



# Evaluation of Literature PFOA & PFOS Bioaccumulation Factors for use in Surface Water Standards Development

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# *PFOA & PFOS Standards*

## **NC DEQ Action Strategy for PFAS (2022)**

Surface water goals:

- Establish SW standards - water supplies, recreation, aquatic life uses
- Work with SSAB to determine appropriate BAFs and toxicity values for standards development
- Start date – Winter 2022-2023

NC DEQ staff have begun this work by evaluating literature BAFs published by EPA

The Action Strategy can be found [here](#).

# *Surface Water Standards*

## **Surface Water Standards**

Protect a variety of surface water uses including:

- Human consumption of fish tissue
- Protection of specified waters for use as public water supplies (Water Supplies)

Standards established from:

- Published EPA Clean Water Act criteria
- Other published EPA regulatory values
- Calculated per 15A NCAC 02B .0208 – Narrative Standard for Toxic Substances

# *What are Bioaccumulation Factors (BAFs)?*

## **Bioaccumulation Factors (BAFs)**

Estimate accumulation in fish tissues from exposure with water & food

Determined by comparing fish tissue concentrations to water column concentrations from samples taken at the same location

$$BAF = \frac{C_{Biota}}{C_{Water}}$$

Where:

$C_{Biota}$  = Concentration in fish tissue  
 $C_{Water}$  = Concentration in water

BAF units = L/kg-wet weight

## *How are BAFs used to develop standards?*

BAFs used to **determine water column concentrations** that, if met, **prevent accumulation** of a substance in fish tissue **to a level that is potentially harmful to people**

BAF used in the 02B .0208 criteria calculations

$$\text{Fish Tissue Standard} = (RfD \times RSC) \times \frac{BW}{FCR \times \mathbf{BAF}}$$

$$\text{Water Supply Standard} = (RfD \times RSC) \times \frac{BW}{WCR + (FCR \times \mathbf{BAF})}$$

*Constants defined in 02B .0208:*

*BW = Body Weight = 70 kg*

*WCR = Water Consumption Rate = 2 L/day*

*FCR = Fish Consumption Rate = 17.5 g/person/day*

## Example calculation

$$\text{Fish Tissue Standard} = (RfD \times RSC) \times \frac{BW}{FCR \times \mathbf{BAF}}$$

Exposure factors defined in rule (02B .0208)

*Body Weight (BW) = 70 kg*

*Fish Consumption Rate (FCR) = 17.5 g/person/day*

RfD (mg/kg/day)	RSC	BAF	Fish Tissue Standard (ug/L)
0.1	1	50	8000
0.1	1	100	4000
0.1	1	1000	400

## *BAF sources*

- EPA National Recommended Water Quality Criteria (primary resource)
- EPA databases (ECOTOX, CompTox)
- Other sources (literature, other states, etc.)

For PFOA & PFOS:

EPA evaluated literature BAFs as part of their draft criteria documents for Aquatic Life (2022)

[Draft Aquatic Life Ambient Water Quality Criteria for PFOA \(EPA 842-D-22-001\)](#)

[Draft Aquatic Life Ambient Water Quality Criteria for PFOS \(EPA 842-D-22-002\)](#)

# *EPA PFOA & PFOS BAFs*

Limited universe of BAF data for PFAS -> **very fortunate that EPA has provided this information!**

Literature BAFs sourced from:

**North America** (most of the fish)

Lake Niapenco, Ontario, Canada

**China** (shellfish, carp)

Jiaozhou Bay

Taihu Lake

Xiaoqing River

Xiamen Sea

**Europe** (shellfish)

Orbetello lagoon, Italy Gironde estuary, France

**\*PFAS sources difficult to determine for most sites**



# EPA PFOA & PFOS BAFs

EPA evaluation based on:

**Table 2-2. Evaluation Criteria for Screening Bioaccumulation Factors (BAFs) in the Public Literature.**

*Table modified from Burkhard (2021) – Draft Manuscript.*

Screening Factor	High Quality	Medium Quality	Low Quality
Number of Water Samples	> 3	2 – 3	1
Number of Organism Samples <sup>1</sup>	> 3	2 – 3	1
Temporal Coordination	Concurrent collection	Within one year	Collection period > 1 year
Spatial Coordination	Collocated collection	Within 1 - 2 km	Significantly different locations (> 2 km)
General Experimental Design			Mixed species tissues samples

<sup>1</sup> Organismal samples from the same species and tissue type.

## *NC Evaluation of BAFs*

NCDEQ staff further evaluated EPA BAFs to identify:

- NC resident fish species
- Shellfish species with related species in NC
- Commonly consumed species
- Fish muscle tissue BAFs
- Whole body (WB) BAFs for shellfish

## *NC-Specific BAFs by Location, Organism, & Species*

PFAS	Total # BAFs	Location	# Fish Muscle BAFs	# Fish Species by Location	# Shellfish WB BAFs	# Shellfish Species by Location
PFOA	24	Canada	9	9	0	0
		China	2	1	2	1
		France	0	0	1	1
		Italy	0	0	10	2
PFOS	23	Canada	9	9	0	0
		China	3	1	3	2
		France	0	0	1	1
		Italy	0	0	7	2

## *PFOA BAFs*

### PFOA BAF Comparison

Group	Range	NC Geometric Mean	Average	Median
Fish Muscle	2.884-213	12.559	29.029	10.00
Shellfish WB	11.86-9680	169.318	1343.36	128.3
Fish + Shellfish	2.88-9680	51.392	740.986	31.84

The BAFs listed here are a NC-specific subset of the BAFs published in the 2022 EPA Draft Aquatic Life Criteria for PFOA (see slide # 7 for reference information)

Fish = Fish Muscle Tissue BAFs

Shellfish = Whole Body BAFs

## *PFOS BAFs*

### PFOS BAF Comparison

Group	Range	Geometric Mean	Average	Median
Fish Muscle	537-7943	1961.9	3081.38	1585
Shellfish WB	122-5029	1356.52	2148.67	1150
Fish + Shellfish	122-7943	1644.51	2635.3	1585

The BAFs listed here are a NC-specific subset of the BAFs published in the 2022 EPA Draft Aquatic Life Criteria for PFOS (see slide # 7 for reference information)

Fish = Fish Muscle Tissue BAFs

Shellfish = Whole Body BAFs

## *Request for SSAB*

- 1) Does the SAB support for the use of EPA literature for the foundation for BAFs for NC?
- 2) Is the method that DEQ Applied to the EPA's vetted BAF data a scientifically sound approach for NC BAFs?
- 3) Which value is most appropriate - the average, geomean, median, or some other statistic to represent PFOA & PFOS BAFs for NC?

*What other information would the Board need to evaluate these questions?*

*Questions?*