

**DERIVATION OF ACUTE AND CHRONIC TOXICITY CRITERIA
FOR ARSENIC
PREPARED BY: JIM SCHMIDT - WDNR
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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)

Snail (*Aplexa hypnorum*)

VALUE (ug/L)	REFERENCE
24500	Holcombe, et al. 1983
SMAV = 24500	(1 result)

Cladoceran (*Simocephalus serrulatus*)

VALUE (ug/L)	REFERENCE
812	Sanders and Cope, 1966
SMAV = 812	(1 result)

Cladoceran (*Simocephalus vetulus*)

VALUE (ug/L)	REFERENCE
1700	Mount and Norberg, 1984
SMAV = 1700	(1 result)

Cladoceran (*Ceriodaphnia reticulata*)

VALUE (ug/L)	REFERENCE
1800	Mount and Norberg, 1984
1269	Elnabarawy, et al. 1986
SMAV = 1511.36	(2 results)

Cladoceran (*Daphnia pulex*)

VALUE (ug/L)	REFERENCE
1044	Sanders and Cope, 1966
1740	Johnson and Finley, 1980
2366	Elnabarawy, et al. 1986
SMAV = 1626.88	(3 results)

Cladoceran (*Daphnia magna*)

VALUE (ug/L)	REFERENCE
5278	Anderson, 1946
3800	Mount and Norberg, 1984
4340	Call, et al. 1983, Lima, et al. 1984
4501	Elnabarawy, et al. 1986
SMAV = 4449.00	(4 results)

Amphipod (*Gammarus pseudolimnaeus*)

VALUE (ug/L)	REFERENCE
874	Call, et al. 1983, Lima, et al. 1984
SMAV = 874	(1 result)

Stonefly (*Pteronarcys californica*)

VALUE (ug/L)	REFERENCE
22040	Sanders and Cope, 1968, Johnson and Finley, 1980
SMAV = 22040	(1 result)

Midge (*Tanytarsus dissimilis*)

VALUE (ug/L)	REFERENCE
97000	Holcombe, et al. 1983
SMAV = 97000	(1 result)

Brook trout (*Salvelinus fontinalis*)

VALUE (ug/L)	REFERENCE
14960	Cardwell, et al. 1976
SMAV = 14960	(1 result)

Rainbow trout (*Onchorhynchus mykiss*)

VALUE (ug/L)	REFERENCE
13340	Johnson and Finley, 1980
SMAV = 13340	(1 result)

Fathead minnow (*Pimephales promelas*)

VALUE (ug/L)	REFERENCE
15660	Cardwell, et al. 1976
14100	Call, et al. 1983, Lima, et al. 1984
12600	Spehar and Fiandt, 1986
SMAV = 14064.59	(3 results)

Bluegill (*Lepomis macrochirus*) – juv FT

VALUE (ug/L)	REFERENCE
41760	Cardwell, et al. 1976
SMAV = 41760	(1 result)

Channel catfish (*Ictalurus punctatus*) - FT

VALUE (ug/L)	REFERENCE
18096	Cardwell, et al. 1976
SMAV = 18096	(1 result)

Goldfish (*Carassius auratus*) - juv

VALUE (ug/L)	REFERENCE
26040	Cardwell, et al. 1976
SMAV = 26040	(1 result)

Flagfish (*Jordanella floridae*)

EPA SMAV is not used in Wisconsin since Genus *Jordanella* is non-resident to Wisconsin, Iowa, and the other Great Lakes states. The result is used for the ACR determination, so the information is summarized here.

VALUE (ug/L)	REFERENCE
28130	Cardwell, et al. 1976
14400	Call, et al. 1983, Lima, et al. 1984
SMAV = not used	(2 results)

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. pulex*)
4. Amphipod (*G. pseudolimnaeus*)
5. Stonefly (*P. californica*)
6. Fathead minnow, family Cyprinidae
7. Snail (*A. hypnorum*)
8. Channel catfish, family Ictaluridae

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

<u>GENUS NAME (w/ component species)</u>	<u>GMAV</u> <u>(ug/L)</u>	<u>CLASSIFICATIONS *</u>			
		<u>CW</u>	<u>WW</u>	<u>LFF</u>	<u>LAL</u>
Tanytarsus	97000	x	x	x	x
Lepomis	41760	x	x		
Carassius	26040	x	x	x	
Aplexa	24500	x	x	x	x
Pteronarcys	22040	x	x	x	x
Ictalurus	18100	x	x		
Salvelinus	14960	x			
Pimephales	14065	x	x	x	
Onchorhynchus	13340	x			
Daphnia:	2689.52	x	x	x	x
D. magna	4449				
D. pulex	1626				
Ceriodaphnia	1511.36	x	x	x	
Simocephalus:	1174.90	x	x	x	x
S. serrulatus	812				
S. vetulus	1700				
Gammarus	874	x	x	x	x
TOTAL NUMBER OF GENERA REPRESENTED:		13	11	9	7

* - 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). For arsenic, the four most sensitive genera are in every classification, meaning the coldwater criterion (based on 13 genera) shall be applied to all surface waters of the state. No relief is available in other classifications because the same sensitive organisms are in all waters. From this point, the results of the calculation are shown using the variables listed in sub. (2).

CRITERION CALCULATION:		all waters
GMAV RANKS		
	4	2689.525
	3	1511.357
	2	1174.904
	1	874
n		13
ln GMAV		
	4	7.89712
	3	7.320763
	2	7.068942
	1	6.77308
(ln GMAV)^2		
	4	62.3645
	3	53.59357
	2	49.96994
	1	45.87462
P		
	4	0.285714
	3	0.214286
	2	0.142857
	1	0.071429
sq rt P		
	4	0.534522
	3	0.46291
	2	0.377964
	1	0.267261
EV		29.05991
EW		211.8026
EP		0.714286
EPR		1.642658
J		0.05
S		4.147885
L		5.561587
A		6.489082
FAV		657.9192
ATC		328.9596

The calculated coldwater criterion is more stringent than the EPA criterion calculated in the 1995 document for GLI; this is because the non-resident flagfish was deleted from EPA's database for application in Wisconsin waters. Since Wisconsin's database is a subset of EPA's, it is recommended that the Wisconsin acute criteria be set equal to EPA's in recognition that no relief is available as a result of the consideration of the database subset of species resident to the Great Lakes states.

Acute toxicity criterion for arsenic: ATC = 339.8 ug/L (all classifications)

EPA SPECIES MEAN CHRONIC VALUES

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

Cladoceran (*Daphnia magna*)

VALUE (ug/L)	METHOD	REFERENCE
914.1		Call, et al. 1983, Lima, et al. 1984
SMCV = 914.1		(1 result)

Fathead minnow (*Pimephales promelas*)

VALUE (ug/L)	METHOD	REFERENCE
3330		Spehar and Fiandt, 1986
3026		Call, et al. 1983, Lima, et al. 1984
SMCV = 3174		(2 results)

USED ONLY FOR ACR CALCULATION (not resident species):

Flagfish (*Jordanella floridae*)

VALUE (ug/L)	METHOD	REFERENCE
2962		Call, et al. 1983, Lima, et al. 1984
SMCV = 2962		(1 result)

EPA ACUTE-CHRONIC RATIOS:

Not enough data are available to permit the calculation of independent chronic toxicity criteria (only three species have 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).

<u>SPECIES</u>	<u>ACUTE VALUE</u>	<u>CHRONIC VALUE</u>	<u>TEST ACR</u>	<u>SMACR</u>
<i>Daphnia magna</i>	4340	914.1	4.75	4.75
Fathead minnow:	12600	3330	3.78	
	14100	3026	4.66	4.20
Flagfish	14400	2962	4.86	4.86

The flagfish ratio was used only because it is similar to those for the Wisconsin-resident genera. This makes the coldwater Final ACR consistent with that used by EPA. The FACRs for each classification are as follows:

Coldwater = Geo. mean of 4.75, 4.20, and 4.86 = 4.59

Warmwater and limited forage = Geo. mean of 4.75 and 4.20 = 4.46

Limited aquatic life = 4.75 > 4.46

Since the FACR for LAL is greater than that used for warmwater and LFF, the latter ratio is applied to LAL. This means there is no additional relief available to the LFF classification's criterion because of the available database.

Chronic toxicity criteria for arsenic:

CW = $339.8 \times 2 / 4.59 = 148.0$ ug/L

WW, LFF and LAL = $339.8 \times 2 / 4.46 = 152.2$ ug/L

NOTE: The coldwater criteria are marginally different from EPA's. When rounding at the last step only, namely the criterion calculation and expression, the criterion rounds to 148 instead of 147.9.