

# Regulation No. 31 Table III Metal Parameters: Calculator for Hardness-based Equations

(updated February 26, 2021)

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This table shows the hardness-based table value standards calculated at hardness values ranging from 25 - 400 mg/L (Columns D - N). It also includes a calculator to generate standards using a site-specific hardness value (Column O).

Hardness values to be used in equations are in mg/L as calcium carbonate (CaCO<sub>3</sub>) and shall be no greater than 400 mg/L. The exception is for aluminum, where the upper cap on calculations is a hardness of 220 mg/L.

If data for hardness as CaCO<sub>3</sub> are not available, hardness can be calculated using calcium and magnesium data in the "Hardness Calculator" tab.

Source: Regulation No. 31 - The Basic Standards and Methodologies for Surface Water.

To generate the standards for a given site, enter the site-specific hardness value (as CaCO<sub>3</sub>) here:

250

Parameter	Equation	Mean Hardness in mg/L as CaCO <sub>3</sub> a											Site-specific
		25	50	75	100	150	200	220	250	300	350	400	
<b>Aluminum (µg/L, total recoverable)b</b>													
Acute	$e^{(1.3695 \cdot \ln(\text{hardness}) + 1.8308)}$	512	1,324	2,307	3,421	5,960	8,838	10,071	10,071	10,071	10,071	10,071	10,071
Chronic	$e^{(1.3695 \cdot \ln(\text{hardness}) - 0.1158)}$	73	189	329	488	851	1,262	1,438	1,438	1,438	1,438	1,438	1,438
<b>Cadmium (µg/L, dissolved)c,d</b>													
Acute(warm)	$b \cdot e^{(0.9789 \cdot \ln(\text{hardness}) - 3.443)}$	0.75	1.43	2.09	2.74	4.00	5.23	5.72	6.44	7.64	8.82	9.99	6.44
Acute(cold)	$b \cdot e^{(0.9789 \cdot \ln(\text{hardness}) - 3.866)}$	0.49	0.94	1.37	1.79	2.62	3.43	3.75	4.22	5.00	5.78	6.54	4.22
Chronic	$c \cdot e^{(0.7977 \cdot \ln(\text{hardness}) - 3.909)}$	0.25	0.43	0.58	0.72	0.97	1.21	1.30	1.43	1.64	1.84	2.03	1.43
<b>Chromium III (µg/L, dissolved)</b>													
Acute	$e^{(0.8190 \cdot \ln(\text{hardness}) + 2.5736)}$	183	323	450	570	794	1005	1087	1207	1401	1590	1773	1207
Chronic	$e^{(0.8190 \cdot \ln(\text{hardness}) + 0.5340)}$	24	42	59	74	103	131	141	157	182	207	231	157
<b>Copper (µg/L, dissolved)</b>													
Acute	$e^{(0.9422 \cdot \ln(\text{hardness}) - 1.7408)}$	3.6	7.0	10.2	13.4	19.7	25.8	28.2	31.9	37.8	43.8	49.6	31.9
Chronic	$e^{(0.8545 \cdot \ln(\text{hardness}) - 1.7428)}$	2.7	5.0	7.0	9.0	12.7	16.2	17.6	19.6	22.9	26.1	29.3	19.6
<b>Lead (µg/L, dissolved)c</b>													
Acute	$f_a \cdot e^{(1.273 \cdot \ln(\text{hardness}) - 1.460)}$	13.9	30	47	65	100	136	151	172	209	245	281	172
Chronic	$f_c \cdot e^{(1.273 \cdot \ln(\text{hardness}) - 4.705)}$	0.54	1.17	1.84	2.52	3.90	5.31	5.87	6.72	8.13	9.54	10.9	6.7
<b>Manganese (µg/L, dissolved)</b>													
Acute	$e^{(0.331 \cdot \ln(\text{hardness}) + 6.4676)}$	1881	2370	2713	2986	3417	3761	3882	4051	4305	4532	4738	4051
Chronic	$e^{(0.331 \cdot \ln(\text{hardness}) + 5.8743)}$	1040	1309	1499	1650	1888	2078	2145	2238	2379	2504	2618	2238
<b>Nickel (µg/L, dissolved)</b>													
Acute	$e^{(0.8460 \cdot \ln(\text{hardness}) + 2.253)}$	145	260	367	468	660	842	912	1017	1186	1351	1513	1017
Chronic	$e^{(0.8460 \cdot \ln(\text{hardness}) + 0.0554)}$	16	29	41	52	73	93	101	113	132	150	168	113
<b>Silver (µg/L, dissolved)</b>													
Acute	$0.5 \cdot e^{(1.72 \cdot \ln(\text{hardness}) - 6.52)}$	0.19	0.6	1.2	2.0	4.1	6.69	7.9	9.8	13.4	17.5	22.0	9.8
Chronic(trout)	$e^{(1.72 \cdot \ln(\text{hardness}) - 10.51)}$	0.01	0.02	0.05	0.08	0.15	0.25	0.29	0.36	0.50	0.65	0.81	0.36
Chronic	$e^{(1.72 \cdot \ln(\text{hardness}) - 9.06)}$	0.03	0.1	0.2	0.3	0.6	1.1	1.2	1.5	2.1	2.8	3.5	1.5
<b>Uranium (µg/L, dissolved)e</b>													
Acute	$e^{(1.1021 \cdot \ln(\text{hardness}) + 2.7088)}$	521	1119	1750	2402	3756	5157	5728	6595	8062	9555	11070	6595
Chronic	$e^{(1.1021 \cdot \ln(\text{hardness}) + 2.2382)}$	326	699	1093	1501	2346	3221	3578	4119	5036	5968	6915	4119
<b>Zinc (µg/L, dissolved)f</b>													
Acute	$e^{(0.9094 \cdot \ln(\text{hardness}) + 0.9095)}$	45	85	123	160	231	301	328	368	435	500	564	368
Chronic(sculpin)	$e^{(2.140 \cdot \ln(\text{hardness}) - 5.084)}$	6.1	27	64	118	--	--	--	--	--	--	--	--
Chronic	$e^{(0.9094 \cdot \ln(\text{hardness}) + 0.6235)}$	34	65	93	121	175	228	248	279	329	379	428	279

Notes:

a Hardness values to be used in equations are in mg/L as calcium carbonate and shall be no greater than 400 mg/L. The exception is for aluminum, where the upper cap on calculations is a hardness of 220 mg/L.

b Where the pH is equal to or greater than 7.0 in the receiving water after mixing, the chronic hardness-dependent equation will apply. Where pH is less than 7.0 in the receiving water after mixing, either the 87 µg/l chronic total recoverable aluminum criterion or the criterion resulting from the chronic hardness-dependent equation will apply, whichever is more stringent.

c Acute (cfa) and chronic (cfc) conversion factors for cadmium and lead are provided in the table below.

d The acute(warm) cadmium equation applies to segments classified as Aquatic Life Warm Class 1 or 2. The acute(cold) cadmium equation applies to segments classified as Aquatic Life Cold Class 1 or 2.

e When applying the table value standards for uranium to individual segments, the Commission shall consider the need to maintain radioactive materials at the lowest practical level as required by Section 31.11(2) of the Basic Standards regulation.

f The chronic zinc equation for sculpin applies in areas where mottled sculpin are expected to occur and hardness is less than or equal to 102 mg/L CaCO<sub>3</sub>. The regular chronic zinc equation applies where mottled sculpin are expected to occur, but the hardness is greater than 102 mg/L CaCO<sub>3</sub>. The regular chronic zinc equation also applies where mottled sculpin are not expected to occur.

Conversion Factors (cf) Used in the Table Above		
Cadmium	cfa	$1.136672 \cdot (\ln(\text{hardness}) + 0.041838)$
Cadmium	cfc	$1.101672 \cdot (\ln(\text{hardness}) + 0.041838)$
Lead	cfa	$1.46203 \cdot (\ln(\text{hardness}) + 0.145712)$
Lead	cfc	$1.46203 \cdot (\ln(\text{hardness}) + 0.145712)$

## Hardness Calculator

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If data for hardness as CaCO<sub>3</sub> are not available, this sheet can be used to calculate hardness using paired calcium and magnesium data.

Insert additional rows as needed.

Sample	Ca, mg/L	Mg, mg/L	Hardness, mg/L
1	25	25	165.38
2			0.00
3			0.00
4			0.00
5			0.00
6			0.00
7			0.00
8			0.00
9			0.00
10			0.00
11			0.00
12			0.00
13			0.00
14			0.00
15			0.00
16			0.00
17			0.00
18			0.00
19			0.00
20			0.00