COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

RATIONALE FOR THE DEVELOPMENT OF AMBIENT WATER QUALITY CRITERIA FOR THE PROTECTION OF AQUATIC LIFE USE

Ambient water quality criteria are numeric values limiting the amount of chemicals present in our nation's waters. A water quality criterion is the highest concentration of a pollutant in water that is not expected to pose a significant risk to, or adversely impact, in this case, aquatic life. Water quality criteria are based solely on the best available scientific data and scientific judgments on pollutant concentrations and environmental or human health effects. These water quality criteria are developed under Section 304(a) of the federal Clean Water Act of 1972. Section 304(a)(1) of the Clean Water Act requires that the Administrator, U.S. Environmental Protection Agency (EPA), develop criteria for water quality that accurately reflects the latest scientific knowledge. Section 303(c)(2) requires states to adopt criteria for all toxic pollutants listed pursuant to section 307(a)(1) of this Act for which criteria have been published under section 304(a), the discharge or presence of which in the affected waters could reasonably be expected to interfere with those designated uses adopted by the State, as necessary to support such designated uses.

The following water quality criteria for aquatic life are being evaluated as part of this triennial review of water quality standards since have been either recommended by EPA, or have been developed by the Department since the previous triennial review was finalized in April, 2010:

- Nonylphenol
- Fluoride
- Manganese
- Molybdenum

NONYLPHENOL

The Department is proposing to adopt the EPA recommended freshwater aquatic life criteria for nonylphenol (EPA-822-F-05-003, Feb. 2006). Nonylphenol is an organic chemical produced in large quantities in the United States, and is expected to be present in Pennsylvania. It is toxic to aquatic life, causing reproductive effects in aquatic organisms. Nonylphenol is moderately soluble and resistant to natural degradation in water. It is used as a chemical intermediate and is often found in wastewater treatment plant effluent as a breakdown product from surfactants and detergents. Freshwater aquatic life and their uses should not be affected if the one-hour average concentration of nonylphenol does not exceed 28 ug/L more than once every three years on the average (acute criterion) and if the four-day average concentration of nonylphenol does not exceed 6.6 ug/l more than once every three years on the average (chronic criterion). Upon

adoption, this criterion will be placed in Chapter 93, Table 5 (relating to water quality standards for toxic substances).

CRITERIA DEVELOPED BY THE DEPARTMENT

Other aquatic life use criteria for toxic substances to be included in this proposal are for criteria that were developed by the Department, at the request of staff from one or more of the Departments regional offices. These compounds have been found in effluent discharges throughout Pennsylvania and are needed by the Department's permit engineers to set discharge limits to maintain compliance with the NPDES program. These proposed criteria were developed using the current best available toxicity data, scientific information, and methods described in "Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Life and Their Uses" (Stephan et al. 1985) (1985 Aquatic Life Criteria Guidelines). The compounds, the toxicity data used in the criteria derivation, and where these criteria will be contained in Chapter 93 standards are as stated below:

FLUORIDE and MANGANESE

There are currently no federal water quality criteria for the protection of aquatic life for manganese and fluoride. The Department currently has public water supply (PWS) criteria for these compounds.. It has become apparent for fluoride, which applies at the point of water withdrawal, that the aquatic life use is the more sensitive intervening use. The Department has therefore, in addition to the PWS criteria, developed acute aquatic life criteria for these parameters.

The toxicity data to calculate these acute aquatic life criteria were obtained from the EPA ECOTOX database, and the EPA Region 5 report, "Final report on Acute and Chronic Toxicity of Nitrate, Nitrite, Boron Manganese, Fluoride, Chloride and Sulfate to Several Aquatic Animal Species" (US EPA November, 2010). The Department calculated the freshwater aquatic life criteria as instructed in the 1985 Aquatic Life Criteria Guidelines. The guideline requires toxicity data from eight different families, at minimum, to derive a fully supported water quality criterion.

The acute or criteria maximum concentration (CMC) for fluoride is calculated as 3000 ug/L. The species most sensitive to fluoride include a variety of aquatic organisms, including two crustaceans, an insect and a fish species.

The CMC aquatic life criterion for manganese is 210 ug/L. The species most sensitive to manganese also include a verity of aquatic organisms including an amphibian, crustacean, insect and a worm.

The data set used in the calculation for these parameters is as follows:

Fluoride (F)

FAMILY	SPECIES	LC 50 UG/L	GMAV UG/L	REFERENCE
Daphniidae	Ceriodaphnia dubia (water flea)	157900	157900	ECOTOX, 8764
	Daphnia magna (water flea)	353600 279000 201000 335000 220000 284000 680000 340000	336575	ECOTOX, 8764 11880
Poeciliidae	Gambusia affinis (mosquito fish)	560000 418000 481000	465333	ECOTOX, 508
Centrarchidae	Lepomis Macrochirus (bluegill)	830000	830000	ECOTOX, 344
Samonidae	Oncorhynchus mykiss (rainbow trout)	1075000 128000 140000 193000 317000 200000	180917	ECOTOX, 9523 10539
Samonidae	Salmo trutta (brown trout)	164500 135600 118500 105100 97500	124240	ECOTOX, 9523
Cyprinidae	Pimephales promelas (fathead minnow)	315000 315000 180000 205000	253750	ECOTOX, 11675
Hydopsychidae	Chimarra marginata (caddisfly)	44900	36880	ECOTOX, 14970
	Hydropsyche bulbifera	26500		
	H. exocellata	26500		
	H. lobata	48200		
	H. pellucidulla	38500		
Unionidae	Actinoaias	117660	255583	ECOTOX,

	pectorosa	259130 298540 347000		76251
Dogielinotidae	Hyalella azteca (scud)	13400	13400	EPA, Final Report on Chronic Toxicity, Nov 2010

*GMAV – genesis mean acute value
LC 50 – lethal concentration at 50 %

Summary of Toxicity Data for Fluoride:

Most sensitive species	**GMAV**
4. Ceriodaphnia dubia	157900
3. Salmo trutta	124240
2. Hydropsyche (species)	36880
1. Hyalella azteca	13400

FAV = 6731
CMC = 3366 (3000 ug/L)

Manganese (Mn)

FAMILY	**SPECIES**	**LC 50 UG/L**	**GMAV UG/L**	**REFERENCE**
Daphniidae	Daphnia magna (water flea)	15200 16000 19200 19500 12600 14400	13983	ECOTOX, 3783
Cyprinidae	Pimephales promelas (fathead minnow)	30600 35900 30600 38500	34150	ECOTOX, 3783
	Agosia chrysogaster (longfin dace)	130000	130000	ECOTOX, 2000
Samonidae	Oncorhynchus mykiss (rainbow trout)	116000 14500 30000 87000	61875	ECOTOX, 58501

Tubificidae	Tubifex tubifex	768 429 295	746	ECOTOX, 61824
Microhylidae	Microhyla ornate (frog)	16620 17560 16030 16520 15570 15710 14330 14840	15898	ECOTOX, 6357
	Gastrophryne carolinensis (frog)	1420	1420	ECOTOX, 4943
Dogielinotidae	Hyalella azteca (scud)	2769	2769	ECOTOX, 80935
Chironomidae	Chironomus plumosus (midge)	12400 3800 4500 5600 6100 9500 9500	7343	ECOTOX 111291
Ceratopogonidae	Culicoides furens (little gray punkie)	3800 3800 6100 9500 9500 9500	7033	
Umionidae	Megalonais nervosa (mussel)	31500	31500	EPA, Final Report on Chronic Toxicity, Nov 2010
	Lampsilis siliquoidea (clam)	43300	43330	EPA, Final Report on Chronic Toxicity, Nov 2010

*GMAV – genesis mean acute value
LC 50 – lethal concentration at 50 %

Summary of Toxicity Data for Manganese:

Most sensitive species	**GMAV**
4. Culicoides furens	7033
3. Hyalella azteca	2769
2. Gastrophryne cordinensis	1420
1. Tubifex tubifex	746

FAV = 419
CMC = 209.5 (210 ug/L)

There was one aquatic life chronic data set in the ECOTOX database for manganese toxicity. This was a 28 day study of Daphnia magna. The LC50 was 8990 ug/L. This data is insufficient to determine a chronic aquatic life criterion.

MOLYBDENUM (Mo)

The Department has collected toxicity data in several water bodies in PA indicating molybdenum concentrations that are high enough to have acute effects on aquatic life and human health. Molybdenum toxicity data collected at PA water quality network (WQN) stations since 2007 has revealed an average detectable acute concentration for Mo of 4028 ug/L. The highest concentration recorded is 15400 ug/L. Waterbodies displaying intermediate concentrations of molybdenum were found in Dauphin, Bradford, and Washington counties. At the request of our regional office permit engineers, and based on the data provided, it has been determined it is appropriate to incorporate statewide aquatic life criteria for molybdenum.

Below is the acute and chronic data sets used by Pennsylvania to calculate the aquatic life criteria for molybdenum. The Department reviewed acute test data (Aquatic Life Water Quality Criteria for Molybdenum) developed for the Nevada Division of Environmental Protection by Tetra Tech, Inc., 2008. The aquatic life organisms used in the Nevada data sets were applicable to organisms found in Pennsylvania. The acute data set used by Pennsylvania is the same as the Nevada data set, with the exception of Oncorhynhus nerka and Catostomus latipinnis which are not found in Pennsylvania waters. The effect levels for the species in the genus Oncorhynhus were averaged. The genus level toxicity data (GMAV's) were used to calculate the aquatic life criteria. The acute criterion calculated by Pennsylvania is the same as that developed by Nevada, rounded to two significant figures. (Acute – 6000 ug/L)

Acute Test Data

Rank	Species	Common Name	Acute Effect Level mg/L
1	Tubifex tubifex tubificid	worm	28.9100
2	Euglena gracilis	protistan	72.3000

3	Pimephales promelas	fathead minnow	253.8110
4	Oncorhynchus tshawytscha	chinook salmon	1,000.0000
	Oncorhynchus kisutch	coho salmon	1,000.0000
5	Ceriodaphnia dubia	cladoceran	1,015.0000
6	Girardia dorotocephala	flatworm	1,225.6000
	Catostomus latipinnis	flannelmouth sucker	1,940.0000
7	Catostomus commersoni	white sucker	2,000.0000
	Oncorhynchus nerka	kokanee salmon	2,000.0000
8	Daphnia magna	cladoceran	2,218.0871
	Oncorhynchus mykiss	rainbow trout	2,269.4034
9	Crangonyx pseudogracilis	isopod	2,650.0000
10	Gammarus fasciatus	scud	3,940.0000
11	Lepomis macrochirus	bluegill	6,790.0000
12	Chironomus tentans	midge	7,533.3000
13	Ictalurus punctatus	channel catfish	10,000.0000

Most sensitive species	GMAV
4. Ceriodaphnia dubia	1015.
3. Pimephales promelas	253.8
2. Euglena gracilis	72.3
1. Tubifex tubifex	28.9

FAV = 12.36
CMC = 6.12 (6120 ug/L)

The chronic data set used by Pennsylvania was also obtained from Aquatic Life Water Quality Criteria for Molybdenum, developed for the Nevada Division of Environmental Protection by Tetra Tech, Inc.

After incorporating the species prevalent in Pennsylvania waters, the chronic criterion is calculated at 1000. ug/L. This criterion is slightly more stringent than the criterion proposed by the Nevada DEP, based on a final acute-chronic ratio of 10.98.

Chronic Test Data - NV

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

Species	Average Acute Value mg/L	Average Chronic Value mg/L	ACR	Species Mean ACR
Oncorhynchus mykiss	**2269.4034**	**866.0254**	**2.6**	
Pimephales promelas	**253.8110**	**163.5427**	**1.6**	
Daphnia magna	**2218.0871**	**97.0183**	**22.9**	
Ceriodaphnia dubia	**1015.**	**60.438**	**16.8**	
Catostomus commersoni	**2000.**	**1.7**	**NA**	
Final ACR			**10.98**	

ACR = 10.98
CCC = 1.13 (1130. ug/L)

REFERENCES USES IN THIS EVALUATION:

1. EPA ECOTOX database references:

Reference Number:	344
Author(s):	Office of Pesticide Programs
Publication Year:	2000
Title:	Pesticide Ecotoxicity Database (Formerly: Environmental Effects Database (EEDB))
Source:	Environmental Fate and Effects Division, U.S.EPA, Washington, D.C.(): -

Reference Number:	508
Author(s):	Wallen, I.E., W.C. Greer, and R. Lasater
Publication Year:	1957
Title:	Toxicity to Gambusia affinis of Certain Pure Chemicals in Turbid Waters
Source:	Sewage Ind. Wastes29(6): 695-711

Reference Number:	5184
Author(s):	LeBlanc, G.A.
Publication Year:	1980
Title:	Acute Toxicity of Priority Pollutants to Water Flea (Daphnia magna)
Source:	Bull. Environ. Contam. Toxicol.24(5): 684-691

Reference Number:	8764
Author(s):	Hickey, C.W.
Publication Year:	1989
Title:	Sensitivity of Four New Zealand Cladoceran Species and Daphnia magna to Aquatic Toxicants
Source:	N.Z.J.Mar.Freshw.Res.23(1): 131-137

Reference Number:	9523
Author(s):	Camargo, J.A., and J.V. Tarazona

Publication Year:	1991
Title:	Short-Term Toxicity of Fluoride Ion (F-) in Soft Water to Rainbow Trout (Salmo gairdneri) and Brown Trout (Salmo trutta fario)
Source:	Fluoride24(2): 76-83

Reference Number:	10539
Author(s):	Pimentel, R., and R.V. Bulkley
Publication Year:	1983
Title:	Influence of Water Hardness on Fluoride Toxicity to Rainbow Trout
Source:	Environ. Toxicol. Chem.2(4): 381-386

Reference Number:	11675
Author(s):	Smith, L.R., T.M. Holsen, N.C. Ibay, R.M. Block, and A.B. De Leon
Publication Year:	1985
Title:	Studies on the Acute Toxicity of Fluoride Ion to Stickleback, Fathead Minnow, and Rainbow Trout
Source:	Chemosphere14(9): 1383-1389

Reference Number:	11880
Author(s):	Fieser, A.H., J.L. Sykora, M.S. Kostalos, Y.C. Wu, and D.W. Weyel
Publication Year:	1986
Title:	Effect of Fluorides on Survival and Reproduction of Daphnia magna
Source:	J. Water Pollut. Control Fed.58(1): 82-86

Reference Number:	14970
Author(s):	Camargo, J.A., and J.V. Tarazona
Publication Year:	1990
Title:	Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water
Source:	Bull. Environ. Contam. Toxicol.45(6): 883-887

Reference Number:	76251
Author(s):	Keller, A.E.
Publication Year:	2000
Title:	Personal Communication to U.S. EPA: Water Quality and Toxicity Data for Unpublished Unionid Mussel Tests

Reference Number: 2000
Author(s): Lewis, M.
Publication Year: 1978
Title: Acute Toxicity of Copper, Zinc, and Manganese in Single and Mixed Salt Solutions to Juvenile Longfin Dace, Agosia chrysogaster
Source: J. Fish Biol.13(6): 695-700

Reference Number: 3783
Author(s): Kimball, G.
Publication Year: 1978
Title: The Effects of Lesser Known Metals and One Organic to Fathead Minnows (Pimephales promelas) and Daphnia magna
Source: Manuscr., Dep.of Entomol., Fish.and Wildl., Univ.of Minnesota, Minneapolis, MN():

Reference Number: 58501
Author(s): Davies, P.H.
Publication Year: 1980
Title: Water Pollution Studies. Investigations on the Toxicity of Metals to Fish
Source: Federal Aid in Fish and Wildl.s Restoration, Job Progress Rep.No.F-33-R-15, Colorado Div.of Wildl., Ft.Collins, CO(): -

Reference Number: 61824
Author(s): Fargasova, A.
Publication Year: 1999
Title: Ecotoxicology of Metals Related to Freshwater Benthos
Source: Gen. Physiol. Biophys.18(Focus Issue): 48-53

Reference Number: 4934
Author(s): Birge, W.J., J.A. Black, and A.G. Westerman
Publication Year: 1979
Title: Evaluation of Aquatic Pollutants Using Fish and Amphibian Eggs as Bioassay Organisms
Source: In: S.W.Nielsen, G.Migaki, and D.G.Scarpelli (Eds.), Symp.Animals Monitors Environ.Pollut.1977, Storrs, CT12(): 108-118

Reference Number: 111291

Author(s):	Vedamanikam, V.J., and N.A.M. Shazilli
Publication Year:	2008
Title:	The Effect of Multi-Generational Exposure to Metals and Resultant Change in Median Lethal Toxicity Tests Values over Subsequent Generations
Source:	Bull. Environ. Contam. Toxicol.80(1): 63-67

2. Final report on Acute and Chronic Toxicity of Nitrate, Nitrite, Boron Manganese, Fluoride, Chloride and Sulfate to Several Aquatic Animal Species". (US EPA November, 2010)

3. US EPA, Aquatic life criteria – Nonylphenol, Feb. 2006, (EPA-822-F-05-003).

4. Aquatic Life Water Quality Criteria for Molybdenum) developed for the Nevada Division of Environmental Protection by Tetra Tech, Inc., 2008.

5. International Molybdenum Association (IMOA), Freshwater effects assessment of molybdenum: data evaluation and predicted no effect concentration (PNEC)-derivation, prepared by EURAS, 12/2008.