Basis for recommended groundwater standards – Metals and Metalloids

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Today’s presentation

Groundwater standard process

Recommended groundwater standards for:

- Aluminum
- Barium
- Cobalt
- Molybdenum
- Boron
- Strontium
- Hexavalent Chromium
Two-thirds of Wisconsin residents use groundwater.
Wisconsin’s groundwater standards have 2 parts.

- Enforcement Standard
- Preventive Action Limit
The enforcement standard is established from available health information.
Enforcement standards can be based on:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Enforcement standards based on

- EPA value
- Technical information

Set to protect a young child
Body weight
Acceptable daily intake
Relative source contribution

Enforcement Standard

Specified in Statute

10 kg
1 L/d
100%
Enforcement standards based on Cancer risk

Set to protect from a lifetime of exposure
Enforcement Standard

Risk level \( 10^{-6} \) \times \text{Body weight} 80 kg

Cancer slope factor

Water consumption 2.4 L/d

Specified in Statute

Recommended by EPA
The preventive action limit is set at a percentage of the enforcement standard.
Preventive action limit = 10% of the enforcement standard

Substances that cause carcinogenic, mutagenic, teratogenic, or interactive effects
Preventive action limit = 20% of the enforcement standard

All other substances
Aluminum
Wisconsin has groundwater standards for aluminum.

The current enforcement standard is based on:

- 200 μg/L for aluminum
- Established in 2010
- Based on research study in rabbits
The current preventive action limit for **aluminum** is set at:

Preventive action limit = 10% of the enforcement standard

Aluminum has been shown to have carcinogenic properties in rats.
Available scientific information for **aluminum**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Available scientific information for **aluminum**:

Secondary maximum contaminant level (SMCL)
50 to 200 μg/L for aluminum
Established in 2018
Available scientific information for **aluminum**:

Food and Drug Administration
200 μg/L for aluminum in bottled drinking water
Available scientific information for **aluminum**:

**Technical information**

**World Health Organization**

100 to 200 μg/L for aluminum in drinking water
Available scientific information for aluminum:

Critical studies
Toxicity studies (7) evaluating effects on development and reproduction in mice and rats
DHS recommends no change to the enforcement standard for aluminum.
Data from recent studies suggest that the existing acceptable daily intake for aluminum is protective.
DHS recommends no change to the preventive action limit for aluminum.
Wisconsin has groundwater standards for barium.

The current enforcement standard is based on:

Maximum contaminant level
2000 μg/L
Established in 1992
The current preventive action limit for barium is set at:

Preventive action limit = 20% of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.
Available scientific information for barium:
Available scientific information for barium:

Federal number

Maximum contaminant level
2000 μg/L for barium
Reviewed in 2003
Available scientific information for **barium**:

**State standard**

**Maximum contaminant level**

- Based on federal MCL
- 2000 μg/L
- Established in 2016
Available scientific information for **barium**:

**Oral reference dose**

0.2 mg/kg-d for barium

Established in 2005

Based on kidney damage in mice
Available scientific information for **barium**:

**Technical information**

Chronic oral minimum reference level

0.2 mg/kg-d for barium

Established by ATSDR in 2007

Based on same study as EPA’s oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry
DHS recommends no change to the enforcement standard for barium.
DHS recommends no change to the preventive action limit for barium.
Cobalt
Wisconsin has groundwater standards for cobalt.

The current enforcement standard is based on:

40 μg/L
Established in 1997
Based on a toxicity value from ATSDR

ATSDR = Agency for Toxic Substances and Disease Registry
The current preventive action limit for cobalt is set at:

Preventive action limit = 20% of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.
Available scientific information for **cobalt**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Available scientific information for **cobalt**:

**Oral maximum contaminant level**

0.01 mg/kg-d for cobalt

Established by ATSDR in 2004

Based on effects on blood in people

ATSDR = Agency for Toxic Substances and Disease Registry
Available scientific information for **cobalt**:

**Technical information**

**Critical studies**
Toxicity studies (2) evaluating effects on development and reproduction in mice, rats, and rabbits
DHS recommends no change to the enforcement standard for cobalt.
Data from recent studies suggest that the existing **acceptable daily intake for cobalt** is protective.
DHS recommends lowering the preventive action limit for cobalt.
DHS recommends that the preventive action limit for **cobalt** be set at:

New studies shown that cobalt can cause birth defects in mice and rats.
Molybdenum
Wisconsin has groundwater standards for molybdenum.

The current enforcement standard is based on:

- 40 μg/L
- Established in 1993
- EPA lifetime health advisory
The current preventive action limit for molybdenum is set at:

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.
Available scientific information for molybdenum:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Available scientific information for molybdenum:

10-Day child health advisory
80 μg/L for molybdenum
Established in 1993
Based on development effects in rats
Available scientific information for molybdenum:

Federal number

Lifetime health advisory
40 μg/L for molybdenum
Established in 1993
Based on oral reference dose
Available scientific information for molybdenum:

**Oral reference dose**

0.005 mg/kg-d for molybdenum

Established in 1992

Based on increased incidence of gout in Armenian community
Available scientific information for molybdenum:

Intermediate oral minimum reference level
0.008 mg/kg-d for molybdenum
Established by ATSDR in 2017
Based on effects on reproduction in rats

ATSDR = Agency for Toxic Substances and Disease Registry
Available scientific information for molybdenum:

Critical studies
Toxicity studies (2) evaluating effects on reproduction in rats
DHS recommends no change to the enforcement standard for molybdenum.
DHS recommends lowering the preventive action limit for molybdenum.
DHS recommends that the preventive action limit for **molybdenum** be set at:

\[
\text{Preventive action limit} = 10\% \text{ of the enforcement standard}
\]

Molybdenum can cause interactive effects with copper and birth defects in rats.
Boron
Wisconsin has groundwater standards for boron.

The current enforcement standard is based on:

1000 μg/L for boron
Established in 2010
EPA lifetime health advisory
The current preventive action limit for boron is set at:

Preventive action limit = 20% of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.
Available scientific information for boron:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Available scientific information for **boron**:

**Federal number 10-**

**Day child health advisory**

3000 μg/L for boron

Established in 2008

Based on effects on sperm in rats
Available scientific information for boron:

**Longer-term child health advisory**
2000 μg/L for boron
Established in 2008
Based on effects on testes in rats
Available scientific information for boron:

**Federal number**

Longer-term adult health advisory

5000 μg/L for boron

Established in 2008

Based on effects on development in rats
Available scientific information for boron:

**Lifetime health advisory**

5000 μg/L for boron
Established in 2008
Based on same study as longer-term adult health advisory
Available scientific information for boron:

**Oral reference dose**

0.2 mg/kg-d for boron

Established in 2004

Based on effects on development in rats (used to set the adult/lifetime health advisories)
Available scientific information for boron:

Chronic oral minimum reference level

0.2 mg/kg-d for boron
Established by ATSDR in 2017
Based on same study as EPA’s oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry
Available scientific information for boron:

WHO drinking water guideline value
2400 μg/L for boron
Established in 2009
Based on effects on development in rats

WHO = World Health Organization
Available scientific information for boron:

Critical study
Toxicity study (1) evaluating effects on immune function in rats
DHS recommends raising the enforcement standard for boron.
DHS recommends that the enforcement standard for boron be set at:

\[\text{Enforcement Standard} = 2000 \, \mu\text{g/L} \]

based on EPA’s longer-term child health advisory.
DHS recommends no change to the preventive action limit for boron.
DHS recommends that the preventive action limit for **boron** be set at:

Preventive action limit = 20% of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, and interactive effects.
Strontium
Wisconsin currently does not have groundwater standards for strontium.
Available scientific information for **strontium**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk
Available scientific information for **strontium**:

1- and 10-Day child health advisories
25000 μg/L for strontium
Established in 1993
Based on effects of strontium supplementation in people
Available scientific information for strontium:

Federal number

Lifetime health advisory
4000 μg/L for strontium
Established in 1993
Based on oral reference dose set by IRIS

IRIS = Integrated Risk Information System
Available scientific information for **strontium**:

**Federal number**

Health reference level

1500 μg/L for strontium
Established by EPA
Based on oral reference dose set by the Office of Water

UCMR3 = unregulated contaminant monitoring rule 3 (2014)
Available scientific information for strontium:

EPA value

Oral reference dose
0.6 mg/kg-d for strontium
Established in 1993 by IRIS
Based on effects on bone calcification in rats (20 day study)

IRIS = Integrated Risk Information System
Available scientific information for strontium:

**Oral reference dose**

0.3 mg/kg-d

Established in 2014 by the Office of Water

Based on effects on bone calcification in rats (60 day study)
Available scientific information for strontium:

Critical study
Toxicity study (1) evaluating effects on development in rats
DHS recommends that the enforcement standard for **strontium** be set at:

\[
\text{Enforcement Standard} = 1500 \, \mu g/L
\]

based on EPA’s health reference level.
DHS recommends that the preventive action limit for strontium be set at:

\[
\text{Preventive action limit} = 10\% \text{ of the enforcement standard}
\]

Strontium can cause birth defects in rats.
Hexavalent chromium
Wisconsin currently does not have a groundwater standard for chromium (VI).

Wisconsin has groundwater standards for total chromium.
Available scientific information for chromium (VI):
Available scientific information for chromium (VI):

Oral reference dose
2.5 mg/kg-d for chromium (VI)
Established in 1998
Based on one year rat study that did not see adverse effects
Available scientific information for chromium (VI):

Draft oral reference dose
0.0009 mg/kg-d for chromium (VI)
Established in 2010
Based on intestinal damage in mice
Available scientific information for chromium (VI):

Chronic minimum risk level
0.0009 mg/kg-d for chromium (VI)
Established in 2012 by ATSDR
Based on same study as EPA’s oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry
Available scientific information for chromium (VI):

**Critical study**
Toxicity studies (3) evaluating non-cancer effects in rodents
Available scientific information for chromium (VI):

- **Cancer slope factor**
  - 0.0791 (mg/kg-d)$^{-1}$
  - Established by EPA’s pesticide program in 2008
Available scientific information for chromium (VI):

Draft cancer slope factor
0.05 (mg/kg-d)^{-1}
Established by EPA’s IRIS program in 2010
DHS recommends establishing an enforcement standard for chromium (VI) based on cancer risk.
Carcinogens cause cancer through one of two ways.
Genotoxic chemicals

Directly alter DNA

Default approach

No safe level of exposure

Use cancer slope factor
Non-genotoxic chemicals

Do not directly cause gene damage

Safe level of exposure

Use acceptable daily intake
Recent study found that chromium (VI) caused cancer in mice and rats.

- Small intestine tumors
- Oral mucosa tumors
Chromium (VI) is treated as genotoxic because the mode of action is unclear.
Pesticide Program

0.791 (mg/kg-d)^{-1}

Adenomas and carcinomas in the small intestines of female mice
Pesticide Program

0.791 \text{ (mg/kg-d)}^{-1}

Adenomas and carcinomas in the small intestines of \textit{female} mice

IRIS

0.5 \text{ (mg/kg-d)}^{-1}

Adenomas and carcinomas in the small intestines of \textit{male} mice

IRIS = integrated risk information system
0.5 \text{(mg/kg-d)}^{-1}

Adenomas and carcinomas in the small intestines of \textit{male} mice

IRIS = integrated risk information system

Used by EPA, ATSDR, and California to evaluate cancer risk
DHS recommends that the enforcement standard for chromium (VI) be set at:

Enforcement Standard \[=\] 70 ng/L based on cancer risk
Enforcement Standard

Risk level

Body weight

Cancer slope factor

Water consumption

Specified in Statute

Recommended by EPA
DHS recommends that the preventive action limit for chromium (VI) be set at:

Preventive action limit = 10% of the enforcement standard

Chromium (VI) causes carcinogenic effects in mice and rats.
In summary, DHS recommends

<table>
<thead>
<tr>
<th>Element</th>
<th>Change Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>No change</td>
</tr>
<tr>
<td>Barium</td>
<td>No change</td>
</tr>
<tr>
<td>Boron</td>
<td>Higher standard</td>
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<tr>
<td>Chromium (VI)</td>
<td>New standard</td>
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<tr>
<td>Cobalt</td>
<td>Lower preventive action limit</td>
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<td>Molybdenum</td>
<td>Lower preventive action limit</td>
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<td>Strontium</td>
<td>New standard</td>
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</tbody>
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Thanks!

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608-266-9337
Additional information can be found on DHS’ webpage: [dhs.wisconsin.gov\water\gws.htm](dhs.wisconsin.gov\water\gws.htm)

The full scientific support document for all of the Cycle 10 compounds is available here: [dhs.wisconsin.gov\publications\p02434v.pdf](dhs.wisconsin.gov\publications\p02434v.pdf).