (3.17-3.96)	3.60 (3.10-4.20)	5.20 (4.60-6.20)	7.80 (7.00-8.90)	9.30 (7.90-11.7)	401
Age 12-19 years (2015 - 2016)	2.94 (2.70-3.19)	2.90 (2.70-3.30)	4.30 (3.70-5.00)	6.00 (5.50-6.60)	6.60 (6.10-7.70)	353

https://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Volume1_Jan2019-508.pdf

Development of screening levels



Body weight and water intake

- Upper percentile water intake (protect high-end consumers)
- Connection between body weight (age) and water intake
  - Often use 90th or 95th percentile of water intake with average body weight
  - US EPA Exposure Factors Handbook (2011)
- Infants are the population likely to have the highest water intake in relation to their body weight

Intake Rates

- Breastmilk Intake Rate – PFOA, PFOS, PFHxS, PFNA
  - Upper percentile (mean plus two standard deviations)*

    * USEPA Exposure Factors Handbook: MDH 2017

- Water Intake Rate – PFOA, PFOS, PFHxS, PFNA
  - Birth to more than 21 years old
    - 95th percentile DW intake, consumers only (USEPA Exposure Factors Handbook: MDH 2017)
  - 30 to 35 years of age (to calculate maternal serum at delivery)
    - Time-weighted-average DW intake rate (MDH 2017)

How it all fits together to develop a screening level

- Standard equations

$$screening\ level = \frac{reference\ dose\ *\ relative\ source\ contribution\ *\ body\ weight}{water\ intake}$$

- Toxicokinetic model
  - Accounts for prenatal (maternal serum and placental transfer) exposure along with exposure through breastmilk (maternal serum and transfer to breastmilk)

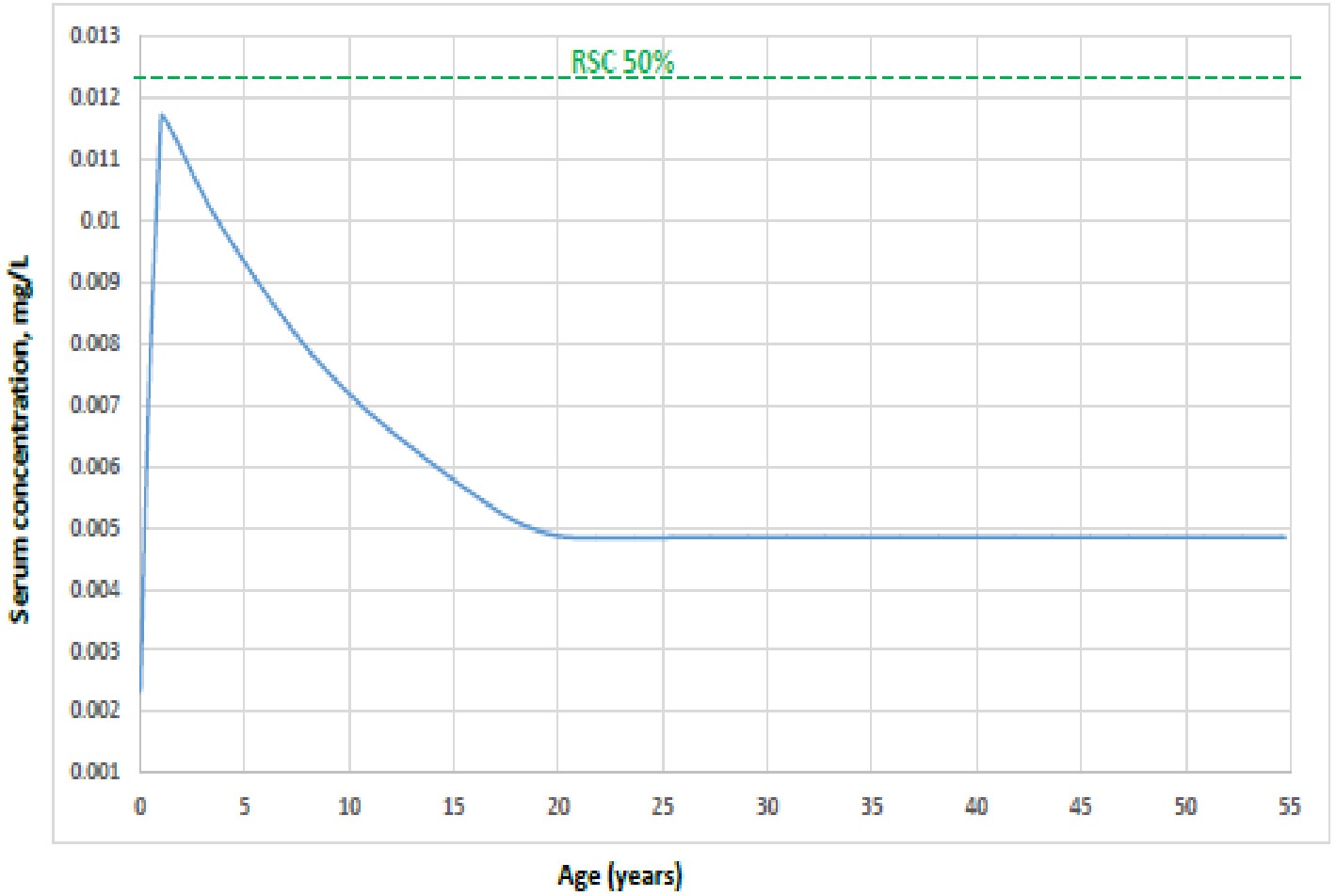


Figure 2. PFOS serum concentration for an infant exclusively breast-fed for 12 months, followed by drinking contaminated water through life (RSC of 50% [0.0124 mg/L = 50% of the serum equivalent at the RfD] and a water concentration of 8 ng/L).

MDHHS-led Human Health Workgroup PFAS public health drinking water screening levels

PFAS	Public Health Drinking Water Screening Level
PFOA	9 ng/L (parts per trillion [ppt])
PFOS	8 ng/L (ppt)
PFNA	9 ng/L (ppt)
PFHxS	84 ng/L (ppt)
PFBS	1000 ng/L (ppt)

PFBS public health drinking water screening level calculated using standard exposure parameters and equations. The MDH toxicokinetic model cannot be used.

PFOA

US EPA Lifetime Health Advisory, for PFOA individually or in combination with PFOS (2016)
- Water intake for a woman who is breast-feeding
- US EPA RfD
- Daily exposure
- 20% Relative Source Contribution

70 ppt

78 ppt

ATSDR Environmental Media Evaluation Guide for adults only (2018)
- Adult drinking water intake
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

NH DES proposed MCL
- Water intake for a woman who is breast-feeding
- NH RfD
- Daily exposure
- 40% Relative Source Contribution

38 ppt

35 ppt

Minnesota Dept of Health, protective of breast-feeding infants, both from exposure they may receive prenatally and while breast-feeding (2018)
- Water intake varies by age
- US EPA RfD
- Daily exposure
- 50% Relative Source Contribution

ATSDR Environmental Media Evaluation Guide for children (2018)
- Water intake for children less than 1 year old
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

21 ppt

14 ppt

New Jersey DEP (2017)
- Adult drinking water intake
- NJ RfD
- Daily exposure
- 20% Relative Source Contribution

MDHHS screening level, MDH toxicokinetic model
- Water intake varies by age
- ATSDR MRL
- Daily exposure
- 50% Relative Source Contribution

9 ppt

NY Proposed MCL: 10 ppt (not all details are available yet)

PFOS

NH DES proposed MCL
- Water intake for a woman who is breast-feeding
- NH RfD
- Daily exposure
- 50% Relative Source Contribution

70 ppt

US EPA Lifetime Health Advisory, for PFOS individually or in combination with PFOS (2016)
- Water intake for a woman who is breast-feeding
- US EPA RfD
- Daily exposure
- 20% Relative Source Contribution

ATSDR Environmental Media Evaluation Guide for adults only (2018)
- Adult drinking water intake
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

52 ppt

Minnesota Dept of Health, protective of breast-feeding infants, both from exposure they may receive prenatally and while breast-feeding (2018)
- Water intake varies by age
- MDH RfD
- Daily exposure
- 50% Relative Source Contribution

ATSDR Environmental Media Evaluation Guide for children (2018)
- Water intake for children less than 1 year old
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

15 ppt

14 ppt

13 ppt

New Jersey DEP (2017)
- Adult drinking water intake
- NJ RfD
- Daily exposure
- 20% Relative Source Contribution

MDHHS screening level, MDH toxicokinetic model
- Water intake varies by age
- ATSDR MRL
- Daily exposure
- 50% Relative Source Contribution

8 ppt

NY Proposed MCL: 10 ppt (not all details are available yet)

PFNA

NH DES proposed MCL
- Water intake for a woman who is breast-feeding
- NH RfD
- Daily exposure
- 50% Relative Source Contribution

78 ppt

ATSDR Environmental Media Evaluation Guide for adults only (2018)
- Adult drinking water intake
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

23 ppt

ATSDR Environmental Media Evaluation Guide for children (2018)
- Water intake for children less than 1 year old
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

21 ppt

13 ppt

New Jersey DEP (2015)
- Adult drinking water intake
- NJ developed target serum level
- 200:1 ratio between PFNA serum levels and drinking water concentrations, which is meant to represent a central tendency estimate
- 50% Relative Source Contribution

MDHHS screening level, MDH toxicokinetic model
- Water intake varies by age
- ATSDR MRL
- Daily exposure
- 50% Relative Source Contribution

8 ppt

PFHxS

520 ppt

ATSDR Environmental Media Evaluation Guide for adults only (2018)
- Adult drinking water intake
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

140 ppt

ATSDR Environmental Media Evaluation Guide for children (2018)
- Water intake for children less than 1 year old
- ATSDR MRL
- Daily exposure
- No Relative Source Contribution

85 ppt

NH DES proposed MCL
- Water intake for a woman who is breast-feeding
- NH RfD
- Daily exposure
- 50% Relative Source Contribution

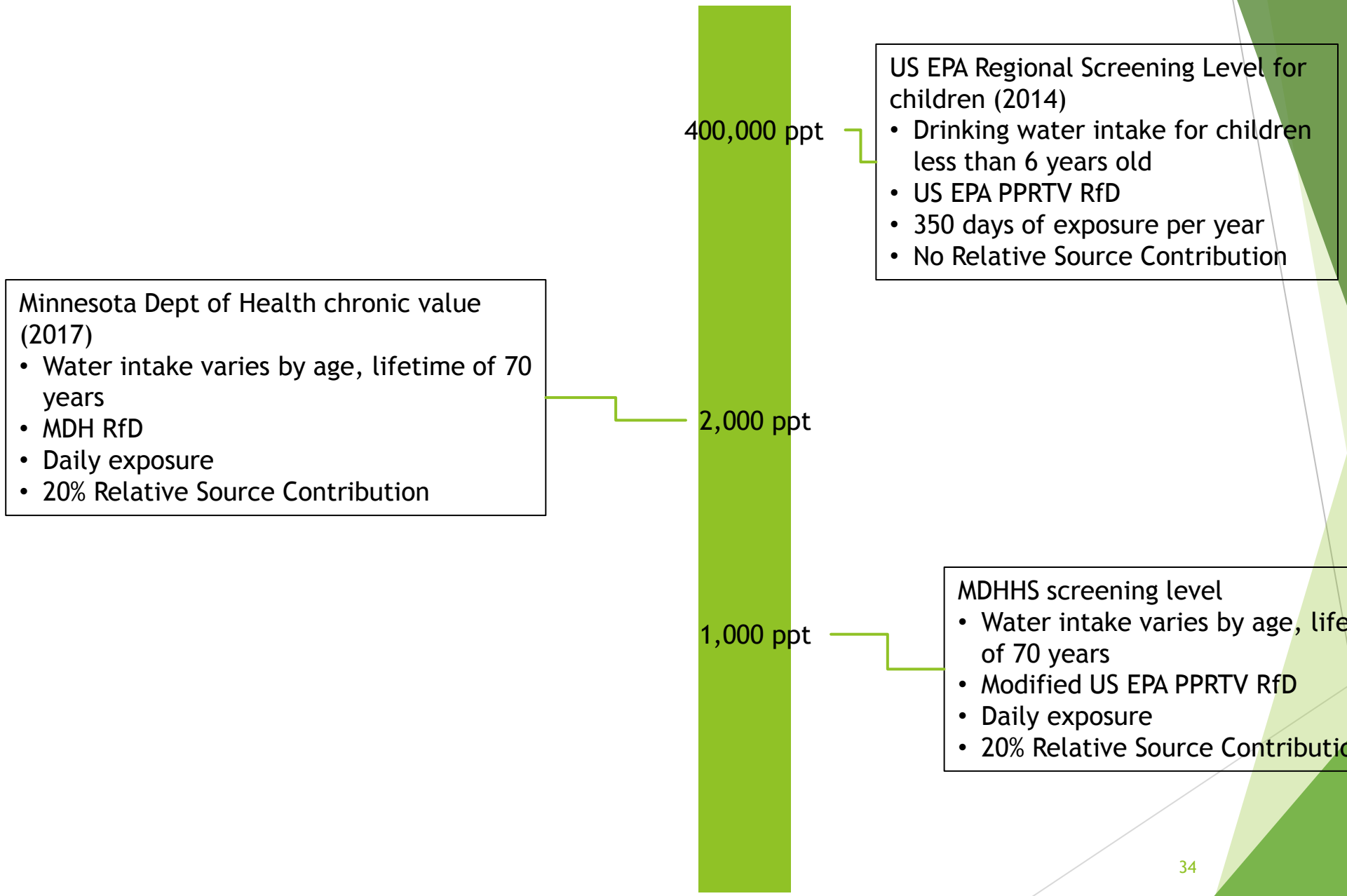
84 ppt

MDHHS screening level, MDH toxicokinetic model
- Water intake varies by age
- ATSDR MRL
- Daily exposure
- 50% Relative Source Contribution

47 ppt

Minnesota Dept of Health, protective of breast-feeding infants, both from exposure they may receive prenatally and while breast-feeding (2018)
- Water intake varies by age
- MDH RfD
- Daily exposure
- 50% Relative Source Contribution

PFBS

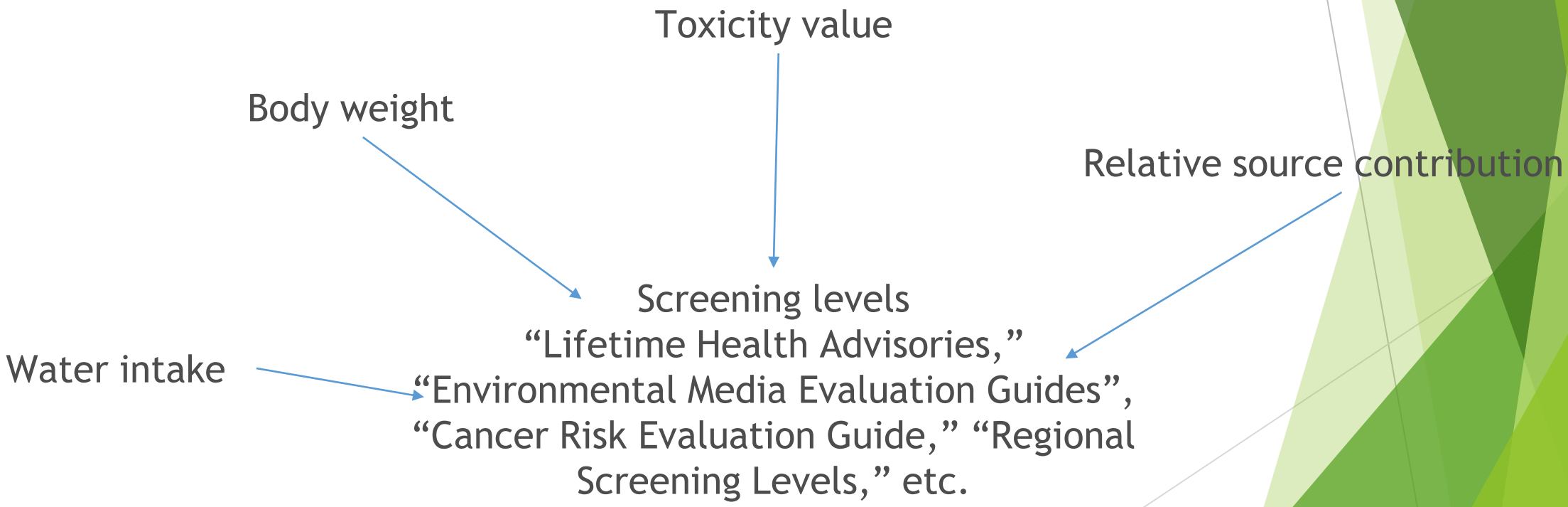

400,000 ppt
2,000 ppt
1,000 ppt
US EPA Regional Screening Level for children (2014)
• Drinking water intake for children less than 6 years old
• US EPA PPRTV RfD
• 350 days of exposure per year
• No Relative Source Contribution
Minnesota Dept of Health chronic value (2017)
• Water intake varies by age, lifetime of 70 years
• MDH RfD
• Daily exposure
• 20% Relative Source Contribution
MDHHS screening level
• Water intake varies by age, lifetime of 70 years
• Modified US EPA PPRTV RfD
• Daily exposure
• 20% Relative Source Contribution

Thank you and any questions?

Calculation of Toxicity Values

- $$Toxicity\ Value = \frac{Point\ of\ Departure\ (e.g.,\ NOAEL,\ LOAEL,\ BMDL,\ serum\ level)}{Uncertainty\ factors}$$

Development of screening levels



	US EPA MCLs (ppb)	ATSDR Child Chronic EMEG (ppb)	ATSDR Adult Chronic EMEG (ppb)	ATSDR CREG (ppb)	US EPA LHA (ppb)	US EPA Tapwater RSL (ppb)	MDEQ Part 201 Residential Drinking Water Criteria (ppb)
Arsenic	10	2.1	7.8	0.016	NA	0.052 (C)/6 (NC)	10 (MCL)
Benzene	5	3.5	13	0.44	3	0.46 (C)/33 (NC)	5.0 (MCL)
Chloropyrifos	NA	7	26	NA	2	8.4 (NC)	22
Diazionon	NA	4.9	18	NA	1	10 (NC)	1.3
Dibromochloromethane	80 (TTHM)	630	2,300	0.29	60 (TTHM)	0.87 (C)/380 (NC)	80 (TTHM)
1,4-Dioxane	NA	700	2,600	0.24	200	0.46 (C)/57 (NC)	7.2
Ethylbenzene	700	NA	NA	NA	700	1.5 (C)/810 (NC)	74 (aesthetic)
Malathion	NA	140	520	NA	500	390 (NC)	NA
Pentachlorophenol	1	7	26	0.061	40	0.041 (C)/23 (NC)	1.0 (MCL)
Selenium	50	35	130	NA	50	100 (NC)	50 (MCL)
Tetrachloroethylene	5	56	210	12	10	11 (C)/41 (NC)	5.0 (MCL)
Trichloroethylene	5	3.5	13	0.43	NA	0.49 (C)/2.8 (NC)	5.0 (MCL)
Xylenes, total	10,000	1,400	5,200	NA	NA	190 (NC)	280 (aesthetic)