



Ministry of
Environment

DIRECTOR'S INTERIM STANDARDS **FOR CONTAMINATED SITES**

Generic Numerical Drinking Water Standards for Aluminum, Iron and Manganese

Prepared pursuant to Sections 63.1 of the
Environmental Management Act

Effective: From June 1, 2010 to May 31, 2011

Approved:

J.E. Hofweber
Director of Waste Management

October 12, 2010
Date

1.0 Introduction and background

The Contaminated Sites Regulation Schedule 6 generic numerical water standards to protect drinking water were adopted, without modification, from the [Canadian Drinking Water Guidelines](#). The Canadian drinking water guidelines are normally designed to either protect human health or address aesthetic (typically organoleptic) concerns related to drinking water quality. However, the Canadian drinking water guidelines for aluminum, iron and manganese have no direct relation to either human health or organoleptic concerns.

The aesthetic Canadian drinking water guidelines for iron (≤ 0.3 mg/L) and manganese (≤ 0.05 mg/L) were established to address physical and chemical concerns related to possible staining of laundry and plumbing fixtures [1, 2]. The guideline for aluminum (0.1 mg/L - conventional (i.e. aluminum coagulant) treatment plants and 0.2 mg/L - other types of treatment systems) is unique among the Canadian drinking water guidelines in that it is a technical water treatment operational guideline, solely applicable to drinking water treatment plants [3, 4]¹.

A similar situation for aluminum, iron and manganese drinking water standards exists in the United States. The US Environmental Protection Agency has not instituted primary (i.e., mandatory) drinking water standards for aluminum, iron or manganese to protect human health. The US EPA has however, developed secondary (i.e., non-mandatory) drinking water standards for the three substances to address aesthetic or technical water treatment concerns [5]. In the case of iron and manganese, the secondary standards address aesthetic (i.e., primarily colour, and to a lesser extent taste) and technical concerns related to water treatment/distribution systems (i.e., corrosivity and staining of water pipes). For aluminum, the secondary standard is only relevant to limiting the formation of mineral scale and sediment inside water distribution pipes, boilers and heat exchangers which could restrict or block water flow [5].

1 "There is no consistent, convincing evidence that aluminum in drinking water causes adverse health effects in humans, and aluminum does not affect the acceptance of drinking water by consumers or interfere with practices for supplying good water. Therefore, a health-based guideline or aesthetic objective has not been established for aluminum in drinking water.

In recognition of advancing research into the health effects of aluminum and in an exercise of the precautionary principle, water treatment plants using aluminum-based coagulants should optimize their operations to reduce residual aluminum levels in treated water to the lowest extent possible. For plants using aluminum-based coagulants, operational guidance values of less than 0.1 mg/L (100 µg/L) total aluminum for conventional treatment plants and less than 0.2 mg/L (200 µg/L) total aluminum for other types of treatment systems (e.g., direct or in-line filtration plants, lime softening plants) are recommended. These values are based on a 12-month running average of monthly samples" [3].

As risk-based drinking water guidelines to protect human health are currently unavailable from Health Canada, the Director has established for aluminum, iron and manganese, the following toxicologically-derived generic numerical water standards to protect drinking water quality for use under the Contaminated Sites Regulation. These Director's interim standards replace the corresponding drinking water standards for aluminum and iron listed in Schedule 6 and for manganese listed in Schedules 6 and 10 of the Regulation. The Director's interim standards have the same legal standing as any other generic numerical water standard to protect drinking water listed in the Contaminated Sites Regulation.

Cautionary Note: It is expected that the Director's interim generic numerical drinking water standards for aluminum, iron and manganese will be used to determine drinking water quality in groundwater drinking water wells. The quality of drinking water provided by water purveyors is legislated under the provisions of the *Drinking Water Protection Act*. The Director's interim drinking water standards provided below, do not supersede or otherwise invalidate any: condition, objective or requirement related to drinking water quality established under the *Drinking Water Protection Act*.

2.0 Director's Interim Generic Numerical Drinking Water Standards for Aluminum, Iron and Manganese

GENERIC NUMERICAL WATER STANDARDS¹

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
Substance	Aquatic Life ² (AW)	Irrigation ^{2,3} (IW)	Livestock ² (LW)	Drinking Water ⁴ (DW)
aluminum		5 000	5 000	9 500 ^{5,6,7}
iron		5 000		6 500 ^{5,6,7}
manganese		200		550 ^{5,6,7}

Footnotes

- 1 All values are in ug/L unless otherwise stated. Substances must be analyzed using methods specified in a director's protocol or alternate methods acceptable to a director.
- 2(a) Aquatic life standards assume minimum 1:10 dilution available. Aquatic life standards are to protect freshwater and marine life unless otherwise indicated.
- 2(b) Standards for all organic substances are for total substance concentrations. Any water sample to be analyzed for organic substances should not be filtered.
- 2(c) Standards for surface water samples analyzed for metals, metalloids and inorganic ions are total substance concentrations. In addition, it is recommended that surface water samples analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for dissolved substance concentrations.
- 2(d) Standards for groundwater samples analyzed for metals, metalloids and inorganic ions are for dissolved substance concentrations. In addition, it is recommended that groundwater samples analyzed for metals, metalloids and inorganic ions should also be analyzed for total substance concentrations.
- 3 Applies to irrigation of all soil types.

- 4 Drinking water standards are for unfiltered samples obtained at the point of consumption. Metals, metalloids and inorganic ions are expressed as total substance concentrations unless otherwise indicated.
- 56 Standard is specific to protection of human health. Standard has been derived based on a toxicological reference value (TRV) protective of adults. Standard may not adequately protect other age groups.
- 57 Standard may not address aesthetic (organoleptic) or physical/chemical concerns related to drinking water quality. Water treatment may be required.

3.0 Legal and Regulatory Authority

The authority of the Director to establish standards for use in the assessment and remediation of contaminated sites is provided under section 63.1 of the *Environmental Management Act* and section 17 (1) (c) of the Contaminated Sites Regulation.

4.0 References

1. Health Canada. (1978). Guidelines for Canadian Drinking Water Quality – Technical Documents, Iron. Ottawa, Canada. (updated Nov. 1987).
2. Health Canada. (1979). Guidelines for Canadian Drinking Water Quality – Technical Documents, Manganese. Ottawa, Canada. (updated Nov. 1987).
3. Health Canada. (1998). Guidelines for Canadian Drinking Water Quality – Technical Documents, Aluminum. Ottawa, Canada. (edited Nov. 1998).
4. Health Canada. (2008). Guidelines for Canadian Drinking Water Quality Summary Table. Federal-Provincial-Territorial Committee on Drinking Water. Federal-Provincial-Territorial Committee on Health and the Environment. Ottawa, Canada. May 2008.
5. US Environmental Protection Agency. (1992). Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals. EPA 810/K-92-001. US EPA Office of Water, Groundwater and Drinking Water. Washington D.C., United States of America. July 1992.
6. Health Canada. (1995). Canadian Drinking Water Guidelines. Part 1. Approach to the Derivation of Drinking Water Guidelines. Federal-Provincial-Territorial Committee on Drinking Water. Ottawa, Canada. February, 1995.
7. Health Canada. (2004). Federal Contaminated Site Risk Assessment in Canada. Part I. Guidance on Human Health Preliminary Quantitative Risk Assessment

(PQRA). Cat. H46-2/04-367E. Environmental Health Assessment Services. Safe Environments Program. Ottawa, Canada. September 2004.

8. US EPA. (2009a). Regional Screening Table. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Aluminum PPRTV. US EPA Region 3. Accessed through Risk Assessment Information System. US Department of Energy. Office of Environmental Management. Oak Ridge Operations (ORO) Office. Tennessee, U.S.A. January, 2010.
9. US EPA. (2009b). Regional Screening Table. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Iron PPRTV. US EPA Region 3. Accessed through Risk Assessment Information System. US Department of Energy. Office of Environmental Management. Oak Ridge Operations (ORO) Office. Tennessee, U.S.A. January, 2010.
10. US Environmental Protection Agency. (1996). Manganese (CASRN 7439-96-5). Integrated Risk information System. National Center for Environmental Assessment. Office of Research and Development. Washington D.C., U.S.A. May 1, 1996.
11. US EPA. (2009c). Regional Screening Table - User's Guide. Section 5. Special Considerations. 5.3 Manganese. USEPA Region 3. Philadelphia, Pennsylvania. U.S.A. December, 2009.

For more information, contact the Environmental Management Branch at site@gov.bc.ca.

Appendix 1

Toxicological Derivation

A1. General Considerations

Director's interim drinking water standards for aluminum, iron and manganese were derived for the adult receptor, using:

1. Health Canada, [6] drinking water guideline derivation equations,
2. US EPA, toxicity reference values (i.e. RfDo-chronic) for aluminum, iron and manganese, (see section A2 below) and
3. Health Canada, [7] characteristic Canadian general population adult body weight and water ingestion rate values.

A2. Source of Toxicity Reference Values (TRV)

Substance	RfDo - chronic (mg/kg-day)	Reference	TRV type
Aluminum	1.00E+00	[8]	PPRTV
Iron	7.00E-01	[9]	PPTRV
Manganese (diet)	1.40E-01	[10]	IRIS
Manganese (water)	2.40E-02	[10]	IRIS

A3. Health Canada [6] Drinking Water Guideline Derivation Equations

Non-carcinogenic substances:

$$DW \text{ std} = \frac{TRV \times CF \times BW \times AF}{IR}$$

Carcinogenic substances:

$$DW \text{ std} = \frac{AR \times BW}{UR} \times IR$$

Where:

TRV = chronic oral Reference Dose - RfDo-chronic (mg/kg-day)

CF = conversion factor (1000 ug/mg)

BW = body weight (70.7 kg)

AF = allocation factor (0.2, aluminum and iron : 0.5, manganese)

IR = water ingestion rate (1.5 L/day)

AR = acceptable risk level (1 x 10⁻⁵)

UR = Unit risk (mg/kg bw-day)

A4. Calculation of Director's Interim Drinking Water Standards for Aluminum, Iron and Manganese

$$\text{Aluminum drinking water standard} = \frac{1.0 \times 1000 \times 70.7 \times 0.2}{1.5} = 9426.7 \text{ ug/L}$$

$$\text{Iron drinking water standard} = \frac{0.7 \times 1000 \times 70.7 \times 0.2}{1.5} = 6598.7 \text{ ug/L}$$

$$\text{Manganese drinking water standard} = \frac{0.024 \times 1000 \times 70.7 \times 0.5}{1.5} = 565.6 \text{ ug/L}$$

(Note: for manganese derivation, AF = 0.5, see section A7 below)

A5. Final Director's Interim Drinking Water Standards – CSST Rounded

Aluminum 9500 ug/L
Iron 6500 ug/L
Manganese 550 ug/L

A6. Manganese – Adjustment of TRV and Allocation Factor for water

The US EPA [11] in regard to the US EPA [10] IRIS RfDo for manganese has cautioned that:

"The IRIS RfD (0.14 mg/kg-day) includes manganese from all sources, including diet. The author of the IRIS assessment for manganese recommended that the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) be subtracted when evaluating non-food (e.g., drinking water or soil) exposures to manganese, leading to a RfD of 0.071 mg/kg-day for non-food items. The explanatory text in IRIS further recommends using a modifying factor of 3 when calculating risks associated with non-food sources due to a number of uncertainties that are discussed in the IRIS file for manganese, leading to a RfD of 0.024 mg/kg-day. This modified RfD has been used in the derivation of some manganese screening levels for soil and water."

The Director's interim drinking water standard for manganese, was derived using the US EPA [11] recommended RfDo of 0.024 mg/kg-day. As this recommended TRV is specific to water and soil exposure, the environmental media allocation factor (AF) used in deriving the Director's interim drinking water standard for manganese was increased from AF = 0.2 to AF = 0.5 to reflect a conservative assumption of a 50% apportionment of the adjusted TRV to each of soil and water.