

**Iowa Department of Natural Resources
Environmental Protection Commission**

ITEM

12

INFORMATION

TOPIC

**Proposed Rule – Chapter 61 Water Quality Standards- Chloride,
Sulfate and Total Dissolved Solids**

Background

In 2004, the DNR moved forward with a proposed chloride standard. Concerns were raised that the proposed chloride standard was not scientifically defensible for use in Iowa. The result was that a chloride standard was not approved and an interim strategy using Total Dissolved Solids as an indicator regarding water quality was put in place while the Department worked through the issues surrounding the chloride standard.

Recently the research and analysis related to toxicity of total dissolved solids, chloride and sulfate has been completed by the Department in conjunction with the Environmental Protection Agency. The purpose was to update and develop criteria for these parameters to better protect aquatic life based on new scientific information.

The DNR worked with the U.S. Environmental Protection Agency to ensure that the research compiled met certain scientific standards. Gaps were identified in the research and resulted in new toxicity tests being performed in 2008 and 2009.

With the availability of new research and toxicity data, the information is now available to propose numeric criteria for chloride and sulfate to better protect river, stream and lake aquatic life uses and remove the current interim approach for total dissolved solids criteria.

Timeline and Proposed Criteria

In May 2009, the Department plans to bring forth a Notice of Intended Action proposing water quality standard parameters for chloride and sulfate as well as to remove the interim strategy used regarding Total Dissolved Solids.

Proposed chloride criteria

To calculate the applicable acute and chronic criteria for chloride, use the equations below. Statewide default values for hardness and sulfate will be used unless site specific data is available.

Acute Chloride Criteria Equation

$$287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452} = \text{Acute Criteria Value (mg/L)}$$

Chronic Chloride Criteria Equation

$$177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452} = \text{Chronic Criteria Value (mg/L)}$$

Proposed Sulfate Criteria

Chloride Hardness mg/L as CaCO ₃	Cl ⁻ < 5 mg/L	5 ≤ Cl ⁻ < 25	25 ≤ Cl ⁻ <=500
H < 100 mg/L	500	500	500
100 ≤ H ≤ 500	500	[-57.478 + 5.79 (hardness) + 54.163 (chloride)] * 0.65	[1276.7 + 5.508 (hardness) - 1.457 (chloride)] * 0.65
H > 500	500	2,000	2,000

Statewide Background Values

The following statewide background values were determined by analyzing DNR ambient water monitoring data from 2000 to 2007:

Hardness: 200 mg/L as CaCO₃

Sulfate: 63 mg/L

Chloride: 34 mg/L

Total Dissolved Solids

The current interim approach for total dissolved solids levels through Whole Effluent Toxicity Testing will be replaced by the proposed numerical criteria for chloride and sulfate.

This revision is based on scientific review that demonstrates individual ions cause toxicity to aquatic life. This review revealed that in Iowa, chloride and sulfate are the specific ions of concern. As a result, ion criteria for chloride and sulfate are better indicators than integrative parameters such as TDS, conductivity and salinity for water quality protection.

A fact sheet regarding this issue has been attached for your information.

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March 30, 2009

Revising Criteria for Chloride, Sulfate and Total Dissolved Solids

By revising Iowa's water quality standards, the Iowa Department of Natural Resources (DNR) is working for improved water quality and safety in Iowa. Water Quality Standards are the goals that we set for Iowa's streams, rivers and lakes.

Water Quality Standards have three components:

- Designate the use or uses of the waterbody (aquatic life and recreational uses)
- Set the criteria for protecting those uses
- Protect and maintain existing water quality

Recently, the DNR began to compile all research related to toxicity of total dissolved solids, chloride and sulfate. The purpose was to update and develop criteria for these parameters to better protect aquatic life based on new scientific information.

The DNR worked with the U.S. Environmental Protection Agency to ensure that the research compiled met certain scientific standards. Gaps were identified in the research and resulted in new toxicity tests being performed in 2008.

With the availability of new research and toxicity data, the information is now available to propose numeric criteria for chloride and sulfate to better protect river, stream and lake aquatic life uses and reevaluate the current interim approach for total dissolved solids criteria.

Chloride Criteria

Results of the research and toxicity testing completed for chloride showed that chloride toxicity is heavily dependent on water hardness, and to a lesser degree, sulfate levels in the water. Using all of the literature and this most recent toxicity testing, EPA developed an equation (see below) for the acute and chronic chloride criteria to protect Iowa's waters.

Proposed chloride criteria

To calculate the applicable acute and chronic criteria for chloride, use the equations below. Statewide default values for hardness and sulfate will be used unless site specific data is available. The DNR updated its proposed chloride criteria on March 3, 2009, based on new EPA toxicity data.

Acute Chloride Criteria Equation

$$287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452} = \text{Acute Criteria Value (mg/L)}$$

Chronic Chloride Criteria Equation

$$177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452} = \text{Chronic Criteria Value (mg/L)}$$

The following statewide background values were determined by analyzing DNR ambient water monitoring data from 2000 to 2007:

- Hardness: 200 mg/L as CaCO₃
- Sulfate: 63 mg/L
- Chloride: 34 mg/L

For example, if a Hardness value of 200 mg/L and a Sulfate value of 63 mg/L are used:

The acute criteria value for chloride would be:

$$287.8(200 \text{ mg/L})^{0.205797}(63 \text{ mg/L})^{-0.07452} = \mathbf{629 \text{ mg/L Chloride}}$$

The chronic criteria value for chloride would be:

$$177.87(200 \text{ mg/L})^{0.205797}(63 \text{ mg/L})^{-0.07452} = \mathbf{389 \text{ mg/L Chloride}}$$

Sulfate Criteria

In 2005 and 2006, the State of Illinois worked with U.S. EPA

Chloride is a major ion commonly found in streams and wastewater. Chloride may get into surface water from several sources, including:

- Wastewater from certain industries
- Wastewater from communities that soften water
- Road salting
- Agricultural runoff
- Produced water from oil and gas wells



to complete a review of research related to sulfate toxicity similar to the work done for chloride. The result of that work was a proposed criteria equation for sulfate based on background hardness and chloride levels. The similarities between the landscape and waterbodies of Iowa and Illinois and the high level of scientific review of this data allow for the same sulfate criteria proposed by Illinois to apply to protect aquatic life in Iowa's waters.

The proposed sulfate criteria also incorporates an upper limit of 2,000 mg/L to ensure that other beneficial uses of the waterbody, such as livestock watering, are protected in addition to aquatic life.

Total Dissolved Solids

The current interim approach for total dissolved solids levels through Whole Effluent Toxicity Testing will be replaced by the proposed criteria for chloride and sulfate.

This revision is based on scientific review that demonstrates individual ions cause toxicity to aquatic life. This review revealed that in Iowa, chloride and sulfate are the specific ions of concern.

As a result, ion criteria for chloride and sulfate are better indicators than integral parameters such as TDS, conductivity and salinity for water quality protection.

Proposed Sulfate Criteria for Iowa Waters

The results of the following equations provide sulfate water quality standards in mg/L for the specified ranges of hardness (in mg/L as CaCO₃) and chloride (in mg/L) and must be met at all times:

- If the hardness concentration of waters is between 100 mg/L and 500 mg/L and if the chloride concentration of waters is between 25 mg/L and 500 mg/L:

$$[1276.7 + 5.508 (\text{hardness}) - 1.457 (\text{chloride})] * 0.65$$
- If the hardness concentration of waters is between 100 mg/L and 500 mg/L and if the chloride concentration of waters ranges between 5 mg/L and less than 25 mg/L:

$$[-57.478 + 5.79 (\text{hardness}) + 54.163 (\text{chloride})] * 0.65$$

The following sulfate standards must be met at all times when hardness (in mg/L as CaCO₃) and chloride (in mg/L) concentrations other than specified are present:

- If the hardness concentration of waters is less than 100 mg/L, or chloride concentration of waters is less than 5 mg/L, the sulfate standard is 500 mg/L.
- If hardness concentration of waters is greater than 500 mg/L, the sulfate standard is 2,000 mg/L.

PROPOSED SULFATE CRITERIA FOR IOWA WATERS			
Chloride \ Hardness mg/L as CaCO ₃	Cl- < 5 mg/L	5 ≤ Cl- < 25	25 ≤ Cl- ≤ 500
H < 100 mg/L	500	500	500
100 ≤ H ≤ 500	500	$[-57.478 + 5.79 (\text{hardness}) + 54.163 (\text{chloride})] * 0.65$	$[1276.7 + 5.508 (\text{hardness}) - 1.457 (\text{chloride})] * 0.65$
H > 500	500	2,000	2,000

Total Dissolved Solids is a measure of all constituents, or elements, dissolved in water. This can include inorganic anions (negatively charged ions) like carbonates, chlorides, sulfates and nitrates. The inorganic cations (positively charged ions) include sodium, potassium, calcium and magnesium.

Sulfate is a constituent of TDS and may form salts with sodium, potassium, magnesium and other cations. Sulfate is widely distributed in nature and may be present in natural waters at concentrations ranging from a few to several hundred milligrams per liter.

For more information:

Proposed Chloride Criteria at Various Concentrations of Hardness and Sulfate

Acute Chloride Criteria:

Sulfate mg/L	Hardness (as CaCO ₃) mg/L												
	50	100	150	200	250	300	350	400	450	500	600	700	800
5	571	659	716	760	795	826	852	876	897	917	952	983	1010
10	542	625	680	721	755	784	809	832	852	871	904	933	959
15	526	607	660	700	733	761	785	807	827	845	877	906	931
20	515	594	646	685	717	745	769	790	809	827	859	886	911
25	506	584	635	674	705	732	756	777	796	813	845	872	896
50	481	555	603	640	670	695	718	738	756	773	802	828	851
100	457	527	573	608	636	660	682	701	718	734	762	786	808
150	443	511	556	589	617	641	661	680	697	712	739	763	784
200	434	500	544	577	604	627	647	665	682	697	723	747	767
250	427	492	535	567	594	617	637	654	671	685	711	734	755
300	421	485	528	560	586	609	628	646	661	676	702	724	745
350	416	480	522	553	579	602	621	638	654	668	694	716	736
400	412	475	516	548	574	596	615	632	647	662	687	709	729
450	408	471	512	543	569	590	609	626	642	656	681	703	722
500	405	467	508	539	564	586	605	622	637	651	676	697	717

Chronic Chloride Criteria:

Sulfate mg/L	Hardness (as CaCO ₃) mg/L												
	50	100	150	200	250	300	350	400	450	500	600	700	800
5	353	407	442	469	491	510	527	541	555	567	589	607	624
10	335	387	420	446	467	485	500	514	527	538	559	577	593
15	325	375	408	433	453	470	485	499	511	522	542	560	575
20	318	367	399	423	443	460	475	488	500	511	531	548	563
25	313	361	392	416	436	453	467	480	492	503	522	539	554
50	297	343	373	395	414	430	444	456	467	477	496	512	526
100	282	326	354	375	393	408	421	433	444	453	471	486	499
150	274	316	343	364	381	396	409	420	430	440	457	471	485
200	268	309	336	357	373	388	400	411	421	431	447	461	474
250	264	304	331	351	367	381	394	404	414	423	440	454	467
300	260	300	326	346	362	376	388	399	409	418	434	448	460
350	257	297	322	342	358	372	384	394	404	413	429	443	455
400	255	294	319	339	355	368	380	391	400	409	425	438	450
450	252	291	316	336	351	365	377	387	397	405	421	434	447
500	250	289	314	333	349	362	374	384	394	402	418	431	443

Proposed Sulfate Criteria at Various Concentrations of Hardness and Chloride

Chloride (mg/L)	Hardness as CaCO ₃ (mg/L)										
	<100	100	150	200	250	300	350	400	450	500	>500
<5	500	500	500	500	500	500	500	500	500	500	2000
5	500	515	703	891	1080	1268	1456	1644	1832	2020	2000
10	500	691	879	1067	1256	1444	1632	1820	2008	2196	2000
15	500	867	1055	1243	1432	1620	1808	1996	2184	2372	2000
20	500	1043	1231	1419	1608	1796	1984	2172	2360	2549	2000
25	500	1164	1343	1522	1701	1880	2059	2238	2417	2596	2000
50	500	1141	1320	1499	1678	1857	2036	2215	2394	2573	2000
100	500	1093	1272	1451	1630	1809	1988	2167	2346	2525	2000
150	500	1046	1225	1404	1583	1762	1941	2120	2299	2478	2000
200	500	998	1177	1356	1535	1715	1894	2073	2252	2431	2000
250	500	951	1130	1309	1488	1667	1846	2025	2204	2383	2000
300	500	904	1083	1262	1441	1620	1799	1978	2157	2336	2000
350	500	856	1035	1214	1393	1572	1751	1930	2109	2288	2000
400	500	809	988	1167	1346	1525	1704	1883	2062	2241	2000
450	500	762	941	1120	1299	1478	1657	1836	2015	2194	2000
500	500	714	893	1072	1251	1430	1609	1788	1967	2146	2000