



pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION



Office of Water Management

Triennial Review of Water Quality Standards TR17 Updates to Ammonia Criteria

Water Resources Advisory Committee
November 18, 2015

Tom Wolf, Governor

John Quigley, Secretary

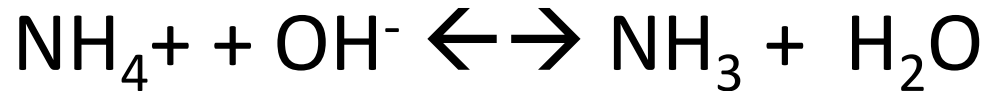
Ammonia Aquatic Life Criteria

- EPA published final Recommended Aquatic Life Criteria for Ammonia:

*AQUATIC LIFE AMBIENT WATER QUALITY
CRITERIA FOR AMMONIA – FRESHWATER 2013
(EPA 822-R-13-001)*

April 2013

Chemistry of Ammonia



As pH rises \rightarrow NH_3 rises

NH_3 = un-ionized ammonia – **MORE TOXIC**

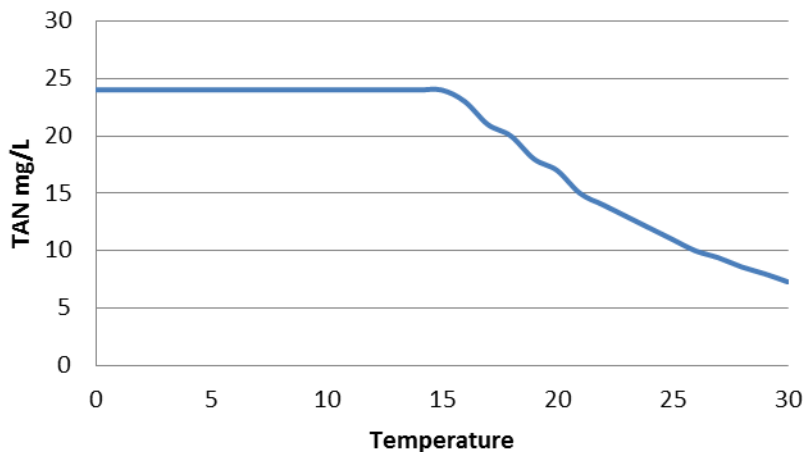
NH_4^+ = ammonium ion – **MORE ABUNDANT**

Ammonia toxicity is pH dependent

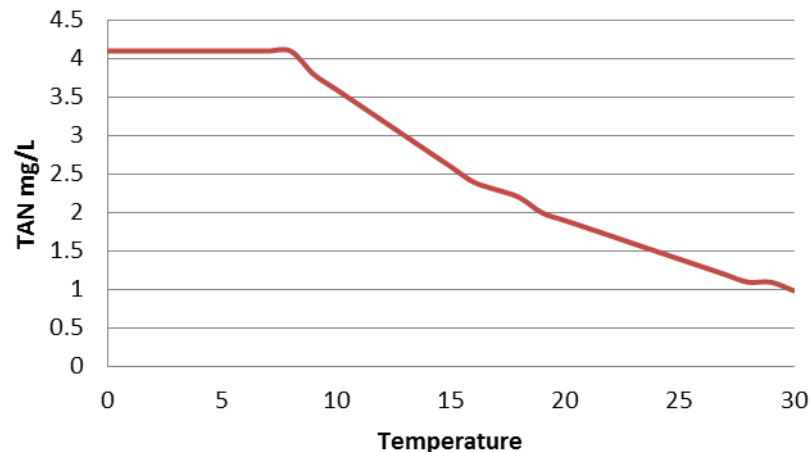
▶ Toxicity is Affected by pH and Temperature

- As pH increases, organisms are more sensitive to ammonia
- As temperature increases, invertebrates are more sensitive to ammonia
- The criteria vary as a function of pH and temperature based on an equation

**EPA 2013 CMC criteria
@ pH = 7**



**EPA 2013 CCC criteria
@ pH = 7**



Mussels and Snails

- Many freshwater unionid mussels are federally-listed as endangered or threatened species
- Freshwater mussels and non-pulmonate (gill-bearing) snails are
 - Broadly distributed across the U.S.
 - Sensitive to ammonia
 - Included in the ammonia dataset

Sensitive Unionids

- Approximately 65 unionid species in PA, including many that are rare or endangered
- Acute dataset
 - 7 most sensitive genera are unionids
 - 6 of these 7 in PA (not *Venustaconcha*)
- Chronic dataset
 - 2 most sensitive genera are unionids
 - Both found in Pennsylvania

Acute Criterion

The one-hour (duration) average concentration of total ammonia nitrogen (in mg TAN/L) is not to exceed, more than once every three years (frequency) on the average, the CMC (acute criterion magnitude) calculated using the following equation:

$$CMC = MIN \left(\left(\frac{0.275}{1 + 10^{7.204 - pH}} + \frac{39.0}{1 + 10^{pH - 7.204}} \right), \text{ or} \right. \\ \left. \left(0.7249 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \right. \right. \\ \left. \left. \times \left(23.12 \times 10^{0.036 \times (20 - T)} \right) \right) \right)$$

This equation is recommended by EPA when both mussels and salmonids are present.

Acute Criteria Comparison

Values on tables given in milligrams of Total Ammonia Nitrogen per liter (MG TAN / L)

Color Code = The difference between the federally recommended acute aquatic life criteria (EPA2013) and Pennsylvania's current acute aquatic life criteria (PA Current) is given in milligrams of total ammonia nitrogen per liter. (EPA2013 minus PA Current)

0 - 3 3 - 6 6 - 9 9 - 12 >12

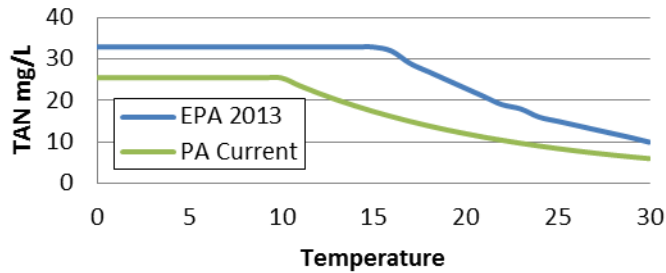
PA Current vs EPA2013

		Temperature															
		0 °C 32	2 35.6	4 39.2	6 43	8 46.4	10 50	12 53.6	14 57.2	16 60.8	18 64.4	20 68	22 71.6	24 75.2	26 78.8	28 82.4	30 86
6	PA Current	26.98	26.98	26.98	26.98	26.98	26.97	23.09	19.80	17.02	14.66	12.65	10.94	9.48	8.23	7.16	6.24
	EPA2013	36.72	36.72	36.72	36.72	36.72	36.72	36.72	36.72	35.57	30.14	25.53	21.63	18.33	15.53	13.16	11.15
6.5	PA Current	25.51	25.51	25.51	25.51	25.51	25.50	21.83	18.73	16.10	13.87	11.97	10.35	8.97	7.79	6.78	5.91
	EPA2013	32.61	32.61	32.61	32.61	32.61	32.61	32.61	32.61	31.59	26.76	22.67	19.21	16.28	13.79	11.68	9.90
7	PA Current	20.59	20.59	20.59	20.59	20.59	20.58	17.62	15.12	13.00	11.20	9.67	8.37	7.26	6.31	5.49	4.79
	EPA2013	24.10	24.10	24.10	24.10	24.10	24.10	24.10	24.10	23.35	19.78	16.76	14.20	12.03	10.19	8.64	7.32
7.5	PA Current	12.40	12.40	12.40	12.40	12.40	12.40	10.62	9.12	7.85	6.77	5.85	5.07	4.41	3.83	3.34	2.92
	EPA2013	13.28	13.28	13.28	13.28	13.28	13.28	13.28	13.28	12.87	10.90	9.24	7.83	6.63	5.62	4.76	4.03
8	PA Current	5.47	5.47	5.47	5.47	5.47	5.47	4.70	4.04	3.49	3.02	2.62	2.28	1.99	1.74	1.53	1.34
	EPA2013	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.44	4.61	3.90	3.31	2.80	2.37	2.01	1.70
8.5	PA Current	2.03	2.03	2.03	2.03	2.03	2.03	1.76	1.52	1.32	1.16	1.01	0.89	0.79	0.70	0.62	0.56
	EPA2013	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.07	1.76	1.49	1.26	1.07	0.90	0.77	0.65
9	PA Current	0.75	0.75	0.75	0.75	0.75	0.75	0.66	0.58	0.52	0.46	0.41	0.37	0.34	0.31	0.29	0.26
	EPA2013	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.86	0.73	0.62	0.52	0.44	0.37	0.32	0.27

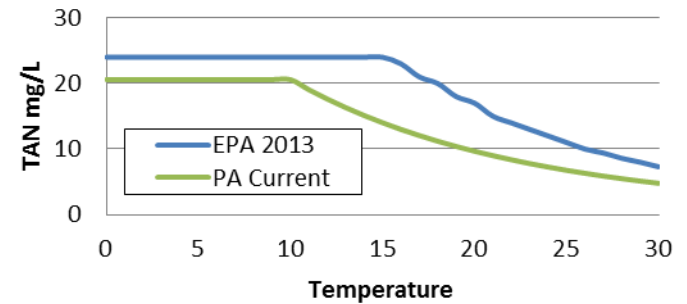
Acute Criteria: pH Comparison

PA's Current vs. EPA (2013)

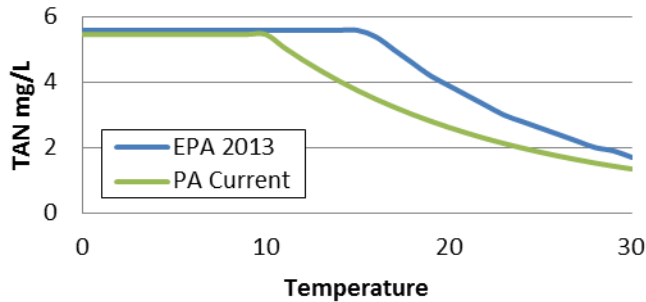
@ pH = 6.5



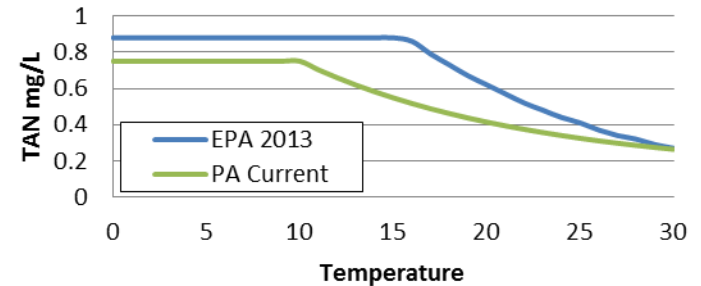
@ pH = 7



@ pH = 8.0



@ pH = 9.0



Chronic Criterion

The thirty-day rolling average concentration of total ammonia nitrogen (in mg TAN/L) is not to exceed, more than once every three years on the average, the chronic criterion magnitude (CCC) calculated using the following equation:

$$CCC = 0.8876 \times \left(\frac{0.0278}{1 + 10^{7.688 - pH}} + \frac{1.1994}{1 + 10^{pH - 7.688}} \right) \times \left(2.126 \times 10^{0.028 \times (20 - \text{MAX}(T, 7))} \right)$$

In addition, the highest four-day average within the 30-day averaging period should not be more than 2.5 times the CCC, more than once in three years on average.

Chronic Criteria Comparison

Values on table given in milligrams of Total Ammonia Nitrogen per liter (MG TAN / L)

Color Code = The difference between the federally recommended chronic aquatic life criteria (EPA2013) and Pennsylvania's current chronic aquatic life criteria (PA Current) was calculated in milligrams of total ammonia nitrogen per liter. (EPA2013 minus PA Current) The value for the difference was assigned to a particular range and color coded as follows:

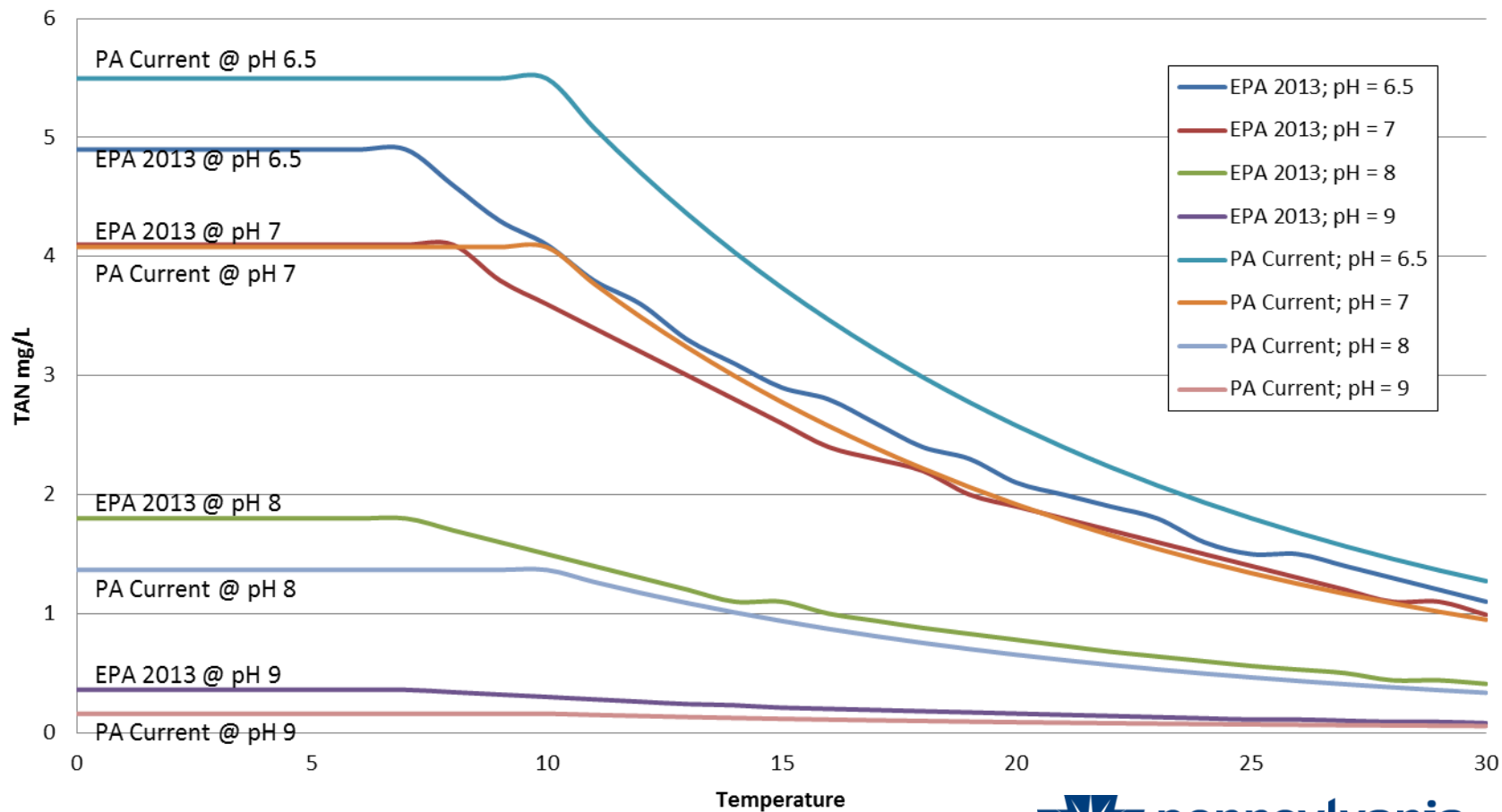
< -2.5	-1.25 to -2.5	-0.5 to -1.25	0 to -0.5	0 to 0.13	0.13 to 0.27	0.27 to 0.4	>0.4
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PA Current vs EPA2013

		Temperature															
		°C		°F													
pH		0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
		32	35.6	39.2	43	46.4	50	53.6	57.2	60.8	64.4	68	71.6	75.2	78.8	82.4	86
6	PA Current	7.41	7.41	7.41	7.41	7.41	7.41	6.34	5.44	4.68	4.03	3.48	3.01	2.61	2.26	1.97	1.71
	EPA2013	5.13	5.13	5.13	5.13	4.81	4.23	3.72	3.27	2.87	2.52	2.22	1.95	1.71	1.51	1.32	1.16
6.5	PA Current	5.50	5.50	5.50	5.50	5.50	5.50	4.70	4.04	3.47	2.99	2.58	2.23	1.93	1.68	1.46	1.27
	EPA2013	4.92	4.92	4.92	4.92	4.61	4.06	3.57	3.13	2.75	2.42	2.13	1.87	1.64	1.45	1.27	1.12
7	PA Current	4.08	4.08	4.08	4.08	4.08	4.08	3.49	3.00	2.58	2.22	1.92	1.66	1.44	1.25	1.09	0.95
	EPA2013	4.36	4.36	4.36	4.36	4.09	3.60	3.16	2.78	2.44	2.15	1.89	1.66	1.46	1.28	1.13	0.99
7.5	PA Current	3.04	3.04	3.04	3.04	3.04	3.04	2.60	2.23	1.92	1.66	1.43	1.24	1.08	0.94	0.82	0.72
	EPA2013	3.22	3.22	3.22	3.22	3.02	2.66	2.33	2.05	1.80	1.59	1.39	1.22	1.08	0.95	0.83	0.73
8	PA Current	1.37	1.37	1.37	1.37	1.37	1.37	1.17	1.01	0.87	0.75	0.65	0.57	0.50	0.43	0.38	0.34
	EPA2013	1.80	1.80	1.80	1.80	1.68	1.48	1.30	1.14	1.01	0.88	0.78	0.68	0.60	0.53	0.46	0.41
8.5	PA Current	0.45	0.45	0.45	0.45	0.45	0.45	0.39	0.34	0.29	0.26	0.22	0.20	0.17	0.15	0.14	0.12
	EPA2013	0.80	0.80	0.80	0.80	0.75	0.66	0.58	0.51	0.45	0.40	0.35	0.31	0.27	0.24	0.21	0.18
9	PA Current	0.16	0.16	0.16	0.16	0.16	0.16	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06
	EPA2013	0.36	0.36	0.36	0.36	0.34	0.30	0.26	0.23	0.20	0.18	0.16	0.14	0.12	0.11	0.09	0.08

Chronic Criteria: pH Comparison

PA's Current vs. EPA (2013)





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Questions?

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