



# Manganese

## Development of Water Quality Criteria for Human Health

Water Resources Advisory Committee

July 25, 2019

# Manganese : Criteria Development

- **Act 40** – October 30, 2017
- **Advanced Notice of Proposed Rulemaking** – January 27, 2018
- **Science Presentation to WRAC** – May 23, 2019

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## CHAPTER 93. WATER QUALITY STANDARDS

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### WATER QUALITY CRITERIA

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TABLE 3

<i>Parameter</i>	<i>Symbol</i>	<i>Criteria</i>	<i>Critical Use*</i>
* * * * *			
Iron	Fe <sub>1</sub>	30-day average 1.5 mg/l as total recoverable.	CWF, WWF, TSF, MF
	Fe <sub>2</sub>	Maximum 0.3 mg/l as dissolved.	PWS
Manganese	Mn	Maximum 1.0 mg/l, as total recoverable.	PWS
Nitrite plus Nitrate	N	Maximum 10 mg/l as nitrogen.	PWS
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## CHAPTER 96. WATER QUALITY STANDARDS

### IMPLEMENTATION

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#### § 96.3. Water quality protection requirements.

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(d) As an exception to subsection (c), the water quality criteria for total dissolved solids, nitrite-nitrate nitrogen, phenolics, chloride, sulfate, manganese and fluoride established for the protection of potable water supply shall be met at least 99% of the time at the point of all existing or planned surface potable water supply withdrawals unless otherwise specified in this title.

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Impacts to Public Drinking Water Suppliers – conventional treatment facilities are able to remove Mn from source waters containing up to 1 mg/L to achieve the SMCL = 0.05 mg/L; **BUT** modifications will be necessary.

- Sequestration is an option for low Mn concentrations in source water
- Oxidation with chlorine → by-product issues
- Oxidation with  $\text{KMnO}_4$  → also problematic
- HABs are an additional complication – avoid lysing cells
- Removal & disposal of Mn by DW Suppliers = \$\$\$

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The proposed rule will include a request for comment on the adoption of a toxic substance criterion for manganese.

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## Development of Water Quality Criteria for Human Health Protection for Toxic Substances

### Chapter 93. Water Quality Standards

- § 93.6. *General water quality criteria.*
- § 93.8a. *Toxic substances.*
- § 93.8c. *Human health and aquatic life criteria for toxic substances*

### Chapter 16. Water Quality Toxics Management Strategy – Statement of Policy

- Threshold vs. Non-Threshold toxic effects
- § 16.32. *Threshold level toxic effects*

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## Development of Water Quality Criteria for Human Health Protection for Toxic Substances

### § 16.32. *Threshold level toxic effects*

§ 16.32(d) The sources the Department uses to obtain relevant risk assessment values for protection for threshold level toxic effects to human health are as follows:

- (1) Verified references doses, listed in the EPA agency-wide supported data system known as IRIS and other EPA approved data sources referred through IRIS.**
- (2) Maximum contaminant level goals.
- (3) The EPA's CWA 304(a) health criteria under 40 CFR 131.56.
- (4) Teratology and other data that have been peer-reviewed.

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## Development of Water Quality Criteria for Human Health Protection for Toxic Substances

Literature review included:

- animal toxicity studies (rats, mice, non-human primates)
- epidemiological studies
- epigenetic studies (human and animal)
- information on human dietary needs, exposure routes and sources, etc.

Many of the reference studies evaluated manganese exposure as it relates to developmental neurotoxicity. The studies and data generally support the continued need for an IRIS reference dose.



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## Development of Water Quality Criteria for Human Health Protection for Toxic Substances

### Summary of EPA IRIS human health assessment information

- Oral reference dose information is available.
- It was last revised in 1995.
- The critical effect identified = Central Nervous System (CNS) effects.
- NOAEL (No Observed Adverse Effect Level) is based on dietary studies.
- Modifying factor (MF) of 3 recommended for exposures from water or soil.

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Reference Dose = RfD = NOAEL / Uncertainty Factor (UF) or (MF)

RfD published in IRIS = 0.14 mg/kg-day

RfD published in IRIS assumes UF = 1 and MF = 1; however the NOAEL values were all obtained from dietary studies

EPA recommends that an assessment of water exposure should include a MF = 3

$RfD_w = (0.14 \text{ mg/kg-day}) / 3 = \mathbf{0.05 \text{ mg/kg-day}}$

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## Justification for a modifying factor of 3

- Increased uptake of Mn from water when fasting
- Possible health concern associated with lifetime consumption of drinking water with Mn = 2 mg/L
- Concern for infants fed formula with a much higher concentration of Mn than human milk
- Evidence pertaining to neonates
  - absorb more Mn from the gastrointestinal tract
  - are less able to excrete absorbed Mn
  - the absorbed Mn more easily passes the blood brain barrier

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$$AWQC_{Mn} = RfD_w \times RSC \times (BW \div [DWI + (FI \times BAF)])$$

$AWQC_{Mn}$  - Ambient Water Quality Criteria for Manganese

$RfD_w$  (Reference Dose – Water) = 0.05 mg/kg-day

$RSC$  (Relative Source Contribution) = 0.2

$BW$  (Body Weight) = 80 kg

$DWI$  (Drinking Water Intake) = 2.4 L

$FI$  (Fish Intake) = 0.022 kg/day

$BAF$  (Bioaccumulation Factor) = 1

$AWQC_{Mn} = 0.05 \text{ mg/kg-day} \times 0.2 \times (80 \div [2.4 + (0.022 \text{ kg/day} \times 1)])$

$$AWQC_{Mn} = 0.3 \text{ mg/L} = 300 \text{ } \mu\text{g/L}$$



**pennsylvania**  
DEPARTMENT OF ENVIRONMENTAL  
PROTECTION



Bureau of Clean Water

# Questions?

Rodney McAllister  
Bureau of Clean Water

[romcallist@pa.gov](mailto:romcallist@pa.gov)

717-783-2952