



Health
Canada

Santé
Canada

Your health and
safety... our priority.

Votre santé et votre
sécurité... notre priorité.

Contribution of Drinking Water to Dietary Requirements of Essential Metals

Michelle Deveau
Water Quality Science Division
Health Canada

May 7, 2008
Workshop on Health Risk Assessment of Essential Metals
University of Ottawa



Introduction

- 1) **Brief overview of some essential metals in drinking water**
- 2) **Comparison of intake of metals from water at guideline maximum levels and typical Canadian levels with RDA/AI**



RDA – Recommended Dietary Intake

AI – Adequate Intake

Copper in Water - Overview

Health Canada

- Guideline – 1 mg/L (Aesthetic Objective; 1992)
- Sources
 - Very low levels in surface water (rarely exceeds 0.005 mg/L)
 - Copper can leach from plumbing or distribution system, especially if water is corrosive
- Exposure
 - Guideline assumed typical water concentration of 0.176 mg/L (1989 study in Ontario); water contributes 11% of total intake of copper

WHO – 2 mg/L (health-based)

USEPA – 1.3 mg/L (Treatment Technique action level and MCLG)

- 1.0 mg/L (SMCL)



Health Canada (HC) Aesthetic Objective (AO) - Prevention of green staining of laundry & plumbing fixtures; also below taste threshold (causes unpleasant, astringent taste)

World Health Organization (WHO) - should permit consumption of 2 or 3 litres of water per day, use of a nutritional supplement and copper from foods without exceeding the IOM tolerable upper intake level of 10 mg/day

US Environmental Protection Agency (EPA) – If more than 10% of samples taken (at the tap after standing for >6 h) exceed the action level (1.3 mg/L), action must be taken by the treatment plant to decrease the corrosivity of water; MCLG is a health-based goal and not enforceable (unless mandated at the state level), it is set at concentrations at which no known or expected adverse health effects occur and the margins of safety are adequate

- Maximum Contaminant Level Goal (MCLG) of 1.3 is based on a case study of nurses that consumed an alcoholic beverage that was contaminated with copper; 5.3 mg caused GI symptoms, $5.3 \text{ mg} / 2 \text{ L} = 2.65 \text{ mg/L}$, which was divided by a safety factor of 2 (in recognition of its essentiality)

- SMCL = Secondary Maximum Contaminant Level

Manganese in Water - Overview

Canada

- Guideline – 0.05 mg/L (Aesthetic Objective; 1987)
- Source
 - Weathered from geological deposits
- Exposure
 - Varies greatly across the country
 - 1974-76 national study: 67% of 84 sites <0.02 mg/L, 25% >0.05 mg/L
 - Guideline assumed typical water concentration of 0.02 mg/L; water contributes 0.6% of total intake of manganese

WHO – 0.4 mg/L (Health-based)

EPA – 0.05 mg/L (SMCL)



“At levels exceeding 0.15 mg/L, manganese stains plumbing fixtures and laundry and causes undesirable tastes in beverages. Even at concentrations as low as 0.02 mg/L, problems may be encountered; however, it is difficult to remove manganese to achieve concentrations below 0.05 mg/L.”

-Intake from food is substantially higher than intake from drinking water, even in areas where the Mn content of water is high

-Manganese usually becomes an issue in groundwater; can become an issue in surface water when anoxic

Zinc in Water - Overview

Canada

- Guideline – 5 mg/L (Aesthetic Objective; 1987)
- Sources
 - Industrial and domestic emissions
 - Weathered from geological deposits
 - Can leach from plumbing fittings
- Canadian exposures
 - Guideline assumed typical water concentration of <0.013 mg/L; water contributes <1% of total intake of zinc

WHO – No health-based objective developed

EPA – 5 mg/L (SMCL)



Industrial emissions – primary iron, steel, copper and nickel production; fuel combustion; transportation; solid waste incineration; pesticide application (all to atmosphere)

Plumbing – brass, bronze and gunmetal fittings

Objective of Calculating Intake from Water

- To determine to what level water contributes to the daily intake of 6 essential trace elements that are found in Canadian drinking water
 - Copper, Manganese, Zinc
 - Results for Chromium, Iron, Selenium are not presented today



Methods for Calculating Intake from Water

- 1) Created groups of similar age categories
- 2) Multiplied default water intake (L) for each agency by the respective guideline level (mg/L) to determine the maximum ingestion (mg) of each metal per day
- 3) Multiplied default water intake for Health Canada by the Canadian exposure data used in guideline development
- 4) Compared each of the calculated intake values with IOM's RDA or AI for the similar age category



IOM= Institute of Medicine

RDA= Recommended Daily Amount

AI= Adequate Intake

Breakdown of Age Categories

Age category	Drinking Water Guidelines (Limits)			Nutritional Intake
	HC	WHO	EPA	IOM
Bottle-fed infants	0-6 mo (0.75 L)	bottle-fed infants (0.75 L)		0-6 mo
Toddlers/Young Children	7 mo-4 yrs (0.8 L)	children (1 L)		7-12 mo 1-3 yrs
Children	5-11 yrs (0.9 L)			4-8 yrs 9-13 yrs
Adolescents	12-19 yrs (1.3 L)			14-18 yrs
Adults	>20 yrs (1.5 L)	adult (2 L)	adult (2 L)	>19 yrs



Health Canada & WHO age categories paired up by comparing default assumptions for BW:

HC – 0-6 mo – 7 kg infants – 5 kg	≈	WHO – bottle-fed
HC – 7 mo-4 yrs – 13 kg	≈	WHO – children – 10 kg

Health Canada & IOM age categories paired up by matching age ranges as best as possible

RESULTS



Maximum Copper Intake from Water

Age	DRI	Ingestion at Maximum		
		HC	WHO	EPA
Bottle-fed infants (0-6 mo)	0.20 mg/d (AI; 0-6 mo)	0.75 mg/d YES	1.5 mg/d YES	--
Toddlers/Young Children (7 mo-4 yrs)	0.22 mg/d (AI; 7-12 mo)	0.8 mg/d YES	2 mg/d YES	--
	0.34 mg/d (RDA; 1-3 yr)	0.8 mg/d YES	2 mg/d YES	--
Children (5-11 yrs)	0.44 mg/d (RDA; 4-8 yr)	0.9 mg/d YES	--	--
	0.70 mg/d (RDA; 9-13 yr)	0.9 mg/d YES	--	--
Adolescents (12-19 yrs)	0.89 mg/d (RDA; 14-18 yr)	1.3 mg/d YES	--	--
Adults (>20 yrs)	0.90 mg/d (RDA; >19 yr)	1.5 mg/d YES	4 mg/d YES	2.6 mg/d YES



DRI = Dietary Reference Intake

Bottle-fed infants (0-6 months)

Health Canada: 0.75 mg/d (0.75 L/d x 1 mg/L)

WHO: 1.5 mg/d (0.75 L/d x 2 mg/L)

Sufficient to meet the AI of 0.20 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

Health Canada: 0.8 mg/d (0.8 L/d x 1 mg/L)

WHO: 2 mg/d (1 L/d x 2 mg/L)

Sufficient to meet the AI of 0.22 mg/d for 7-12 mo and RDA of 0.34 mg/d for 1-3 yr

Children (5-11 yrs)

Health Canada: 0.9 mg/d (0.9 L/d x 1 mg/L)

Sufficient to meet the RDA values of 0.44 mg/d for 4-8 years and 0.70 mg/d for 9-13 years

Adolescents (12-19 yrs)

Health Canada: 1.3 mg/d (1.3 L/d x 1 mg/L)

Sufficient to meet the RDA of 0.89 mg/d for 14-18 yrs

Adults (20+ yrs)

Health Canada: 1.5 mg/d (1.5 L/d x 1 mg/L)

WHO: 4 mg/day (2 L/d x 2 mg/L)

EPA: 2.6 mg/day (2 L/d x 1.3 mg/L)

Sufficient to meet the RDA of 0.90 mg/d for 19+ yrs

Maximum Manganese Intake from Water

Age	DRI	Ingestion at Maximum		
		HC	WHO	EPA
Bottle-fed infants (0-6 mo)	0.003 mg/d (AI; 0-6 mo)	0.038 mg/d YES	0.3 mg/d YES	--
Toddlers/Young Children (7 mo-4 yrs)	0.6 mg/d (AI; 7-12 mo)	0.04 mg/d NO	0.4 mg/d NO	--
	1.2 mg/d (AI; 1-3 yr)	0.04 mg/d NO	0.4 mg/d NO	--
Children (5-11 yrs)	1.5 mg/d (AI; 4-8 yr)	0.045 mg/d NO	--	--
	1.9 (M), 1.6 (F) mg/d (AI; 9-13 yr)	0.045 mg/d NO	--	--
Adolescents (12-19 yrs)	2.2 (M), 1.6 (F) mg/d (AI; 14-18 yr)	0.065 mg/d NO	--	--
Adults (>20 yrs)	2.3 (M), 1.8 (F) mg/d (AI; >19 yr)	0.075 mg/d NO	0.8 mg/d NO	0.1 mg/d NO



Bottle-fed infants (0-6 months)

Health Canada: 0.038 mg/d (0.75 L/d x 0.05 mg/L)

WHO: 0.3 mg/d (0.75 L/d x 0.4 mg/L)

Sufficient to meet the AI of 0.003 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

Health Canada: 0.04 mg/d (0.8 L/d x 0.05 mg/L)

WHO: 0.4 mg/day (1 L/d x 0.4 mg/L)

Not sufficient to meet the AI values of 0.6 mg/d for 7-12 mo and 1.2 mg/d for 1-3 yr

Children (5-11 yrs)

Health Canada: 0.045 mg/d (0.9 L/d x 0.05 mg/L)

Not sufficient to meet the AI values of 1.5 mg/d for 4-8 years and 1.9 mg/day (males) or 1.6 mg/d (females) for 9-13 years

Adolescents (12-19 yrs)

Health Canada: 0.065 mg/d (1.3 L/d x 0.05 mg/L)

Not sufficient to meet the AI of 2.2 mg/d (males) or 1.6 mg/d (females) for 14-18 yrs

Adults (20+ yrs)

Health Canada: 0.075 mg/d (1.5 L/d x 0.05 mg/L)

WHO: 0.8 mg/d (2 L/d x 0.4 mg/L)

EPA: 0.1 mg/d (2 L/d x 0.05 mg/L)

Not sufficient to meet the AI of 2.3 mg/d (males) or 1.8 mg/d (females) for 19+ yrs

Maximum Zinc Intake from Water

Age	DRI	Ingestion at Maximum		
		HC	WHO	EPA
Bottle-fed infants (0-6 mo)	2 mg/d (AI; 0-6 mo)	3.75 mg/d YES	No Guideline	--
Toddlers/Young Children (7 mo-4 yrs)	3 mg/d (RDA; 7-12 mo)	4 mg/d YES	No Guideline	--
	3 mg/d (RDA; 1-3 yr)	4 mg/d YES	No Guideline	--
Children (5-11 yrs)	5 mg/d (RDA; 4-8 yr)	4.5 mg/d NO	No Guideline	--
	8 mg/d (RDA; 9-13 yr)	4.5 mg/d NO	No Guideline	--
Adolescents (12-19 yrs)	11 (M), 9 (F) mg/d (RDA; 14-18 yr)	6.5 mg/d NO	No Guideline	--
Adults (>20 yrs)	11 (M), 8 (F) mg/d (RDA; >19 yr)	7.5 mg/d NO	No Guideline	10 mg/d NO (M), YES (F)



Bottle-fed infants (0-6 months)

Health Canada: 3.75 mg/d (0.75 L/d x 5 mg/L)

Sufficient to meet the AI of 2 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

Health Canada: 4 mg/d (0.8 L/d x 5 mg/L)

Sufficient to meet the RDA of 3 mg/d for 7-12 mo and 1-3 yr

Children (5-11 yrs)

Health Canada: 4.5 mg/d (0.9 L/d x 5 mg/L)

Not sufficient to meet the RDA of 5 mg/d for 4-8 years or 8 mg/d for 9-13 years

Adolescents (12-19 yrs)

Health Canada: 6.5 mg/d (1.3 L/d x 5 mg/L)

Not sufficient to meet the RDA of 11 mg/d (males) or 9 mg/d (females) for 14-18 yrs

Adults (20+ yrs)

Health Canada: 7.5 mg/d (1.5 L/d x 5 mg/L)

EPA: 10 mg/d (2 L/d x 5 mg/L)

Not sufficient to meet the RDA of 11 mg/d (males) or 8 mg/d (females) for 19+ years, except for females using EPA calculations

Estimated Intake of Metals from Water in Canada

	% of DRI	% of AI (bottle-fed)	Contribution of water to total daily intake (%)
Copper	23-64	66	10.7
Manganese	0.9-3	500	0.6
Zinc	0.1-0.3	0.5	<1



-Although the contribution of drinking water to the total daily requirements for most metals, water may have a slightly bigger role to play than just this number would indicate because the contribution of water to the required amount is usually greater than the amount that water contributes to total daily intake of each of the metals, and because metals in water may be more bioavailable than the metals in food

-Water may play a role in supplementing the intake of metals for individuals whose diets are borderline deficient/insufficient

-Actual intakes will vary greatly between locations, over time, and even throughout the day for metals that leach into the water from the distribution system. Also, water samples obtained do not necessarily represent the water an individual is actually drinking, especially for metals that leach from the distribution system.

-Data of actual intakes was taken from exposure data used in the HC guidelines, which haven't been updated since 1980s/90s, therefore data may be out of date – National Survey will be underway relatively soon; should update the data (measured at various points in distribution system, but not at the tap)

-Therefore the ranges here are not meant to be precise; they are estimates being used to give an idea of the contribution of drinking water to dietary requirements

Conclusion

- If metal concentrations are as high as the guidelines, DRIs would be met only for copper, zinc in children younger than 5
 - Still not high enough to fully contribute to DRI for other metals
- Ingestion of measured concentrations of metals in Canadian water contributes only a minor amount towards meeting the DRI
 - Except Cu – 23-66% of either AI or RDA
- Infants 0-6 mo are on upper end of range for percentage of DRI for all metals
 - Bottle-fed infants may consume more Mn than breastfed infants, even prior to adding the water to formula



Conclusion

- In populations with poor intakes of essential metals from food, water could become a significant source of these metals
 - May become problematic in areas with desalination for treatment of water – essential metals will be removed from water
- Water should be considered as a source of some essential trace metals, but treatment should not be reduced to increase the concentrations of the metals
 - Treatment methods remove many other non-essential chemicals
 - Aesthetic effects may occur at lower concentrations than adverse health effects
 - Aesthetic effects may not be acceptable, even if the water is acceptable for health



THANK YOU



Appendix – Extra Slides



Other Essential Metals in Water - Overview

Chromium

- HC – 0.05 mg/L (MAC, total Cr; 1986)
- Weathered from geological deposits, anthropogenic sources; median concentration 0.002 mg/L (1979); 5% of total daily intake
- EPA – 0.1 mg/L (MCL & MCLG); WHO – 0.05 mg/L (provisional guideline)

Iron

- HC – 0.3 mg/L (AO; 1987)
- Mainly from source water (weathered from geological deposits, anthropogenic sources), some from distribution system; mean concentration of 0.046 mg/L; 0.4% of total daily intake
- EPA – 0.3 mg/L (SMCL); no WHO HBV

Selenium

- HC – 0.01 mg/L (MAC; 1992)
- Weathered from geological deposits; concentration <0.0005 mg/L (1984); negligible
- EPA – 0.05 mg/L (MCL & MCLG); WHO – 0.01 mg/L (HBV)



-Cr – Anthropogenic sources: industrial waste discharge, water from cooling systems in which chromates are used as corrosion inhibitors

-Guideline is for total Cr even though adverse health effects arise only from the hexavalent ion due to limitations in analytical capabilities.

-WHO guideline is provisional until additional information is available

-If trivalent chromium is found in the raw water, it can become oxidized to hexavalent chromium during chlorination

-Fe – Anthropogenic sources: acidic mine water drainage, landfill leachates, sewage effluents, iron-related industries

-Cast iron and ductile iron make up more than two-thirds of Canadian drinking water distribution systems

-Fe data is from an Ontario study

Se – May later find that selenium is being leached from no-lead brass

Maximum Copper Intake from Water

Bottle-fed infants (0-6 months)

- Health Canada: 0.75 mg/d (0.75 L/d x 1 mg/L)
- WHO: 1.5 mg/d (0.75 L/d x 2 mg/L)
 - Sufficient to meet the AI of 0.20 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

- Health Canada: 0.8 mg/d (0.8 L/d x 1 mg/L)
- WHO: 2 mg/d (1 L/d x 2 mg/L)
 - Sufficient to meet the AI of 0.22 mg/d for 7-12 mo and RDA of 0.34 mg/d for 1-3 yr



Maximum Copper Intake from Water - 2

Children (5-11 yrs)

- Health Canada: 0.9 mg/d (0.9 L/d x 1 mg/L)
 - Sufficient to meet the RDA values of 0.44 mg/d for 4-8 years and 0.70 mg/d for 9-13 years

Adolescents (12-19 yrs)

- Health Canada: 1.3 mg/d (1.3 L/d x 1 mg/L)
 - Sufficient to meet the RDA of 0.89 mg/d for 14-18 yrs

Adults (>20 yrs)

- Health Canada: 1.5 mg/d (1.5 L/d x 1 mg/L)
- WHO: 4 mg/d (2 L/d x 2 mg/L)
- EPA: 2.6 mg/d (2 L/d x 1.3 mg/L)
 - Sufficient to meet the RDA of 0.90 mg/d for >19 yrs



Maximum Manganese Intake from Water

Bottle-fed infants (0-6 months)

- Health Canada: 0.038 mg/d (0.75 L/d x 0.05 mg/L)
- WHO: 0.3 mg/d (0.75 L x 0.4 mg/L)
 - Sufficient to meet the AI of 0.003 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

- Health Canada: 0.04 mg/d (0.8 L/d x 0.05 mg/L)
- WHO: 0.4 mg/d (1 L/d x 0.4 mg/L)
 - Not sufficient to meet the AI values of 0.6 mg/d for 7-12 mo and 1.2 mg/d for 1-3 yr



Maximum Manganese Intake from Water - 2

Children (5-11 yrs)

- Health Canada: 0.045 mg/d (0.9 L/d x 0.05 mg/L)
 - Not sufficient to meet the AI values of 1.5 mg/d for 4-8 years and 1.9 mg/d (males) or 1.6 mg/d (females) for 9-13 years

Adolescents (12-19 yrs)

- Health Canada: 0.065 mg/d (1.3 L/d x 0.05 mg/L)
 - Not sufficient to meet the AI of 2.2 mg/d (males) or 1.6 mg/d (females) for 14-18 yrs

Adults (>20 yrs)

- Health Canada: 0.075 mg/d (1.5 L/d x 0.05 mg/L)
- WHO: 0.8 mg/d (2 L/d x 0.4 mg/L)
- EPA: 0.1 mg/d (2 L/d x 0.05 mg/L)
 - Not sufficient to meet the AI of 2.3 mg/d (males) or 1.8 mg/d (females) for >19 yrs



Maximum Zinc Intake from Water

Bottle-fed infants (0-6 months)

- Health Canada: 3.75 mg/d ($0.75 \text{ L/d} \times 5 \text{ mg/L}$)
 - Sufficient to meet the AI of 2 mg/d for 0-6 months

Toddlers/Young Children (7 mo-4 yrs)

- Health Canada: 4 mg/d ($0.8 \text{ L/d} \times 5 \text{ mg/L}$)
 - Sufficient to meet the RDA of 3 mg/d for 7-12 mo and 1-3 yr



Maximum Zinc Intake from Water - 2

Children (5-11 yrs)

- Health Canada: 4.5 mg/d (0.9 L/d x 5 mg/L)
 - Not sufficient to meet the RDA of 5 mg/d for 4-8 years or 8 mg/d for 9-13 years

Adolescents (12-19 yrs)

- Health Canada: 6.5 mg/d (1.3 L/d x 5 mg/L)
 - Not sufficient to meet the RDA of 11 mg/d (males) or 9 mg/d (females) for 14-18 yrs

Adults (>20 yrs)

- Health Canada: 7.5 mg/d (1.5 L/d x 5 mg/L)
- EPA: 10 mg/d (2 L/d x 5 mg/L)
 - Not sufficient to meet the RDA of 11 mg/d (males) or 8 mg/d (females) for >19 years, except for females using EPA calculations



Max. Intake of Other Essential Metals from Water

Metal	DRI	Ingestion at Maximum (Adult)		
		HC	WHO	EPA
Chromium	0.035 mg/d (M), 0.025 mg/d (F) (AI; 19-50 yr)	0.075 mg/d YES[†]	0.1 mg/d YES[†]	0.2 mg/d YES[†]
Iron	8 mg/d (M), 18 mg/d (F) (RDA; 19-50 yr)	0.45 mg/d NO	No Guideline	0.6 mg/d NO
Selenium	0.055 mg/d (RDA; >19 yr)	0.015 mg/d NO	0.02 mg/d NO	0.1 mg/d YES

[†]Speciation is not taken into account; drinking water guidelines are for total Cr whereas only trivalent chromium is considered nutritionally beneficial



Pattern is similar at other age categories

- Cr is sufficient to meet the AI values for all other age categories
- Fe and Se are not sufficient to meet the AI and RDA values for all other age categories

Cr – trivalent chromium becomes oxidized to hexavalent chromium with chlorination, therefore the majority of chromium in drinking water may be present in the hexavalent form, and would not actually have such a large contribution to recommended intakes

- AI is 0.03 mg/d for males and 0.02 mg/d for females at age 50+

Iron – intake of water at max concentration is almost 100-fold lower than RDA (but very close in 0-6 mo: 0.225 mg/d at MAC, but 0.27 required)

Se – if taken in at MAC, DW is source of 10-25% of total Se intake (but closer in 0-6 mo: 0.0075 intake at both HC & WHO guidelines, but 0.015 required)

Iron

- Intakes of Iron from water are much lower than the RDA, even at maximum guidelines
 - For adults, RDA is 8 mg/d for males and 18 mg/d for females
 - Health Canada – 0.45 mg/d
 - EPA – 0.6 mg/d

Selenium

- Intakes of Selenium from water are lower than the RDA at the maximum of the Health Canada and WHO guidelines, but sufficient at water concentrations equivalent to EPA MCL

For adults, RDA is 0.055 mg/d
 Health Canada – 0.015 mg/d
 WHO – 0.02 mg/d
 EPA – 0.1 mg/d

Chromium

- Intakes of Chromium at the maximum of the guidelines are sufficient to meet the AI
 - For adults, AI is 0.035 mg/d for males and 0.025 mg/d for females
 - Health Canada – 0.075 mg/d
 - WHO – 0.1 mg/d
 - EPA – 0.2 mg/d

Estimated Intake of Metals from Water in Canada

	% of DRI	% of AI (bottled)	Contribution of water to total daily intake (%)
Copper	23-64	66	10.7
Manganese	0.9-3	500	0.6
Zinc	0.1-0.3	0.5	<1
Chromium	7.0-29	750	5
Iron	0.3-1	13	0.4
Selenium	1.0-2	3	negligible



-Although the contribution of drinking water to the total daily requirements for most metals, water may have a slightly bigger role to play than just this number would indicate because the contribution of water to the required amount is usually greater than the amount that water contributes to total daily intake of each of the metals, and because metals in water may be more bioavailable than the metals in food

-Water may play a role in supplementing the intake of metals for individuals whose diets are borderline deficient/insufficient

-Actual intakes will vary greatly between locations, over time, and even throughout the day for metals that leach into the water from the distribution system. Also, water samples obtained do not necessarily represent the water an individual is actually drinking, especially for metals that leach from the distribution system.

-Data of actual intakes was taken from exposure data used in the HC guidelines, which haven't been updated since 1980s/90s, therefore data may be out of date – National Survey will be underway relatively soon; should update the data (measured at various points in distribution system, but not at the tap)

-Therefore the ranges here are not meant to be precise; they are estimates being used to give an idea of the contribution of drinking water to dietary requirements

Max. Intake of Other Essential Metals from Water

Iron

- Intakes of Iron from water are much lower than the RDA, even at maximum guidelines
 - For adults, RDA is 8 mg/day for males and 18 mg/day for females
 - Health Canada – 0.45 mg/day
 - EPA – 0.6 mg/day

Selenium

- Intakes of Selenium from water are lower than the RDA at the maximum of the Health Canada and WHO guidelines, but sufficient at water concentrations equivalent to EPA MCL
 - For adults, RDA is 0.055 mg/day
 - Health Canada – 0.015 mg/day
 - WHO – 0.02 mg/day
 - EPA – 0.1 mg/day

Chromium

- Intakes of Chromium at the maximum of the guidelines are sufficient to meet the AI
 - For adults, AI is 0.035 mg/day for males and 0.025 mg/day for females
 - Health Canada – 0.075 mg/day
 - WHO – 0.1 mg/day
 - EPA – 0.2 mg/day

NOTE: Speciation is not taken into account; guidelines are for total Cr whereas only trivalent chromium is considered nutritionally beneficial



Iron – intake of water at max concentration is almost 100-fold lower than RDA (but very close in 0-6 mo: 0.225 mg/d at MAC, but 0.27 required)

Se – if taken in at MAC, DW is source of 10-25% of total Se intake (but closer in 0-6 mo: 0.0075 intake at both HC & WHO guidelines, but 0.015 required)

Cr – trivalent chromium becomes oxidized to hexavalent chromium with chlorination, therefore the majority of chromium in drinking water may be present in the hexavalent form, and would not actually have such a large contribution to recommended intakes

- AI is 0.03 mg/day for males and 0.02 mg/day for females at age 50+