Idaho Aquatic Human Health Criteria for Arsenic Technical Justification

Docket 58-0102-2201

State of Idaho

Department of Environmental Quality

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Table of Contents

List of Tables

List of Equations

Abbreviations, Acronyms, and Symbols

BAF	bioaccumulation factor
BCF	bioconcentration factor
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
DWS	Domestic Water Supply
EPA	US Environmental Protection Agency
HHC	human health criteria
IRIS	Integrated Risk Information System
kg	kilograms
L	liter
MCL	maximum contaminant level
mg	milligram
ppb	parts per billion
SWDA	Safe Water Drinking Act
TL	tropic level
TL-BAF	tropic level weighted bioaccumulation factor

1 Executive Summary

The Idaho Department of Environmental Quality (DEQ) is proposing to revise Idaho's human health water quality criteria (HHC) for arsenic as shown in Table 1. This document provides the scientific justification, technical analysis, and rationale for the development of the Idaho-specific Fish Only HHC for arsenic in Idaho Code (58.02.01.210). The analysis included a review of existing scientific literature regarding protective levels of HHC and an evaluation of methods and monitoring used to develop the criterion. The proposed HHC and related justification was informed by various stakeholders participating in the negotiated rulemaking process used by the DEQ to update its statewide arsenic criterion for human health (DEQ Docket No. 58-0102-1801).

Table 1. Proposed Human Health Water Quality Criteria for Inorganic Arsenic

Water & Fish		Fish Only	
Current Criteria	Proposed Criteria	Current Criteria	Proposed Criteria
10 ug/L water column	10 µg/L water column	10 ug/L water column	4.3 µg/L water column 8.0 µg/kg fish tissue

The proposed Fish Only HHC consists of two elements: (1) fish tissue (fillet or muscle) element and (2) water column element. The proposed water column HHC was derived using EPA's linear low-dose extrapolation cancer effects equation (Equation 1-3 in EPA's *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health,* 2000). The fish tissue HHC was derived by revising the HHC calculation by removing the drinking water term to calculate for Fish Only exposure.

2 Background

DEQ developed the HHC for arsenic in accordance with Section 303(c) of the Clean Water Act (CWA) and the federal regulations implementing the CWA, 40 CFR Part 131. States have the discretion to adopt EPA's criteria recommendations, EPA's recommendations modified to reflect site-specific conditions, or criteria based on other scientifically defensible methods.

DEQ proposes adopting locally derived criteria rather than EPA's nationally recommended criteria values because the natural background levels of arsenic in many Idaho waters are much higher than the national criteria. Naturally occurring arsenic in Idaho comes from geologic sources and levels are often higher in ground water than in surface waters. Inorganic arsenic is toxic to humans, however, it doesn't bioaccumulate in fish tissue as quickly as other constituents.

The arsenic HHC was derived consistent with the procedures set forth in EPAs *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (EPA 2000) and based on the most recent science available, including EPA's Integrated Risk Information System (IRIS) for the most up-to-date toxicity values when deriving the proposed criteria. Specifically, the fish tissue and water column criterion elements were derived using current EPA guidance on bioaccumulation factors (BAF) and trophic level (TL) considerations to account for differences in inorganic arsenic tissue concentrations between fish species, and to account for various uptake routes of inorganic arsenic in fish species.

2.1 Idaho's Aquatic Life Criteria Rulemaking for Arsenic

In May 2016, EPA entered into a Consent Decree with Northwest Environmental Advocates to reconsider EPA's 2010 approval of Idaho's human health criteria for arsenic. In September 2016, EPA disapproved Idaho's human health criteria of 10 µg/L arsenic for both consumption of Fish Only and consumption of Water & Fish. The Consent Decree required that EPA propose new human health criteria for arsenic by November 15, 2018, and that EPA either approve Idaho's submittal of revised human health criteria for arsenic or promulgate federal criteria by July 15, 2019. In June 2018 and again in June 2022, the Court granted the Unopposed Motion to Modify Consent Decree, ultimately extending the November 15, 2018, and July 15, 2019, deadlines to November 15, 2023, and November 15, 2024, respectively.

On April 4, 2018, the notice of negotiated rulemaking was published in the Idaho Administrative Bulletin under Docket No. 58-0102-1801. Eight meetings were held between April 2018 and November 2020. On December 9, 2020, a preliminary draft rule was posted on DEQ's website. Five additional meetings were held between December 2020 and November 2021 for a total of 13 negotiated rulemaking meetings. Stakeholders participated by attending the meetings and providing verbal and written comments. At the conclusion of the negotiated rulemaking process, DEQ formatted the final draft for publication as a proposed rule under Docket No. 58-0102-2201. The proposed rule was published in the March 2, 2022, issue of the Idaho Administrative Bulletin followed by a formal 30-day comment period.

The rule was presented to the Idaho Board of Environmental Quality on May 26, 2022, and adopted as a pending rule. The pending rule was noticed in the July 6, 2022, issue of the Idaho Administrative Bulletin and finalized by the 2023 Idaho Legislature, becoming effective under Idaho Law on April 6, 2023, and the notice of Final Legislative Action was posted June 7, 2023.

Key information was posted on DEQ's website and distributed to persons who participated in the negotiated rulemaking. All comments received during the negotiated rulemaking process were considered by DEQ when making decisions regarding the development of the rule. The negotiated rulemaking record, which includes the negotiated rule drafts, documents distributed during the negotiated rulemaking process, and the negotiated rulemaking summary, is available at *https://www.deq.idaho.gov/water-quality-docket-no-58-0102-2201/*.

2.2 History of Arsenic Water Quality Criteria

In 1976, the EPA published Quality Criteria for Water (known as the "Red Book"), where it established 50 µg/L of arsenic as a recommended criteria for domestic water supplies, and 100 µg/L for agricultural water supplies. In the 1986 edition of Quality Criteria for Water (known as the "Gold Book"), EPA updated its recommended criteria to include thresholds for the protection of human health from arsenic impacts through the consumption of fish and the consumption of Water & Fish at 0.022 µg/L and 0.175 µg/L, respectively, for a cancer risk level of 10^{-5}. The EPA's current HHC for arsenic was finalized in 1992 under the National Toxics Rule and is based on a cancer risk level of 10^{-6}, resulting in 0.14 ug/L for Fish Only and 0.018 ug/L for Water & Fish (EPA 2022a, 1986, 1976; NARA 1992). Arsenic was not included in the 2015 update to the recommended Human Health Ambient Water Quality Criteria, which included updates to the criteria calculations, the addition of trophic level weighted BAFs (TL-BAF) and updated exposure inputs (EPA 2015).

History of Idaho's arsenic human health criteria is shown below (Table 2), from EPA's promulgation under the National Toxics rule in 1992, to the current rule.

Table 2. Timeline of changes to Idaho Human Health Criteria for Arsenic, 1992-Present

		Arsenic Human Health Criteria		
Date	**Action**	**Fish Only (µg/L)**	**Fish + Water (µg/L)**	**Notes**
December 22, 1992	EPA promulgation of the National Toxics Rule (NTR), includes arsenic criteria for human health	0.14	0.018	Based on fish consumption rate of 6.5 g/day, drinking water intake of 2 L/day, and Bioconcentration Factor (BCF) of 44. These federally promulgated criteria become effective for Clean Water Act Purposes in Idaho
August 24, 1994	Idaho adopts NTR into state WQS by reference			
March 8, 1995	Idaho As criteria revised by State Legislature	6.2	0.02	Revised Fish Only criterion using BCF of 1, rounded Fish + Water criterion up from 0.018
June 25, 1996	EPA approves Idaho adoption of NTR and revised arsenic criteria			
November 10, 1997	EPA final Federal rule removing Idaho from the NTR for As becomes effective			Idaho criteria adopted in 1995 become effective for Clean Water Act purposes
March 19, 1999	Idaho adoption of revised As criteria based on current (1999) SDWA MCL approved by state legislature	50	50	Submitted for EPA approval April 23, 1999. EPA has not acted on this submittal. Submittal predates adoption of the "Alaska Rule"; criteria are effective for Clean Water Act purposes upon effective date of final rule
January 22, 2006	SDWA MCL for drinking water reduced from 50 µg/L to 10 µg/L becomes effective			
March 29, 2010	Idaho adoption of revised As criteria based on SDWA MCL approved by state legislature	10	10	Submitted for EPA approval June 21, 2010. Approved by EPA July 7, 2010; effective for Clean Water Act purposes
September 14, 2016	EPA disapproval of previously approved As criteria			Some uncertainty over what is the current, effective criteria for Clean Water Act purposes.
April 4, 2018	Idaho initiates negotiated rulemaking			13 rulemaking meetings were held with stakeholder involvement
May 26, 2022	Idaho Board of Environmental Quality Adopts as a pending rule.	4.3 water column 8.0 µg/kg fish tissue	10	
April 6, 2023	Rule became effective under Idaho Law			

Other states have human health arsenic criteria ranging from a low of 0.011 µg/L (Connecticut Water & Fish) to a high of 205 µg/L (Oklahoma Fish Consumption). Many states have criteria of 10 or 50 µg/L based on the current or previous Safe Drinking Water Act maximum contaminant level (MCL)[1]. A few states have recalculated their arsenic criteria using the 2000 EPA human health criteria development methodology calculations but altering some of the variables utilized in the EPAs equations to be more state specific. Some of the revisions made were based on changes of the bioconcentration factor (BCF), the EPA cancer slope factor (using the current IRIS value of 1.5), the fish consumption rate, and/or the risk level (using 10^{-5} rather than 10^{-6}). Table 3 lists human health criteria for arsenic in other western states.

Table 3. Arsenic HHC in other States

State	Fish Only (µg/L)	Water & Fish (µg/L)
Montana	10	10
Nevada	None	50
Oregon	2.1	2.1
Washington[a]	0.018	0.14
Wyoming	10	10
Utah	None	10 (Domestic and Agricultural Water Supply)

[a]: Washington’s human health criteria was disapproved by EPA in 2016 and promulgated to EPA recommended criteria.

2.3 Baseline Levels of Arsenic in Idaho

Arsenic is a naturally occurring element found in the earth’s crust. Arsenic is released into the environment through natural processes such as volcanic activity (including geothermal, as occurs throughout Idaho), erosion, forest fires, or through human activities such as pesticide application, improper disposal of arsenic-containing waste chemicals, agricultural applications, mining, and smelting (CLU-IN 2022; Gorny et al. 2015; Chung et al. 2014; ATSDR 2007). Arsenic in surface water typically originates from mining activities and the natural weathering of soil and rocks.

In many instances in Idaho, natural background concentrations of arsenic in waters may exceed nationally recommended arsenic water quality criteria. Welch et al. (2000, 1988) identifies the Western U.S. (including Idaho) as having naturally higher concentrations of arsenic in groundwater than other regions of the United States, in excess of 10 µg/L due to specific geologic conditions and geothermal activity. Welch et al. (1988) found that mean dissolved arsenic concentrations in geothermal ground waters are higher than mean arsenic concentrations in non-thermal ground waters in any of the physiographic provinces in the United States. Groundwaters in Idaho were found to have average concentrations between 10-50 µg/L (Welch et al. 2000).

[1] On October 31, 2001, the EPA announced the 10 ppb standard for arsenic would remain. The EPA Administrator, Christine Todd Whitman, stated that "the 10 ppb protects public health based on the best available science and ensures that the cost of the standard is achievable."

According to the Idaho Department of Water Resources, arsenic has exceeded the public water system MCL of 10 ppb at 15% of Statewide Program sites. In Idaho, arsenic occurs commonly in groundwater in certain areas in the southern part of the state, such as the Weiser area (southern Washington County), the Treasure Valley (Ada and Canyon Counties), and Twin Falls County (IDWR 2021). Flow of this arsenic-enriched geothermal water from hot springs may result in high concentrations of arsenic in surface water systems.

A statewide assessment of 34 major rivers in Idaho conducted in 2006 and 2008 found concentrations of inorganic arsenic ranging from 0.02 to 12.0 µg/L, with a mean of 1.75 µg/L and median of 0.84 µg/L (DEQ 2010). Only two of the 34 major river sites sampled had inorganic arsenic concentrations that were less than the EPA recommended Fish only criterion of 0.14 µg/L; none of the sites sampled had inorganic arsenic below the Water & Fish criterion of 0.018 µg/L (DEQ 2010).

From 2019 to 2021, DEQ conducted a probabilistic monitoring study to measure total and inorganic arsenic levels in paired surface water column and fish tissue samples, as well as monitoring inorganic and total arsenic levels in surface waters throughout Idaho for the purpose of deriving the proposed Idaho-specific inorganic arsenic human health criteria (DEQ, 2020; Morrison et al, 2023). Results of the monitoring study showed an average concentration of 1.63 µg/L of inorganic arsenic present in water column samples. An analysis of Water Quality Portal data for inorganic arsenic in surface waters across Idaho from 2012–2022 showed average concentrations of 1.36 µg/L of inorganic arsenic in Idaho waters. (National Water Quality Monitoring Council, 2022).

3 Criteria Development

The current EPA recommended arsenic human health criteria do not account for known local fish consumption rates or the updated IRIS oral cancer slope factor. Furthermore, the recommended criteria were calculated on the basis of a BCF, as opposed to a BAF, which does not account for all uptake routes and trophic level differences in arsenic bioaccumulation.

Idaho used EPA guidance (EPA 2000, 2009) to develop a scientifically rigorous and Idaho-specific dual element arsenic criterion for the protection of human health for the consumption of fish tissue (Fish Only) using updated recommended exposure inputs and an Idaho-specific trophic level weighted bioaccumulation factor and fish consumption rate (Table 4).

Table 4. Equation factors used in HHC calculation for arsenic.

Exposure Factors	
Target Incremental Cancer Risk	$1x\ 10^{-5}$
Body Weight	80 kg
Fish Intake	0.0665 kg/day
Chemical Specific Factors	
Inorganic Arsenic Cancer Slope Factor	1.5 $(mg/kg\text{-}day)^{-1}$
TL-Weighted BAF	1.87

The Water & Fish criterion is taken directly from the Safe Water Drinking Act (SWDA) maximum contaminant level (MCL) and is protective of the consumption of water under SWDA. However, since almost all waters in Idaho have the recreational use designation, most waters will use the more stringent Fish Only criteria.

3.1 Trophic-Level Weighted Bioaccumulation Factor

Idaho's decision to implement a BAF rather than a BCF is consistent with EPA human health criteria development guidance, as well as with State recommendations (IDAPA 58.01.02.210.05.b.ii; EPA 2015a, 2009, 2000). Bioaccumulation is the net accumulation of a chemical by an aquatic organism as a result of uptake from all environmental sources, including water, food, and sediment; and is measured as the final result of competing rates of chemical uptake and elimination (EPA, 2003, 2000; Arnot and Gobas, 2006).

Rates of arsenic uptake and bioaccumulation depend on a variety of factors, such as aquatic setting (marine, estuarine, freshwater), organism type (fish, invertebrate), species, age, trophic status within the aquatic food chain, exposure concentrations, history of exposure, route of uptake, environmental pH, dissolved organic matter and phosphorus content (Williams et al. 2006, Shah et al. 2008; Ghosh et al. 2022; Zhang et al. 2022). Bioconcentration factors (BCFs) only consider the uptake of chemicals by exposure through the water column, while BAF values include both dietary contributions as well as direct uptake from the environment (such as diffusion across the gill surface) (Mackay et al. 2012; Arnot and Gobas 2006; EPA, 2003, 2000).

While BAF values are more representative of contaminant uptake by organisms from a variety of sources, it does not capture the bioaccumulation potential of different species of fish. Arsenic does not appear to biomagnify through aquatic food chains but seems to diminish at higher trophic levels due to the ability of organisms to biotransform and eliminate this form of arsenic (ATSDR 2007; Williams et al. 2006; EPA 2003; Ghosh et al. 2022*).* One way to reduce the variability between BAF values is to calculate the values by trophic level. More specifically, calculation by trophic level helps to account for broad physiological differences, such as lipid content or life stage, among organisms that may influence bioaccumulation (EPA 2003). A TL-BAF can be calculated by assigning fish to trophic level by species and, using the BAFs at each trophic level as well as a relative consumption proportion for each trophic level.

3.1.1 Idaho Arsenic Bioaccumulation Factor Development

Field-based BAF data for chemicals are derived by collecting paired tissue and water column data in the field and are generally preferred for calculating HHC. Therefore, both the EPA and DEQ prefer field-based BAFs derived by collecting paired tissue and water column data over other estimates of bioaccumulation (such as BCFs) when determining human health criteria (IDAPA 58.01.02.210.05.b.ii; EPA 2000, 2003, 2009).

From September 2019 through November 2019, DEQ conducted a probabilistic monitoring project to determine a statewide TL-BAF for calculating arsenic HHC by collecting sufficient, quantified inorganic arsenic data from paired fish tissue and water across Idaho. Detailed monitoring and analytical methods are found in the *Arsenic Monitoring to Support Human Health Criteria Adoption Quality Assurance Project Plan* (DEQ, 2019), and results were presented in *2019 Arsenic Accumulation in Fish Tissue Preliminary Results* (DEQ, 2020), as well as in Morrison et al. (2023).

For each species sampled, trophic level assignments were made based on a synthesis of information found in Simpson and Wallace (1982), Wallace and Zaroban (2013), Sigler and Zaroban (2018), and FishBase (Frose & Pauly, 2000). A geometric mean was calculated from individual sample BAFs by trophic level (Table 5).

Table 5. TL assignments for calculation of a TL-BAF factor, and the geometric mean of calculated BAFs by TL.

Trophic Level	Species	Rationale	Bioaccumulation Factor (L/kg)
2	Bridgelip Sucker	Herbivorous	2.99
3	Brook Trout, Channel Catfish, Common Carp, Cutthroat Trout, Longnose Dace, Mottled Sculpin, Mountain Whitefish, Rainbow Trout, Redside Shiner	Primarily invertivores, or opportunistic invertivore/piscivore where invertebrates make up a large component of diet	1.82
4	Brown Trout, Largemouth Bass, Northern Pikeminnow, Smallmouth Bass	Primarily piscivores, or diet composed mostly of large invertebrates and fishes	0.27

Fish tissue and water were analyzed for total inorganic arsenic, and for each fish tissue sample, an inorganic arsenic BAF was calculated using Equation 1:

$$\mathbf{BAF_{iAs}} = \frac{[\mathbf{iAs}]_{\mathbf{Fish}}}{[\mathbf{iAs}]_{\mathbf{Water}}}$$

Equation 1. Bioaccumulation Factor calculation.

Where:

$\mathrm{BAF_{iAs}}$= sample BAF for inorganic arsenic in L/kg

$[\mathrm{iAs}]_{\mathrm{Fish}}$ = concentration of inorganic arsenic in fish in µg/kg

$[\mathrm{iAs}]_{\mathrm{Water}}$ = concentration of inorganic arsenic in water, in µg/L

A TL- BAF can then be calculated by applying consumption proportions to each trophic level BAF (Equation 2).

$$\boldsymbol{TL\ BAF = [(BAF_{TL2})(P_{TL2}) + (BAF_{TL3})(P_{TL3}) + (BAF_{TL4})(P_{TL4})]}$$

Equation 2. Trophic level weighted BAF calculation

Where:

TL-BAF= trophic level weighted bioaccumulation factor.

BAF_{TLi} = geometric mean of BAFs calculated for all samples for species assigned to TL_i.
P_{TLi} = proportion of national fish consumption rate for TL_i fishes.

TL specific consumption rates were based on the proportion of the 90th percentile of TL-specific consumption of freshwater + estuarine fishes to the total consumption rate from the national estimated fish consumption study as presented in Table 6 (EPA 2014; see page 6 of EPA 2015b *Update of Human Health Ambient Water Quality Criteria: Benzene 71-43-2* [*https://downloads.regulations.gov/EPA-HQ-OW-2014-0135-0165/content.pdf*] for an example).

Table 6. TL-specific consumption rates from the national fish consumption study.

Trophic Level	National Consumption Rate (grams/day)	Proportion
2	7.6	0.36
3	8.6	0.40
4	5.1	0.24
Total	21.3	1.0

Source: EPA 2014. *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations*.

Substituting the TL-specific geometric mean BAFs from the Idaho probabilistic fish accumulation study and the TL-specific consumption proportions from the national fish consumption study (Table 6) yields a TL-BAF for inorganic arsenic of 1.87 (Equation 3):

$$\boldsymbol{TL\ BAF} = [(\mathbf{2.99}\ \boldsymbol{L/kg})(\mathbf{0.36}) + (\mathbf{1.82}\ \boldsymbol{L/kg})(\mathbf{0.40}) + (\mathbf{0.27}\ \boldsymbol{L/kg})(\mathbf{0.24})] = \mathbf{1.87}\ \boldsymbol{L/kg}$$

Equation 3: Result for statewide TL-BAF calculations.

Idaho's study indicates the concentration of inorganic arsenic in the water column was not significantly related to the concentration of inorganic arsenic in fish tissue and has been previously discussed (DEQ 2020; Morrison et al. 2023). However, most measures of the central tendency of BAFs from paired tissue and water samples throughout Idaho were in the 1 to 2 L/kg range (DEQ 2020).

4 Recreation Use Criterion

The Fish Only exposure for recreation beneficial use, is a dual-element criterion consisting of a fish tissue element and a water column element, with the fish tissue element superseding the water column element. Due to the uncertainty associated with bioaccumulation of inorganic arsenic, this two-part criterion provides a direct measure of the exposure route that is intended to be protected by allowing direct comparison of the fish tissue. In addition, it provides a water column criterion that can be used when sufficient fish tissue data might not be available or obtainable. A water column translation process is also available where a site-specific TL-BAF is developed.

4.1 Water Column Element

While it is true that the primary route of exposure for recreation uses is through the consumption of fish tissue, and the data from the 2019 Idaho arsenic monitoring study indicate that the relationship between concentration of inorganic arsenic in the water column and fish tissue is weak, there are certain applications of water quality standards (such as TMDL targets, effluent limits, etc.) where a water column value is necessary.

Acquisition of fish tissue data is labor and resource intensive, inherently difficult, and at times, not possible due to regulatory restrictions or safety concerns. To ensure adequate protection of the beneficial use, it is necessary to also have a water column value that can be used when fish tissue is unavailable or unattainable. Furthermore, in many instances, the water column value can be met. Based on Idaho's targeted sampling effort, the vast majority of Idaho streams monitored have annual average concentrations below the proposed water column criterion element of 4.3 µg/L. In 2019, only 4 of 40 sites had annual average inorganic arsenic concentrations >4.3 µg/L. Only two of these sites exceeded 4.3 µg/L annual average concentrations in 2020 and 2021.

Water column criterion elements are derived from assessing the bioaccumulation responses in fish and other aquatic taxa given this updated understanding of arsenic bioaccumulation. Since water column criterion elements are derived from fish tissue; it is expected that if water column values are meeting criteria, then fish should be as well. The same is true when fish are meeting criteria, then water should be as well. But if there is discordance, the fish tissue criteria take precedence.

4.1.1 Water Column Criterion Calculation

The HHC calculation outlined below (Equation 4) was used to calculate the ambient water quality criterion for the exposure to inorganic arsenic using the equation factor inputs in Table 4. The equation was taken from the EPA Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000) but modified to calculate criteria to protect recreational uses through the exposure of fish consumption only by removing the drinking water intake term.

$$\textbf{AWQC = RSD * }\left(\frac{\textbf{BW}}{\textbf{(FI *BAF)}}\right) * \mathbf{1,000}\ \mathbf{\mu g/mg}$$

Equation 4: Fish Only water column element criterion calculation.

Where:

$AWQC_{FO}$ = ambient water quality criterion, Fish Only exposure

RSD = risk-specific dose based on a target incremental cancer risk of 1 x 10^{-5} and a cancer slope factor for inorganic arsenic of 1.5 $(mg/kg\text{-}day)^{-1}$

BW = mean adult body weight of 80 kg

FI = fish intake of 0.0665 kg/day

BAF = bioaccumulation factor, using the Idaho-specific calculated TL-BAF of 1.87 (L/kg)

1,000 µg/kg mg = a conversion factor to convert criteria in units of µg/L

The resulting value using the inputs above yields a Fish Only water column criterion for inorganic arsenic of 4.3 µg/L (Equation 5).

$$\mathbf{AWQC} = \frac{\mathbf{1{\times}10^{-5}}}{\mathbf{1.5\ (}\boldsymbol{mg/kg/day}\mathbf{)^{-1}}} * \left(\frac{\mathbf{80}\ \boldsymbol{kg}}{\mathbf{0.0665}\ \boldsymbol{kg/day} * \mathbf{1.87}\ \boldsymbol{L/kg}}\right) * \mathbf{1{,}000\ \mu g/mg} = \mathbf{4.3\ \mu g/L}$$

Equation 5: Result of water column element calculation.

4.2 Fish Tissue Element

In Idaho's Water Quality Standards, Fish Only criteria are intended to protect consumers of fish from increased cancer risk due to exposure to toxic pollutants that may be found in fish tissue. The fish tissue element is the most direct measure of human exposure to inorganic arsenic from consumption of fish. In recognition of this fact, in the rule language, the fish tissue criterion element supersedes the water column element (IDAPA 58.01.02.210.01 footnote k, and IDAPA 58.01.02.210.03.d.ii).

The fish tissue criterion value of 8 µg/kg is a direct measure of the concentration of inorganic arsenic in fish tissue that would provide protection for consumers at the Idaho specific fish consumption rate and cancer risk factor and is the tissue concentration that the water column concentration is intended to protect.

The rule language also makes it clear that there are no circumstances where DEQ would consider analysis of a single fish useful or sufficient for determining compliance with the arsenic criterion. Stating the minimum number of fish required, in rule, also clarifies that regulatory decisions should be made based on the affected fish community (as measured by an average or composite) as opposed to a single fish. The rule also states that gamefish, those most often consumed, should be targeted unless they are not present.

The fish tissue element can only be utilized when 90 days have passed without any new inputs or activities within a watershed. Research has shown varying lengths of time to achieve site equilibrium based on various environmental parameters and organism traits (EPRI 2008, 2011). Laboratory studies have shown that equilibrium for arsenic is close to 60 days in rainbow trout and catfish, with arsenic levels beginning to decrease by 50% between days 60 and 90 (EPRI 2008, 2011). However, field conditions have many variables that can affect the rates of assimilation and elimination. Thus, DEQ has determined that a 90-day period after new activity or discharge should be sufficient to evaluate effective inorganic arsenic levels in fish tissue for the protection of human health.

In IDAPA 58.01.02.010.65, the definition for **new activity** or discharge is defined as:

> "…an activity or discharge that has not been previously authorized. Existing activities or discharges not currently permitted or licensed will be presumed to be new unless the Director determines to the contrary based on review of available evidence. An activity or discharge that has previously taken place without need for a license or permit is not a new activity or discharge when first licensed or permitted."

4.2.1 Fish Tissue Criterion Calculation

The ambient water quality criterion equation (Equation 4) produces a value for the water column concentration. However, Equation 4 can be transformed to provide a fish tissue concentration by removing the BAF term (Equation 6). This fish tissue criterion value is a direct measure of the concentration of inorganic arsenic in fish tissue that would provide protection for consumers at the Idaho specific fish consumption rate and cancer risk factor.

$$\mathbf{AWQC_{tissue} = RSD * \left(\frac{BW}{FI}\right) * 1,000\ \mu g/mg}$$

Equation 6: Fish Only fish tissue element criterion calculation.

Where:

$AWQC_{tissue}$ = fish tissue criterion for inorganic arsenic in muscle, or fillet, tissue on a wet weight basis

RSD = risk-specific dose based on a target incremental cancer risk of 1 x 10^{-5} and a cancer slope factor for inorganic arsenic of 1.5 $(mg/kg\text{-}day)^{-1}$

BW = mean adult body weight of 80 kg

FI = fish consumption rate of 0.0665 kg/day

1,000 µg/kg mg = conversion factor to convert criteria in units of µg/kg

The resulting value using the inputs above yields a Fish Only, fish tissue criterion for inorganic arsenic in muscle, or fillet, tissue on a wet weight basis of 8 µg/kg (Equation 7).

$$\mathbf{AWQC_{tissue} = \frac{1\times10^{-5}}{1.5\ (mg/kg/day)^{-1}} * \left(\frac{80\ kg}{0.0665\ kg/day}\right) * 1,000\ \mu g/mg = 8.0\ \mu g/kg}$$

Equation 7: Result of fish tissue element calculation.

4.3 Water Column Translation

For developing effluent limits, TMDL targets (i.e., water column targets for fishless waters) or remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act (e.g., applicable or relevant and appropriate requirements) for waters designated for recreational use, the fish tissue element may be translated to a water column value using the following equation:

$$\boldsymbol{WC_T\left(\frac{\mu g}{L}\right) = \frac{8.00\mu g/kg}{BAF_{SS}L/kg}}$$

Equation 8: Water column translation calculation.

Where:

WC_T (µg/L) = translated water column value

BAF_{SS} L/kg = site-specific BAF calculated consistent with IDAPA 58.01.02.210.03.e.v.

The translation is determined using a site-specific TL-BAF based on the ratio of total recoverable inorganic arsenic in fish muscle or fillet tissue to dissolved inorganic arsenic in the water column. The site-specific translation is not a site-specific criterion, it translates the fish tissue element to an applicable water column target using both the fish tissue criterion and a site-specific TL-BAF. Site-specific TL-BAF calculations for arsenic will be evaluated and used on a case-by-case basis. Sampling for TL-BAF development for a water column translation must meet the requirements of IDAPA 58.01.02.210.03.e.v which states:

- Data used to translate the fish tissue element must be based on current conditions and consistent with Subsections 210.03.e.i. and ii.
- Whenever practical, fish tissue samples must be representative of the game fish species present within the waterbody and include game fish of legally harvestable size. In the absence of suitable game fish species, other resident fish species may be used.
- Water column samples must be representative of the annual average concentration of dissolved inorganic arsenic at the site.
- BAFs are calculated as a trophic-level weighted BAF or other scientifically defensible method for deriving protective BAF.

Data used to translate the fish tissue element must be based on current conditions. Sampling for a water column translation should develop translation in a spatial and temporal manner consistent with Statewide criteria development (e.g., consider annual variation) and collect fish tissue data for trophic levels 2, 3, and 4.

5 Domestic Water Supply Criterion

Waters designated for DWS must protect humans from harmful levels of inorganic arsenic through both drinking water and fish tissue consumption. According to Idaho's Water Quality Standards, the DWS designation should meet water quality appropriate for use as untreated raw water for public drinking water:

> *Water quality appropriate for use as untreated raw water (as defined under IDAPA 58.01.08, "Idaho Rules for Public Drinking Water Systems") for public drinking water. (IDAPA 58.01.02.100.03).*

The Water & Fish water column criterion of 10 µg/L is taken from the SWDA MCL for arsenic (EPA 2022). Waters meeting the DWS water quality criteria also meet SWDA standards, which protect public drinking water systems. However, since almost all waters in Idaho have the recreational use designation, most waters will use the more stringent Fish Only criteria.

References

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