DERIVATION OF ACUTE AND CHRONIC TOXICITY CRITERIA FOR CYANIDE

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EPA SPECIES MEAN ACUTE VALUES

(values from 1985 EPA AWQC document and 3/95 GLI Criteria Update, EPA-820-B-95-004)

Cladoceran *(Daphnia pulex)*

VALUE (ug/L)	REFERENCE
83	Lee, 1976
110	Cairns, et al. 1978
SMAV = 95.55	(2 results)

Cladoceran *(Daphnia magna)*

VALUE (ug/L)	REFERENCE
160	Dowden and Bennett, 1965
SMAV = 160	(1 result)

Snail *(Physa heterostropha)*

VALUE (ug/L)	REFERENCE
432	Cairns & Scheier, 1958; Patrick, et al. 1968
SMAV = 432	(1 result)

Isopod *(Asellus communis)*

VALUE (ug/L)	REFERENCE
2326	Oseid and Smith, 1979
SMAV = 2326	(1 result)

Amphipod *(Gammarus pseudolimnaeus)*

VALUE (ug/L)	REFERENCE
167	Oseid and Smith, 1979
SMAV = 167	(1 result)

Stonefly *(Pteronarcys dorsata)*

VALUE (ug/L)	REFERENCE
426	Call and Brooks, 1982
SMAV = 426	(1 result)

Midge *(Tanytarsus dissimilis)*

VALUE (ug/L)	REFERENCE
2490	Call, et al. 1983
SMAV = 2490	(1 result)

Atlantic salmon *(Salmo salar)*

VALUE (ug/L)	REFERENCE
90	Tryland and Grande, 1983 (juv)
SMAV = 90	(1 result)

Brook trout *(Salvelinus fontinalis)* - all suf and/or juv

VALUE (ug/L)	REFERENCE
156	Cardwell, et al. 1976
84	Smith, et al. 1978
54.4	Smith, et al. 1978
86.5	Smith, et al. 1978
104	Smith, et al. 1978
90.3	Smith, et al. 1978
99	Smith, et al. 1978
96.7	Smith, et al. 1978
112	Smith, et al. 1978
52	Smith, et al. 1978
60.2	Smith, et al. 1978
66.8	Smith, et al. 1978
71.4	Smith, et al. 1978
97	Smith, et al. 1978
143	Smith, et al. 1978
73.5	Smith, et al. 1978
83	Smith, et al. 1978
75	Smith, et al. 1978
86.4	Smith, et al. 1978
91.9	Smith, et al. 1978
SMAV = 85.80	(20 FT results)

Rainbow trout *(Onchorhynchus mykiss)*

VALUE (ug/L)	REFERENCE
57	Smith, et al. 1978; Broderius & Smith, 1979
27	Kovacs, 1979; Kovacs & Leduc, 1982
40	Kovacs, 1979; Kovacs & Leduc, 1982
65	Kovacs, 1979; Kovacs & Leduc, 1982
SMAV = 44.73	(4 results)

Goldfish *(Carassius auratus)*

VALUE (ug/L)	REFERENCE
318	Cardwell, et al. 1976
SMAV = 318	(1 result)

Fathead minnow *(Pimephales promelas)*

VALUE (ug/L)	REFERENCE
120	Smith, et al. 1978
98.7	Smith, et al. 1978
81.8	Smith, et al. 1978
110	Smith, et al. 1978
116	Smith, et al. 1978
119	Smith, et al. 1978
126	Smith, et al. 1978
81.5	Smith, et al. 1978
124	Smith, et al. 1978; Broderius & Smith, 1979
137	Smith, et al. 1978
131	Smith, et al. 1978
105	Smith, et al. 1978
119	Smith, et al. 1978
131	Smith, et al. 1978
122	Smith, et al. 1978
161	Smith, et al. 1978
188	Smith, et al. 1978
175	Smith, et al. 1978
163	Smith, et al. 1978
169	Smith, et al. 1978
120	Broderius, et al. 1977
113	Broderius, et al. 1977
128	Broderius, et al. 1977
128	Broderius, et al. 1977
SMAV = 125.14	(24 FT results)

Yellow perch *(Perca flavescens)*

VALUE (ug/L)	REFERENCE
88.9	Smith, et al. 1978
93	Smith, et al. 1978
74.7	Smith, et al. 1978
94.7	Smith, et al. 1978
101	Smith, et al. 1978
107	Smith, et al. 1978
SMAV = 92.64	(6 FT results)

Black crappie *(Pomoxis nigromaculatus)*

VALUE (ug/L)	REFERENCE
102	Smith, et al. 1979
SMAV = 102	(1 result)

Bluegill *(Lepomis macrochirus)*

VALUE (ug/L)	REFERENCE
81	Smith, et al. 1978
85.7	Smith, et al. 1978
74	Smith, et al. 1978
100	Smith, et al. 1978
107	Smith, et al. 1978
99	Smith, et al. 1978
113	Smith, et al. 1978
121	Smith, et al. 1978
126	Smith, et al. 1978
SMAV = 99.28	(9 FT results)

Largemouth bass *(Micropterus salmoides)*

VALUE (ug/L)	REFERENCE
102	Smith, et al. 1979
SMAV = 102	(1 result)

Guppy *(Poecilia reticulata)*
EPA SMAV is not used in Wisconsin since Genus Poecilia is non-resident to Wisconsin, Iowa, and the other Great Lakes states.

MINIMUM DATABASE REQUIREMENT EVALUATION
According to s. NR 105.05(1)(a), acute toxicity criteria can be calculated if data are available on one or more species of freshwater animal in at least 8 different families, provided that of the 8 species:

1. At least one is a salmonid fish in the family Salmonidae in the class Osteichthyes,
2. At least one is a non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important species,
3. At least one is a planktonic crustacean (e.g., cladoceran, copepod),
4. At least one is a benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish),
5. At least one is an insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge),
6. At least one is a fish or amphibian from a family in the phylum Chordata not already represented in one of the other subdivisions,
7. At least one is an organism from a family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca), and
8. At least one is an organism from a family in any order of insect or any other phylum not already represented in subds. 1. to 7.

Using the above numbering scheme, the following species are represented in the minimum database requirements for criteria calculation. If any of the 8 categories are not represented in the database, a criterion cannot be calculated under ch. NR 105. Instead, a secondary value must be calculated.

1. Rainbow trout
2. Bluegill
3. Cladoceran *(D. magna)*
4. Amphipod (*G. pseudolimnaeus*)
5. Midge *(T. dissimilis)*
6. Fathead minnow, family Cyprinidae
7. Snail (*P. heterostropha*)
8. Yellow perch, family Percidae

CONCLUSION: An acute toxicity criterion can be calculated for cyanide according to ch. NR 105.

GENUS NAME (w/ component species)		GMAV (ug/L)	CLASSIFICATIONS * CW	WW	LFF	LAL
Tanytarsus		2490.00	x	x	x	x
Asellus		2326.00	x	x	x	x
Physa		432.00	x	x	x	x
Pteronarcys		426.00	x	x	x	x
Carassius		318.00	x	x	x	
Gammarus		167.00	x	x	x	x
Pimephales		125.14	x	x	x	
Daphnia:		123.65	x	x	x	x
D. pulex	95.55					
D. magna	160.00					
Micropterus		102.00	x	x		
Pomoxis		102.00	x	x		
Lepomis		99.25	x	x		
Perca		92.64	x	x		
Salmo		90.00	x			
Salvelinus		85.80	x			
Onchorhynchus		44.73	x			
TOTAL NUMBER OF GENERA REPRESENTED:			15	12	8	6

* - KEY TO CLASSIFICATIONS (an X is listed for species considered in each):

CW = Coldwater community, all genera are considered here.

WW = Warmwater sportfish community, only the coldwater fish are excluded from this database (also includes warmwater forage).

LFF = Limited forage fish community, all sport fish are excluded from this database.

LAL = Limited aquatic life, all fish are excluded from this database.

The four most sensitive genera in each classification are used to calculate the criteria under each classification, pursuant to s. NR 105.05 (2). From this point, the results of the calculation are shown using the variables listed in sub. (2).

CRITERION CALCULATION:

	CW	WW	LFF	LAL
GMAV RANKS				
4	92.64	102.00	318.00	432.00
3	90.00	102.00	167.00	426.00
2	85.80	99.28	125.14	167.00
1	44.73	92.64	123.65	123.65
n	15	12	8	6
ln GMAV				
4	4.5287092	4.6249728	5.7620514	6.0684256
3	4.4998097	4.6249728	5.1179938	6.0544393
2	4.4519859	4.597994	4.8294548	5.1179938
1	3.8005387	4.5287092	4.8174172	4.8174172
(ln GMAV)^2				
4	20.509207	21.390374	33.201236	36.825789
3	20.248287	21.390374	26.193861	36.656236
2	19.820178	21.141549	23.323634	26.193861
1	14.444095	20.509207	23.207508	23.207508
P				
4	0.25	0.3076923	0.4444444	0.5714286
3	0.1875	0.2307692	0.3333333	0.4285714
2	0.125	0.1538462	0.2222222	0.2857143
1	0.0625	0.0769231	0.1111111	0.1428571
sq rt P				
4	0.5	0.5547002	0.6666667	0.7559289
3	0.4330127	0.4803845	0.5773503	0.6546537
2	0.3535534	0.3922323	0.4714045	0.5345225
1	0.25	0.2773501	0.3333333	0.3779645
EV	17.281043	18.376649	20.526917	22.058276
EW	75.021767	84.431503	105.92624	122.88339
EP	0.625	0.7692308	1.1111111	1.4285714
EPR	1.5365661	1.704667	2.0487548	2.3230696
J	0.05	0.05	0.05	0.05
S	3.2331176	0.380709	3.0846145	3.9540479
L	3.0782862	4.4319167	3.5518246	3.2181869
A	3.8012332	4.5170458	4.2415654	4.1023389
FAV	44.756345	91.564698	69.516587	60.481582
ATC	22.378172	45.782349	34.758293	30.240791

Since the criteria for limited forage, and limited aquatic life are all less than the warmwater criterion, they are set equal to the warmwater criterion. Essentially, this means that there is no additional relief available for the criteria in these other classifications beyond that afforded to the warmwater criterion compared to coldwater. This is due to either the amount of data or the results of the acute tests, or both, and since those species are all included in the "larger" databases already (warmwater), it was deemed appropriate to set the criteria equal to those for the coldwater databases rather than having more restrictive criteria

applied to these "subset" classifications.

EPA lowered its calculated criterion to equal the SMAV for rainbow trout (or in this case, the GMAV for genus Onchorhynchus) because EPA considers rainbow trout to be a commercially and/or recreationally important species. DNR concurs with this approach under s. NR 105.05(3)(m). There is little impact on the criterion, though, as the GMAV for Onchorhynchus is 44.73 ug/L and the calculated FAV is 44.76 ug/L after rounding, so the adjusted ATC for coldwater is 44.73 ug/L/2, or 22.4 ug/L after rounding. To be consistent with the rule language and the EPA application, however, the criteria are as follows:

Acute toxicity criteria for cyanide:
Coldwater ATC = 22.4 ug/L
Warmwater, limited forage fish, and limited aquatic life ATC = 45.8 ug/L

As recommended by EPA, the above criteria may be expressed either as “free cyanide” or as “cyanide amenable to chlorination.” This does not represent a change in the manner DNR has implemented cyanide criteria under the past in NR 105/106.

EPA SPECIES MEAN CHRONIC VALUES

(values from 10/80 EPA AWQC document, EPA 440/5-80-019 and 3/95 GLI Criteria Update, EPA-820-B-95-004)

Isopod *(Asellus communis)*

VALUE (ug/L)	METHOD	REFERENCE
34.06		Oseid & Smith, 1979
SMCV = 34.06		(1 result)

Amphipod *(Gammarus pseudolimnaeus)*

VALUE (ug/L)	METHOD	REFERENCE
18.33		Oseid & Smith, 1979
SMCV = 18.33		(1 result)

Brook trout *(Salvelinus fontinalis)*

VALUE (ug/L)	METHOD	REFERENCE
7.849		Koenst, et al. 1977
SMCV = 7.849		(1 result)

Fathead minnow *(Pimephales promelas)*

VALUE (ug/L)	METHOD	REFERENCE
16.39		Lind, et al. 1977
SMCV = 16.39		(1 result)

Bluegill *(Lepomis macrochirus)*

VALUE (ug/L)	METHOD	REFERENCE
13.57		Kimball, et al. 1978
SMCV = 13.57		(1 result)

EPA ACUTE-CHRONIC RATIOS:

Not enough data are available to permit the calculation of independent chronic toxicity criteria (only five species with data). Instead, acute-chronic ratios (ACRs) must be developed such that the chronic criterion equals the final acute value divided by the appropriate ACR. The following table summarizes the calculation procedure for the ACRs using the procedure in s. NR 105.06 (5).

SPECIES	ACUTE VALUE	CHRONIC VALUE	TEST ACR	SMACR
Isopod (*A. communis*)	2326	34.06	68.29	68.29
Amphipod (*G. pseudo*.)	167	18.33	9.11	9.11
Brook trout	83.14 *	7.849	10.59	10.59
Fathead minnow	125.1 #	16.39	7.63	7.63
Bluegill	99.28 #	13.57	7.32	7.32

- No acute result was available from the same reference source as the chronic result. Since cyanide toxicity is unrelated to hardness, the ACR was calculated using the SMAV divided by the chronic result.
* - The source of the acute value is not clear.

The isopod is the second most tolerant species to cyanide on an acute basis. The other four species have SMAVs much closer to the criterion. As a result, EPA used a geometric mean of the other four

ACRs to calculate the Final ACR. Wisconsin adjusts the FACR based on the species associated with each classification. The Final ACRs for each classification are as follows:

Coldwater = Geo. mean of 9.11, 10.59, 7.63, and 7.32 = 8.57
Warmwater = Geo. mean of 9.11, 7.63, and 7.32 = 7.98
LFF = Geo. mean of 9.11 and 7.63 = 8.34
LAL = 9.11

Chronic toxicity criteria for cyanide:
CW = 44.73 ug/L / 8.57 = 5.22 ug/L
WW = 91.56 ug/L / 7.98 = 11.47 ug/L
LFF = 91.56 ug/L / 8.34 < 11.47 ug/L, set CTC equal to 11.47 ug/L
LAL = 91.56 ug/L / 9.11 < 11.47 ug/L, set CTC equal to 11.47 ug/L