Human Health Ambient Water Quality Criteria

Human and Ecological Criteria Branch/HEAD/OWOW/OW
US Environmental Protection Agency

Virtual WQS Academy

February 2026

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- Determine the obligations of the regulated community
- Change or substitute for any statutory provision or regulatory requirement
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Outline

1. What are human health ambient water quality criteria (HH AWQC)?

2. How are health assessments interpreted and used?
   - Hazard identification
   - Dose response: Linear and non-linear for cancer and noncancer health effects

3. How is an exposure analysis conducted?
   - Identification of the Target Population
   - Defining exposure parameters for target population
     - Drinking water intake, fish consumption, bioaccumulation factor, relative source contribution

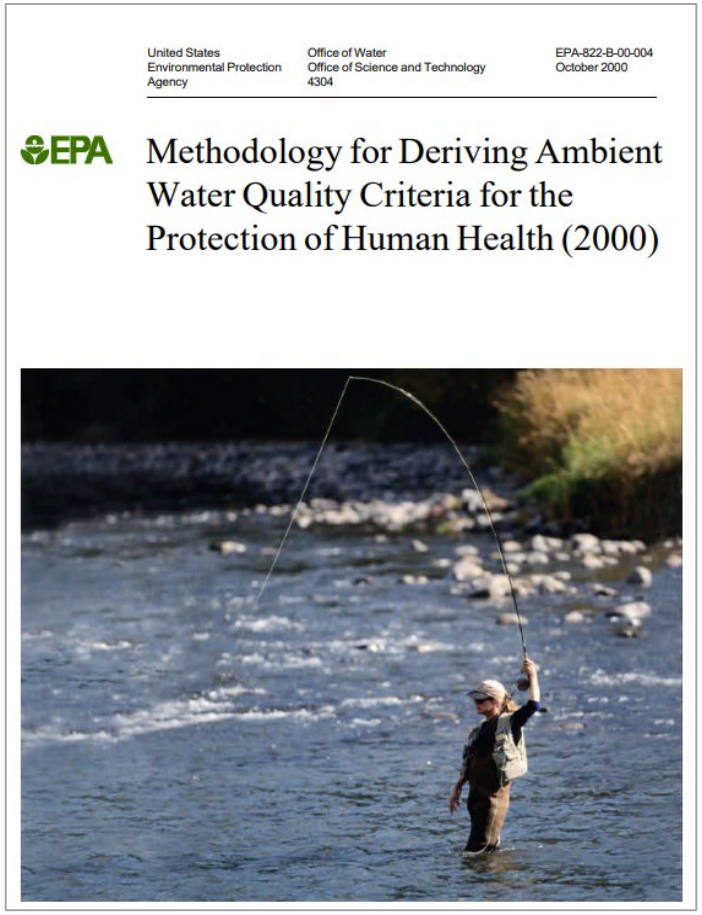
4. How are human health AWQC calculated?
   - Equations used to calculate HH AWQC

What are Human Health AWQC?

- HH AWQC are:
  - Developed pursuant to CWA Section 304(a)(1).
  - Ambient concentrations of pollutants in waters of the US, which, if not exceeded will protect the general population from adverse health effects due to the consumption of aquatic organisms (freshwater/estuarine fish and shellfish) and water (USEPA, 2000a).
  - Health-based values that reflect the most current science.
- HH AWQC are not:
  - Regulations
  - Do not consider economics or treatment feasibility
- Water quality criteria for human health can be referred to as:
  - Human Health Ambient Water Quality Criteria (HH AWQC);
  - Human Health 304(a)(1) Criteria; or
  - **Human Health Criteria (HHC)**

Source: USEPA (2000a). Section 1.1 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

EPA Method for HHC Development



Source: USEPA (2000a). Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

- Describes EPA's recommended current methods for developing HHC.
- Summarizes "state of the science" as of 2000.
- Recommends approaches based on different chemical properties, exposure scenarios, and risk management policy decisions.

HHC Values Calculated

- Two separate HHC values are derived for each chemical:
  - Water + Organism HHC
  - Organism only HHC
- Some HHC are based on non-cancer and others are based on cancer toxicity values.
- For contaminants with data that allow for the derivation of both a non-cancer and a cancer HHC, **the lower value is selected as the national recommended HHC because it is more health protective** (per the 2000 Methodology).

Source: USEPA (2000a). Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

2015 Updated HHC

- Goals
  - Incorporate the latest science on toxicity and exposure
  - Increase transparency
- Process
  - May 2014: EPA published draft updated criteria for 94 chemicals
  - June 2015: EPA published final updated criteria for 94 chemicals based on peer reviewed studies and methods
- Outcomes
  - 94 of 116 chemicals were updated
  - Publication of 94 criteria documents addressing chemical specific input values, assumptions, and calculations

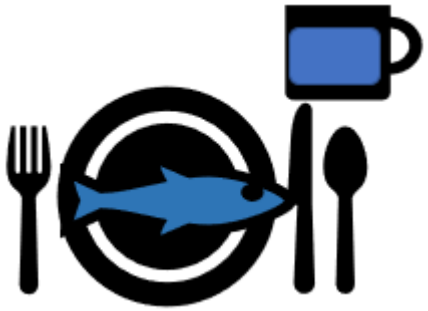
Source: USEPA (2015a). Human Health Ambient Water Quality Criteria: 2015 Update Factsheet

HHC Example: Chlorobenzene (2015)

100 µg/L

Water and Organism Criteria

Protects against histopathologic changes in the liver from exposure to chlorobenzene through drinking water and fish/shellfish consumption



800 µg/L

Organism Only Criteria

Protects against histopathologic changes in the liver from exposure to chlorobenzene through fish/shellfish consumption only

*Chlorobenzene is also regulated under the Safe Drinking Water Act and therefore has a National Primary Drinking Water Regulation.

Source: USEPA (2015b). Update of Human Health Ambient Water Quality Criteria: Chlorobenzene

Examples of HHC

1,1 Dichloroethylene

Water + Organism Criteria =

300 µg/L

No adverse health effects are expected if the population is exposed to 1,1 dichloroethylene at concentrations

≤ 300 µg/L.

Source: USEPA (2015c). Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

Hexachlorobenzene*

Water + Organism Criteria =

0.000079 µg/L

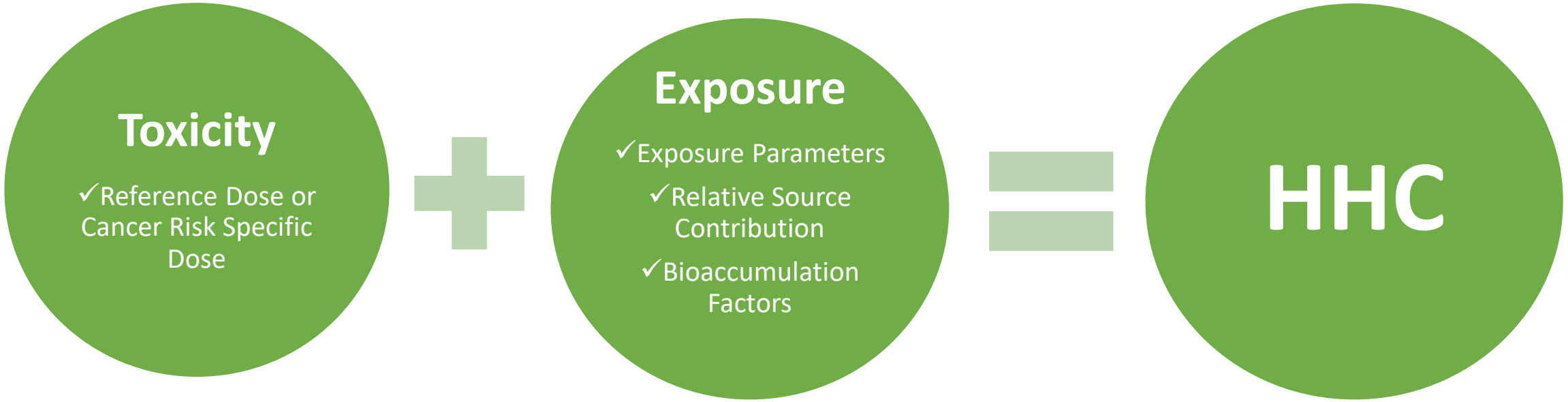
There is potential for one additional cancer case per one million people due to exposure to hexachlorobenzene at concentrations

≤ 0.000079 µg/L.

* This criterion is based on carcinogenicity of 10^{-6} risk.

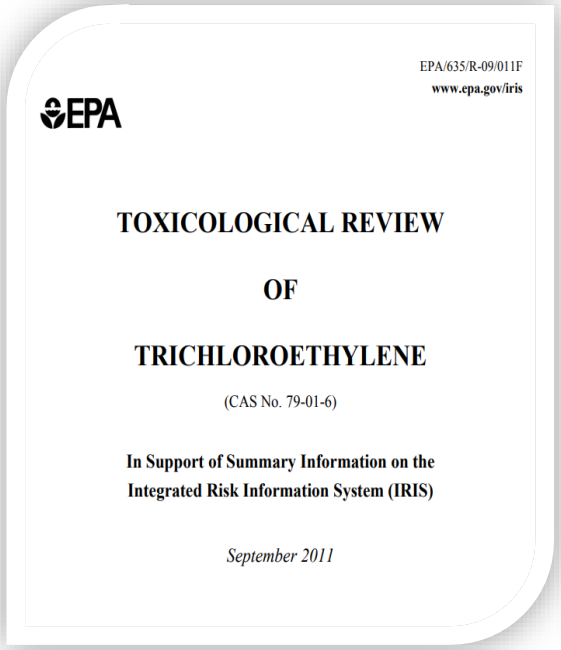
Source: USEPA (2015d). Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

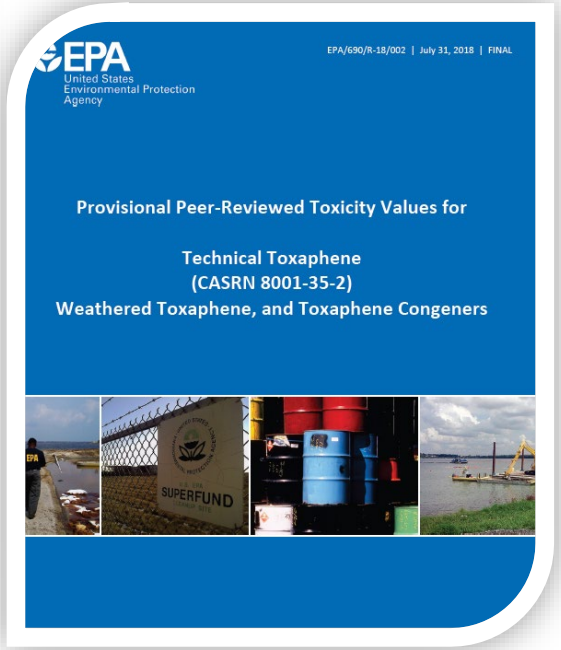
Required Information for HHC Development

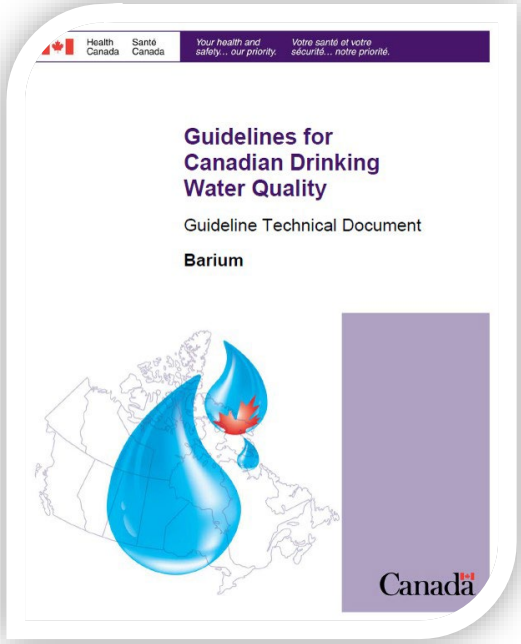


Learn About a Contaminant's Toxicity

- Does the contaminant have publicly available Health Assessments?







Peer-reviewed health assessment sources include:

EPA considers *publicly available* assessments that have undergone *peer-review.*

EPA Assessments

Office of Water:
- Health Advisories, Criteria Documents, Health Effects Support Documents

Office of Research and Development:
- Integrated Risk Information System assessments, Provisional Peer-Reviewed Toxicity Value Reports

Office of Pesticides
- Registration Eligibility Documents, Human Health Risk Assessments

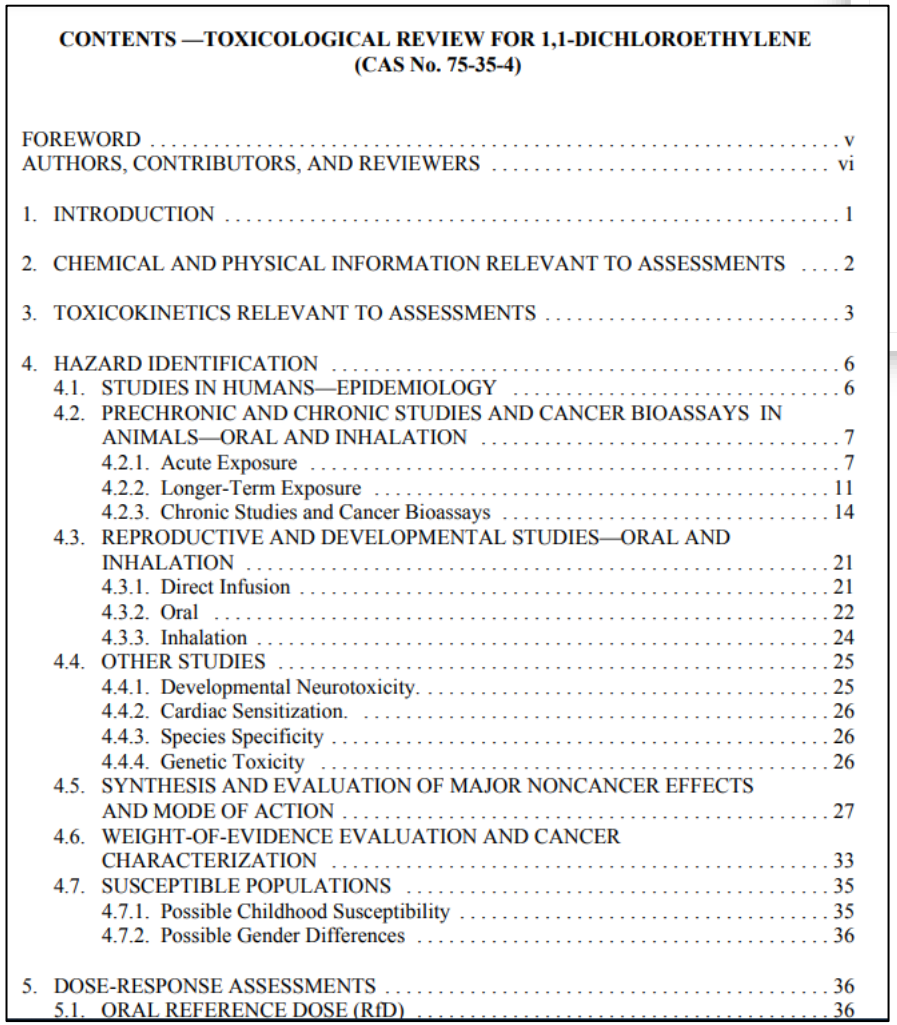
Office of Pollution Prevention and Toxics:
- Toxic Substance Control Act (TSCA) Risk Evaluations

Other Assessments

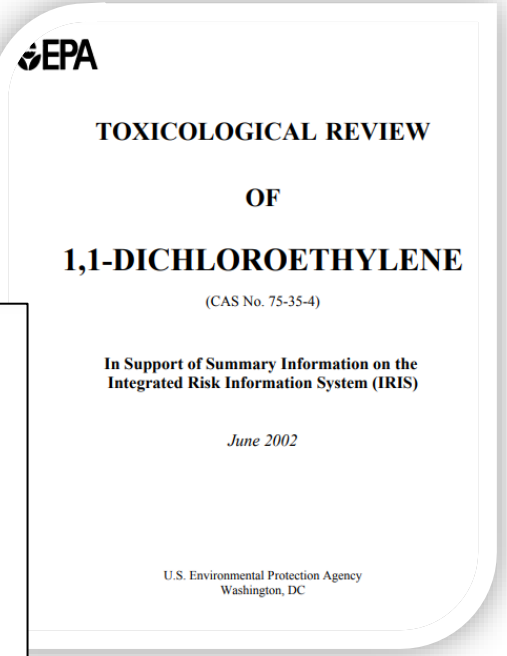
Agency for Toxic Substances and Disease Registry Toxicological Profiles	Guidelines for Drinking Water	Drinking Water Guidelines	State assessments - e.g., CalEPA Public Health Goals

Components of a Health Assessment

- Health assessments detail:
  - Hazard (adverse health effects) and dose response for a given chemical.
    - Dose-response information generally results in the development of toxicity values such as a Reference Dose (RfD) or Cancer Slope Factor (CSF)
  - Physical/chemical properties, fate and transport, use profiles, etc.



CONTENTS —TOXICOLOGICAL REVIEW FOR 1,1-DICHLOROETHYLENE (CAS No. 75-35-4)



EPA

TOXICOLOGICAL REVIEW

OF

1,1-DICHLOROETHYLENE

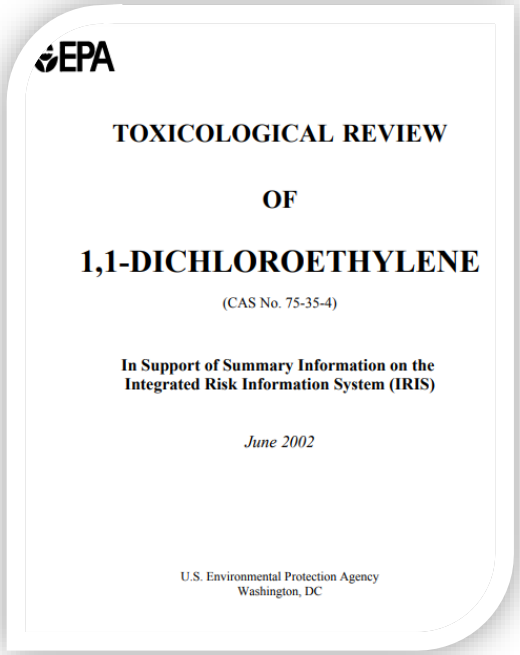
(CAS No. 75-35-4)

In Support of Summary Information on the Integrated Risk Information System (IRIS)

June 2002

U.S. Environmental Protection Agency
Washington, DC

HHC Example: 1,1 Dichloroethylene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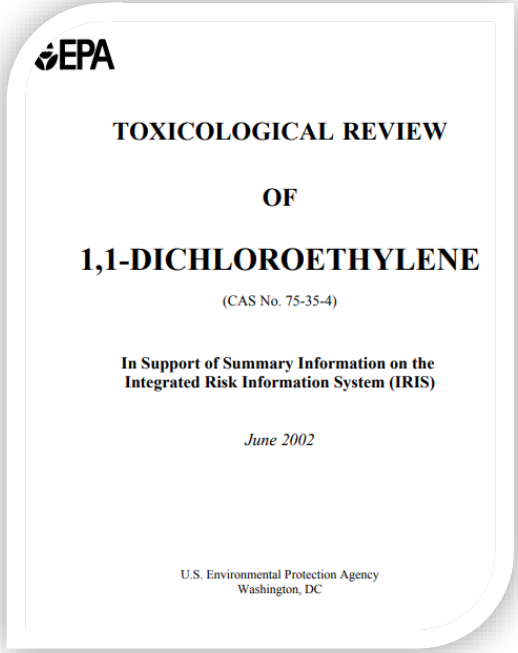
Available Data Summarized in the Health Assessment

- Epidemiological study in 138 employees
  - No significant impact on hematology or clinical chemistry parameters (Ott et al., 1976)
- Acute study in rodents
  - Increase in liver enzymes in serum (Jenkins et al., 1972)
- Chronic study in rats
  - Liver toxicity (Quast et al., 1983)
- Chronic study in dogs
  - No adverse health effects observed (Quast et al., 1983)
- Developmental study in rats
  - No evidence of toxicity to dams or offspring (Murray et al., 1979)
- Carcinogenicity study in mice
  - Evidence of induction of kidney adenocarcinomas, however, data presented is insufficient (Speerschneider and Dekant, 1995; Amet et al., 1997; Cummings et al., 2000)

Source: USEPA (2002). Toxicological Review of 1,1-Dichloroethylene

* Not an exhaustive list of available data

HHC Example: 1,1 Dichloroethylene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OF

1,1-DICHLOROETHYLENE

(CAS No. 75-35-4)

In Support of Summary Information on the Integrated Risk Information System (IRIS)

June 2002

U.S. Environmental Protection Agency
Washington, DC

The *weight of evidence* suggests that liver toxicity is the most sensitive effect (i.e., adverse effect seen at the lowest dose)

Available Data Summarized in the Health Assessment

- Epidemiological study in 138 employees
  - No significant impact on hematology or clinical chemistry parameters (Ott et al., 1976)
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Source: USEPA (2002). Toxicological Review of 1,1-Dichloroethylene

* Not an exhaustive list of available data

Hazard Identification: Qualitative Cancer Descriptors

- Assessments may assign qualitative cancer descriptors for evidence of human carcinogenic potential based on available cancer information
- 2005 EPA Cancer Guidelines replace the 1986 and 1999 guidelines.

2005 Cancer Descriptors

- Carcinogenic to humans
- Likely to be carcinogenic to humans
- Suggestive evidence of carcinogenic potential
- Inadequate information to assess carcinogenic potential
- Not likely to be a carcinogen

Helpful Guidance: USEPA (2005). Cancer Guidelines

AWQC Example: 1,1 Dichloroethylene

- Under the 1986 guidelines:
  - Group C, possible human carcinogen.
- Under the 1999 guidelines:
  - Suggestive evidence of carcinogenicity
- Under the 2005 guidelines:
  - Suggestive evidence of carcinogenic potential

Source: USEPA (2015c). Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

Understanding Health Assessment Toxicity Conclusions

A pollutant typically has one prevailing dose-response pattern

Source: USEPA (2022). IRIS Glossary

Understanding Health Assessment Toxicity Conclusions

A pollutant typically has one prevailing dose-response pattern

Non-Linear or Threshold Dose-Response

Indicates that there is a dose below which no adverse effects were observed

Typical of non-cancer effects

Source: USEPA (2022). IRIS Glossary

Understanding Health Assessment Toxicity Conclusions

A pollutant typically has one prevailing dose-response pattern

Non-Linear or Threshold Dose-Response

Indicates that there is a dose below which no adverse effects were observed

Typical of non-cancer effects

Linear Dose-Response

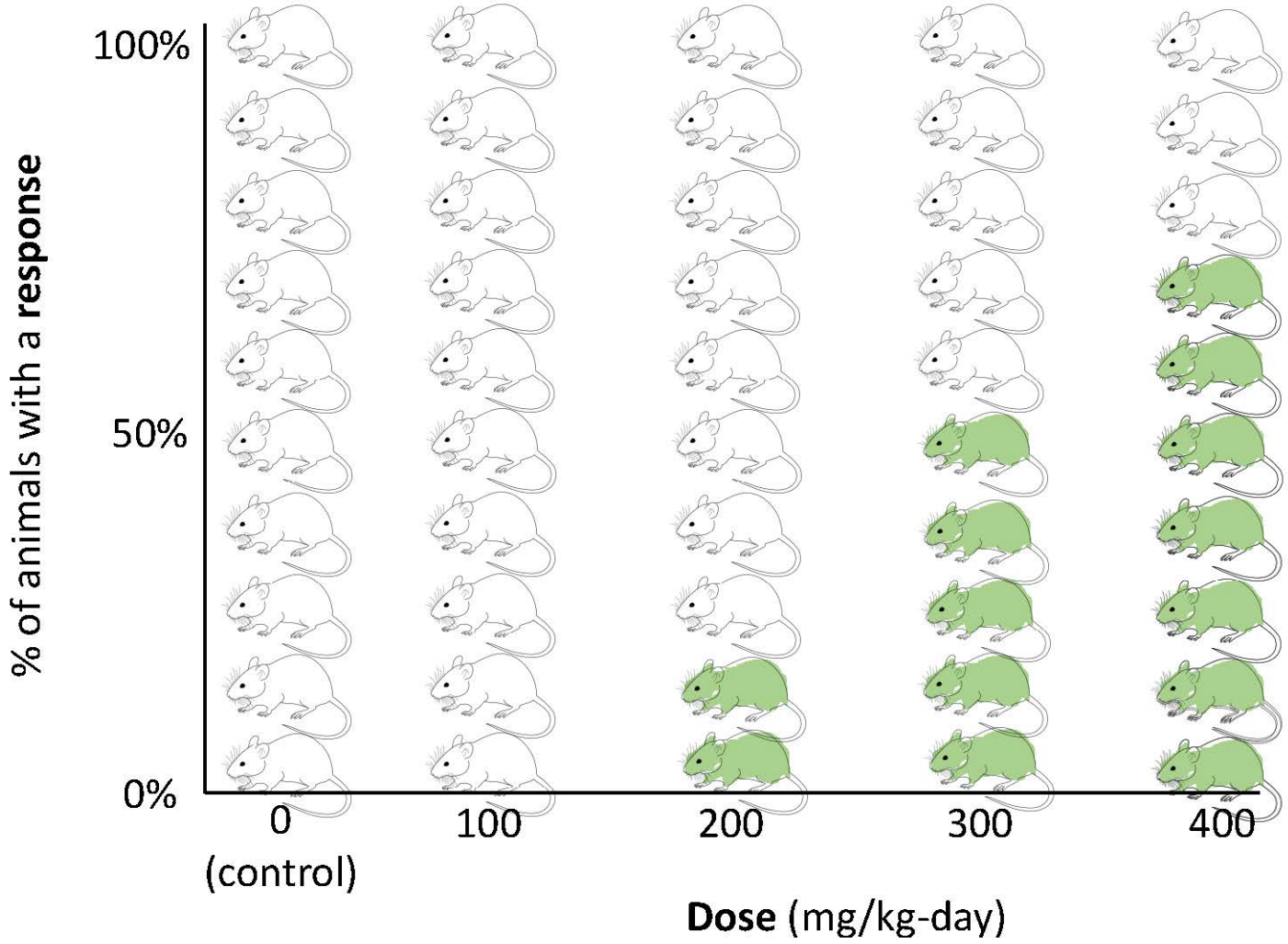
Assumes increased probability of effects at all levels of exposure

Typical of cancer effects

Source: USEPA (2022). IRIS Glossary

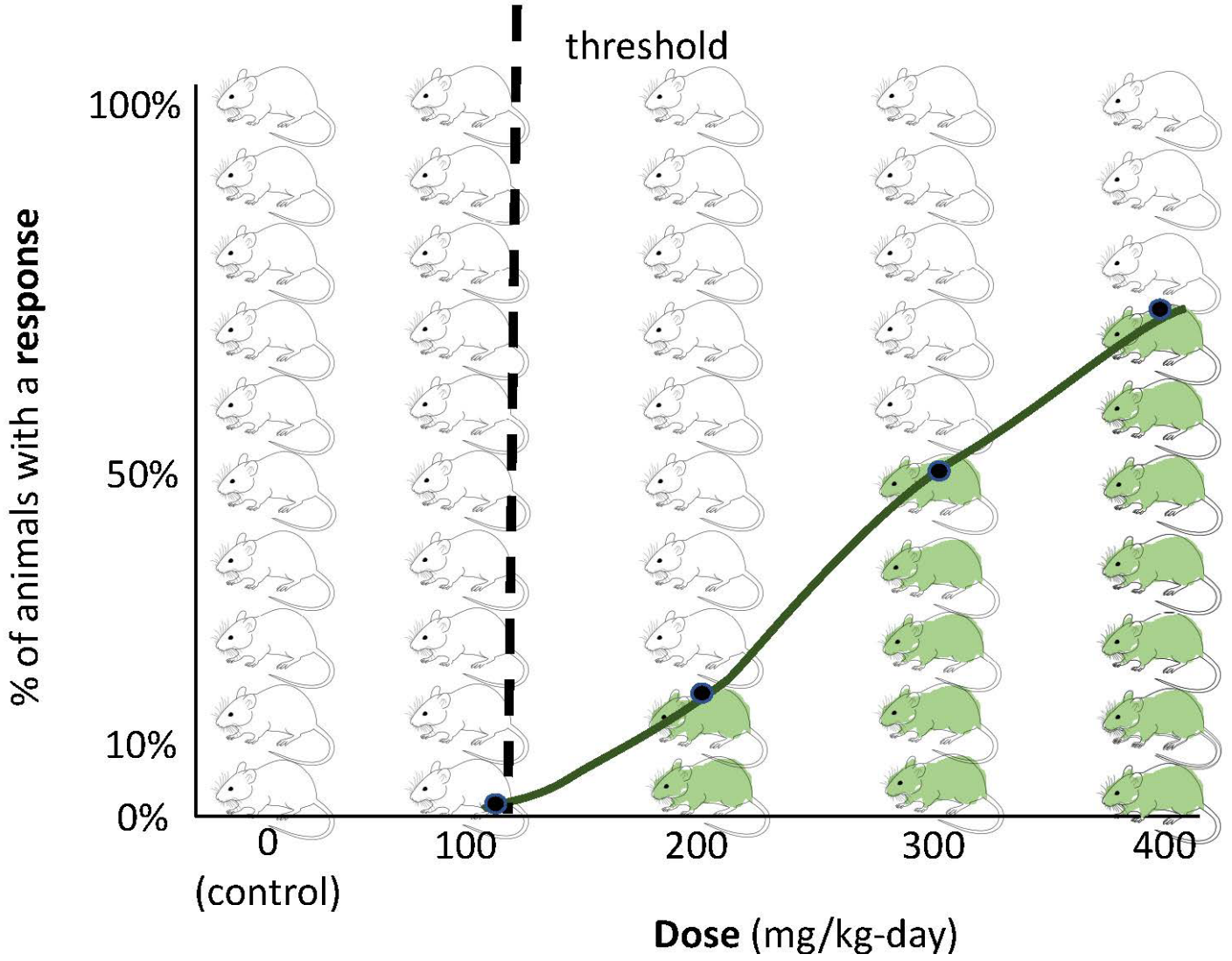
“Non-linear” or “Threshold” Dose-Response Curve

- In a hypothetical study, groups of 10 mice were exposed to Chemical A at 0, 100, 200, and 300, and 400 mg/kg-day.



“Non-linear” or “Threshold” Dose-Response Curve

- In a hypothetical study, groups of 10 mice were exposed to Chemical A at 0, 100, 200, and 300, and 400 mg/kg-day.
- We can see that exposure at some doses do not result in adverse effects.
  - Threshold
    - There is a dose below which no adverse effects were observed



“Point of Departure” for Threshold Effects

Point of Departure **(POD)** is the dose in the toxicity study used to calculate the “protective” dose in humans.

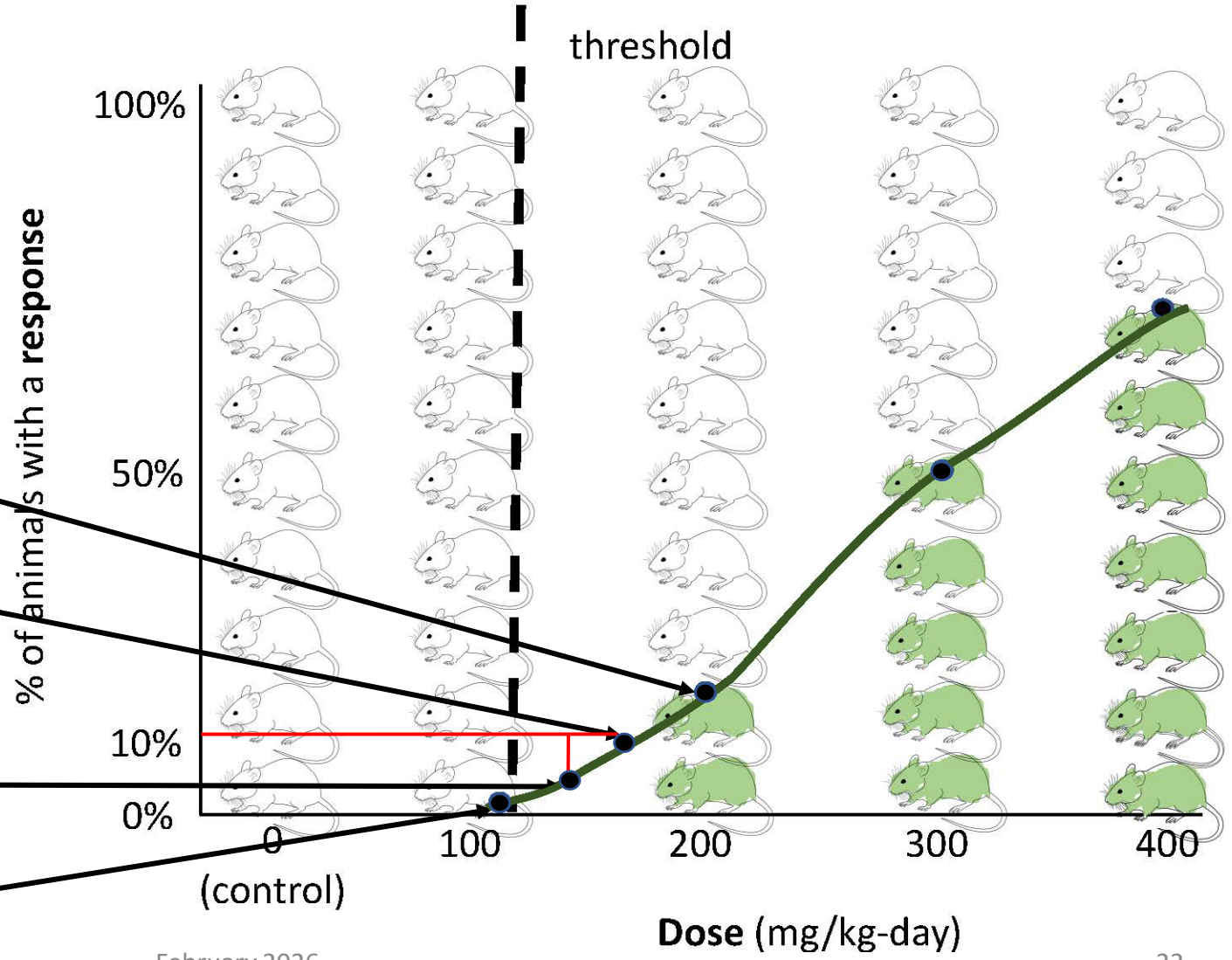
Possible PODs

LOAEL: lowest dose at which an adverse effect is observed

BMD: exposure level determined from a dose-response model

BMDL: lower bound of confidence interval for BMD; corresponds to a pre-defined level of response (such as 5% or 10%) in excess of a control response

NOAEL: highest dose at which NO adverse effect is observed



Point of Departure (POD)

A point of departure **(POD)** is the dose in the toxicity study used to calculate the "protective" dose in humans. There are several different types of PODs:

- **Lowest observed adverse effect level (LOAEL)** = lowest dose at which an adverse effect is observed

- **No observed adverse effect level (NOAEL)** = highest dose at which no adverse effect is observed

- **Benchmark dose lower bound (BMDL)** = lower bound of a confidence interval for a specific benchmark dose (BMD) which is a dose level corresponding to specific response levels, or benchmark responses, near the low end of the observable range of the data

Helpful Guidance: USEPA (2012). BMD Technical Guidance; USEPA (2023). BMD Tools

Source: USEPA (2022). IRIS Glossary

Calculating a Reference Dose (RfD) from the POD using Uncertainty Factors (UFs)

- **Reference Dose = POD / UF_{Total}**
  - *A reference dose is an estimate of the amount of a chemical a person can ingest daily over a lifetime (chronic RfD) or less (subchronic RfD) that is unlikely to lead to adverse health effects.*
  - Five areas of uncertainty
    - Intraspecies variation **(UF_H)** 
    - Interspecies variation **(UF_A)** 
    - Uncertainty due to study exposure duration **(UF_S)** 
    - Uncertainty due to use of a LOAEL **(UF_L)** 
    - Uncertainty due to inadequate database **(UF_D)** 

$UF_{Total} = UF_H \times UF_A \times UF_S \times UF_L \times UF_D$

- UF values of either 1, 3, or 10 can be selected
- EPA policy is that the maximum total UF = 3000

Helpful Guidance: EPA (2000b). Technical Support Document Volume 1: Risk Assessment

Source: USEPA (2000a). Section 3.2.2 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

Example: Uncertainty Factor Selection for HHC

Chemical	Selected Assessment	Critical Effect	POD	Uncertainty Factors	RfD
1,1 Dichloroethylene	US EPA IRIS, 2002	Liver toxicity in rats (chronic study)	$BMDL_{10}$ = 4.6 mg/kg-day	TOTAL = 100 UF_H = 10 UF_A = 10	0.05 mg/kg-day

Source: USEPA (2015c). Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

Chemical	Selected Assessment	Critical Effect	POD	Uncertainty Factors	RfD
2,4-dinitrophenol	US EPA IRIS, 1986	Development of cataracts in humans (chronic study)	LOAEL = 2 mg/kg-day	TOTAL = 1000 UF_H = 10 UF_L = 10 UF_S= 10	0.002 mg/kg-day

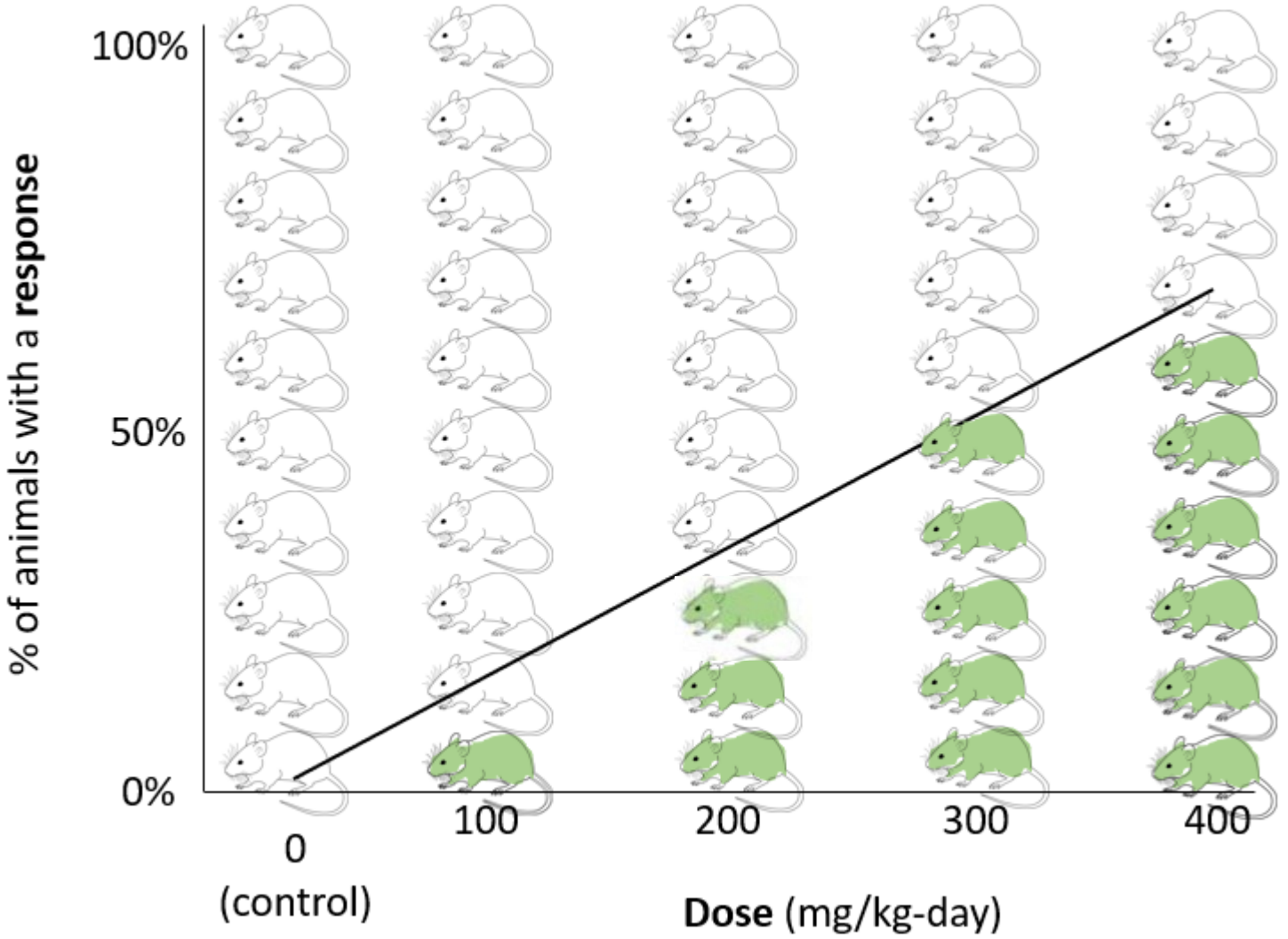
Source: USEPA (2015e). Update of Human Health Ambient Water Quality Criteria: 2,4-dinitrophenol

Chemical	Selected Assessment	Critical Effect	POD	Uncertainty Factors	RfD
1,1,1-trichloroethane	US EPA IRIS, 2007	Reduced bodyweight in mice (subchronic study)	$BMDL_{10}$ = 2,155 mg/kg-day	TOTAL = 1000 UF_H = 10 UF_A = 10 UF_S = 3 UF_D= 3	2 mg/kg-day

Source: USEPA (2015f). Update of Human Health Ambient Water Quality Criteria: 1,1,1-trichloroethane

Linear Dose-Response Curve

- Assumes increased probability of effects at all levels of exposure (typically cancer)
- EPA targets a $1x10^{-6}$ cancer risk level (CRL)
  - One additional cancer case per one million people due to exposure to pollutant
  - Other cancer risk levels could be evaluated for consideration of risk management options and/or policy decisions
    - 1 case in 10,000 people
    - 1 case in 100,000 people
    - 1 case in 10 million people



Source: USEPA (2000a). Section 2.4 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

Risk-Specific Dose (RSD)

The RSD is the dose at which the population meets the targeted cancer risk level (e.g., 1 case in 1 million or 10^{-6})

$$\textbf{Risk Specific Dose (RSD)} = \frac{\textbf{Cancer Risk Level (CRL)}}{\textbf{Cancer Slope Factor (CSF)}}$$

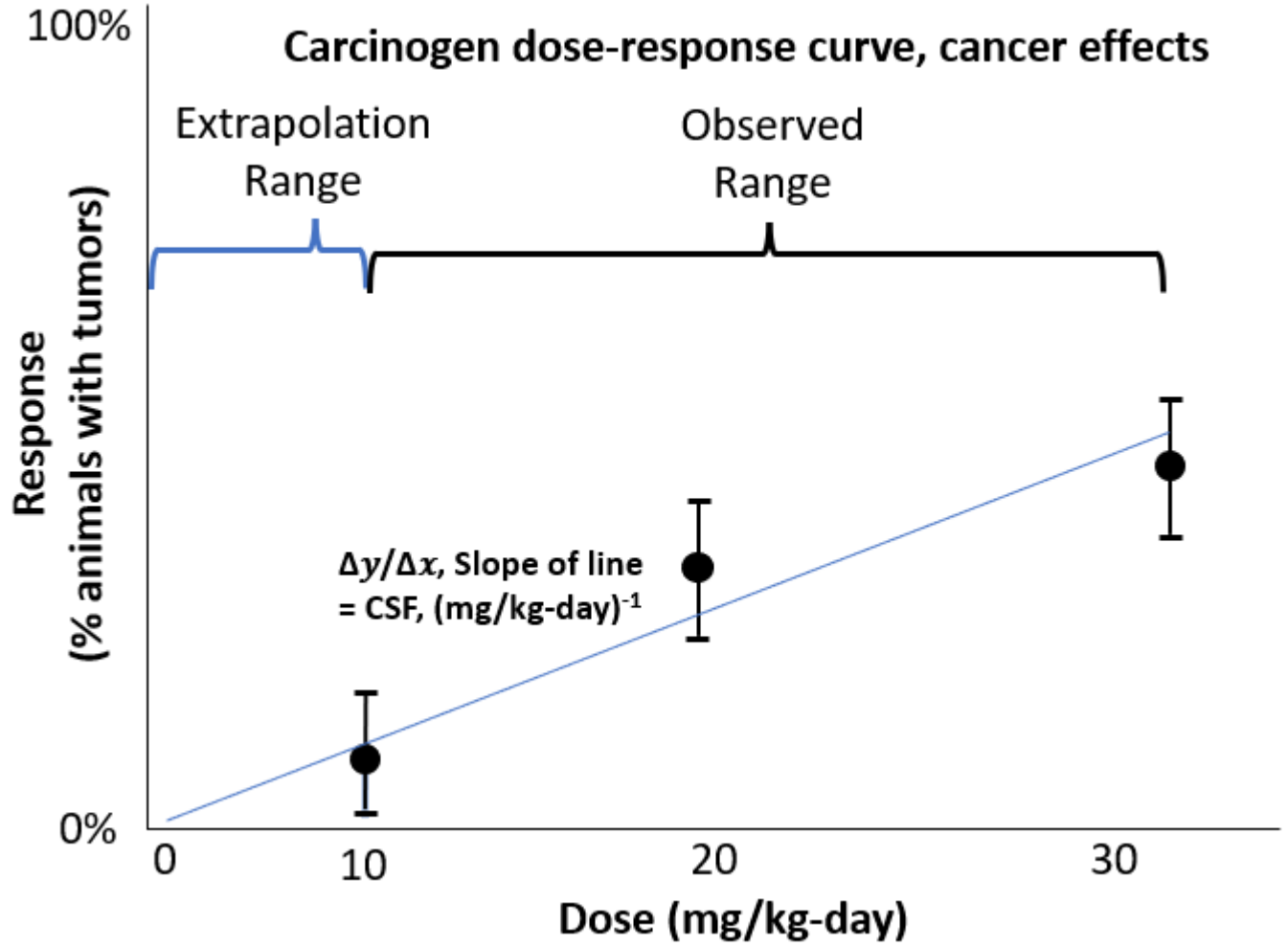
From 2000 Methodology on the Cancer Risk Level:

- "With the 2000 Methodology, EPA will publish its national 304(a) water quality criteria at the 10^{-6} risk level, which EPA considers appropriate for the general population."

Source: USEPA (2000a). Section 3.1 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

Understanding the Cancer Slope Factor (CSF)

- Cancer Slope Factor
  - Measures incidence of cancer relative to dose over a lifetime exposure to a carcinogen
  - Used to derive the risk-specific dose
  - Derived similarly to a non-cancer BMD



Source: USEPA (2000a). Section 3.1 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

Example: Risk Specific Dose Calculations

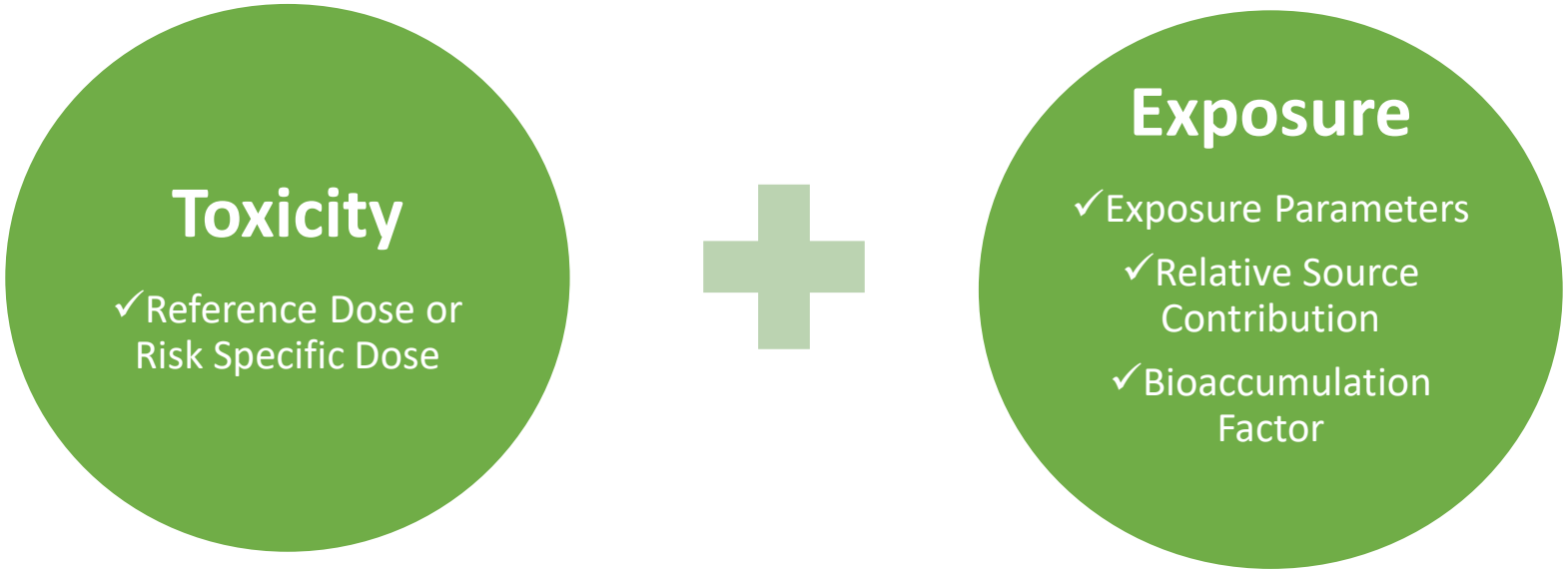
Chemical	Selected Assessment	Critical Effect	Cancer Slope Factor	Cancer Risk Level	RSD
Hexachlorobenzene	EPA OPP RED, 2008	Development of hepatocellular carcinomas in rats	1.02 per mg/kg-day	1×10^{-6}	9.8×10^{-7}

Hexachlorobenzene is classified as B2, "probably human carcinogen" based on the 1996 Proposed Guidelines for Carcinogen Risk Assessment.
Source: USEPA (2015d). Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

Chemical	Selected Assessment	Critical Effect	Cancer Slope Factor	Cancer Risk Level	RSD
1,2-Dichloroethane	Health Canada, 2015	Development of mammary tumors in female rats	0.0033 per mg/kg-day	1×10^{-6}	3.0×10^{-4}

1,2 Dichloroethane is classified as B2, "probably human carcinogen" based on the 1986 EPA Guidelines for Carcinogen Risk Assessment.
Source: USEPA (2015g). Update of Human Health Ambient Water Quality Criteria: 1,2-Dichloroethane

Required Information for HHC Development



Exposure Information for HHC Development

- How much exposure to a pollutant could occur from direct ingestion of drinking water?
  - What is the Drinking Water Intake **(DWI)?**
- How much exposure could occur from eating fish and shellfish?
  - What is the Fish Consumption Rate **(FCR)?**
- How much does this pollutant accumulate in fish/shellfish tissue?
  - What is the Bioaccumulation Factor **(BAF)?**
- How much exposure could occur from other sources (e.g., air, diet, soil, dust)?
  - What is the Relative Source Contribution **(RSC)?**
- Are any life stages or populations either more highly exposed or more sensitive to exposure compared to the general population?

Exposure parameters used to calculate HHC for adults in the general population

- Body Weight (**BW**)
  - 80 kg; average adult body weight
- Drinking Water Intake (**DWI**)
  - 2.4 L/day; 90th percentile per capita consumption rate
- Fish Consumption Rates (**FCRs**): Total and trophic level (**TL**)-specific
  - Total = 22 g/day
  - TL 2 (first order consumers) = 7.6 g/day
  - TL 3 (intermediate predators)= 8.6 g/day
  - TL 4 (top predators) = 5.1 g/day

See USEPA (2019). Chapter 3 (2019) of EPA's Exposure Factors Handbook and USEPA (2014) report "Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)" for BW, DI, and fish consumption rate statistics

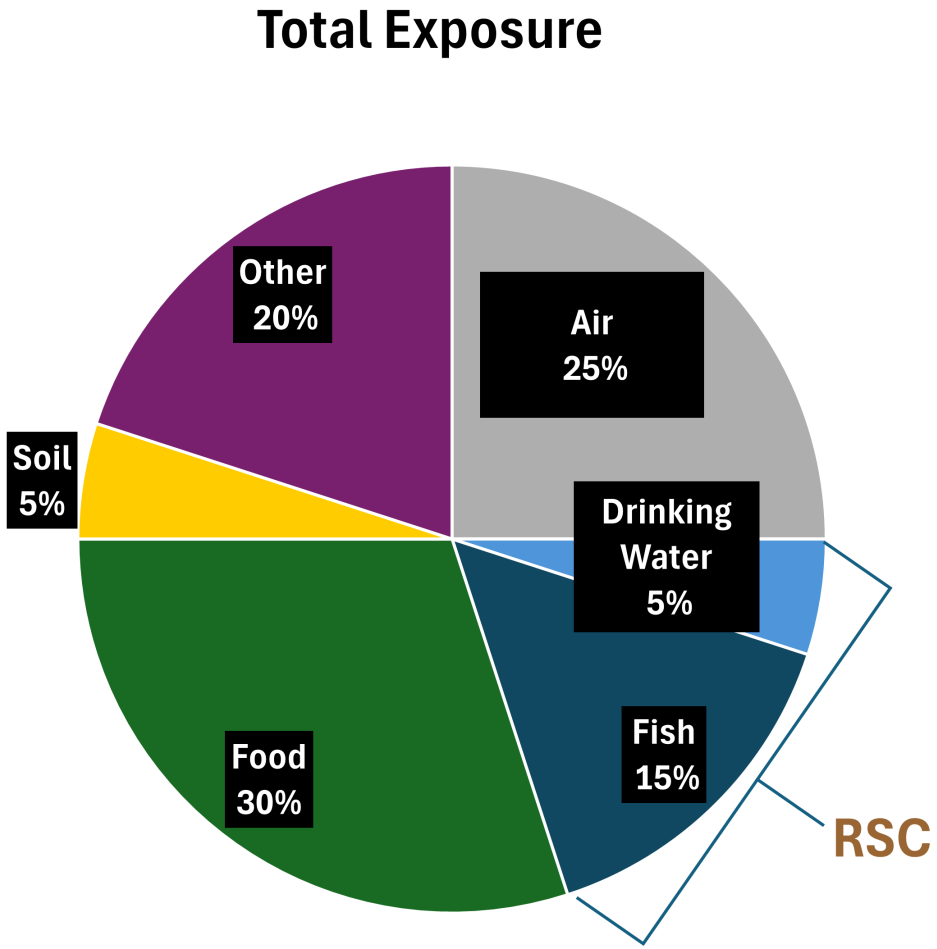
Considerations when a different Target Population is Identified: Exposure Parameters

- If a pollutant causes adverse effects in a specific life stage:
  - Pregnant women, lactating women, or women of childbearing age
    - Consider as a target population if observed effects include development of the fetus, breastfed newborn baby, or female reproductive system
  - Children
    - Consider as a target population if observed effects include postnatal developmental effects

- If a specific population or life stage is likely to be highly exposed versus general population
  - Subsistence fishers
    - Consider as a target population if there are subsistence fishers in the community, or if the toxicant bioaccumulates dramatically in fish, such that the majority of exposure occurs through fish consumption
  - Postnatal Childhood
    - Consider as a target population due to incidental ingestion from recreational exposure in ambient waters

Relative Source Contribution (RSC)

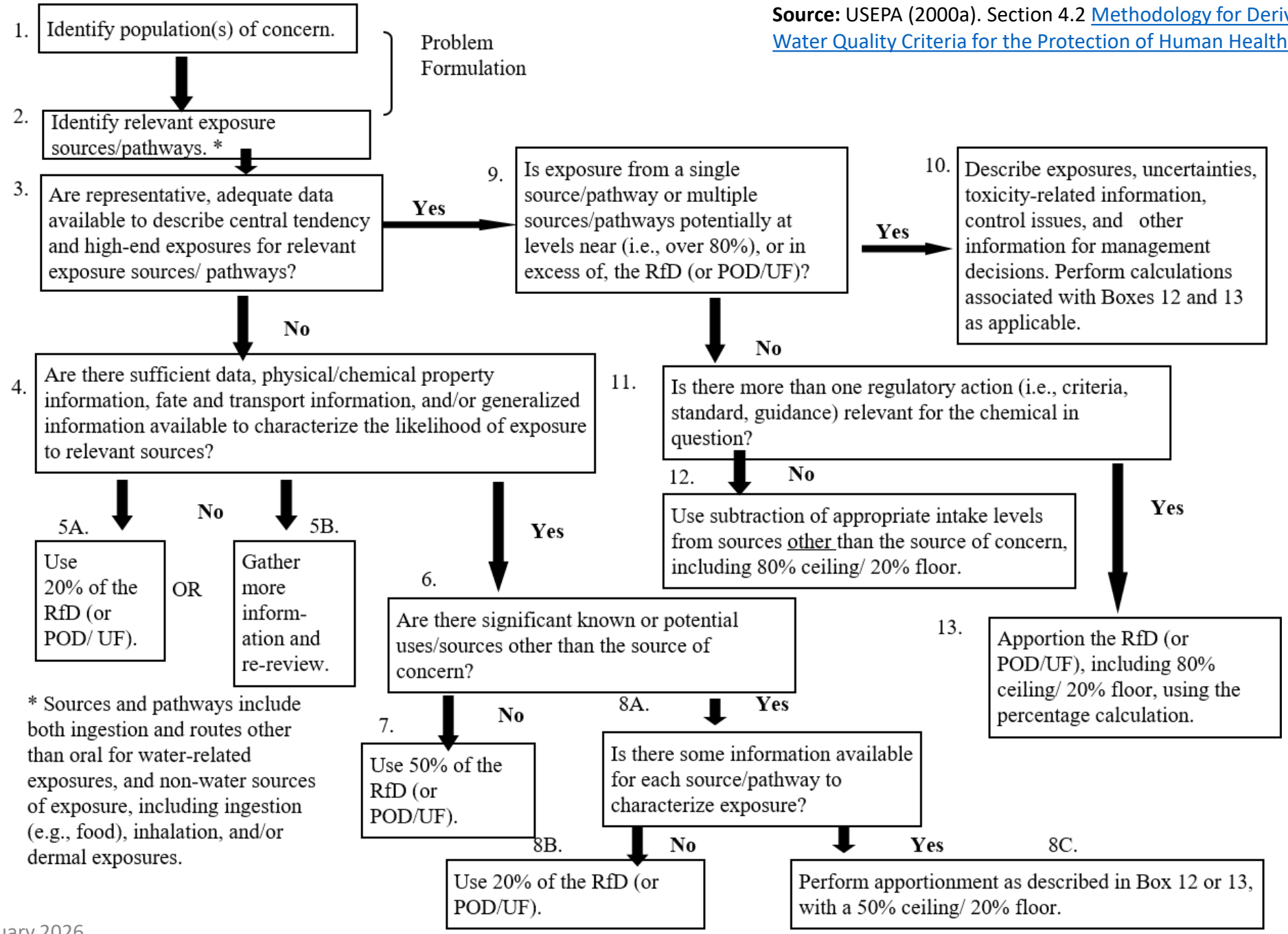
- The RSC is the percentage of total exposure to a pollutant attributed to drinking water and eating fish and shellfish.
  - EPA follows the Exposure Decision Tree approach described in the 2000 Methodology when making decisions about the RSC.
- Other sources of exposure could include:
  - Inhalation from ambient air
  - Consumption of food other than freshwater and estuarine fish/shellfish
  - Consumption of soil or dust
  - Dermal exposure



Source: USEPA (2000a). Section 4.2 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.

The RSC Decision Tree

Source: USEPA (2000a). Section 4.2 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.



RSC Examples for HHC

1,1 Dichloroethylene

- Air, drinking water, and non-fish food are potentially significant sources.
- Following the Exposure Decision Tree, significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (**Box 8A** in the Decision Tree); however, information is not available to **quantitatively** characterize exposure from these different sources (**Box 8B** in the Decision Tree). Therefore, EPA recommends an RSC of **20%.**

Source: USEPA (2015c) Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

Hexachlorobenzene

- For substances for which the toxicity endpoint is carcinogenicity based on a linear low-dose extrapolation, only the **exposures from drinking water and fish ingestion** are reflected in human health AWQC: non-water sources are not explicitly included and **no RSC** is applied.
- AWQC are derived with respect to the incremental lifetime cancer risk posed by the presence of a substance in water, rather than an individual's total risk from all sources of exposure.

Source: USEPA (2015d) Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

RSC Examples for HHC

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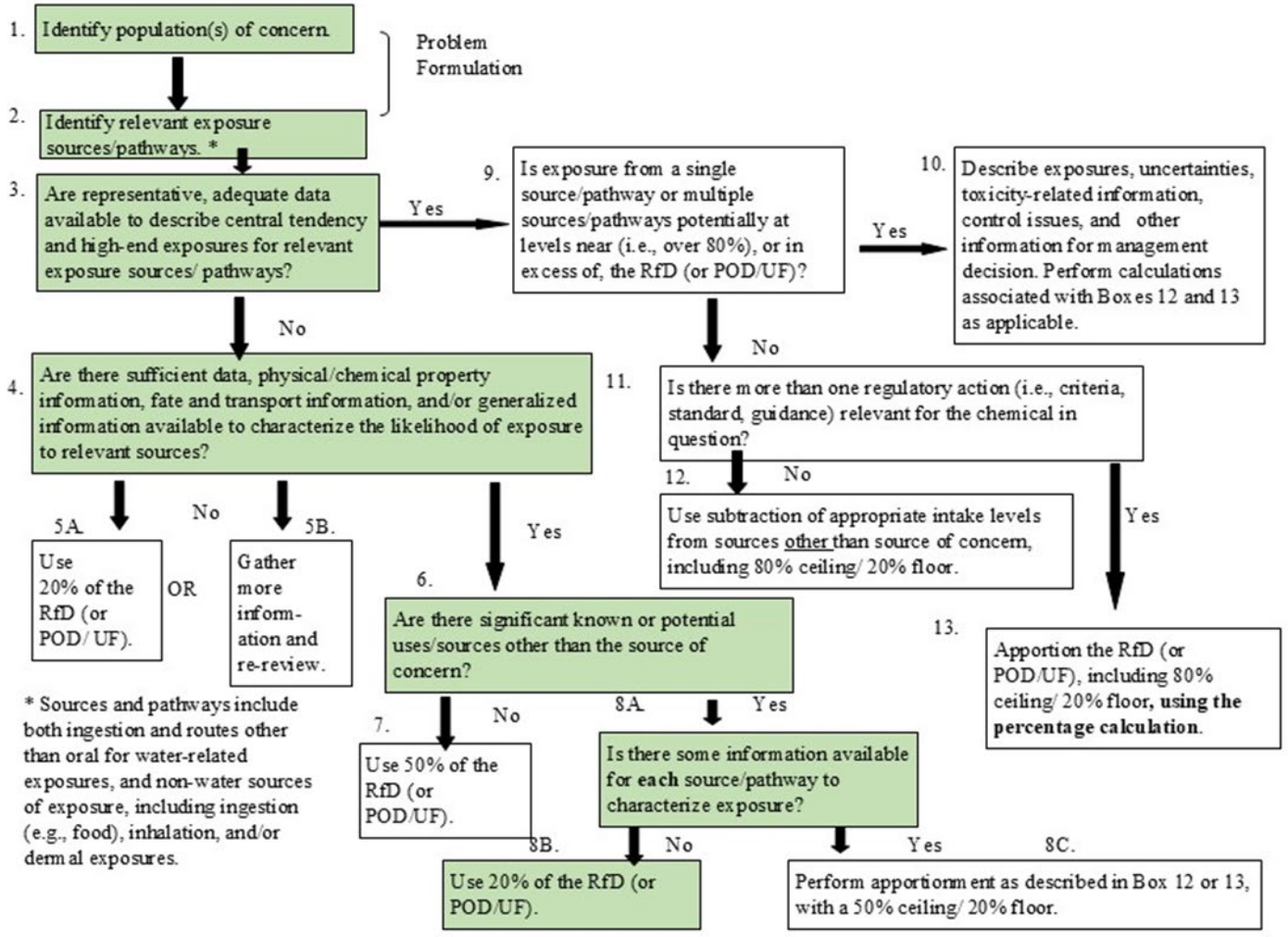
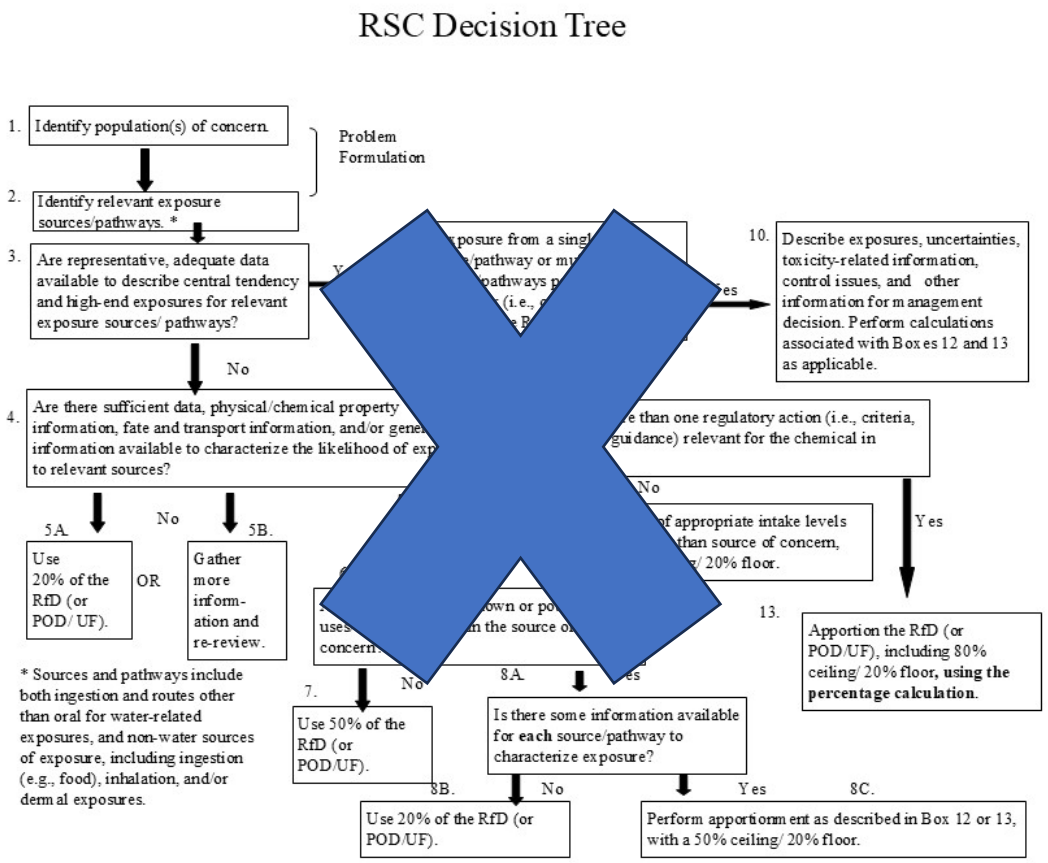
- Following the Exposure Decision Tree, significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (**Box 8A** in the Decision Tree); however, information is not available to **quantitatively** characterize exposure from these different sources (**Box 8B** in the Decision Tree). Therefore, EPA recommends an RSC of **20%.**



Source: USEPA (2015c) Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

RSC Examples for HHC



Hexachlorobenzene (carcinogen)

- For substances for which the toxicity endpoint is carcinogenicity based on a linear low-dose extrapolation, only the **exposures from drinking water and fish ingestion** are reflected in human health AWQC: non-water sources are not explicitly included and **no RSC** is applied.
- AWQC are derived with respect to the incremental lifetime cancer risk posed by the presence of a substance in water, rather than an individual's total risk from all sources of exposure.

Source: USEPA (2015d) Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

How Much Exposure Is Coming From Fish?

- Bioaccumulation refers to the uptake and retention of a chemical by an aquatic organism from all surrounding media (e.g., water, food, sediment).
- Bioaccumulation Factors (**BAFs**) are the ratio (in liters per kilogram of tissue) of the concentration of a chemical in the tissue of an aquatic organism to its concentration in water.

Source: USEPA (2000a). Section 5 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.

Goals of the National BAF

- To represent the long-term, average bioaccumulation potential of a chemical in edible tissues of aquatic organisms that are commonly consumed by humans throughout the United States.
- Derive separate BAFs for each trophic level to account for potential biomagnification of some chemicals in aquatic food webs and broad physiological differences among organisms that may influence bioaccumulation.

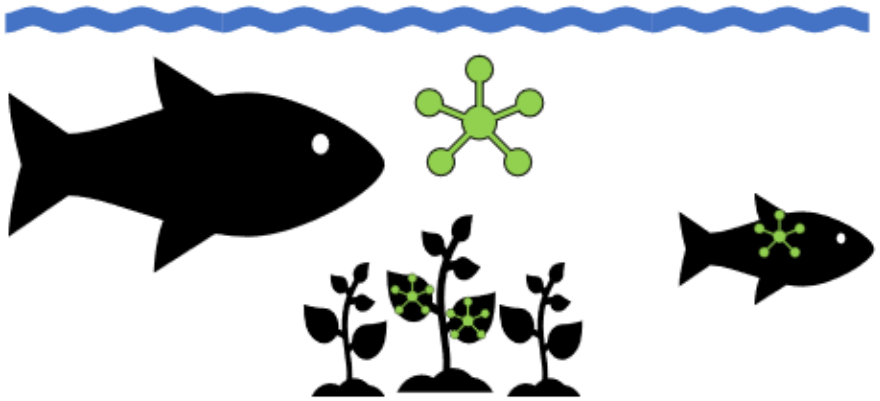
Helpful Guidance: EPA (2003c). Technical Support Document Volume 2: Development of National BAFs; EPA (2016) Development of BAFs; Supplemental Information for EPA's 2015 Human Health Criteria Update

Source: USEPA (2000a). Section 5.1 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

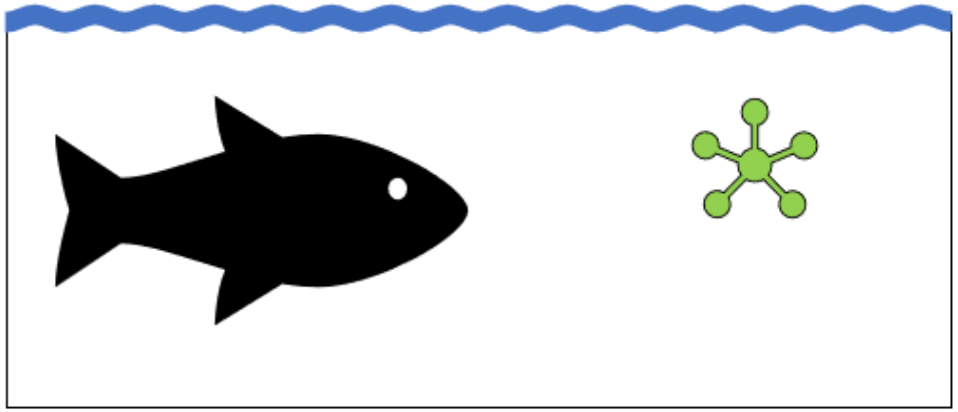
Determining the Bioaccumulation Potential

$$\text{BAF} = \frac{\text{Concentration of chemical in } tissue}{\text{Concentration of chemical in } water}$$

Bioaccumulation Factor (BAF): measurements in natural conditions



Bioconcentration Factor (BCF): measurement in lab with only direct water exposure



While BAFs are preferred, BCFs can be used in the absence of BAF values.

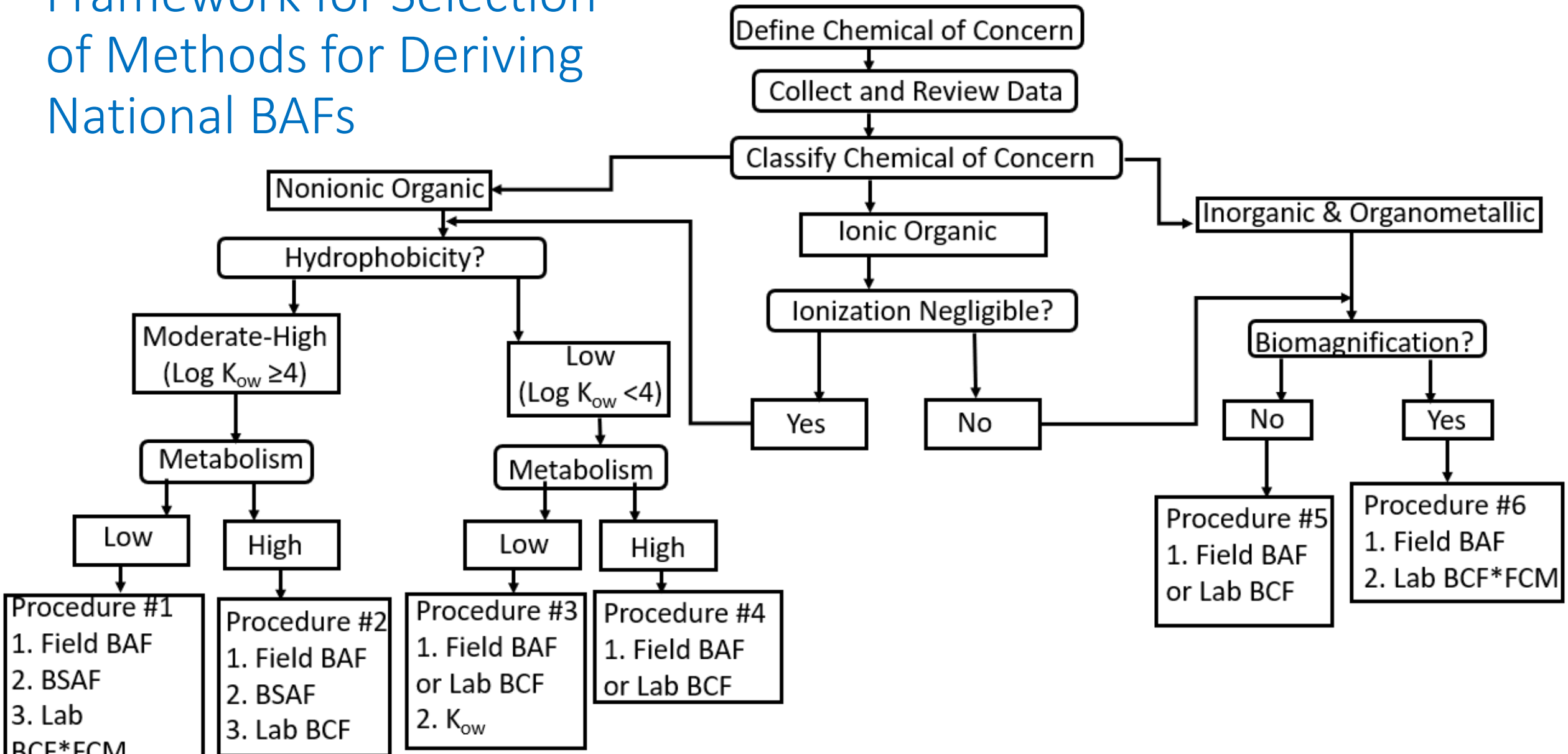
Source: USEPA (2000a). Section 5.2 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

EPA Methods for Deriving BAFs for HHC

Field-measured BAF	• Applicable to all chemical types • High-quality data currently limited to a few sites and chemicals
BAF predicted from field-measured Biota-Sediment Accumulation Factors (BSAF)	• Limited to nonionic organic chemicals • Useful for chemicals that are difficult to analyze in water
BAF predicted from lab-measured BCF x Food Chain Multiplier (FCM)	• Applicable to all chemical types • Chemical metabolism, when present in food web, generally not accounted for
BAF predicted from a K_{OW} x FCM	• Limited to nonionic organic chemicals • Readily applied with minimal input data

Source: USEPA (2000a). Section 5.3 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

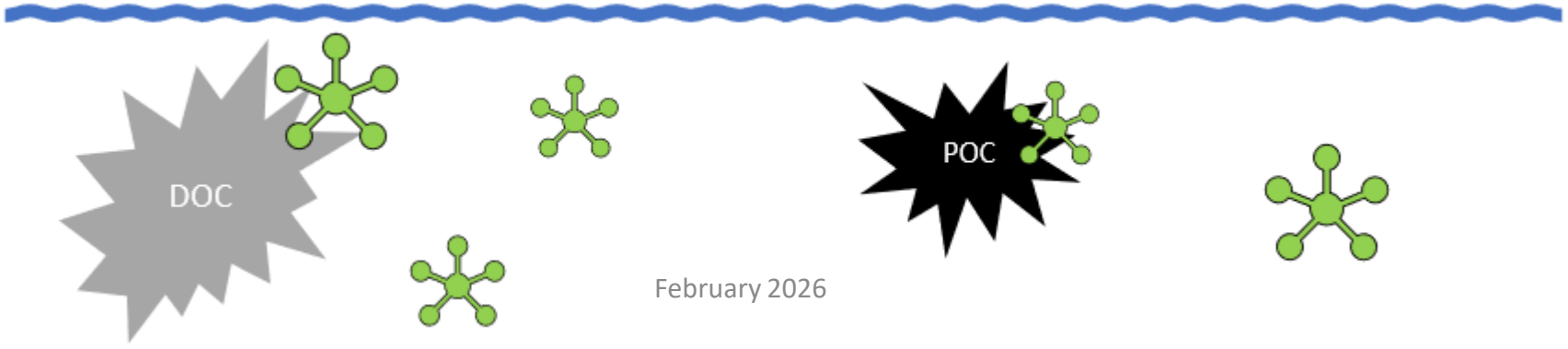
Framework for Selection of Methods for Deriving National BAFs



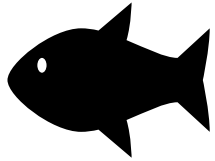
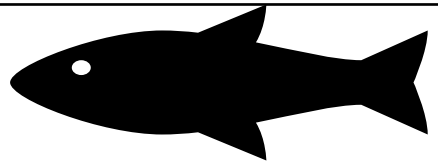
Source: USEPA (2000a). Section 5.3 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

EPA Methods for Deriving BAFs for HHC

- The degree of bioaccumulation depends on the *bioavailable* concentration of the compound in water
  - **Dissolved organic carbon (DOC)** and **particulate organic carbon (POC)** concentrations correlate to the bioavailable fraction of the compound.
- National Default DOC and POC values are used to calculate the national BAFs for nonionic organic chemicals (EPA 2003).
- States can derive **state and/or site-specific BAF values** from EPA's published baseline BAFs by using representative POC and DOC concentrations for their state.
- BCFs make no adjustments to control for natural conditions, like POC and DOC concentrations, that might lessen or heighten the bioaccumulation of the compound in the environment.



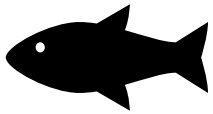
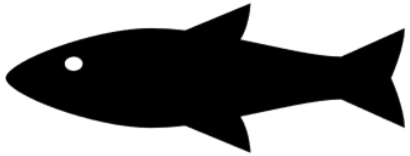
BAF Examples for HHC

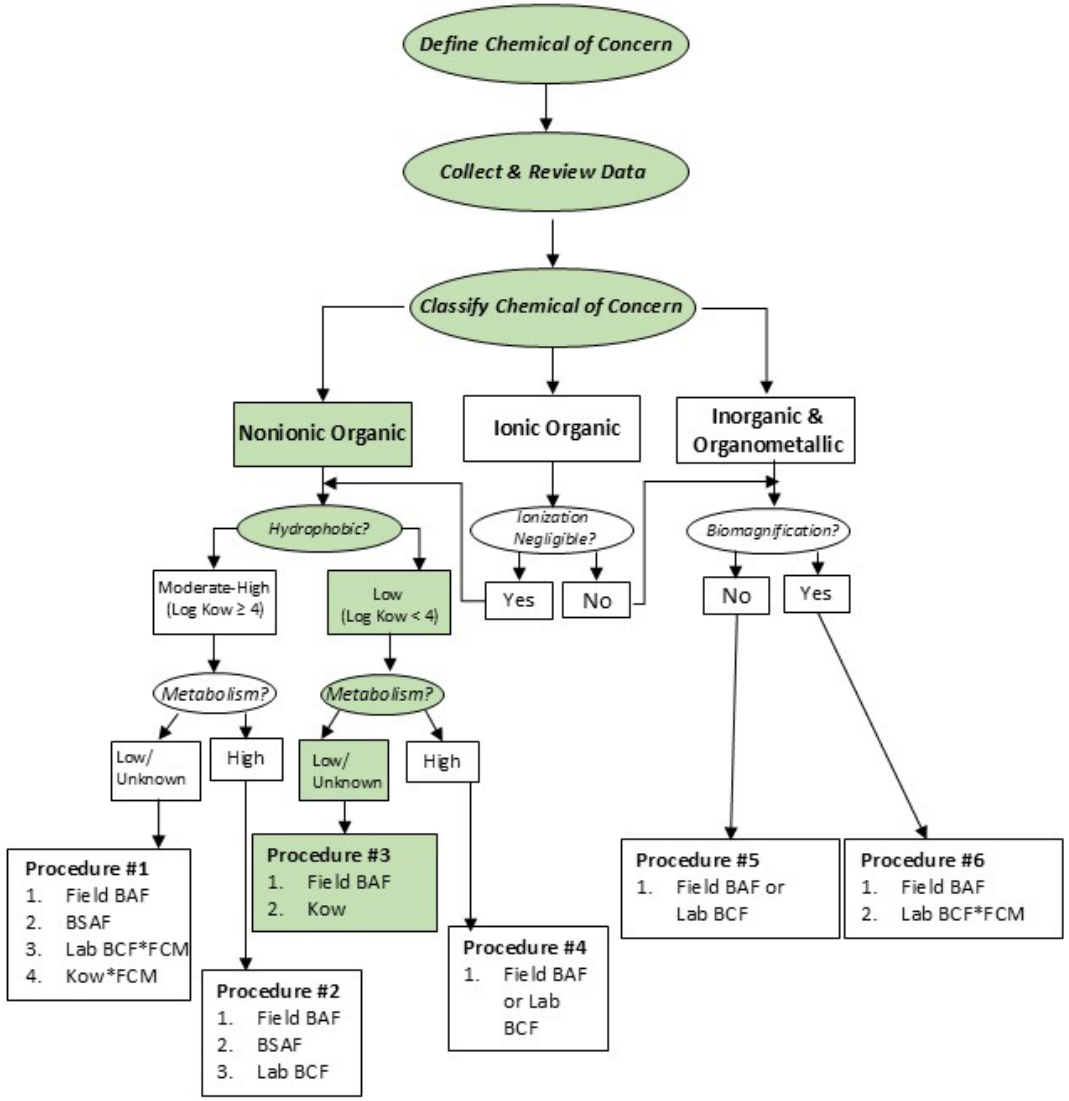
Trophic Level (TL)	1,1 Dichloroethylene BAF (L/kg)	Hexachlorobenzene BAFs (L/kg)
TL 2 	2.0	18,000
TL 3 	2.4	46,000
TL 4 	2.6	90,000
Method	**Procedure 3: K_{ow} Method**	**Procedure 1: Field-measured BAFs**

Source: USEPA (2015c) Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

Source: USEPA (2015d) Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

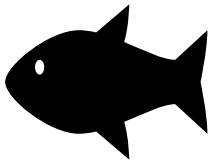
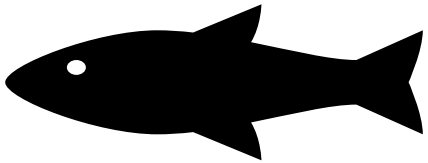
BAF Examples for HHC

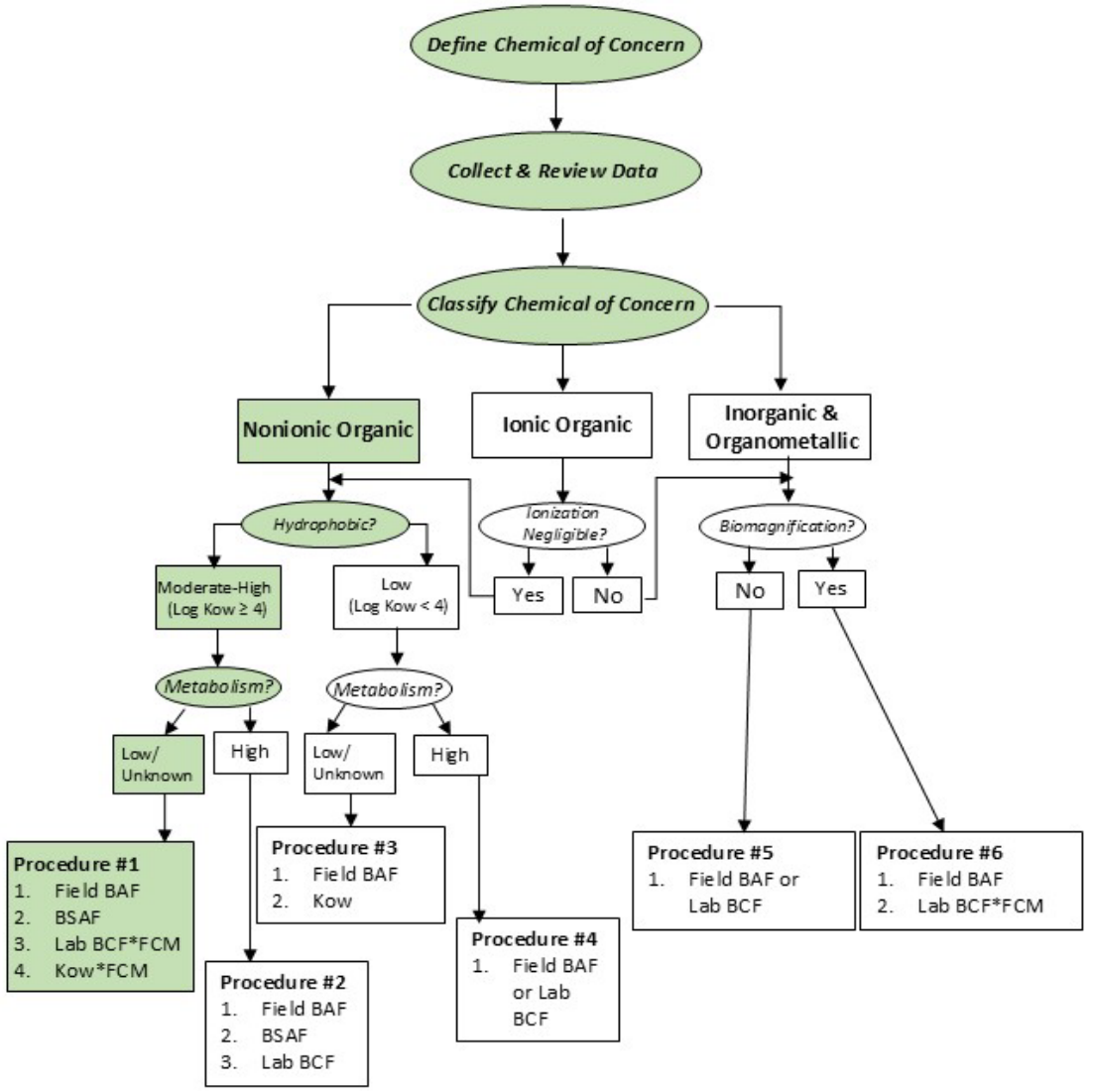
Trophic Level (TL)	1,1 Dichloroethylene BAF (L/kg)
TL 2 	2.0
TL 3 	2.4
TL 4 	2.6
Method	**Procedure 3: K_{ow} Method**



Source: USEPA (2015c) Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

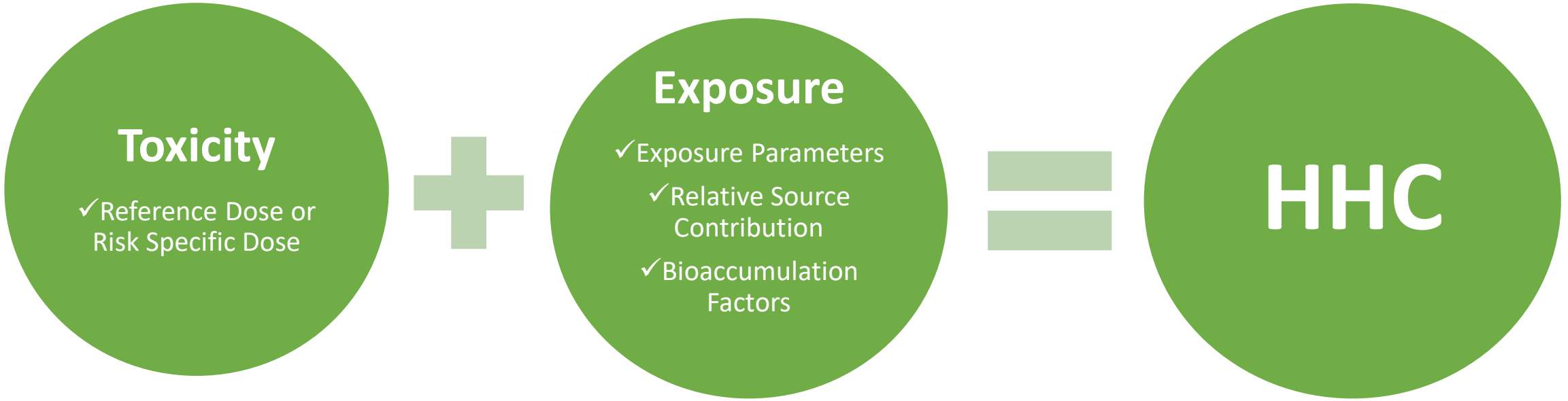
BAF Examples for HHC

Trophic Level (TL)	Hexachlorobenzene BAFs (L/kg)
TL 2 	18,000
TL 3 	46,000
TL 4 	90,000
Method	**Procedure 1: Field-measured BAFs**



Source: USEPA (2015d) Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

Required Information for HHC Development



Water + Organism HHC Equations and Input Values

HHC for Noncarcinogens =

$$\frac{\text{RfD x RSC x Body Weight}}{\text{Drinking Water Rate} + \text{(Fish Consumption Rate x Bioaccumulation Factor)}}$$

HHC for Carcinogens =

$$\frac{\text{Oral Cancer Slope Factor at } 10^{-6} \text{ x Body Weight}}{\text{Drinking Water Rate} + \text{(Fish Consumption Rate x Bioaccumulation Factor)}}$$

*For Organism Only HHC, the Drinking Water Rate is removed from the equation.

Key:
RfD = Reference dose or toxicity value
RSC = Relative source contribution

Source: USEPA (2000a) Section 1.6 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health

HHC Example: 1,1, Dichloroethylene (non-carcinogen)

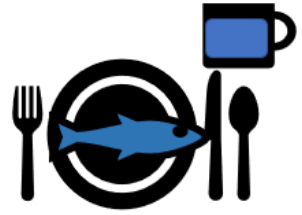
Input Values:

Toxicity

- RfD = 0.05 mg/kg-day

Exposure

- RSC = 0.20
- BW = 80 kg
- DWI = 2.4 L/day
- FCR =
  - TL 2 = 7.6 g/day
  - TL 3 = 8.6 g/day
  - TL 4 = 5.1 g/day
- BAFs =
  - TL 2 = 2.0 (L/kg)
  - TL 3 = 2.4 (L/kg)
  - TL 4 = 2.6 (L/kg)



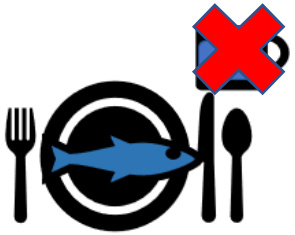
For consumption of water and organisms:

$$HHC = \frac{\text{toxicity value (RfD [mg/kg-d]} \times \text{RSC)} \times \text{BW [kg]} \times 1{,}000\ [\mu g/mg]}{\text{DWI [L/d]} + \Sigma_{i=2}^{4}\ (\text{FCR [kg/day]} \times \text{BAF}_i\ [\text{kg/d}])}$$

$$= \frac{0.05\ \text{mg/kg-d} \times 0.20 \times 80.0\ \text{kg} \times 1{,}000\ \mu g/mg}{2.4\ \text{L/d} + \left((0.0076\ \text{kg/d} \times 2.0\ \text{L/kg}) + (0.0086\ \text{kg/d} \times 2.4\ \text{L/kg}) + (0.0051\ \text{kg/d} \times 2.6\ \text{L/kg})\right)}$$

$$= 327\ \mu g/L$$

$$= 300\ \mu g/L\ \text{(rounded)}$$



For consumption of organisms only:

$$HHC = \frac{\text{toxicity value (RfD [mg/kg-d]} \times \text{RSC)} \times \text{BW [kg]} \times 1{,}000\ [\mu g/mg]}{\Sigma_{i=2}^{4}\ (\text{FCR [kg/day]} \times \text{BAF}_i\ [\text{kg/d}])}$$

$$= \frac{0.05\ \text{mg/kg-d} \times 0.20 \times 80.0\ \text{kg} \times 1{,}000\ \mu g/mg}{\left((0.0076\ \text{kg/d} \times 2.0\ \text{L/kg}) + (0.0086\ \text{kg/d} \times 2.4\ \text{L/kg}) + (0.0051\ \text{kg/d} \times 2.6\ \text{L/kg})\right)}$$

$$= 16{,}293\ \mu g/L$$

$$= 20{,}000\ \mu g/L\ \text{(rounded)}$$

EPA recommends rounding the number of significant figures at the end of the criterion calculation to the same number of significant figures in the least precise parameter.

Source: USEPA (2015c) Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene

HHC Example: Hexachlorobenzene (carcinogen)

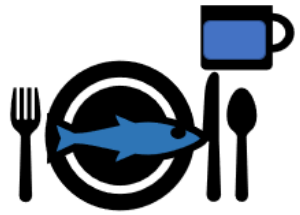
Input Values:

Toxicity

- RSD = 9.8 x 10^{-7} mg/kg-day

Exposure

- RSC = N/A
- BW = 80 kg
- DWI = 2.4 L/day
- FCR =
  - TL 2 = 7.6 g/day
  - TL 3 = 8.6 g/day
  - TL 4 = 5.1 g/day
- BAFs =
  - TL 2 = 18,000 (L/kg)
  - TL 3 = 46,000 (L/kg)
  - TL 4 = 90,000 (L/kg)



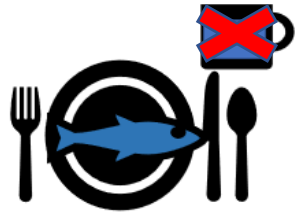
For consumption of water and organisms:

$$\text{HHC} = \frac{\text{toxicity value } (10^{-6}/\text{CSF [mg/kg-d]}) \times \text{BW [kg]} \times 1{,}000\ [\mu\text{g/mg}]}{\text{DWI [L/d]} + \Sigma_{i=2}^{4}\ (\text{FCR [kg/day]} \times \text{BAF}_i\ \text{[kg/d]})}$$

$$= \frac{(10^{-6}/1.02)\ \text{mg/kg-d} \times 80.0\ \text{kg} \times 1{,}000\ \mu\text{g/mg}}{2.4\ \text{L/d} + ((0.0076\ \text{kg/d} \times 18{,}000\ \text{L/kg}) + (0.0086\ \text{kg/d} \times 46{,}000\ \text{L/kg}) + (0.0051\ \text{kg/d} \times 90{,}000\ \text{L/kg}))}$$

$$= 0.00007892\ \mu\text{g/L}$$

$$= 0.000079\ \mu\text{g/L (rounded)}$$



For consumption of organisms only:

$$\text{HHC} = \frac{\text{toxicity value } (10^{-6}/\text{CSF [mg/kg-d]}) \times \text{BW [kg]} \times 1{,}000\ [\mu\text{g/mg}]}{\Sigma_{i=2}^{4}\ (\text{FCR [kg/day]} \times \text{BAF}_i\ \text{[kg/d]})}$$

$$= \frac{(10^{-6}/1.02)\ \text{mg/kg-d} \times 80.0\ \text{kg} \times 1{,}000\ \mu\text{g/mg}}{(0.0076\ \text{kg/d} \times 18{,}000\ \text{L/kg}) + (0.0086\ \text{kg/d} \times 46{,}000\ \text{L/kg}) + (0.0051\ \text{kg/d} \times 90{,}000\ \text{L/kg})}$$

$$= 0.00007911\ \mu\text{g/L}$$

$$= 0.000079\ \mu\text{g/L (rounded)}$$

EPA recommends rounding the number of significant figures at the end of the criterion calculation to the same number of significant figures in the least precise parameter.

Source: USEPA (2015d) Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene

Helpful Resources

Methodology Resources

- Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health
- Technical Support Documents:
  - Volume 1: Risk Assessment
  - Volume 2: Development of National Bioaccumulation Factors
  - Volume 3: Development of Site-Specific Bioaccumulation Factors
- Human Health Ambient Water Quality Criteria Fish Consumption Rates FAQ
- Guidelines for Carcinogen Risk Assessment
- Benchmark Dose Tools
- Update for Chapter 3 of the Exposure Factors Handbook

2015 HHC Update Resources

- Fact Sheet: Human Health Ambient Water Quality Criteria: 2015 Update
- Table Comparing EPA's Updated 2015 Final Updated Human Health Criteria
- Table Summarizing Updated Input Values for EPA's 2015 Final Updated Human Health Criteria
- Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)
- 2015 National Bioaccumulation Factors- Supplemental Information Document

For a full list of available resources, visit EPA's Human Health Water Quality Criteria and Methods for Toxics homepage.

References

USEPA. 2000a. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/wqc/fact-sheet-methodology-deriving-ambient-water-quality-criteria-protection-human-health-revised.

USEPA. 2000b. Technical Support Document Volume 1: Risk Assessment. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2018-12/documents/methodology-wqc-protection-hh-2000-volume1.pdf

USEPA. 2003. Technical Support Document Volume 2: Development of National BAFs. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2018-10/documents/methodology-wqc-protection-hh-2000-volume2.pdf

USEPA. 2002. Toxicological Review of 1,1-Dichloroethylene. U.S. Environmental Protection Agency, Office of Research and Development, Integrated Risk Information System, Washington, DC. Accessed April 2023. https://iris.epa.gov/static/pdfs/0039tr.pdf

USEPA. 2005. Guidelines for Carcinogen Risk Assessment. U.S. Environmental Protection Agency, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2013-09/documents/cancer_guidelines_final_3-25-05.pdf.

USEPA. 2012. Benchmark Dose Technical Guidance. U.S. Environmental Protection Agency, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2015-01/documents/benchmark_dose_guidance.pdf

USEPA. 2014. Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010). U.S. Environmental Protection Agency, Washington, DC, Accessed April 2023. https://www.epa.gov/sites/default/files/2015-01/documents/fish-consumption-rates-2014.pdf

USEPA. 2015a. Human Health Ambient Water Quality Criteria: 2015 Update Factsheet. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2015-10/documents/human-health-2015-update-factsheet.pdf

USEPA. 2015b. Update of Human Health Ambient Water Quality Criteria: Chlorobenzene. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.regulations.gov/document/EPA-HQ-OW-2014-0135-0214

USEPA. 2015c. Update of Human Health Ambient Water Quality Criteria: 1,1 Dichloroethylene. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.regulations.gov/document/EPA-HQ-OW-2014-0135-0204

USEPA. 2015d. Update of Human Health Ambient Water Quality Criteria: Hexachlorobenzene. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.regulations.gov/document/EPA-HQ-OW-2014-0135-0198

USEPA. 2015e. Update of Human Health Ambient Water Quality Criteria: 2,4, -Dinitrophenol. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2015-10/documents/final-2-4-dinitrophenol.pdf

USEPA. 2015f. Update of Human Health Ambient Water Quality Criteria: 1,1,1-Trichloroethane. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2015-10/documents/final-1-1-1-trichloroethane.pdf

USEPA. 2015g. Update of Human Health Ambient Water Quality Criteria: 1,2 Dichloroethane. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.regulations.gov/document/EPA-HQ-OW-2014-0135-0190

USEPA. 2016. Development of BAFs; Supplemental Information for EPA's 2015 Human Health Criteria Update. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2016-01/documents/national-bioaccumulation-factors-supplemental-information.pdf

USEPA. 2019. Update for Chapter 3 of the Exposure Factors Handbook. U.S. Environmental Protection Agency, Office of Research and Development, Integrated Risk Information System, Washington, DC. Accessed April 2023. https://www.epa.gov/sites/default/files/2019-02/documents/efh_-_chapter_3_update.pdf

USEPA. 2022. IRIS Glossary. U.S. U.S. Environmental Protection Agency, Office of Research and Development, Integrated Risk Information System, Washington, DC. Accessed April 2023. https://www.epa.gov/iris/iris-glossary#r

USEPA. 2023. Benchmark Dose Tools. U.S. Environmental Protection Agency, Washington, DC. Accessed April 2023. https://www.epa.gov/bmds

Questions?