

DRAFT

TECHNICAL MEMORANDUM

December 2004

REVISED ZINC CRITERIA

As part of the recent South Platte River Basin water quality hearing (July 2004), Chadwick Ecological Consultants, Inc. (CEC), on behalf of Climax Molybdenum Company, Inc., developed site-specific zinc standards for West Fork Clear Creek (CEC 2004a, b, c, d). These site-specific standards were approved by the Colorado Water Quality Control Commission and adopted for this stream segment (Clear Creek Segment 5).

Development of the site-specific zinc standard was based on the recalculation procedure (USEPA 1994) following deletion of non-resident taxa from the U.S. EPA zinc toxicity database. However, prior to the recalculation, CEC conducted a literature review and updated the existing zinc toxicity database. As a result, it was possible to derive new acute and chronic zinc criteria as well (see Table 7, CEC 2004a).

For our update of zinc criteria, CEC reviewed the zinc criteria in the “1995 Updates” (U.S. EPA 1995) and its precursor “1987 Ambient Water Quality Criteria for Zinc (U.S. EPA 1987). Our reviews consisted of an evaluation of data used by the U.S. EPA for criteria derivation and updating the database with suitable data recently published, which resulted in revised criteria for zinc (CEC 2004a).

Since the release of our report, additional acute and chronic data on the toxicity of zinc to *Onchorhynchus clarki pleuriticus* and *Onchorhynchus mykiss* recently published by the Colorado Division of Wildlife (CDOW) (Brinkman and Hansen 2004) was brought to our attention. This technical memorandum presents how the addition of these data from this document would change our updated acute and chronic criteria for zinc.

Updated Zinc Criteria

A review of Brinkman and Hansen (2004) revealed two suitable acute and chronic data points for both rainbow trout, *O. mykiss*, and Colorado River cutthroat trout, *O. clarki pleuriticus* (Table 1). Adding acute data from Brinkman and Hansen (2004) to the revised acute zinc database lowers the ranking of *Onchorhynchus* from 12th to the 10th most sensitive genera and slightly increases the acute hardness slope from 0.8404 to 0.8489. These changes do not significantly affect acute criteria for zinc (increased the FAV from 133 µg/L to 159 µg/L).

TABLE 1: Data added to the CEC revised zinc acute and chronic database for criteria derivation, hardness slope calculations, and acute-chronic ratio calculations.

Species	Hardness (mg/L)	Acute LC ₅₀ (µg/L)	Chronic Value (µg/L)	Reference
<i>Onchorhynchus mykiss</i>	33.2	125	74	Brinkman and Hansen 2004
<i>Onchorhynchus mykiss</i>	145.4	585	325	Brinkman and Hansen 2004
<i>Onchorhynchus clarki pleuriticus</i>	31.1	140	134	Brinkman and Hansen 2004
<i>Onchorhynchus clarki pleuriticus</i>	149.4	1,645	1,343	Brinkman and Hansen 2004

Including the chronic data for *O. mykiss* and *O. clarki pleuriticus* change chronic criteria by altering the FACR (Table 2). Data for *O. mykiss* updates the existing species mean acute-chronic ratio, whereas data for *O. clarki pleuriticus* introduces a species not previously represented in the FACR. Incorporating the paired acute and chronic data from Brinkman and Hansen (2004) lowers the FACR from 2.8906 to 2.6273 (Table 2), which results in a slightly higher FCV (increased FCV from 52.8 µg/L to 60.5 µg/L).

TABLE 2: Derivation of revised acute-to-chronic ratio for zinc.

Existing ACR data:			New ACR derivation data using data below:		
Species		Ratio	Species		Ratio
<i>Oncorhynchus mykiss</i>		1.554	<i>Daphnia magna</i>		4.5137
<i>Oncorhynchus tshawytscha</i>		0.7027	<i>Oncorhynchus mykiss</i>		1.6809
<i>Daphnia magna</i>		7.26	<i>Oncorhynchus tshawytscha</i>		0.7027
<i>Pimephales promelas</i> ^a		5.664	<i>Salvelinus fontinalis</i>		1.4299
			<i>Oncorhynchus clarki pleuriticus</i>		1.1312
<i>Salvelinus fontinalis</i> ^a		2.335	<i>Salmo trutta</i>		1.6809
<i>Jordanella floridae</i> ^b		41.2	<i>Cottus bairdi</i>		7.5000
EPA acute-chronic ratio =		1.993973	<i>Pimephales promelas</i>		5.6640
			Revised Acute-chronic ratio =		2.6273
<i>Salvelinus fontinalis</i>	60	1,458.0	2,098.0	0.6949	referenced in ERA, USEPA 2002
<i>Salvelinus fontinalis</i>	52.6	932.4	517.5	1.8017	Davies <i>et al.</i> 2000
<i>Cottus bairdi</i>	46.3-48.6	156.0	20.8	7.5000	Woodling <i>et al.</i> 2002
<i>Salmo trutta</i>	50	392.0	194.0	2.0206	Davies and Brinkman 1999
<i>Salmo trutta</i>	39	550.0	457.0	1.2035	Davies and Brinkman 1994a
<i>Salmo trutta</i>	52.6	540.2	276.6	1.9530	Davies <i>et al.</i> 2000
<i>Daphnia spp.</i>	60	128.0	118.0	1.0847	ERA, USEPA 2002
<i>Oncorhynchus mykiss</i>	33.2	125	74	1.6892	Brinkman and Hansen 2004
<i>Oncorhynchus mykiss</i>	145.4	588	325	1.8092	Brinkman and Hansen 2004
<i>Oncorhynchus clarki</i>	31.1	140	134	1.0448	Brinkman and Hansen 2004
<i>Oncorhynchus clarki</i>	149.4	1,645	1,343	1.2249	Brinkman and Hansen 2004

Revised based on Table 6 from CEC 2004 report entitled *Determination of Appropriate Zinc Standards for Segment 5 on West Fork Clear Creek* prepared for Climax Molybdenum Company, Inc.

^a not used in EPA calculation

^b not used because order of magnitude different

Incorporation of these new data modify our updated zinc criteria equations slightly as follows, with resulting changes in calculated criteria (Table 3):

$$\text{Acute Zn} = e^{0.8489 [\ln (\text{hardness})]+1.0549}$$

$$\text{Chronic Zn} = e^{0.8489 [\ln (\text{hardness})]+0.7821}$$

TABLE 3: Summary of existing and revised zinc standards at varying hardness levels using updated toxicity database, revised pooled-hardness slope, and updated acute-to-chronic ratio.

Equations	Mean Hardness in mg/L CaCO ₃									
	25	50	75	100	150	200	250	300	350	400
Current Standards										
Acute = $e^{0.8473 [\ln (\text{hardness})]+0.8840}$	37.02	66.6	93.9	119.82	168.93	215.57	260.43	303.94	346.34	387.83
Chronic = $e^{0.8473 [\ln (\text{hardness})]+0.8840}$	37.02	66.6	93.9	119.82	168.93	215.57	260.43	303.94	346.34	387.83
Updated/Revised Standards										
Acute = $e^{0.8489 [\ln (\text{hardness})]+1.0549}$	44.04	79.50	112.17	143.20	202.03	257.92	311.71	363.89	414.76	464.54
Chronic = $e^{0.8489 [\ln (\text{hardness})]+0.7821}$	33.60	60.52	85.39	109.01	153.80	196.34	237.29	277.01	315.73	353.63

Revised based on Table 7 from CEC 2004 report entitled *Determination of Appropriate Zinc Standards for Segment 5 on West Fork Clear Creek* prepared for Climax Molybdenum Company, Inc.

Literature Cited

Brinkman, S., and D. Hansen. 2004. *Water Pollution Studies*. Federal Aid Project F-243-R11. Colorado Division of Wildlife, Fish Research Section, Fort Collins, CO.

Chadwick Ecological Consultants, Inc. 2004a. *Development of Site-specific Zinc Standards for West Fork Clear Creek (Clear Creek Segment 5), Clear Creek County, Colorado*. Report prepared for Climax Molybdenum Company, Inc.

Chadwick Ecological Consultants, Inc. 2004b. *Development of Site-specific Zinc Standards for West Fork Clear Creek (Clear Creek Segment 5), Clear Creek County, Colorado*, Revised May 2004. Report prepared for Climax Molybdenum Company, Inc.

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Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*. U.S. Environmental Protection Agency, Office of Research and Development, Duluth, MN.

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APPENDIX A

Acute and Chronic Toxicity Databases

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