Overview of Water Quality Planning Regulation R186-08: Revision of Molybdenum Aquatic Life Water Quality Standard

Background

Molybdenum is an essential micronutrient with relatively low toxicity to aquatic life. The current Nevada molybdenum water quality standard (NAC 445A.144) for protection of aquatic life is 19 µg/l (0.019mg/l). The standard is based on recommendations contained in a report prepared in 1988 by the California Regional Water Quality Control Board for the Central Valley Region of California (Regional Board) to regulate agricultural drainage in the San Joaquin River Basin. Revisions are proposed because the existing standard was not developed according to accepted U.S. EPA protocols and is therefore inappropriate.

The 19 µg/l standard was derived by taking the log (or geometric) mean of three toxicity values and a surface water background concentration of molybdenum, as shown below. Thus, the criterion is based on very limited toxicity data and is strongly biased by the low ambient background concentration used in the calculation. The use of an ambient background level in the derivation of a water quality standard is not consistent with current EPA protocols, nor does it reflect a toxicological threshold to aquatic life.

Derivation of Current Molybdenum Standard

Species	Effect Level (µg/L)	Citation
rainbow trout	120	Birge et al., 1980
narrow-mouthed toad	960	Birge, 1978
Daphnia magna	1150	Kimball manuscript
Geometric Mean Adverse Effect Level:	**510**	

Geometric mean of effects level (510 µg/L) and national ambient background concentration (0.68 µg/L) = **19 µg/L**

Development of Revised Molybdenum Aquatic Life Water Quality Criteria

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The proposed acute and chronic molybdenum criteria for the protection of aquatic life were derived according to EPA protocols described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses (EPA 1985).*

This guidance document provides the standard protocol for deriving protective aquatic life criteria for metals and chemicals. The guidance sets the toxicological data requirements which must be met to ensure that a sufficient diversity of aquatic species have been appropriately tested, as well as, the procedures to follow for calculating criteria based upon those data. The criteria calculation methodology is heavily dependent upon the four most sensitive species and the number of different species for which toxicity data are available. The acute test results for 15 aquatic life species and chronic test results for 5 species, as shown below, were used to derive the proposed acute and chronic molybdenum criteria.

Acute Test Data

Rank	Species	Common Name	Acute Effect Level (mg Mo/L)
15	*Ictalurus punctatus*	channel catfish	10,000.0000
14	*Chironomus tentans*	midge	7,533.3000
13	*Lepomis macrochirus*	bluegill	6,790.0000
12	*Gammarus fasciatus*	scud	3,940.0000
11	*Crangonyx pseudogracilis*	isopod	2,650.0000
10	*Oncorhynchus mykiss*	rainbow trout	2,269.4034
9	*Daphnia magna*	cladoceran	2,218.0871
8	*Oncorhynchus nerka*	kokanee salmon	2,000.0000
8	*Catostomus commersoni*	white sucker	2,000.0000
7	*Catostomus latipinnis*	flannelmouth sucker	1,940.0000
6	*Girardia dorotocephala*	flatworm	1,225.6000
5	*Ceriodaphnia dubia*	cladoceran	1,015.0000
4	*Oncorhynchus kisutch*	coho salmon	1,000.0000
4	*Oncorhynchus tshawytscha*	chinook salmon	1,000.0000
3	*Pimephales promelas*	fathead minnow	253.8110
2	*Euglena gracilis*	protistan	72.3000
1	*Tubifex tubifex*	tubificid worm	28.9100

Chronic Test Data

Rank	Species	Common Name	ChronicEffect Level (mg Mo/L)
5	*Oncorhynchus mykiss*	rainbow trout	866.0254
4	*Pimephales promelas*	fathead minnow	163.5427
3	*Daphnia magna*	cladoceran	97.0183
2	*Ceriodaphnia dubia*	cladoceran	60.4380
1	*Catostomus commersoni*	white sucker	1.7000

The proposed molybdenum acute criterion of 6.16 mg/l (6,160 µg/l) was calculated as follows:

Rank	Genus	GMAV (mg/L)	LN GMAV	(LN GMAV)^2	P = R/(N+1)	P$^{0.5}$
4	*Ceriodaphnia*	1,015.0000	6.9226	47.9230	0.2857	0.5345
3	*Pimephales*	253.8110	5.5366	30.6538	0.2143	0.4629
2	*Euglena*	72.3000	4.2808	18.3255	0.1429	0.3780
1	*Tubifex*	28.9100	3.3642	11.3178	0.0714	0.2673
		Sum	20.1042	108.2200	0.7143	1.6427

Sample Size (N) = 13

$$S^2 = \frac{\sum\left((LN\ GMAV)^2\right) - \left(\frac{\left(\sum(LN\ GMAV)\right)^2}{4}\right)}{\sum(P) - \left(\frac{\left(\sum\left(\sqrt{P}\right)\right)^2}{4}\right)} = 180.7081 \qquad S = \sqrt{S^2} = 13.4428$$

$$L = \left(\sum(LN\ GMAV)\right) - \frac{\left(S\left(\sum\left(\sqrt{P}\right)\right)\right)}{4} = -0.4944 \qquad A = S\left(\sqrt{0.05}\right) + L = 2.5114$$

$$FAV = e^A = 12.3232$$

$$\frac{FAV}{2} = \frac{12.3232}{2} = 6.1616$$

Criteria Maximum Concentration (CMC) = Acute Criterion = 6.16 mg Mo/L

Due to the relatively limited amount of chronic test data, the proposed chronic criterion of 1.65 mg/l (1,650 µg/l) was derived by determining an acute-to-chronic ratio of the available data as follows:

Acute-to-Chronic Ratio Derivation

Species	Acute Value (mg/L)	Chronic Value (mg/L)	ACR	Species Mean ACR
Ceriodaphnia dubia	1015.0	76.9	13.2	13.2
Pimephales promelas	644.2	163.5	3.9	3.9
Daphnia magna	1727.8	153.8	11.2	22.9
Daphnia magna	2847.5	61.2	46.5	
Oncorhynchus mykiss	2269.4	866	2.6	2.6
			Final ACR	**7.5**

Chronic Criterion Calculation

Final Acute Value (FAV) ÷ ACR = Final Chronic Value (FCV)

FAV (12.32 mg Mo/L) ÷ ACR (7.5) = FCV (1.65 mg Mo/L)

FCV = Criteria Continuous Concentration (CCC) = Chronic Criterion

Chronic Criterion for Molybdenum = 1.65 mg/L

The proposed molybdenum water quality criteria were developed based upon all available, suitable molybdenum toxicity data following appropriate EPA methodology. As per EPA guidance, these criteria should be protective of aquatic life if the four-day average concentration of molybdenum does not exceed the chronic criterion of 1.65 mg/l (1,650 µg/l) more than once every three years on average and if the one-hour average concentration does not exceed 6.16 mg/l (6,160 µg/l) more than once every three years on average.

Proposed Water Quality Regulation Revisions

The primary revision proposed to regulation NAC 445A.144 replaces the existing molybdenum aquatic life standard with an acute (1-hour average) standard of 6,160 µg/l and a chronic (96-hour average) standard of 1,650 µg/l.

Other minor revisions include:

- revising Section 1 language of the regulation to allow for site-specific waterbody standards of chemicals contained in NAC 445A.144, and revising the "References" section of the regulation to document the origin of the revised molybdenum aquatic life standards; and

- editorial change regarding the location of the Irrigation Standard for Iron in the regulation.