Documentation to Support Amendments
to the Water Quality Regulations (July 2006)
May 2009

1. Coldwater/Warmwater Fishery Designation

Freshwater rivers and streams and lakes and ponds were designated coldwater or warmwater fishery using data collected from 1993 to 2007 by Alan Libby, Principal Biologist in RIDEM's Division of Fish and Wildlife. The data was compiled and evaluated for the presence of native brook trout. Brook trout are the most widespread coldwater fish specie present in Rhode Island and therefore the best indicator of an existing coldwater fishery in the state. If brook trout were present, the river or stream and the headwaters tributary to that river or stream, were designated as coldwater fisheries. The logic was to protect headwater streams for downstream coldwater fisheries. If there were no brook trout present, RIDEM staff in coordination with other stakeholder organizations (WPWA, Blackstone River Coalition, etc.), determined the potential for the presence of brook trout by evaluating historical trout presence/absence information, habitat and physical characteristic data, and Best Professional Judgment. If no trout were present and large quantities of wetlands or impoundments were found in the headwaters, an area was designated warmwater. If no trout were found but it was determined that the area should support trout, it was designated as a coldwater fishery. Rivers not yet sampled or assessed by RIDEM are currently considered unassessed for coldwater/warmwater fishery status however, the Department is committed to identifying and protecting coldwater fisheries. Where coldwater fish exist in waters not yet designated as coldwater, the coldwater fish and habitat will be protected as an existing use. Future updates to the fisheries designations will proceed as additional data becomes available from the current smaller scale monitoring program. Maps depicting the draft fishery designations can be found on DEM's website at http://www.dem.ri.gov/maps/index.htm, under the Environmental Resource interactive maps.

2. Classification Change for Prince's Pond

Prince's Pond is currently classified as Class A. The pond is hydrologically connected to the saltwater Barrington River (Class SA) via a saltwater marsh and creek. The Department is proposing to reclassify the pond as Class SA to more accurately reflect the salinity and ecological status. Although currently classified as a freshwater waterbody, review of salinity data collected in Prince's Pond by the URI Watershed Watch program, shows that the pond is more brackish and generally meets the definition of a saltwater waterbody. Freshwaters are defined in the RI Water Quality Regulations as those waters of the State in which the natural level of salinity is equal to or less than 1 part per thousand, 95 percent or more of the time. Saltwaters are defined as those waters of the State in which the natural level of salinity is equal to or greater than 10 parts per thousand, 95 percent or more of the time. Review of ten years of salinity data (Table 2-1, Figure 2-1) shows that the salinity levels in Prince's Pond are equal to or greater than ten (10) parts per thousand, 80% of the time. Furthermore, DEM's evaluation of the biology revealed the presence of brackish water species of fish and vegetation (Table 2-2), and the lack of obligate freshwater species. Therefore, the salinity and biological data collected in Prince's Pond indicate the presence of a more saltwater environment.

Table 2-1 URI Watershed Watch Salinity Data for Prince's Pond

Prince's Pond Salinity Data (ppt)		
Date of Sample	Depth (m)	Concentration
5/4/97	1	13
5/9/97	1	15
5/31/97	1	12.6
6/15/97	1	14.2
6/29/97	2.5	18.2
7/13/97	1	17
7/26/97	1	18.4
8/10/97	1	17.4
8/24/97	1	19.25
10/4/97	1	22.5
10/26/97	1	24.75
5/9/98	1	14
6/6/98	1	12
8/29/98	1	17
9/12/98	1	17.1
9/26/98	1	26
11/7/98	1	18
5/30/99	2.9	18
6/11/99	2.25	23.6
6/27/99	1	17.5
6/27/99	2.5	18
7/24/99	1	18.2
8/5/99	1	18.8
8/21/99	1	24
9/3/99	1	23.2
9/18/99	1	21.7
9/18/99	2.5	19.2
10/3/99	1	29
10/16/99	1	21
10/16/99	3	21.3
10/29/99	1	20
10/29/99	3.5	20.8
5/20/00	1	14
6/3/00	1	13
6/15/00	1	7
6/15/00	3	7.9
7/1/00	1	7.1
7/1/00	3	8.15
7/22/00	1	9
8/20/00	1	9
8/20/00	3	9
8/31/00	1	8.6
8/31/00	3	9.7
10/1/00	1	9.1
10/1/00	3	10.25

10/14/00	1	9
10/14/00	3	9.1
10/21/00	1	20
5/12/01	1	13.4
5/20/01	1	12.45
6/17/01	1	11
6/30/01	1	11.2
6/30/01	3	10.8
7/12/01	1	11.15
7/12/01	2.66	12.6
7/27/01	1	11.6
7/27/01	3	15.2
9/23/01	1	17.1
9/23/01	3	19.7
10/5/01	1	16.4
10/5/01	3	18.6
10/25/01	1	18
5/4/02	1	16.1
5/4/02	2	16.55
5/19/02	1	14.4
5/19/02	2.5	15.6
6/13/02	1	14
6/29/02	1	13.4
6/29/02	2.5	15.6
7/8/02	1	14
7/25/02	1	15
8/9/02	1	20
8/23/02	1	17
8/23/02	2.5	19.8
9/22/02	1	19
10/17/02	1	19.9
10/17/02	3	21.8
5/3/03	1	11.7
5/3/03	3	12.2
5/18/03	1	12
6/8/03	1	9.2
6/8/03	3	10.8
6/12/03	1	9.3
6/12/03	3	11.6
7/18/03	1	10.8
7/18/03	3	14.4
7/31/03	1	10
8/14/03	1	10.4
8/14/03	3	11.2
8/31/03	1	10
9/11/03	1	10
9/11/03	3	13.2
5/20/04	0.1	10.5

7/3/04	0.1	12
7/17/04	1	11.2
7/17/04	3	14.4
7/22/04	1	14.5
8/7/04	1	13.4
8/7/04	3	17
8/23/04	1	12.2
8/23/04	3	15
9/2/04	0.1	14
9/17/04	0.1	13.2
9/17/04	1	13.2
9/17/04	3	15.4
10/14/04	1	16.7
5/13/05	1	11.2
5/13/05	3.25	11.6
5/28/05	1	14
5/28/05	3	15
6/10/05	1	11.8
6/10/05	3	12.4
6/23/05	1	11
6/23/05	3	18
7/2/05	1	11.6
7/2/05	3	15.2
7/10/05	1	11.6
7/10/05	3.4	13.3
7/26/05	1	12.4
7/26/05	3	17.9
8/6/05	1	18
8/6/05	3	16
8/18/05	1	12.5
8/18/05	3	16.4
9/1/05	1	15
9/1/05	3	18
9/16/05	1	15.2
9/16/05	3.5	19
10/2/05	1	16
10/2/05	3	19
10/17/05	1	13.5
10/17/05	3.5	16.45
5/18/06	1	8
5/18/06	3	7.3
6/4/06	3	6
6/16/06	1	5
6/29/06	1	6
6/29/06	3.5	6.8
7/16/06	1	6
7/29/06	1	5.6
7/29/06	3.5	7.6

8/12/06	1	10.8
8/12/06	3.5	11.2
8/25/06	1	6.7
8/25/06	3.5	9.2
9/9/06	1	7
9/9/06	3	12
9/24/06	1	8.4
9/24/06	3	11.1
10/6/06	1	9
10/6/06	3	13
10/21/06	1	13
10/21/06	3.5	14
10/27/06	1	11.5
10/27/06	3.25	13.8
4/26/07	1	10.8
4/26/07	3.5	12.6
5/12/07	1	9.7
5/27/07	1	8.5
6/8/07	1	8.5
6/8/07	3.5	9.6
6/22/07	1	8
7/6/07	1	8.7
7/6/07	3.5	11.6
7/21/07	1	9.1
7/21/07	3.5	12.65
8/3/07	1	9.6
8/3/07	3.5	14
8/18/07	1	11
8/18/07	3	11
9/1/07	1	11.2
9/1/07	3.5	16.6
9/30/07	1	26
9/30/07	3	22
10/12/07	1	15.7
10/12/07	3.5	18
10/19/07	1	15.4
10/19/07	3.5	18

Cells in Red indicate a value less than 10 ppt salinity.

Figure 2-1 Prince's Pond Ten Year Salinity Profile (ppt), from URI Watershed Watch

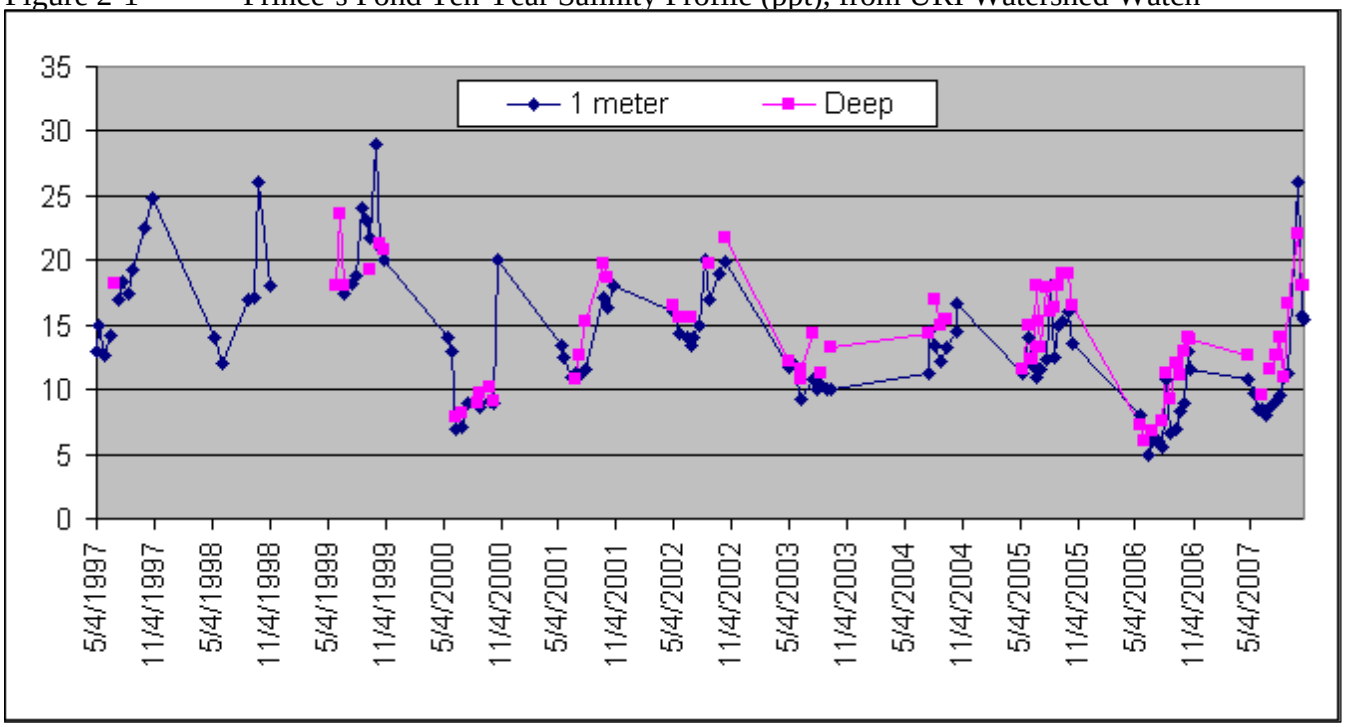

Table 2-2 Flora and Fauna Observed by DEM Staff in and around Prince's Pond

Fauna

Menidia menidia (Silversides)
Fundulus heteroclitus (Mummichogs)
Palaemonetes pugio (Grass Shrimp)
Cyprinodon variegates (Sheepshead minnow)
Anguilla rostrata (American eel)
Apeltes quadracus (Fourspine Stickleback)
Pomolobus pseudoharengus (Alewife)
Barnacles

Flora

Spartina alterniflora (Saltwater or Smooth Cordgrass)
Spartina patens (Salt Hay Grass or Salt Meadow Grass)
Distichlis spicata (Salt Grass or Spike Grass)
Atriplex patula L. (Marsh Orach or Spearscale) l
Baccharis halimifolia L. (Groundsel Tree or Sea Myrtle)
Iva frutescens (High-Tide Bush)
Solidago sempervirens L. (Seaside Goldenrod

3. Adoption of Site Specific Dissolved Copper Criteria for Selected Freshwater Rivers in Rhode Island

Introduction

In 1997, Rhode Island Department of Environmental Management (RI DEM) adopted EPA's hardness-based dissolved metals criteria into the water quality standards as a better approximation for metal bioavailability than total metal in the water column. Previously, aquatic life criteria for metals had been expressed only in terms of total metal. Although this approach accounts for the low bioavailability/toxicity of metals attached to suspended particles, it does not address the fact that for certain metals including copper, not all of the dissolved metal is in forms that are readily toxic to aquatic organisms. There is valid scientific rationale for the contention that the National criteria may be underprotective or overprotective at specific sites. National water quality criteria are based upon laboratory toxicity tests in which aquatic organisms were exposed to known concentrations of toxicants in laboratory water and therefore, may not adequately represent site water and effluent effects. Metals found in wastewater treatment facility (WWTF) effluent are generally less toxic than the pure metal ions used in the National metal criteria development tests. Work conducted by Connecticut DEP (CT DEP), and recently verified and adopted by Massachusetts DEP (MA DEP), showed that organic substances within the water column have a mitigating effect on copper toxicity. Connecticut established that surface waters high in organic content, specifically waters whose 7Q10 flow include a 20% or greater proportion of biologically treated domestic wastewater from a WWTF, exhibited a measurably greater capacity to assimilate copper toxicity. Under these conditions, it was demonstrated that the copper criterion could be increased and still provide the same degree of aquatic life protection as the national guideline. This approach and resulting site specific dissolved copper criteria were approved by EPA Region 1. Massachusetts DEP recently adopted, and EPA approved, the Connecticut site specific copper criteria for rivers in Massachusetts that are similar in the two states. Based upon the work conducted by CT DEP and MA DEP, RI DEM proposes to adopt Connecticut's site specific copper water effect ratio (WER) for selected Rhode Island rivers with comparable water chemistry.

Overview of Work Conducted by CT DEP and MA DEP

Connecticut studied the toxicity of copper in 7 different rivers across the state, all of which had a minimum in-stream effluent concentration of 20% at 7Q10 flows (CT DEP). The rivers studied represented large ranges of hardness concentrations (32.5 – 116.3 mg/l). WERs for dissolved copper were determined for each river by conducting toxicity tests in accordance with "Standard Procedures for Conducting Acute Toxicity Tests for Derivation of WERs" (Dunbar, L.E., 1996). As shown in Table 1, a minimum of three WER determinations were made for each reference site location using *Daphnia pulex* as the test species. The geometric mean WER for each reference site was calculated as the best estimate of the WER for a site. The lowest geometric mean WER, 2.92, was adopted by Connecticut as the Final Water Effect Ratio for derivation of site specific copper criteria. Utilizing the lowest geometric mean ensures that the modified criteria will be protective of all comparable waters. The site specific dissolved copper criteria was derived by multiplying the WER (2.92) by the national guidance criteria for dissolved copper, calculated at a hardness of 50 mg/l, and using the hardness-dependant equation for copper criteria as published at the time of the study. EPA Region I approved Connecticut's adoption of 25.7 ug/l acute site specific dissolved copper criteria and 18.1 ug/l chronic dissolved copper criteria for selected freshwater streams. Note that the slope and intercept within the freshwater hardness-dependant copper criteria equation have since changed (USEPA, 1996).

Table 1 Water Effect Ratios (WERs) in Connecticut Waters

Water Effect Ratios for Dissolved Copper at Reference Sites					
Site	Water Effect Ratio				Geometric Mean WER
	Run 1	Run 2	Run 3	Run 4	
Saugatuck River	4.30	8.90	12.10	11.46	8.53
Housatonic River	2.93	5.63	7.34	9.05	5.75
Shepaug River	3.02	6.00	7.72	-	5.19
Salmon River	4.54	1.35	4.69	3.98	3.27
Willimantic River	3.04	1.47	5.09	4.43	3.17
Eight Mile River	2.93	6.07	4.00	3.12	3.06
	4.30	1.40	5.51	2.00	
	1.00	1.72	2.39	1.68	
	4.92	4.49	4.22	4.51	
	4.88	2.52	1.9	2.72	
	4.62	3.27	2.41	3.27	
	4.83	2.57	3.29	-	
Farmington River	3.36	2.10	3.46	2.99	**2.92**

From Connecticut Department of Environmental Protection

Recognizing the concept of ecoregions and based upon the chemistry of the ambient waters tested by Connecticut and their similarity to many waters in Massachusetts, MA DEP proposed to adopt the revised dissolved copper criteria developed by Connecticut for comparable rivers in Massachusetts (Massachusetts Department of Environmental Protection). As further confirmation of the conservative approach associated with adopting CT DEP's WER, MA DEP presented findings from a Biotic Ligand Model (BLM) study for several Taunton River sites which resulted in allowable dissolved copper concentrations higher than those derived through CT DEP's empirical approach. EPA Region I approved MA DEP's adoption of Connecticut's site specific dissolved copper criteria for a number of rivers in Massachusetts.

Application to Selected Rivers in Rhode Island

Based upon the work conducted by CT DEP and MA DEP, RI DEM proposes to adopt Connecticut's site specific copper WER for the entire length of the Blackstone and Ten Mile Rivers, and the Woonasquatucket River downstream of the Smithfield WWTF discharge to the confluence with the Moshassuck River.

MA DEP has adopted the site specific dissolved copper criteria for the Blackstone River and Ten Mile River to the MA/RI border. The water chemistry in both of these rivers within RI, is consistent with that observed in Massachusetts (Table 2) and, as MA DEP presented, the water chemistry is also comparable to the sites studied in Connecticut. In addition, the Woonasquatucket River, downstream of the Smithfield WWTF discharge to the confluence with the Moshassuck River, has comparable water chemistry as the waters tested by CT DEP (Table 2). These three RI rivers consist of 20% or higher wastewater effluent at 7Q10 flows. The CT DEP study involved rivers with a mean alkalinity range of 21.8-114.5 mg/l; a mean pH range of 7.1-8.2 SU; a mean hardness range of 32.5-116.3; and a mean Total Organic Carbon (TOC) range of 3.95-6.8 mg/l. As can be seen from Table 2, the ranges of data for all three rivers in RI are comparable to the mean ranges reported by CT DEP and as presented by MA DEP for the Blackstone and Ten Mile Rivers. In addition, as presented by MADEP for the Ten Mile and Blackstone Rivers, Whole Effluent Toxicity (WET) test results from the WWTFs discharging into the Massachusetts portion of these rivers show limited or no toxicity. There are no WWTF discharges into the RI portion (6 miles) of the Ten Mile River. As can be seen in Table 3, for the WWTFs discharging into the RI portion of the Blackstone (Woonsocket WWTF) and Woonasquatucket (Smithfield WWTF) rivers, there is also limited or no acute effluent toxicity.

Table 2 Water Quality Summary for Selected Rhode Island Rivers

Waterbody Name	WBID#	WWTF Discharging into Waterbody	WWTF Design Flow (MGD)	River 7Q10 Flow (MGD)	% Effluent at 7Q10	Alkalinity* (mg/l)	pH* (SUs)	Total Organic Carbon* (mg/l)	Average Hardness* (mg/l)
Blackstone River (entire length of river within RI)	RI0001003R-01A RI0001003R-01B	Upper Blackstone Grafton Northbridge Uxbridge Woonsocket	56 2.4 2.0 2.5 16.0	31.1	71	20 (8.0-28.0)	7.1 (6.2-8.2)	5.76[1] (3.96-7.08) 7.1[2] (5.3-12.1)	41.5 (19.0-78.0)
Ten Mile River (entire length of river within RI, including 4 run-of-the-river impoundments)	RI0004009R-01A RI0004009R-01B RI0004009L-02 RI0004009L-01A RI0004009L-01B RI0004009L-03	Attleboro North Attleboro	8.6 4.61	1.93	87.3	no data	7.7 (7.0-9.0)	4.8 (single data point)	47.7 (42.0-53.6)
Woonasquatucket River (below Smithfield WWTF discharge to confluence with Moshassuck River)	RI0002007R-10C RI0002007R-10D	Smithfield	3.5	3.68	48.7	no data	7.0 (5.62-7.61)	4.44 (3.12-7.8)	48.8 (31.6-113.37)

* - Mean value observed for period noted below. Range of data is shown in parentheses

Blackstone River Data Sources:

Alkalinity – (n = 15) February 2000 – August 2002, USGS gage at Manville, RI
pH – (n = 32) February 2000 – June 2008 USGS, gage at Manville, RI
Hardness – (n = 26) February 2000 – May 2008, USGS gage at Manville, RI
NH_3 – (n = 11) June 2000 – August 2002, USGS gage at Manville, RI
Chloride – (n = 6) June 2000 – June 2002, USGS gage at Manville, RI
[1]TOC – (n ≅ 52) biweekly 1982 – 1983, mouth of Blackstone River, Nixon et al 1995[*].
DOC range 3.6-5.88 mg/l, mean 5.04 mg/l
[2]TOC – (n = 9) June 2000 – April 2002, USGS gage at Manville, RI

Ten Mile River Data Sources:

pH – (n = 43) September 2000 – April 2001, along length of river ,Narragansett Bay Commission (NBC)
Hardness – (n = 8) March 2007 and May 2007, along length of the river, RIDEM, TMDL section
TSS – (n = 48) November 2000 – April 2001, NBC April 2007 – September 2007, MADEP
Chloride – (n=3) September 1996 and September 1997, RIDEM Supplemental sampling; Sept 2000 RSD
TOC – (n = 1) Summer 2000 Random Sampling Design (RSD) Project USEPA

Woonasquatucket River Data Sources:

pH – (n = 36) May 2004 – October 2006, along length of the river, URI Watershed Watch
Hardness – (n = 20) August 2002, along length of the river, NBC
TSS – (n = 25) August 2002, along length of the river, NBC
NH_3 – (n = 34) May 2004 – October 2006, along length of the river, URIWW
Chloride – (n = 15) May 2004 – October 2006, along length of the river, URIWW
TOC – (n ≅ 52) biweekly 1982 – 1983, mouth of Woonasquatucket River, Nixon et al 1995[*]
DOC range 2.88-6.66 mg/l, mean 3.96 mg/l

[*] S.W. Nixon, S.L. Granger & B.L. Nowicki, An assessment of the annual mass Balance of carbon, nitrogen, and phosphorus in Narragansett Bay, Biogeochemistry 31: 15-61, 1995.

Table 3 Acute Toxicity Data and Copper Concentrations for WWTFs within Rhode Island

WWTF	Date	Ceriodaphnia		Pimephales		Effluent Cu concentration (ug/l)
		LC50 (%)	A-NOEC (%)	LC50 (%)	A-NOEC (%)	
Woonsocket	2/06	>100	100	>100	100	13
	5/06	>100	100	>100	100	4
	9/06	>100	100	>100	100	16
	10/06	>100	100	>100	6.25	7
	2/07	>100	100	>100	100	<1.0
	6/07	>100	100	>100	100	3.7
	9/07	>100	100	>100	100	10
	12/07	>100	100	>100	100	14
	3/08	>100	100	>100	100	<1.0
Smithfield	2/06	>100	100			11
	6/06	>100	100			7
	8/06	>100	100			6
	10/06	>100	100			4
	3/07	>100	100			3
	6/07	>100	100			6
	8/07	>100	100			4
	12/07	>100	100			3
	3/08	>100	100			4.9

Proposed Site Specific Copper Criteria

Work conducted by CT DEP and MA DEP have shown that, at a minimum, the water quality criterion for dissolved copper in specific waters can be increased by a factor of 2.92 without adversely affecting aquatic life. This is even more conservative than the site specific copper criteria derived for the Pawtuxet River where a copper WER of 4.77 was developed following RI DEM's Site Specific Aquatic Life Water Quality Criteria Development Policy (RIDEM, 2006) and EPA's Interim Guidance on Determination and Use of Water Effect Ratios for Metals (USEPA, 1994).

RI DEM is proposing to adopt Connecticut's site specific copper WER of 2.92 for RI rivers which meet the percent effluent and hardness criteria established in the CT DEP study. This includes the Blackstone River, Ten Mile River (including run-of-the-river Slater Park Pond, Turner Reservoir North and South and Omega Pond) and Woonasquatucket River from the Smithfield WWTF discharge to the confluence with the Moshassuck River. As shown in Table 4, the proposed site specific dissolved copper criteria for these rivers is 20.41 ug/l acute and 14.45 ug/l chronic.

Table 4 Proposed site specific Copper criteria for selected Rhode Island rivers

Effect	National Guidance Criteria *	Final WER	Site Specific Dissolved Cu Criteria (ug/l)
	Dissolved Copper (ug/l)		
Acute	6.99	2.92	20.41
Chronic	4.95	2.92	14.45

* calculated using 50 mg/l hardness and using EPA's current hardness-dependant calculation for freshwater dissolved copper criteria, as adopted by RI DEM.