Arsenic Background Paper and

Draft Options for Discussion

**Briefing Summary**

DEQ is considering several options for deriving arsenic criteria as an alternative to EPA’s current recommended criteria. Three primary alternative approaches are described in this paper:

1. Re-calculation of the federal criteria,
2. Use of the MCL value for drinking water in some manner, and a
3. Natural background based approach.

Table 1 below shows draft proposed values under these three approach options, as well as the criteria values if only the FCR is revised. Both of the recalculated values below use a cancer slope factor of 1.5, the current value in EPA’s IRIS database.

At this time, DEQ’s preferred option for the human health arsenic criteria is to use:

1. the recalculated value for the organism only criterion (2.7 µg/l) for fishing/fish consumption uses; and
2. the same value (2.7 µg/l) as the “MCL Hybrid” approach for the water + organism criterion to protect domestic water supply, fishing and other relevant uses.

These criteria would protect human health and represent an appropriate balance of protection with recognition that Oregon has widespread natural background levels of arsenic far above the calculated water + organism approach shown below. These values are more protective than the MCL of 10 and they are equal to calculated values derived to protect human health at high levels of fish consumption (175 g/d).

|  |  |  |
| --- | --- | --- |
| **Table 1. Arsenic Criteria Options** | | |
| **Approach** | **Estimated**  **Water + Organism**  **(µg/l)** | **Estimated**  **Organism Only**  **(µg/l)** |
| OR recalculation 1:  FCR=175, BCF=44,  % inorganic=100 | 0.005 | 0.006 |
| OR recalculation 2:  FCR=175, BCF=1,  % inorganic=10 | 0.023 | **2.7** |
| MCL | 10 | 10 |
| MCL hybrid | **2.7** | **2.7** |
| Statewide default natural background | **1** | **1** |

The recalculated criteria in Table 1 for the water + organism value do not solve the problems with the current criteria that: 1) natural background levels in Oregon are greater than the criteria on a widespread basis and 2) they are several orders of magnitude below the MCL set to protect drinking water. Some states use the MCL of 10 as their water quality criteria. DEQ staff believes that this value is not sufficiently protective of human health given the high level of fish consumption in Oregon and the fact that nearly all of Oregon’s waters are designated for fishing or fish consumption use.

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**Introduction**

The Oregon Department of Environmental Quality (DEQ) has agreed to review the science behind the human health water quality criteria for arsenic due to the following concerns, which were expressed to the Oregon Environmental Quality Commission (EQC) at their meeting in October, 2008. First, arsenic is a naturally occurring earth metal found in Oregon waters at natural background levels much greater than the current human health criteria. Second, the ambient human health criteria for arsenic are much lower than the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act for drinking water delivered to people’s homes.

DEQ plans to propose revised human health criteria for arsenic simultaneously with the human health criteria revisions being made to incorporate an increased fish consumption rate of 175 grams per day (g/d).

**Concerns about Oregon’s Human Health Water Quality Criteria for Arsenic**

Having arsenic criteria that are significantly below widespread natural background levels of the pollutant presents several problems for the State and for cities and industries that discharge to waters of the state. First, this situation could lead to many 303d listings of water bodies as impaired even though the arsenic levels are due to natural geologic sources. DEQ may be required to do a TMDL for situations where the source of arsenic is natural and can not be controlled, which would not be a good use of public resources.

Another result of a water body being listed as “impaired” or having a background pollutant concentration above the water quality criterion is that it means there is no assimilative capacity or mixing available to cities and industries that discharge to the water body. In this case, the facility must meet the water quality criterion at the “end-of-pipe,” prior to discharging into the river. DEQ expects that under the current arsenic criteria or criteria based on the new fish consumption rate, many municipal wastewater treatment plants and a number of industrial facilities would not be able to meet the criteria. In some cases, a facility may need to discharge the same amount of arsenic they brought into the facility from the river via their intake water. Even if the facility adds no arsenic to its wastewater, if it concentrates the arsenic, which occurs, for example, when the water is used for non-contact cooling, the facility would not be able to meet the limitations required to discharge the water back into the river.

While DEQ has a “natural condition” provision in our standards, EPA has stated that this type of provision should not apply to human health criteria. The criteria need to protect the uses. For aquatic life, we can reason that the aquatic species present are acclimated to the natural conditions. This reasoning does not necessarily hold true for humans. Therefore, if DEQ proposes to set human health criteria based on natural background levels, we will need to show that those levels are protective of human health.

Another concern that has been expressed to DEQ is the fact that the current arsenic criteria and recalculated criteria based on an increased fish consumption rate are far below the MCL.

The MCL is the criterion set under the Safe Drinking Water Act to protect public drinking water supplies.

Thus, DEQ is considering what criteria represent a reasonable balance of human health protection, ability to use waters with natural levels of arsenic for domestic water supply and costs associated with meeting the criteria.

**Background Information on Arsenic in Oregon**

**Background levels.** Based on the available data, natural background levels of arsenic in Oregon appear to be in the range of less than 1 to 3 micrograms per liter (µg/l) in many waters of the state. There is limited data available on arsenic concentrations in surface waters, partly because until recently DEQ used 5.0 µg/l as a quantitation limit. Therefore, much of the data collected by DEQ or permittees report “non-detectable” levels of arsenic. In 2008, DEQ reduced the quantitation limit for arsenic to 0.5 µg/l.

DEQ data from approximately 1979-1981 indicate that much higher levels of arsenic (greater than 5-10 µg/l) may be present in some south central and southeastern Oregon basins. More recent data also show a range of arsenic levels of less than 1 to greater than 10 in upper Klamath basin streams. It is not known whether these levels represent natural geologic sources or are elevated due to anthropogenic activity. However, one spring in the upper Klamath basin had arsenic levels of 16 µg/l (Newton Consultants Inc., for City of Klamath Falls, 2008).

**Natural sources.** There are natural geologic sources of arsenic in Oregon. The City of Portland has found arsenic levels in the Bull Run reservoir, a primary source of Portland’s drinking water ranging from less than 1 µg/l (their minimum reporting level) up to 3 µg/l. Data from the other Oregon streams show arsenic levels in this range as well, such as the Crooked River upstream of Prineville, the Little Deschutes River and some streams in the upper Klamath basin. A spring in the upper Klamath basin had an arsenic concentration of 16 µg/l. Samples from the upper Santiam basin were mostly below the 0.5ug/l detection level.

A USGS (1998) report on arsenic concentrations in ground water of the Willamette Basin found concentrations ranging from < 1 to 2,000 µg/l. The report concludes:

1. “Regional patterns of arsenic occurrence in the Willamette Basin indicate that the sources of arsenic in ground water are not human related. Arsenic-containing metal oxides, volcanic glass in volcanic rocks of rhyolitic to intermediate composition, and clays are likely sources.”
2. High arsenic concentrations (concentrations exceeding the current MCL established by EPA) appear to be associated with particular associations of rock in some areas and with alluvial deposits in others (i.e. the Tualatin basin). (paraphrased)
3. “For alluvial ground water of the Tualatin Basin, (1) presence of competing anions and (2) occurrence of reducing conditions may be important controlling factors in arsenic adsorption/desorption reactions. Dissolution of iron oxides, with subsequent release of adsorbed and (or) coprecipitated arsenic, also may play an important role in arsenic mobility in ground water of the Tualatin Basin.”

A 1998 arsenic study by the Washington Department of Ecology (Ecology), that included data collection from the Columbia River, reported: *“the recent data suggest that total recoverable arsenic concentrations in local rivers and streams are typically in the range of 0.2 - 1.0 µg/L, while concentrations greater than 2 to 5 µg/L may indicate contamination from anthropogenic sources. Arsenic levels in most 303(d) listed waterbodies are not clearly different from waterbodies that have no apparent sources, and some are comparable to rainwater”* (Results and Recommendations from Monitoring Arsenic Levels in 303(d) Listed Rivers in Washington – DOE 2002)*.*

**Human sources.** A document titled *Toxicological Profile for Arsenic* (ATSDR, 2007) describes the various means by which humans have affected the fate and transport of arsenic in the environment, including the following:

* When ores that contain copper or lead are heated in smelters, “most of the arsenic goes up the stack and enters the air as a fine dust. Smelters may collect this dust and take out the arsenic as a compound called arsenic trioxide (As2O3).”
* Presently, about 90% of all arsenic produced is used as a preservative for wood to make it resistant to rotting and decay. The preservative is copper chromated arsenate (CCA) and the treated wood is referred to as “pressure-treated.” In 2003, U.S. manufacturers of wood preservatives containing arsenic began a voluntary transition from CCA to other wood preservatives that do not contain arsenic in wood products for certain residential uses, such as play structures, picnic tables, decks, fencing, and boardwalks. This phase out was completed on December 31, 2003; however, wood treated prior to this date could still be used and existing structures made with CCA-treated wood would not be affected. CCA-treated wood products continue to be used in industrial applications. It is not known whether, or to what extent, CCA-treated wood products may contribute to exposure of people to arsenic.
* In the past, inorganic arsenic compounds were predominantly used as pesticides, primarily on cotton fields and in orchards. Inorganic arsenic compounds can no longer be used in agriculture. However, organic arsenic compounds, namely cacodylic acid, disodium methylarsenate (DSMA), and monosodium methylarsenate (MSMA), are still used as pesticides, principally on cotton. Some organic arsenic compounds are used as additives in animal feed.
* Small quantities of elemental arsenic are added to other metals to form metal mixtures or alloys with improved properties. The greatest use of arsenic in alloys is in lead-acid batteries for automobiles.
* Another important use of arsenic compounds is in semiconductors and light-emitting diodes.

**Arsenic impaired waters.**  The streams shown in the table below are currently 303d listed for exceeding the arsenic criteria for aquatic life or human health.

|  |  |  |  |
| --- | --- | --- | --- |
| Basin | River | River Miles | Year listed |
| Multi | Columbia | 0-142 | 1998 |
| Willamette | Willamette | 175 – 186 | 2002 |
| Upper Willamette | A-3 drain | --- | 2002 |
| Upper Willamette | Amazon Cr. | 0-23 | 2002 |
| Upper Willamette | Willow Cr. | 0-3 | 2002 |
| North Umpqua | N. Umpqua | 35-52 | 2002 |
| North Umpqua | Sutherlin Cr. | 0-16 | 2002 |
| North Umpqua | Unnamed Cr. | --- | 2002 |
| South Umpqua | Middle Cr. | 0-13 | 2004 |
| South Umpqua | S. Umpqua R. | 0-16 | 2002 |
| Warner Lakes | Twentymile Cr. | 0-29 | 2002 |
| Owyhee | Owyhee River | 71-200 | 2004 |
| Jordan | Jordan Cr | 0-95 | 2004 |
| Mid Col-Hood | Lenz Cr | 0-1.5 | 2004 |
| Mid Col-Hood | Neal Cr. | 0-6 | 2004 |
| Molalla-Pudding | Zollner Cr | 0-8 | 2004 |

**Potential Health Impacts of Arsenic**

Arsenic is a known carcinogen that may cause cancer in skin or internal organs such as the liver, kidneys, lungs and bladder. Other potential health impacts from arsenic include cardio vascular, kidney, central nervous system and hyper pigmentation/keratosis effects (USEPA, 2000). Factors for how to represent these effects in the criteria equations are included in EPA’s Integrated Risk Information system (IRIS) database. The federal arsenic criteria are based on the cancer endpoint, as shown below.

**Current Human Health Criteria for Arsenic: State and Federal**

The current Oregon and EPA arsenic criteria are shown in the table below.

|  |  |  |
| --- | --- | --- |
| **Arsenic Criteria** | | |
|  | Water and Organism (µg/L) | Organism Only (µg/L) |
| Currently effective Oregon criteria (Table 20) | 0.0022 | 0.0175 |
| Criteria adopted by Oregon in 2004 | 0.018\* | 0.14\* |
| Current EPA criteria | 0.018\* | 0.14\* |

\* Inorganic arsenic

Oregon’s currently effective criteria (Table 20) are based on EPA’s 1986 recommended criteria. These criteria were based on a fish consumption rate (FCR) of 6.5 g/d. Table 20 does not specify whether the human health criteria are for the inorganic arsenic or organic form arsenic. The toxicity data EPA used to calculate the 1986 recommended criteria was for inorganic arsenic.

EPA’s current arsenic criteria for human health and the criteria adopted by the EQC in 2004 are based on a fish consumption rate (FCR) of 6.5 g/d and a cancer slope factor of 1.75, and are specifically identified as criteria for inorganic arsenic. In 1992, EPA promulgated these arsenic criteria in the National Toxics Rule (USEPA, 1992). Although EPA has since changed the cancer slope factor in IRIS to 1.5 (4/10/1998) and changed their recommended FCR to 17.5 (EPA, 2000), they have not revised the nationally recommended arsenic criteria accordingly.

Although DEQ adopted the current federal arsenic criteria in 2004 and submitted them to EPA on July 8 of that year, they are not yet effective in Oregon because they are less stringent than our prior arsenic criteria and have not yet been approved by EPA. Therefore, the Table 20 criteria remain the effective arsenic criteria for Clean Water Act purposes in Oregon.

EPA did not promulgate human health criteria for arsenic in the California Toxics Rule (CTR) in 2000, stating that “a number of issues and uncertainties existed at the time of the CTR proposal concerning the health effects of arsenic.” Neither did EPA include arsenic criteria in its promulgation of criteria for the Great Lakes States in 1995.

Most states have human health arsenic criteria ranging from a low of the current federal criteria to a high of 50 µg/l. Almost half of the states have criteria of 10 or 50 µg/l based on the current or previous Safe Drinking Water Act maximum contaminant level (MCL). About 10 states have no “water & organism” arsenic criterion and several have no “organism only” criterion. A few states have recalculated their arsenic criteria using EPA equations but altering some of the variables in those equations. The variables States have revised include the bioconcentration factor (BCF), the IRIS cancer slope factor (using the current value of 1.5), the fish consumption rate, and/or the risk level (using 10-5 rather than 10-6). In addition, some states have applied an inorganic proportion to the calculation since the criterion applies to inorganic arsenic. One EPA Region (Region 6) has developed a methodology for developing alternate arsenic criteria. The factors and methods used in the Region 6 approach are discussed further below.

**How the Federal Arsenic Criteria Were Calculated**

The following two equations and accompanying table describe the variables that were used to calculate EPA’s current national human health criteria for arsenic, which Oregon adopted in 2004.

Water + Organism Criterion (µg/L) = 1000 x RF x BW

q1\*[DW + (BCF x FCR)]

Org Only Criterion (µg/L) = 1000 x RF x BW

q1\*[BCF x FCR]

***where:***

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Description** | **Value Used for Arsenic** |
| **RF =** | risk factor (dimensionless) | 1x10-6 |
| **BW =** | body weight (kg) | 70 |
| **q1\* =** | cancer potency factor (mg/kg/day)-1 | 1.75 |
| **DW =** | Drinking water consumption (L/day) | 2 |
| **BCF =** | bioconcentration factor (L/kg) | 44 |
| **FCR =** | fish consumption rate (**kg**/day) | 0.0065 |

**Federal**

**Guidance for Deriving Toxics Criteria for Human Health**

In October 2000, EPA published a “Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.” In this methodology, EPA states that criteria for carcinogens based on a risk level of 10-5 are acceptable for the general population and that highly exposed populations should not exceed a risk level of 10-4 (pp. 1-12 and 2-6). The guidance also says that states should use local fish consumption data when it is available.

**Options Discussion**

DEQ is considering several options for deriving arsenic criteria as an alternative to EPA’s current recommended criteria. Three primary alternative approaches are described in this paper:

1. Re-calculation of the federal criteria,
2. Use of the MCL value for drinking water in some manner, and a
3. Natural background based approach.

Table 1 below shows draft proposed values under these three approach options, as well as the criteria values if only the FCR is revised. Both of the recalculated values below use a cancer slope factor of 1.5, the current value in EPA’s IRIS database. DEQ’s preferred options at this time are to use the recalculated value for the organism only criterion (2.7) and the “MCL Hybrid” (2.7) or the “statewide default natural background” based criterion (1) for the water + organism criterion. There may be variations to these approaches to consider and discuss, but DEQ believes that criteria in this range would serve the purpose of protecting human health and represent an appropriate balance of protection with recognition that Oregon has widespread natural background levels of arsenic far above the criteria generated by the water + organism calculation approaches.

|  |  |  |
| --- | --- | --- |
| **Table 1. Arsenic Criteria Options** | | |
| **Approach** | **Estimated**  **Water + Organism**  **(µg/l)** | **Estimated**  **Organism Only**  **(µg/l)** |
| OR recalculation 1:  FCR=175, BCF=44,  % inorganic=100 | 0.005 | 0.006 |
| OR recalculation 2:  FCR=175, BCF=1,  % inorganic=10 | 0.023 | **2.7** |
| MCL | 10 | 10 |
| MCL hybrid | **2.7** | **2.7** |
| Statewide default natural background | **1** | **1** |

**Option 1: Re-Calculating the Criteria Using Oregon Appropriate Values**

The first approach would be to recalculate the criteria using EPA equations, but using alternative values for some of the factors that DEQ believes are more appropriate to Oregon. This approach has been used in other States and approved by EPA. It is described by the EPA Region 6 interim strategy for arsenic and was described in EPA’s draft proposed arsenic criteria under the Great Lakes Initiative.

One locally driven factor is the fish consumption rate. DEQ proposes to use 175 g/d as the FCR in our recalculation of the criteria. The current federal criteria are based on a consumption rate of 6.5 g/d. Other factors that could be revised to reflect Oregon conditions include the bioconcentration factor (BCF) and the proportion of total arsenic found in fish tissue that is in an inorganic form. These factors are discussed further below. Revising these 3 factors would lead to the criteria shown as “OR Recalculation 2” in Table 1 above.

**Bioconcentration factor (BCF)**. Bioconcentration refers to the uptake and retention of a chemical by an aquatic organism from water only. A bioconcentration factor (BCF) is the ratio (in L/kg-tissue) of the concentration of a substance in tissue of an aquatic organism to its concentration in the ambient water, in situations where the organism is exposed through the water only and the ratio does not change substantially over time. Past arsenic criteria recalculation efforts have explored several aspects relating to the selection and use of the BCF variable.

EPA's current BCF of 44 for arsenic is described in *Ambient Water Quality Criteria for Arsenic* (USEPA, 1980). The BCF was calculated from the geometric mean (weighted with consumption rates) of data from two species, the eastern oyster (BCF=350, 112 day test) and bluegill (BCF=4, 28 day test). EPA has since raised concerns about the BCF of 44. Because it was based on only 2 species and one of those is the eastern oyster, the BCF of 44 most likely overestimates the health risks associated with freshwaterfinfish consumption (USEPA Region 6, mid-1990s). In addition, the data set used to establish the BCF was relatively small (USEPA, 1980).

Additional data reflect lower BCFs for other species. EPA (Stephan, 1993; USEPA Region 6, mid-1990s) has used the following information to support using a BCF of 1 in their draft proposed Great Lakes Initiative arsenic criteria and in an EPA Region 6 Interim Strategy for freshwater arsenic criteria:

* The 1984 criteria document for arsenic (EPA, 1985) contains BCFs for fish calculated from whole body measurements that range from 0 to 4. Results for invertebrates range from 1 to 17. But only data for the eastern oyster and bluegill were used to calculate the BCF of 44 used in EPA’s 1980 criteria document.
* Spehar et al. (1980) obtained BCFs of 0 for various inorganic and organic forms of arsenic based on whole-body measurements of **rainbow trout**.
* DeFoe (1982) found a BCF of 3 for whole-body measurements of fathead minnow.
* Barrows et al. (1980) obtained a BCF of 4 using whole-body measurements on bluegills.

EPA notes that BCFs for muscle tissue, the typically edible portion of the fish, should be lower that those for whole body (Stephan, 1993). Azcue and Dixon (1994; IN USEPA, mid 1990s) conducted a study that exemplifies this. The study measured arsenic in rock bass. The highest concentration was found in bone and scales, followed (in decreasing concentration) by intestines and contents, muscle and liver. A BCF of 0.71 was calculated for muscle tissue whereas the BCF based on whole body concentration was 2.3, three times greater than the muscle tissue BCF.

As a result of this information, some states have adopted criteria based on BCFs that they believe are more representative of the aquatic life in their state. Idaho, Michigan and Colorado have used or are using a BCF of 1, as provided in a draft version of the Great Lakes Initiative rule. A BCF of 1 is also used by EPA Region 6 in their interim strategy for deriving arsenic criteria. Use of a higher BCF value results in more stringent human health criteria for arsenic.

DEQ proposes using a BCF of 1, based on EPA proposals in the Great lakes and Region 6 (USEPA Region 6, mid-1990s), for the recalculation option for revising Oregon’s arsenic criteria for human health. DEQ is proposing to use a fish consumption rate of 175 g/d. Most of the fish consumption reflected by this rate will consist of the muscle tissue of finfish. The BCF data shown above for the muscle tissue of finfish are less than one. BCFs for rainbow trout, the only salmonid fish species tested, were 0. Therefore, DEQ believes that a BCF of 1 is a reasonable and protective value to use in calculating state specific arsenic criteria.

**Percent Inorganic Considerations.**

Arsenic is present in the environment and in fish tissue in organic and inorganic forms or “species.” Inorganic arsenic is more toxic to humans and EPA’s toxicity data for cancer and other end points are for inorganic arsenic. EPA’s recommended human health criteria only apply to the inorganic form of arsenic; however, the BCF value (44 L/kg) that EPA used in deriving the human health criteria for arsenic are based on total arsenic, not inorganic arsenic. Therefore, some states have also elected to multiply the BCF value by what might be called a “% inorganic” variable. For example, the EPA Region 6 Interim Strategy and the State of Colorado use a 30% inorganic variable, and the Maryland recalculation used 4% inorganic.

An EPA study (2002) on fish contaminants in the Columbia River found the following:

Percent inorganic arsenic found in fish tissue: (p. 5-78)

* + Overall arithmetic average for all composite samples 6.5%
  + Average % inorganic by species ranged from 0.5% in carp to 9.2% in sturgeon.
  + Anadromous species about 1.0% on average
  + Resident species about 9% on average

The study said that these findings were consistent with the literature, which shows low percentages of inorganic arsenic levels for most saltwater fish species. A risk assessment performed as part of this EPA study assumed 10% of total arsenic was inorganic for all species.

Use of a higher “% inorganic” value results in more stringent human health criteria for arsenic.

DEQ is proposing to use an inorganic arsenic fraction of 10 percent based on the Columbia River fish contaminant and health risk assessment study (EPA, 2002). The criteria that would result by using this value are show in Table 1 under “OR recalculation 2.” The water + organism criterion is not very sensitive to the % inorganic fraction. Whether DEQ uses a % inorganic fraction of 1, 10 or 30 does not change the water + organism criterion. The % inorganic factor does affect the organism only criterion significantly.

**Toxicity factors.** DEQ is not going to review the toxicity data or re-evaluate the cancer slope factor used to derive human health criteria for arsenic. DEQ relies on EPA research to provide this information. DEQ proposes to use the cancer slope factor in EPA’s Integrated Risk Information System (IRIS) data base as of the date of this review, which is 1.5 mg/kg/day.

**Option 2: Use the Maximum Contaminant Level from the Safe Drinking Water Act to Derive Oregon’s Arsenic Criteria**

The second approach option DEQ is considering is to use a combination of the maximum contaminant level (MCL) for drinking water and the EPA criteria calculation method to represent exposure through fish tissue. Nearly half of the states have utilized the MCL value of 10 for their arsenic criterion in place of EPA’s national criteria recommendations. DEQ believes that using a fraction of the MCL (10) as the water quality criteria is a preferable option over adoption of the MCL due to the additional exposure to arsenic through consumption of fish tissue.

An MCL is the highest level of a contaminant that is allowed in drinking water delivered to the tap (post treatment). MCLs are enforceable standards developed by EPA under the Safe Drinking Water Act. MCLs are set as close to maximum contaminant level goals (MCLGs) as feasible using the best available treatment technology and taking cost into consideration. MCLGs are non-enforceable public health goals that describe the level of a contaminant in drinking water below which there is no known or expected risk to health and allow for a margin of safety. For carcinogens, MCLGs are set to zero. On January 22, 2001, EPA revised its maximum contaminant level (MCL) for arsenic from 50 to 10µg/L, and established a date of January 23, 2006, for all public water supply systems to achieve compliance with the revised MCL.

One option for an MCL “hybrid” approach is to use the calculated organism only criterion (2.7 µg/l) as the value for the water + organism criterion as well. The advantages of this approach include:

* it is well below the MCL of 10 µg/l,
* there is a high degree of confidence that this value protects the consumption of fish at high levels (175 g/d) without adverse health affects, and
* there is no point to having a water + organism criterion that is higher than the organism only criterion. The organism only criterion would apply wherever fishing/fish consumption is a designated use and would thus become the “driver” if the water + organism criterion was less stringent.

**Option 3: Natural Background plus a Minimal Increment for Assimilative Capacity if that Value Protects Human Health**

Under this approach, DEQ would establish a “default” statewide natural background level using the best currently available information on natural background levels of arsenic in the State. The human health criteria for arsenic would then be set at that level. This would prevent widespread identification of waters as “impaired” due to natural sources. This approach could reasonably lead to a water + organism criterion of 1 µg/l. This criterion would protect human health as it is far below the drinking water MCL of 10 µg/l, and is also below the 2.7 µg/l value calculated to protect fish consumption.

A variation on this approach would be to add to the default natural background level, an increment for assimilative capacity, making the criterion slightly higher (~1.5). The purpose of setting the criteria slightly above natural background would be to provide some assimilative capacity for mixing in localized areas. This would allow some discharge of arsenic at concentrations that have been increased due to evaporative cooling, for example, which can occur even if there has been no addition of mass. The discharge would be required to meet the criteria at the edge of an assigned mixing zone, after it has mixed with the receiving water.

**Additional Considerations:**

The following additional considerations could be combined with the 3 primary options discussed above.

1. Apply the fish only criterion where drinking water (public domestic water supply is not a designated use and revise beneficial uses in a follow up rulemaking to more narrowly designate water bodies considered suitable for drinking water supply.

2. Adopt the alternate approaches on a site-specific basis by region or basin where natural background levels are above the criteria that would be set using the default calculations.

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Comments and responses on proposed NTR arsenic criterion. (Melinda has sent this.)

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