Drinking Water and Groundwater Program **White Paper-Rule Development**

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ISSUE
New recommended NR 140 groundwater quality standards for metals: Hexavalent Chromium and Strontium, and recommended updated NR 140 groundwater quality standards for metals/metalloids: Boron, Molybdenum, Aluminum, Cobalt and Barium.

BACKGROUND
This paper provides an overview of recommendations for new and updated groundwater quality standards, for selected substances, in Wisconsin Administrative Code chapter NR 140. Specifically, this paper addresses recommended new standards for inorganic substances: Hexavalent Chromium and Strontium; and recommended revised standards for: Boron, Molybdenum, Aluminum, Cobalt and Barium.

Wisconsin Statute chapter 160 establishes an administrative process for developing numerical state groundwater quality standards to be used as criteria for the protection of public health and welfare by all state groundwater regulatory programs. Chapter 160, Stats., directs the Department of Natural Resources (DNR) and the Department of Health Services (DHS) to use this administrative process to establish numeric groundwater quality standards for substances of public health or welfare concern, found in, or having a reasonable probability of being detected in, the groundwater resources of the state.

As part of a continuing commitment to protect public health, public welfare, and the environment, the DNR periodically updates groundwater quality standards in ch. NR 140, Wis. Adm. Code. The DNR requests that DHS review federal numbers, and available toxicologic information and, as applicable under ch. 160 Stats., provide recommendations for new or revised groundwater quality standards for substances of public health concern. The DNR then proposes amendments to ch. NR 140, Wis. Adm. Code, to incorporate the DHS recommended standards into rule. Since its establishment in 1985, the Natural Resources Board has approved amendments to NR 140 twelve times in order to revise existing standards, establish new standards and clarify rule language.

SETTING NEW/REVISING EXISTING GROUNDWATER STANDARDS UNDER CHAPTER 160
A list of substances which are detected in groundwater, or have a reasonable probability of entering groundwater, is compiled from one of two sources: 1) lists of substances submitted by state regulatory agencies (in accordance with s. 160.05(1), Stats.) related to facilities, activities and practices within their authority to regulate and which have been detected in, or have a reasonable probability of entering, the groundwater resources of the state; or 2) substances petitioned by any person (in accordance with s. 160.05(2), Stats.) to be added to the list.

DNR and DHS determine which substances on the priority list are of public health concern and which are of public welfare concern. In accordance with ss. 160.07 and 160.13, Stats., DHS develops recommendations for state groundwater quality standards for substances of public health concern. DNR develops proposed groundwater quality standards for substances which are not health-related, but cause aesthetic or other effects. Scientific support documents for all recommended groundwater standards are prepared as part of the rulemaking process.

Please note: to ensure full discussion of DG program's rule changes, information on recommended groundwater standards for Volatile Organic Compounds, Pesticides, Indicator Bacteria and PFAS/PFOS, substances have been divided among different meetings and white papers. This paper focuses on recommended groundwater quality standards for metal and metalloid inorganic substances.

RECONENDATIONS FOR NEW AND REVISED GROUNDWATER QUALITY STANDARDS

Recommended groundwater standards for incorporation into NR 140 are organized by substance. A summary of information on how the recommended groundwater standard for each substance on the list was established, and the method used by the DHS, is provided in a Scientific Support Document. The Scientific Support Documents for the recommended groundwater standards for substances described in this paper can be found on the DHS website at:
https://www.dhs.wisconsin.gov/publications/p02434v.pdf .

DEFINITIONS

Enforcement standard: Level of a substance in groundwater that is used to protect public health or welfare and the level at which the sources of the substance might be regulated.

Preventive action limit: Level of a substance in groundwater that is used by regulatory agencies to determine when action may be needed so that levels do not reach or exceed the enforcement standard.

Federal number: A numerical expression of the concentration of a substance in water, established as:

(a) A drinking water standard or maximum contaminant level, by the federal environmental protection agency;
(b) A suggested no−adverse−response level, by the federal environmental protection agency; or
(c) For oncogenic substances, a concentration based on a risk level determination by the federal environmental protection agency or a concentration based on a probability of risk model determined by the national academy of sciences.

Carcinogen: Cancer causing

Mutagenic: Causes DNA damage

Teratogenic: Causes birth defects

Interactive effects: Can affect the toxicity of another substance or its toxicity can be affected by another substance.

CAS RN: Chemical Abstracts Service (CAS) Registry Number (RN) is a chemical naming system that makes it easier to identify specific chemical substances.

UNITS

1 nanogram per liter (ng/L) = 1 part per trillion (ppt), equivalent to one drop of a substance in an Olympic swimming pool.

1 microgram per liter (ug/L) = 1 part per billion (ppb), equivalent to one thousand drops of a substance in an Olympic swimming pool.

1 milligram per liter (mg/L) = 1 part per million (ppm), equivalent to one million drops of a substance in an Olympic swimming pool.

PROPOSED NEW NR 140 HEALTH-BASED GROUNDWATER STANDARDS

Hexavalent Chromium

The DNR's Remediation and Redevelopment program requested a standard for Hexavalent Chromium. This heavy metal has been detected in groundwater at contaminated sites, and in water supply wells in Wisconsin. It can be naturally occurring but is also associated with industrial processes. Hexavalent Chromium is stable in the environment and has carcinogenic, mutagenic, teratogenic and interactive effects.

As required under ch. 160, Stats., DHS based its recommended groundwater quality enforcement standard for Hexavalent Chromium on its potential to cause cancer. If a substance is a potential carcinogen, DHS must identify the level at which the estimated cancer risk is 1 in 1 million for a person with a body weight of 177 pounds (80 kgs). The PAL is set at 10% of the ES as required for carcinogenic substances under ch. 160, Stats.

Recommended Standards:
Enforcement Standard **70 ng/L (ppt)**
Preventive Action Limit **7 ng/L (ppt)**

Hexavalent Chromium Chemical Profile	
Chemical Symbol	Cr^{6+}
CAS RN	18540-29-9
Molar Mass	51.996 g/mol
Synonyms	Chromium (VI) and Chromium 6+
Federal Number	NA

Strontium

The DNR's Waste and Materials Management program requested a standard for the metal Strontium. The proposed standard applies to non-radioactive Strontium which has been detected in both private and municipal water supply wells located in eastern Wisconsin. It occurs naturally the Silurian dolomite and Cambrian-Ordovician aquifers at concentrations of 10 to 39 ppm.

As required under ch. 160, Stats., DHS based its recommended groundwater quality enforcement standard for Strontium on the EPA's Health Reference Level established in 2014. Strontium can interfere with bone development, vitamin D metabolism and intestinal calcium absorption. Some studies indicate that Strontium can cause teratogenic effects.

Recommended Standards:
Enforcement Standard **1,500 ug/L (ppb)**
Preventive Action Limit **150 ug/L (ppb)**

Strontium Chemical Profile	
Chemical Symbol	Sr

CAS RN	7440-24-6
Molar Mass	87.6 g/mol
Synonyms	NA
Federal Number	1,500 ug/L

PROPOSED REVISED NR 140 HEALTH-BASED GROUNDWATER STANDARDS

Boron

The DNR's Waste and Materials Management program requested a review of the current groundwater quality standard for the metalloid Boron. The DHS recommended standard updates the Boron ES established in in 2010 (Cycle 9) from 1,000 ug/L to 2,000 ug/L, and the PAL from 200 ug/L to 400 ug/L, based on a change to the EPA's lifetime health advisory level. Boron occurs naturally in soils and rock as borates, boric oxides, or boric acid, and is used in manufacturing processes, mostly in the production of glass.

As required under ch. 160, Stats., DHS based its recommended groundwater quality enforcement standard for Boron on the EPA's Longer-term Child Health Advisory determined in 2008. Ingesting large amounts of Boron can lead to stomach, intestine, liver, kidney and brain effects in humans. Male animal reproductive organs can be impacted. The PAL is set at 20% of the ES because Boron does not cause carcinogenic, mutagenic, teratogenic or interactive health effects.

Recommended Standards:
Enforcement Standard **2,000 ug/L (ppb)**
Preventive Action Limit **400 ug/L (ppb)**

Boron Chemical Profile	
Chemical Symbol	B
CAS RN	7440-42-8
Molar Mass	10.81 g/mol
Synonyms	NA
Federal Number	2,000 ug/L

Molybdenum

The DNR's Waste and Materials Management program requested a review of the current groundwater quality standard for the metal Molybdenum. The DHS recommended standard updates the Molybdenum PAL established in in 2010 (Cycle 9) from 8 ug/L to 4 ug/L based on new technical information showing Molybdenum has teratogenic and interactive effects. Molybdenum occurs in naturally in minerals. It also is used in the manufacture of steel alloys.

As required under ch. 160, Stats., DHS based its recommended groundwater quality standard for Molybdenum on the EPA's lifetime Health Advisory established in 1993. Animal studies suggest that ingesting large amounts of Molybdenum might damage male and female reproduction systems and may cause liver and kidney damage. EPA didn't evaluate the potential carcinogenic effects of Molybdenum. It can have teratogenic effects or interactive health effects with copper in the body.

Recommended Standards:
Enforcement Standard **40 ug/L (ppb)**

Preventive Action Limit **4 ug/L (ppb)**

Molybdenum Chemical Profile	
Chemical Symbol	Mo
CAS RN	7439-98-7
Molar Mass	95.94 g/mol
Synonyms	NA
Federal Number	40 ug/L

Aluminum

The DNR's Waste and Materials Management program requested a review of the current groundwater quality standard for the metal Aluminum. The DHS has recommended no change to the current Aluminum ES established in 2010 (Cycle 9). Review of technical information published since 2010 was consistent with information reviewed in 2005 used to set the original standard. Aluminum occurs naturally minerals; is used in manufacturing processes; and occurs in coal ash compounds.

As allowed under ch. 160, Stats., DHS based the recommendation not to change the groundwater quality standard for Aluminum on new animal studies and re-calculation of acceptable daily intake (ADI) levels that show ingesting Aluminum can cause reproductive effects in laboratory animals. The PAL is set at 10% of the ES because Aluminum has carcinogenic effects.

Recommended Standards:
Enforcement Standard **200 ug/L (ppb)**
Preventive Action Limit **20 ug/L (ppb)**

Aluminum Chemical Profile	
Chemical Symbol	Al
CAS RN	7429-90-5
Molar Mass	26.98 g/mol
Synonyms	Bauxite
Federal Number	0.05 to 0.2 mg/L*

*Aluminum has a Secondary Maximum Contaminant Level.

Cobalt

The DNR's Waste and Materials Management program requested a review of the current groundwater quality standard for the metal Cobalt. The recommended standard is for non-radioactive Cobalt. The DHS has recommended no change to the current Cobalt ES established in 1997 (Cycle 7). The recommended PAL change from 8 ug/L to 4 ug/L is based on new information showing Cobalt has teratogenic effects on animals. Cobalt occurs naturally minerals; is used in manufacturing processes for glass, paint, ceramic and metal alloys; and occurs in coal ash compounds.

As allowed under ch. 160, Stats., DHS based its recommendation to change the PAL for Cobalt on new animal studies levels that show ingesting Cobalt can cause teratogenic effects in laboratory animals, therefore the PAL is set at 10% of the ES.

Recommended Standards:
Enforcement Standard **40 ug/L (ppb)**

Preventive Action Limit **4 ug/L (ppb)**

Cobalt Chemical Profile	
Chemical Symbol	Co
CAS RN	7440-84-4
Molar Mass	58.93 g/mol
Synonyms	NA
Federal Number	NA

Barium

The DNR's Waste and Materials Management program requested a review of the current groundwater quality standard for the metal Barium. The DHS has recommended no change to the current Barium ES and PAL established in 1992 (Cycle 5). Review of technical information published since 2007 was consistent with information used to set the current standard. Barium occurs naturally in minerals; is used in well drilling fluids; manufacturing of metal alloys, electronics, paint, ceramics, glass, rubber, medical waste; and occurs in coal ash compounds.

As allowed under ch. 160, Stats., DHS based its recommendation not to change the groundwater quality standard for Barium on a clinical study evaluating cardiovascular effects in women after exposure to Barium in drinking water. The current ES is consistent with the Maximum Contaminant Level set by EPA for drinking water in 2003. The PAL is set at 20% of the ES because Barium has not been shown to have carcinogenic, mutagenic, teratogenic or interactive effects.

Recommended Standards:
Enforcement Standard **2,000 ug/L (ppb)**
Preventive Action Limit **400 ug/L (ppb)**

Barium Chemical Profile	
Chemical Symbol	Ba
CAS RN	7440-39-3
Molar Mass	137.33 g/mol
Synonyms	NA
Federal Number	2 mg/L

AFFECTED RULE CHAPTERS

Wisconsin Administrative Code chapter NR 140

OTHER RELATED RULE REVISIONS

None

COMPARABLE FEDERAL AND STATE POLICIES

The United States Environmental Protection Agency (US EPA) establishes health based drinking water maximum contaminant levels (MCLs), cancer risk levels and health advisories (HAs). Federal drinking water MCLs are established based on scientific risk assessments and, in some cases, economic and technological considerations. Cancer risk levels are established as the concentration of a chemical in drinking water that corresponds to a specific excess estimated lifetime cancer risk. Federal lifetime

health advisories (LHAs) are developed based on an established health risk acceptable daily intake (ADI) level or reference dose (RfD). A federal MCL has been established for Barium, and federal LHAs have been established for Strontium, Boron and Molybdenum. The EPA has also established a Secondary Maximum Contaminant Level for aluminum.

The groundwater quality standards contained in ch. NR 140 are used in Wisconsin by state regulatory agencies as state groundwater protection standards. These standards are used as contamination site cleanup levels, design and management criteria for regulated activities and as minimum public health and welfare protection standards for contaminants in groundwater. The states surrounding Wisconsin: Minnesota, Michigan, Illinois and Iowa, also use groundwater protection values/levels/standards in their regulation of practices and activities that might impact the quality of groundwater resources. Groundwater protection quality standards are developed based on health risk assessments. Because states follow state specific health risk assessment methodologies, that use state specific health risk assessments and factors in calculating and developing their groundwater protection standards, different groundwater protection standard levels may be established for the same substance by different states.

DISCUSSION OF POTENTIAL ECONOMIC IMPACTS

The proposed revisions are intended to set health-based standards for two metals, both of which have been found in drinking water wells. Hexavalent Chromium has no federal number but has known carcinogenic, mutagenic, teratogenic and interactive effects. The standard for Strontium is based on EPA's Health Reference Level established in 2014. The proposed revisions to metals/metalloid standards for: Boron, Molybdenum, Aluminum, Cobalt, and Barium are intended to make the numeric standards consistent with new information. Most of the proposed revisions don't introduce new requirements that would have an economic impact. Impacts will be considered in further detail as the rule language is drafted.

COMMENTS

Section 281.12(1), Stats., grants the DNR the authority to carry out planning, management and regulatory programs necessary to protect, maintain and improve the quality and management of the waters of the state, ground and surface, public and private. Section 281.15, Stats., states that the Department shall promulgate rules setting standards of water quality, applicable to the waters of the state, that protect the public interest, including the protection of public health and welfare, and the present and prospective future use of such waters for public and private water systems. Section 281.19(1), Stats., grants the Department the authority to issue general orders and adopt rules applicable throughout the state for the construction, installation, use and operation of practicable and available systems, methods and means for preventing and abating pollution of the waters of the state.