Proposed Revisions to State Water Quality Standards Applicable to Manganese - Human Health Criteria

Technical Support Document

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Contents

1.0 EXECUTIVE SUMMARY

1. The Alaska Department of Environmental Conservation (DEC) proposes to amend the fresh water human health criterion (HHC) for drinking water and consumption of aquatic organisms from 0.05 mg/L to 0.30 mg/L in the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2008), adopted by reference in state water quality standards at 18 AAC 70.020(b)(11);

2. DEC proposes to amend the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2008) at Footnote 50 to reference application of the U.S. EPA (2004) *Lifetime Health Advisory for Manganese* as the basis of the DEC fresh water HHC (drinking water and consumption of aquatic organisms); and

3. DEC proposes to amend the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2008) marine water HHC for manganese (consumption of organisms only) by adding Footnote 79 to clarify the numeric criterion of 0.10 mg/L applies to marine waters only.[1]

2.0 BACKGROUND

Manganese (Mn) is a hard, brittle, grayish-white metal widely distributed in the Earth's rocks and occurs as a component of over 100 minerals. Mn exposure naturally occurs as low levels and is present in soil, water, air, and food. Mn is a common trace element found in different foods with the amount of dietary exposure typically outweighing that which comes from drinking water.[2] Occupational exposure is also known to occur in certain industries. The primary target of Mn toxicity is the nervous system.[3]

Per federal regulations at 40 CFR 131.3(b) *Criteria* are defined as:

> [A]re elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use.

Per section 304(a) of the Clean Water Act (CWA) the U.S. Environmental Protection Agency (EPA) is required to develop and publish water quality criteria that reflect the latest scientific knowledge and protective of designated uses. States are required to consider adoption of new or revised criteria every three years per section 303(c) of the CWA. EPA must approve of state-adopted criteria before application in state water pollution control programs (e.g., APDES program, 303(d) assessments) per 40 CFR 131.21.

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[1] See specific language at section 3.2.9 of this document and the draft *Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2022) at Note 79.
[2] U.S. Environmental Protection Agency. 2003. Health Effects Support Document for Manganese. Health and Ecological Criteria Division. EPA 822-R-03-003
[3] U.S. Environmental Protection Agency. 2003. Health Effects Support Document for Manganese. Health and Ecological Criteria Division. EPA 822-R-03-003

DEC adopted EPA 1976 recommended water quality criteria for Mn, (including HHC) by reference on March 18, 1986, and received EPA approval on April 6, 1987.[4] In a December 19, 1996 letter to Office of Water, EPA Region 10, DEC reaffirmed its position that the EPA-recommended (1986) criteria (inc. human health) for toxic pollutants *by reference* and were in effect for CWA purposes in Alaska.[5]

DEC first published the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (Toxics Manual) in 2003 and adopts the Toxics Manual by reference in state WQS at 18 AAC 70.020(b). The Toxics Manual serves as the source of the numeric criteria applicable in state water pollution control programs and an administrative record of historic rulemaking actions.

2.1 EPA-recommended Water Quality Criteria for Mn Applicable Under the Clean Water Act

EPA's 1973 Water Quality Criteria or "Blue Book" recommendation for Mn established a criterion of 0.05 mg/L soluble Mn for public water sources based on user preference.

The EPA 1976 *Quality Criteria for Water* (referred to as the "Red Book"), also established 0.05 mg/L as the recommended water quality criterion for Mn for protection of domestic water supplies. This criterion was established to protect against objectionable tastes and laundry staining. The Red Book states;

> [A] criterion for domestic water supplies of 0.05 mg/L [for manganese] should minimize the objectionable qualities.

One study found consumer complaints about brownish staining of laundry and objectionable tastes in beverages occur when Mn exceeds 0.15 mg/L (Griffin, 1960 in EPA Red Book). The Red Book also notes that Mn concentrations of 0.010 to 0.020 mg/L are acceptable to most consumers.

In addition, the EPA 1986 *Quality Criteria for Water* "Gold Book" recommended a criterion of 0.05 mg/L for protection of domestic water supplies based on organoleptic or aesthetic qualities (*i.e., taste, color, and odor)* of the water and not based on human health effects. The Gold Book referenced research that when Mn exceeds 0.15 mg/L in domestic water supplies, complaints of objectionable water flavors and discoloration of laundry were present. More recent studies indicate that such an effect may not necessarily be the case as subjects indicated a taste threshold of 165 mg/L (previously reported as a range of 45 mg/L to 101 mg/L.[6]

EPA published the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (Methodology) in 2000. The Methodology established EPA's recommended methods for developing or revising ambient water quality criteria to protect human health, pursuant to Section 304(a) of the CWA. The Methodology provides the formula and inputs to be used when considering exposure to a particular pollutant, potential effects from exposure, and the subsequent criteria considered to be protective of the designated use. EPA has not published updated HHC for Mn that apply the Methodology and would be applicable to surface water under the CWA. EPA's currently

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[4] EPA WQS Approval Letter from Robie Russell, Regional Administrator to Dennis Kelso, Commissioner. April 6, 1987.
[5] See DEC 18 AAC 70.020(B)(1) and note 5 (1987), 1996 Ltr. from DEC Director Leonard Verrelli to Phil G. Millam, Acting Director of Water, Region 10 EPA. Seattle, WA, and EPA 1997 Approval of State Water Quality Standards adopted December 4, 1994, and submitted to EPA for approval on January 26, 1995, and WQS adopted February 14, 1996, which were subsequently submitted to EPA for approval on September 26, 1996..p 5.
[6] A.E. Sain and A.M. Dietrich. (2015) Rethinking aesthetic guidelines for manganese and iron in drinking water. Journal of Water Supply: Research and Technology. AQUA. 10.2166/aqua.2014.091

published National Recommended Water Quality Criteria table recommends HHC of 0.05 mg/L for the designated uses of Consumption of Water + Organism and 0.1 mg/L for the Consumption of Organism Only.[7]

2.2 Other EPA guidance Related to Mn

EPA published the *Health Effects Support Document for Manganese*[8] in 2003 and assigned a Mn dietary intake oral reference dose (RfD) of 10 mg per day (0.14 mg Mn/kg-day, assuming a bodyweight of 70 kg)[9] based on chronic human dietary intake surveys and recommended the use of a modifying factor of three when assessing chronic exposure to Mn from drinking water. This results in a chronic reference dose of 0.047 mg/kg-day. This recommended value is based on data that suggests fasting individuals may be more susceptible to absorption of Mn, concerns associated with a lifetime consumption of drinking water containing two (2) mg/L of Mn, potential neonatal effects in animal studies, and the presence of additional sources of Mn in infant formula.

Per EPA (2003)

> The Agency believes that a meaningful opportunity for health risk reduction does not exist for persons served by public water systems because the average dietary intake of manganese exceeds the contribution normally found in public drinking water systems. Thus, based on the evaluation of available data using the criteria described above, the regulatory determination is **do not regulate**. (Emphasis added)

EPA applied three criteria for making a regulatory determination under the SDWA contaminate candidate list:[10]

- The contaminant may have an adverse effect on the health of persons;
- The contaminant is known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern;
- In the sole judgment of the administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems.

EPA published the *Drinking Water Health Advisory for Manganese*[11] in 2004 and established a Lifetime Health Advisory (HA) of 0.30 mg/L for drinking water to protect against potential neurological effects. The EPA Lifetime HA differs from the EPA (2000) Methodology as it does not explicitly provide for fish consumption as an exposure pathway; however, both programs typically apply an relative source contribution factor of 20 percent to the RfD when adequate exposure data do not exist, assuming that the major portion (80 percent) of the total exposure comes from other sources, such as diet.[12] The Lifetime HA considers the dietary RfD, application of a modifying factor (MF) of

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[7] U.S. Environmental Protection Agency, Retrieved at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table on July 20, 2021

[8] EPA 822-R-03-003

[9] U.S. Environmental Protection Agency. 1995. Integrated Risk Information System Chemical Assessment Summary. Retrieved at https://iris.epa.gov/static/pdfs/0373_summary.pdf on July 19, 2021.

[10] While the criteria used by SDWA and CWA to determine potential risk to human health from exposure differ, this information illustrates the fact that EPA does not consider exposure to Mn rises to the level needed to establish a maximum contaminate level goal, the most stringent level, under the SDWA.

[11] U.S. Environmental Protection Agency. 2004 Drinking Water Heath Advisory for Manganese. Health and Ecological Criteria Division. EPA-822-R-04-003

[12] U.S. EPA. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000). Section 1.5.2. EPA-8222-B-00-004. Office of Water. Washington, D.C.

three for drinking water as recommended by IRIS (EPA, 1996). This modifying factor of three is based on the potential for higher absorption of Mn in water compared to food, consideration of fasting individuals, the concern for infants with potentially higher absorption and lower excretion rates of Mn, and the potential for increased susceptibility to neurotoxic effects of ingested Mn as compared to adults.

2.3 Mn Exposure from Fish Consumption

Mn has the capacity to bioconcentrate as well as bioaccumulate in different parts of fish; especially in aquatic organisms at the bottom trophic levels; however, biomagnification in higher trophic levels is not well documented.[13] A review of literature pertaining to Mn concentrations in aquatic life (fish) indicates that Mn concentrations in pike and bream[14] organs in both lakes followed the order: skin > gills > gonads > liver > digestive tract > kidneys > spleen > muscles. Mn concentrations in gills is attributed to the fact that the gills are directly exposed to water-borne heavy metals, negatively charged, which may attract positively charged metals,[15] and used as an excretion pathway.[16] This is important as muscle is the edible part of fish typically consumed by humans and incorporated into fish consumption studies. Therefore, Mn concentrations determined to present in whole fish estimates are likely to overestimate the amount of Mn that would actually be present in consumed muscle (e.g., fillets). This information is intended to illustrate for select metals (i.e., Mn), state reliance on studies other than those specific to the CWA (i.e., HHC/fish consumption studies) is reasonable when primary means of exposure are anticipated to occur through pathways other than those identified in the EPA 2000 Methodology.

2.4 Role of EPA-recommended Criteria Based on Organoleptic Effects

EPA defines the use of organoleptic criteria in the EPA 2000 Methodology:[17]

> Organoleptic criteria define concentrations of chemicals or materials which impart undesirable taste and/or odor to water. Organoleptic effects, while significant from an aesthetic standpoint, are not a significant health concern. In developing and utilizing such criteria, two factors must be appreciated: (1) the limitations of most organoleptic data; and (2) the non-human health significance of organoleptic properties. In the past, EPA has developed organoleptic criteria if organoleptic data were available for a specific contaminant. The 1980 AWQC National Guidelines made a clear distinction that organoleptic criteria and toxicity-based criteria are derived from completely different endpoints, and that **organoleptic criteria have no demonstrated relationship to potential adverse human health effects because there is no toxicological basis** (emphasis added)**.**

DEC includes this information to illustrate the role of organoleptic criteria, potential relationship with human health criteria, and whether the adopted water quality criteria for Mn are protective of the protected use.

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[13] Niemiec M., Wiśniowska-Kielian B. 2015. Manganese accumulation in selected links of food chain of aquatic ecosystems. J. Elem. 20(4): 945-956. DOI: 10.5601/jelem.2015.20.1.808

[14] Bream is is a European species of freshwater fish in the family Cyprinidae.

[15] Zeeshan Ali, Ali Muhammad Yousafzai, Nadia Sher, Ijaz Muhammad, Gul E. Nayab, Syed Abdul Maajid Aqeel, Syed Touheed Shah, Michael Aschner, Ijaz Khan, Haroon Khan, 2021, Toxicity and bioaccumulation of manganese and chromium in different organs of common carp (Cyprinus carpio) fish, Toxicology Reports, Volume 8, Pages 343-348,

[16] G. Nussey, JHJ van Vuren, and HH du Preez. 2000. Water South Africa. Vol. 26. No. 2.

[17] See P. 2-14

2.5 Safe Drinking Water Act Approach to Mn

The federal Safe Drinking Water Act (SDWA) and associated EPA regulations provide states with enforceable policies for drinking water for the purpose of public consumption. These regulations include both primary and secondary drinking water criteria. Primary and secondary criteria are established based on different risk assessment and management processes. Per EPA's Secondary Drinking Water Standards: Guidance for Nuisance Chemicals[18]

> EPA has established National Primary Drinking Water Regulations (NPDWRs) that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called "maximum contaminant level"; the highest level of a contaminant that is allowed in drinking water as delineated by the National Primary Drinking Water Regulations. These levels are based on consideration of health risks, technical feasibility of treatment, and cost-benefit analysis." MCLs are established to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water which is **delivered to the consumer** (emphasis added).

EPA has also established National Secondary Drinking Water Regulations (s-MCL) that establish non-mandatory water quality criteria for 15 contaminants including Mn. EPA does not enforce s-MCLs, as the criteria are based on a different set of risk factors than the primary drinking water regulations and are designed to assist public water systems in managing their drinking water for aesthetic considerations (i.e. organoleptic factors) such as taste, color, and odor, and give public water systems guidance on concentrations below what the general public may consider objectionable.

All SDWA regulations are intended to apply to finished water[19] rather than raw water (surface or ground) used to source a public water system[20] and provide end users with additional confidence in the public drinking water treatment systems in place. The factors used by SDWA programs determine risk to the public and subsequent criteria are different from that of ambient water quality criteria (e.g., HHC) established under the CWA as SDWA criteria may consider such issues at detection and treatability when establishing criteria. Therefore, it is reasonable to expect that WQS authorized under CWA may differ from those authorized under the SDWA due to differences in the statutory goals, and risk assessment policies, and management practices.

DEC is authorized by EPA to administer the SDWA through the DEC Drinking Water (DW) program. DEC requires all new sources to test for both primary and s-MCLs and all systems to monitor for the presence of pollutants per federal regulations adopted by reference at 18 AAC 80.010 and 18 AAC 80.300. The DW program is subject to federal SDWA regulations and continues to apply the Mn s-MCLs of 0.05 mg/L to finished water, modification of the existing Mn

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[18] Retrieved at https://www.epa.gov/sdwa/secondary-drinking-water-standards-guidance-nuisance-chemicals on April 7, 2021.

[19] Finished water is water that is introduced into the distribution system of a public water system and is intended for distribution and consumption without further treatment, except as treatment necessary to maintain water quality in the distribution system (e.g., booster disinfection, addition of corrosion control chemicals). 40 CFR 141.2 Definitions

[20] Public water system is defined at 40 CFR 125.58 and means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen (15) service connections or regularly serves at least twenty-five (25) individuals. This term includes: (1) Any collection, treatment, storage, and distribution facilities under the control of the operator of the system and used primarily in connection with the system, and (2) Any collection or pretreatment storage facilities not under the control of the operator of the system which are used primarily in connection with the system.

surface water quality criterion of 0.05 mg/L adopted at 18 AAC 70.020(b) will have no practical effect on the degree of exposure protection provided by authorized drinking water sources.[21]

2.6 Recent Scientific Findings Pertaining to Mn and Human Health

In 2020 the World Health Organization (WHO) published *draft* WHO Guidelines for Drinking-water Quality (WHO 2020). The WHO guidelines summarize health studies to date that either directly or indirectly cite Mn exposure as being a mechanism for detrimental effects on human health. The WHO guidelines provide much insight into the challenges with demonstrating a direct relationship between Mn exposure across different age groups and what aspect of human health is affected through acute or chronic exposure. While the preponderance of human-based studies demonstrate the potential for neurological impacts on children due to Mn exposure, the WHO guidelines determined that these studies provide limited demonstrative evidence for establishing regulatory levels.

Similar to EPA studies (2003, 2004), WHO identified infants and children as potentially sensitive groups with regards to exposure to high levels of Mn. Case studies report potential neurological effects and/or behavioral problems in children following oral exposure to high levels of Mn, although the findings are often limited in terms of defining causality. Animal-based studies provide more evidence of the relationship between Mn exposure and neurotoxicity as a number of studies assessed neurodevelopment endpoints that were supported by corresponding neurochemical findings. However, the WHO guidelines go on to state:

> Although a number of LOAELs[22] have been identified, there is some question concerning the suitability of rodent models to assess potential neurotoxicity in humans due to differences in the neurological effects seen in humans as compared to rodents (WHO 2020 pg. 26).

WHO addresses this uncertainty by assigning an uncertainty value of 1000 to be used in the calculation of the tolerable daily intake: [23]

Tolerable daily intake = (25 mg/kg bw per day)/1000.

WHO then calculated a guideline value for non-breast fed infants exposed to Mn through powdered formula (0.08 mg/L) and tap water used to prepare the formula for consumption.

$$Health-based\ guideline\ value = \frac{0.025\frac{mg}{kg}\,bw\ per\ day * 5kg\ (body\ weight) * 0.5\ (50\%\ allocation)}{0.75\ \text{L/d}\ \ (\text{bottle} - \text{fed infant consumption})}$$

DEC recognizes the importance of the WHO *draft* guideline value in terms of its protection to the proposed subpopulation but the *draft* guideline value is designed to protect a subpopulation from toxicity during a very specific life stage – not from a lifetime of exposure as HHC are intended to provide for. DEC interprets the WHO guideline value to be intended for application to finished drinking water as authorized under the SDWA rather than as a WQS authorized under the CWA.

[21] Personal correspondence with DEC Drinking Water Program Manager Cindy Christensen
[22] LOAEL stands for Lowest Observed Adverse Effect Level
[23] 10 for interspecies uncertainty due to discrepancies between rodents and humans, 10 for intraspecies differences due to uncertainties within human population, and 10 for use of lowest observed adverse effects rather than no observed adverse effects data. (10*10*10)

Therefore, DEC is not considering the WHO value to be applicable in the derivation of an HHC that would be applied to a freshwater surface water.

3.0 STATE QUALITY REGULATORY FRAMEWORK

DEC has not adopted a specific protected (i.e., designated) use of *human health* at 18 AAC 70.040 but rather describes its HHC in the Toxics Manual (2008), adopted by reference at 18 AAC 70.020(b):

> **Human health consumption:** Water quality standards for toxic and other deleterious substances for fresh water uses of drinking, culinary, and food processing, and growth and propagation of fish, shellfish, other aquatic life, and wildlife in 18 AAC 70.020(b)(11); and marine water uses of aquaculture, growth and propagation of fish, shellfish, other aquatic life and wildlife, and harvesting for consumption of raw mollusks or other raw aquatic life in 18 AAC 70.020(b)(23) must be based on human health criteria for consumption… (DEC, 2008. pg. 4)

The fresh water sub-classes of (i) drinking, culinary, and food processing are listed at 18 AAC 70.020 **Protected water use classes and subclasses; water quality criteria; water quality standards table** under the class of (A) Water Supply.

Water Supply is defined at 18 AAC 70.990(68):

> "water supply" means any of the waters of the state that are designated in this chapter to be protected for fresh water or marine water uses; A water supply includes waters used for drinking, culinary, food processing, agricultural, aquacultural, seafood processing, and industrial purposes; "water supply" **does not necessarily mean that water in a waterbody that is protected as a supply for the uses listed in this paragraph is safe to drink in its natural state** (emphasis added).

DEC's numeric criteria[24] are shown in Table 1.

Table 1. Numeric Criteria for Manganese (total recoverable metal)**.**

Protected Use	Manganese Criteria (mg/L)
Human Health for the Consumption of Water and Aquatic Organisms (Fresh waters)	0.05
Agriculture (Irrigation) (Fresh water)	0.20
Human Health for the Consumption of Aquatic Organisms Only (Marine waters)	0.10

3.1 Human Health Criterion: Consumption of Water and Aquatic Organisms (0.05 mg/L)

Alaska water quality standards (WQS) at 18 AAC 70.020(b) has adopted a Mn HHC of 0.05 mg/L for the freshwater designated uses of consumption of drinking water and aquatic organisms for

[24] Alaska Department of Environmental Conservation. 2008. *Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances.* Juneau, Alaska

drinking, culinary, and food processing and the growth and propagation of fish, shellfish, other aquatic life and wildlife and (ADEC 2008).

3.1.1. Appropriate HHC for Alaska for the Protection of Drinking water and Consumption of Aquatic Organisms

HHC represent a range of concentrations associated with specified incremental lifetime risk levels. Per EPA (2000) Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (p. 4-17)

> In general, exposure factor values specific to adults and relevant to lifetime exposures are the most appropriate values to consider when determining criteria to protect against effects from long-term exposure which, by and large, the human health criteria are derived to protect.

States and authorized Tribes have four options when considering updates to 304(a) pollutants: (1) adopt EPA's 304(a) recommendations; (2) adopt 304(a) criteria modified to reflect site-specific conditions; (3) develop criteria based on other scientifically defensible methods; or (4) establish narrative criteria where numeric criteria cannot be determined.[25]

DEC has determined that retention of 0.05 mg/L is not appropriate as this value is intended to address organoleptic factors rather than human health toxicity. Rather than repealing the criterion in its entirety and waiting for an EPA-recommended HHC for Mn to be published, the adoption of EPA (2004) Lifetime HA (0.3 mg/l) is a scientifically defensible alternative approach to establishing a criterion protective of human health. Use of an alternative means of deriving criteria other than that recommended in the EPA 2000 methodology is clearly authorized by federal regulation and policy documents.

The EPA Lifetime HA quantifies that portion of an individual's total exposure attributed to treated drinking water and is considered protective of non-carcinogenic adverse health effects over a lifetime of exposure.[26] Adoption of the EPA Lifetime HA clearly provides sufficient protection of the designated use of Water Supply as defined at 18 AAC 70.990(68).

DEC considered the following factors in its decision:

1. Alaska is geographically and geochemically diverse. Establishing default Mn values specific to Alaska based state-specific water quality and toxicological data for Mn based on exposure in Alaska's populace is beyond the department's ability to attain and review and not anticipated to provide a higher degree of protection to human health than the EPA-recommended value(s).

> DEC has previously issued three Total Maximum Daily Loads (TMDLs) that included Mn for waterbodies impacted by historic mine tailings or landfill waste.[27] None of these waters are existing sources of water used by public water systems. Modification of the HHC value is not anticipated to diminish DEC's ability to issue impairment determinations in accordance with state and federal 303(d) listing determination policies.

[25] 40 CFR §131.11(b)(1)
[26] EPA (2004). p 31
[27] TMDLs include Cabin Creek (mine tailings), Klag Bay (mine tailings), and Red Lake/Anton Pond (historic landfill). These locations are geographically dissimilar to one another.

2. Alaska's population is widely dispersed and likely to experience a wide range of exposure factors as demonstrated by water quality assessments, state fish consumption studies, availability of food stuffs with higher/lower concentrations of manganese (which affects the relative source contribution factor), and drinking water (i.e., finished water) consumption patterns.

Should DEC determine that elevated Mn is present in surface waters where high concentrations of untreated private consumption exists, the potential for toxicity to highly susceptible sub-populations (i.e., non-breast fed infants) may be present, or sources of exposure other than drinking water are resulting in exceedances of the 2004 EPA-recommended RfD, DEC has multiple outreach tools (e.g., 303(d) reporting/Integrated Report, drinking water/public health advisories) readily available to inform the general public and health providers. For additional protection of human health from anthropogenic actions, DEC may also rely upon the existing narrative criteria at 18 AAC 70.020(11) and (23) for Water Supply that states:

> Substances may not be introduced at concentrations that cause, or can reasonably be expected to cause, either singly or in combination, odor, taste, or other adverse effects on the use.

This narrative criterion provides the necessary protection of taste, odor and aesthetic effects, should limits be required to protect a surface water domestic water supply source from particularly high levels of manganese from anthropogenic sources.

Per 18 AAC 70.230 DEC may reclassify a water and remove the designated use of drinking water in its entirety should the department conduct a use attainability analysis and determine the use cannot be attained due to naturally occurring pollutant concentrations prevent the attainment of the use.[28]

3. The EPA Lifetime HA represents that portion of an individual's exposure attributed to drinking water and is considered protective of noncarcinogenic adverse health effects.

EPA's process of developing the HA criterion of 0.3 mg/L sufficiently addresses uncertainty when applying human dietary information, potential bioavailability of Mn, and adequately accounts for potential toxicity as demonstrated by applying a modifying factor (MF) of three for drinking water and allocation of an assumed 20% relative source contribution from water ingestion as opposed to total manganese exposure.[29]

4. Drinking Water program data and policies do not indicate that the Mn revision will result in an impact to the designated use or public health. Public drinking water suppliers are required to apply both the primary and s-MCLs as the National Primary and Secondary Drinking Water Standards which are adopted by reference at 18 AAC 80.[30] The proposed revision of Mn criteria at 18 AAC 70 will have no effect on

[28] 40 CFR 131.10(g)(1)

[29] USEPA (2003). Section 1-3

[30] Personal correspondence with DEC Drinking Water Program Manager Cindy Christensen

future application of the national primary and s-MCL values to public drinking water systems in Alaska.

DEC intends to implement this value by amending the existing HHC value of 0.05 mg/L (50 µg/L) to 0.3 mg/L (300 µg/L) in the *Alaska Water Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* and amend endnote 50 to read:

Footnote 50. This human health criterion is based on application of the U.S. EPA (2004) *Lifetime Health Advisory for Manganese.*

3.2. Human Health Criterion: Consumption of Aquatic Organisms (0.10 mg/L)

DEC has adopted a human health Mn criterion of 0.10 mg/L for consumption of aquatic organisms only to protect the designated uses of growth and propagation of fish, shellfish, other aquatic life, and wildlife in 18 AAC 70.020(b)(11); and marine water uses of aquaculture, growth and propagation of fish, shellfish, other aquatic life and wildlife, and harvesting for consumption of raw mollusks or other raw aquatic life in 18 AAC 70.020(b)(23) (ADEC 2008). This criterion is based on EPA's *Quality Criteria for Water* (USEPA 1976) recommendation that a Mn criterion of 0.10 mg/L is appropriate to protect marine organisms from bioconcentrating an amount of manganese that could adversely affect **humans who eat marine organisms** (emphasis added). EPA originally recommended the 0.10 mg/L criterion in 1976, prior to the fish ingestion/bioconcentration factor derivation method, which was published in 1980. The following summary is based on the findings in the EPA "Red Book" and subsequent EPA recommended criteria:

- The average human total intake of manganese is approximately 10 mg (10,000 µg) per day.
- Very large doses of ingested manganese can cause some disease and liver damage but these are not known to occur in the United States.
- The ambient [marine] concentration of manganese is about 0.002 mg/L (Fairbridge,1966). The material is rapidly assimilated and bioconcentrated into nodules that are deposited on the sea floor. The major problem with manganese may be concentration in the edible portions of mollusks, as bioaccumulation factors as high as 12,000 have been reported (NAS, 1974 in EPA, 1976).

3.2.1. Appropriate Manganese HHC for Alaska for the protection of Consumption of Aquatic Organisms

EPA's 1976 recommended criterion is based on the protection of human health from potentially elevated levels of manganese that may bioconcentrate in the edible tissues of saltwater mollusks. The EPA-recommended criterion is not designed for application to freshwater systems or to protect consumers of fishes or freshwater organisms. However, this water quality criterion has been interpreted to protect human health against potential effects of eating organisms of all types (including freshwater species). Therefore, DEC proposes to clarify the criterion of 0.10 mg/L only applies in marine waters through an amendment of End note 51 in the *Alaska Water Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances.*

51. The EPA 1976 recommended criterion for manganese, which has been adopted by the department, is based on the protection of human health from potentially elevated levels of

manganese that may bioconcentrate in the edible tissues of saltwater mollusks. The EPA-recommended criterion is not designed for application to freshwater systems or to protect consumers of fishes or freshwater organisms. DEC will apply the 0.10 mg/L criterion only to the protected water use class and subclass of (1) marine water (D) harvesting for consumption of raw mollusks or other raw aquatic life referenced at 18 AAC 70.020(b)(23).

4.0 Bibliography

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