

Appendix D-1. Calculations for Ionic Composition of Standard Laboratory-Reconstituted Water

<u>Molecular Weights</u>	<u>Atomic Weights</u>
NaHCO ₃ = 84.03	Na = 22.98
CaSO ₄ ·2H ₂ O = 172.12	Ca = 40.08
MgSO ₄ = 120.37	Mg = 24.31
KCl = 74.55	K = 39.10
SO ₄ = 96.06	Cl = 35.45

Example Calculation

[Na] in very soft water:

$$12 \text{ mg NaHCO}_3/\text{L} \times 1 \text{ mmol NaHCO}_3/84.03 \text{ mg NaHCO}_3 = 0.143 \text{ mmol NaHCO}_3/\text{L}.$$

$$0.143 \text{ mmol NaHCO}_3/\text{L} \times (1 \text{ mmol Na}/1 \text{ mmol NaHCO}_3) \times 22.98 \text{ mg Na}/1 \text{ mmol Na} = 3.3 \text{ mg Na}/\text{L}.$$

[Ca] in very soft water:

$$7.5 \text{ mg CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L} \times 1 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/172.12 \text{ mg CaSO}_4 \cdot 2\text{H}_2\text{O} = 0.044 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L}.$$

$$0.044 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L} \times (1 \text{ mmol Ca}/1 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}) \times 40.08 \text{ mg Ca}/1 \text{ mmol Ca} = 1.8 \text{ mg Ca}/\text{L}.$$

[Mg] in very soft water:

$$7.5 \text{ mg MgSO}_4/\text{L} \times 1 \text{ mmol MgSO}_4/120.37 \text{ mg MgSO}_4 = 0.062 \text{ mmol MgSO}_4/\text{L}.$$

$$0.062 \text{ mmol MgSO}_4/\text{L} \times (1 \text{ mmol Mg}/1 \text{ mmol MgSO}_4) \times 24.31 \text{ mg Mg}/1 \text{ mmol Mg} = 1.5 \text{ mg Mg}/\text{L}.$$

[K] in very soft water:

$$0.5 \text{ mg KCl}/\text{L} \times 1 \text{ mmol KCl}/74.55 \text{ mg KCl} = 0.0067 \text{ mmol KCl}/\text{L}.$$

$$0.0067 \text{ mmol KCl}/\text{L} \times (1 \text{ mmol K}/1 \text{ mmol KCl}) \times 39.102 \text{ mg K}/1 \text{ mmol K} = 0.26 \text{ mg K}/\text{L}.$$

[Cl] in very soft water:

$$0.5 \text{ mg KCl}/\text{L} \times 1 \text{ mmol KCl}/74.55 \text{ mg KCl} = 0.0067 \text{ mmol KCl}/\text{L}.$$

$$0.0067 \text{ mmol KCl}/\text{L} \times (1 \text{ mmol Cl}/1 \text{ mmol KCl}) \times 35.453 \text{ mg Cl}/1 \text{ mmol Cl} = 0.24 \text{ mg Cl}/\text{L}.$$

[SO₄] in very soft water:

$$7.5 \text{ mg CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L} \times 1 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/172.12 \text{ mg CaSO}_4 \cdot 2\text{H}_2\text{O} = 0.044 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L}.$$

$$0.044 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}/\text{L} \times (1 \text{ mmol SO}_4/1 \text{ mmol CaSO}_4 \cdot 2\text{H}_2\text{O}) \times 96.064 \text{ mg SO}_4/1 \text{ mmol SO}_4 = 4.2 \text{ mg SO}_4/\text{L}.$$

[SO₄] in very soft water:

$$7.5 \text{ mg MgSO}_4/\text{L} \times 1 \text{ mmol MgSO}_4/120.37 \text{ mg MgSO}_4 = 0.062 \text{ mmol MgSO}_4/\text{L}.$$

$$0.062 \text{ mmol MgSO}_4/\text{L} \times (1 \text{ mmol SO}_4/1 \text{ mmol MgSO}_4) \times 96.064 \text{ mg SO}_4/1 \text{ mmol SO}_4 = 6.0 \text{ mg SO}_4/\text{L}.$$

Total SO₄ = 10.2 mg/L

Conversion Factors to calculate water hardness (as CaCO₃) from [Ca] and [Mg]:

$$[\text{Ca}] \times 2.497$$

$$[\text{Mg}] \times 4.116$$

Appendix D-2. Dissolved, Particulate, and Estimated Total Organic Carbon for Streams and Lakes by State (as presented in EPA Document #822-B-98-005)

State	Streams				Lakes			
	POC	DOC	Est. TOC	Est. DOC:TOC	POC	DOC	Est. TOC	Est. DOC:TOC
AK	0.54	4.6	5.14	89.49	0.53	6.4	6.93	92.35
AL	0.72	3.4	4.12	82.52	---	---	---	---
AR	0.8	7.2	8	90.00	0.4	2.7	3.1	87.10
AZ	0.71	5.2	5.91	87.99	0.52	4.2	4.72	88.98
CA	1.13	8.2	9.33	87.89	0.32	2.3	2.62	87.79
CO	1.29	8.6	9.89	86.96	---	---	---	---
CT	0.71	4.8	5.51	87.11	---	---	---	---
DC	---	---	---	---	---	---	---	---
DE*	0.7	7.1	7.8	91.03	---	---	---	---
FL^	0.68	16.1	16.78	95.95	2.9	12.1	15	80.67
GA	0.67	4.3	4.97	86.52	---	---	---	---
HI	0.59	4	4.59	87.15	---	---	---	---
IA	1.79	11.6	13.39	86.63	---	---	---	---
ID	0.6	3.2	3.8	84.21	---	---	---	---
IL	1.77	6.8	8.57	79.35	0.12	4.7	4.82	97.51
IN	0.71	9.2	9.91	92.84	---	---	---	---
KS	1.75	5.2	6.95	74.82	1.53	4.5	6.03	74.63
KY	0.75	3.1	3.85	80.52	---	---	---	---
LA	1.52	6.9	8.42	81.95	0.65	5.6	6.25	89.60
MA	0.47	5.9	6.37	92.62	---	---	---	---
MD	1.66	3.7	5.36	69.03	---	---	---	---
ME	0.46	15.3	15.76	97.08	---	---	---	---
MI	0.58	6.3	6.88	91.57	0.32	2.7	3.02	89.40
MN	1.79	12.2	13.99	87.21	0.16	4.8	4.96	96.77
MO	0.56	4.2	4.76	88.24	---	---	---	---
MT	0.9	9.4	10.3	91.26	0.91	8.2	9.11	90.01
NC	1.14	11.5	12.64	90.98	---	---	---	---
ND	1.14	14.5	15.64	92.71	0.8	14.9	15.7	94.90
NE	1.84	6.8	8.64	78.70	---	---	---	---
NH	0.28	4.2	4.48	93.75	---	---	---	---
NJ	0.69	5.5	6.19	88.85	1.04	5	6.04	82.78
NM	1.43	6.3	7.73	81.50	0.51	5.2	5.71	91.07
NV	0.82	4.2	5.02	83.67	---	---	---	---
NY	1.4	4	5.4	74.07	0.46	2.4	2.86	83.92
OH	0.57	5	5.57	89.77	0.49	2.6	3.09	84.14
OK^	1.27	7.7	8.97	85.84	1.72	15	16.72	89.71
OR*^	1.14	2.1	3.24	64.81	0.64	4.4	5.04	87.30
PA	2.19	5.4	7.59	71.15	0.63	3.2	3.83	83.55
RI*	0.42	8.3	8.72	95.18	---	---	---	---
SC	0.7	5.7	6.4	89.06	---	---	---	---
SD	1.25	7.6	8.85	85.88	---	---	---	---
TN	0.67	2.3	2.97	77.44	---	---	---	---
TX	1.33	6.5	7.83	83.01	1.55	10.3	11.85	86.92
UT^	1.38	8.9	10.28	86.58	0.5	2.4	2.9	82.76
VA	0.81	4.7	5.51	85.30	---	---	---	---
VT	0.31	4.5	4.81	93.56	---	---	---	---
WA	1.52	5.4	6.92	78.03	0.61	2.8	3.41	82.11
WI	1.03	9.2	10.23	89.93	0.16	4.1	4.26	96.24
WV	0.63	2.8	3.43	81.63	---	---	---	---
WY	1.07	8.2	9.27	88.46	---	---	---	---

State	POC	DOC	<u>Streams</u>		POC	DOC	<u>Lakes</u>	
			Est. TOC	Est. DOC:TOC			Est. TOC	Est. DOC:TOC
			Mean	85.71			Mean	87.84
			Max	97.08			Max	97.51
			Min	64.81			Min	74.63

* States where sample size was low for streams.

^ States where sample size was low for lakes.

**Appendix D-3. Mean TOC and DOC in Lake Superior Dilution Water
(data from Greg Lien, U.S. EPA-Duluth, MN)**

	Replicate	Ambient (8/29/2000)	pH 7.0 (8/30/2000)	pH 6.2 (8/31/2000)
Filter Blank*		-0.04	0.22	0.38
Pre-gill experiment TOC	a	1.13	1.34	1.26
	b	1.37	1.30	1.36
	Mean	1.25	1.32	1.31
Post-gill experiment TOC	a	1.20	1.24	1.18
	b	1.27	1.46	1.10
	Mean	1.24	1.35	1.14
Pre-gill experiment DOC	a	1.96	1.51	1.34
	b	1.52	1.28	0.99
	Mean	1.74	1.40	1.17
Post-gill experiment DOC	a	1.49	1.36	1.44
	b	1.64	1.58	1.24
	Mean	1.57	1.47	1.34

* Filter blank is ultra-pure Duluth-EPA laboratory water.

**Appendix D-4. Measured Hardness and Major Ion and Cation Concentrations
in WFTS Well Water from April 1972 to April 1978. Concentrations Given as Mg/L
(data from Samuelson 1976 and Chapman, personal communication)**

Month	Total Hardness	Ca	Mg	Na	K	SO ₄	Cl
Mar-72							
Apr-72		7.9	2	5	1.1	<10.0	8
May-72	22	5.8	1.4	4.4	0.5	<5.0	7
Jun-72	24	5.8	1.6	4.4	0.5	3	7
Jul-72	23	6.7	1.6	4.6	0.5	<1.0	8.3
Aug-72	23	6.5	1.7	4.7	0.5	<10.0	6.3
Sep-72	22	6	1.6	4.5	0.6	<10.0	4
Oct-72	22	6.7	1.9	4.7	0.6	5	5.5
Nov-72	23	6.2	1.6	4.2	0.6	3.7	5.3
Dec-72	23	6.2	1.5	4.2	0.5	3	4
Jan-73	52	15.3	3.5	7.1	0.7	7.8	12.4
Feb-73	33	7.7	2.1	5	0.5	5	5
Mar-73	30	8	2.1	5.3	0.7	5	6
Apr-73	31	8.9	2.3	5.4	0.7	5.3	8.8
May-73	28	8.3	2.4	5.8	0.7	3	8
Jun-73	28	8.4	2.2	5.8	0.7	4.8	7.5
Jul-73	26	7.4	1.9	5.8	0.8	<5.0	6.8
Aug-73	25	6.5	1.7	5.7	0.7	3.1	5.8
Sep-73	25	6.7	1.7	5.4	0.7	3.1	5.3
Oct-73	27	7	1.8	5.4	0.7	2.9	5.4
Nov-73	28	7.9	2.1	4.8	0.7	10	6.8
Dec-73	62	20.3	4.2	9	0.8	13	14
Jan-74	67	21.3	4.8	7	0.8	17.3	11.3
Feb-74	58	14.3	3.4	6.9	0.9	14.7	6.7
Mar-74	53	20.8	3.8	7.2	0.7	13	7
Apr-74	51	18.2	3.7	6.8	0.6	15.5	8.5
May-74	23	7.5	2.1	4.6	0.6	5	4.8
Jun-74	22	6	1.9	4.8	0.5	3	4.5
Jul-74	23	5.4	1.7	5	0.6	3.3	6.3
Aug-74	23	4.8	1.6	5	0.7	3	6
Sep-74	23	5.8	1.5	5.1	0.7	2.9	4.8
Oct-74	23	11	2	7.1	0.8	3.1	5
Nov-74	23	12	2.6	4.5	0.5	3.8	5.3
Dec-74	24	6.4	2.5	5.2	0.7	3.8	5
Jan-75	41	7.7	2.9	6.7	0.6	8	8
Feb-75	61	11.6	4.2	8.6	0.8	16	11.8
Mar-75	54	9.1	3.1	6.4	0.6	8	8
Apr-75		4.4	1.6	4.4	0.5	3	5
May-75		7.2	2	5	0.5	6	7
Jun-75		4.4	1.6	4.6	0.6	5	6
Jul-75		5.2	1.6	7	0.7	5	7
Aug-75		5.2	1.4	7	0.6	5	5
Sep-75		4.5	1.5	4.5	0.7	5	4
Oct-75		7.1	1.9	4.3	0.5	20	5
Nov-75	18	5.3	1.5	4.2	0.5	5	4
Dec-75							
Jan-76							
Feb-76		9.8	5	5.4	0.4	9	9
Mar-76				4.1	0.1	3	6
Apr-76				5.3	0.1	6	9

Month	Total Hardness	Ca	Mg	Na	K	SO ₄	Cl
May-76		7.9	1.8	4.5	0.5	3	6
Jun-76	27	8.1	1.9	3.3	0.6	4	7
Jul-76	26						
Aug-76	23	4.9	1.3	4.8	0.1	3	6
Sep-76	23	6.7	2.6	4.7	0.1		
Oct-76	21	6.7	2.6	4.7	0.1		
Nov-76	22	7.7	3	4.7	0.1	3	
Dec-76	25.5	6.4	1.8	5	0.1	4	7
Jan-77	27.2	7.7	2.6	5.6	0.6	4	8
Feb-77		10.7	4.9	5.9	0.6	3	11
Mar-77						3	8
Apr-77		10.7	2.2	5.5	0.8	3	7
May-77	25	5	1.8	5	0.8	3	5
Jun-77	27	6.6	2	5.2	0.7	3	5
Jul-77	24	6.7	2	7.1	0.8	3	7
Aug-77	25	6.9	1.9	6.9	1		8
Sep-77	27	9.9	2.1	5.9	0.9	3	6
Oct-77						3	
Nov-77		6.6	2.1	5.6	0.9	10	4.6
Dec-77	27	9.7		4.95	0.65	9	4.6
Jan-78		10.9	3.75		0.85	6	12
Feb-78		10.6	3.8	8.6	0.7	5	11
Mar-78		10.2	2.6	4.7	0.6	6	9
Apr-78		8.3	2.4		0.7	5	9.55

**Appendix D-5. Results of the Sample Analysis of New and Clinch Rivers
and Sinking Creek, VA.**

Samples were analyzed August and September 2000, under WA 1-20. Water was collected for analysis by Dr. Don Cherry, Virginia Polytechnic Institute and State University, Blacksburg, VA. Units are mg/L, except pH, which are standard units.

Sampling Point: New River			
<i>General Chemistry</i>		<i>Metals</i>	
Parameter	Value	Parameter	Value
NO₃	0.7	Ca	15
Cl	6.1	Mg	0.6
Sulfate	9.8	K	2
Sulfide	0.05	Na	6.6
Alkalinity	52		
pH	8		
DOC	2		
TOC	2.25		
Sampling Point: Clinch River			
<i>General Chemistry</i>		<i>Metals</i>	
Parameter	Value	Parameter	Value
NO₃	1	Ca	42
Cl	9.2	Mg	11
Sulfate	19	K	2.4
Alkalinity	150	Na	12
Hardness	150		
pH	8.3		
DOC	2.3		
Sampling Point: Sinking Creek			
<i>General Chemistry</i>		<i>Metals</i>	
Parameter	Value	Parameter	Value
NO₃	0.6	Ca	33
Cl	2.6	Mg	1.1
Sulfate	5	K	6.7
Sulfide	0.05	Na	1.7
Alkalinity	130		
pH	8.1		
DOC	1.05		
TOC	1.3		

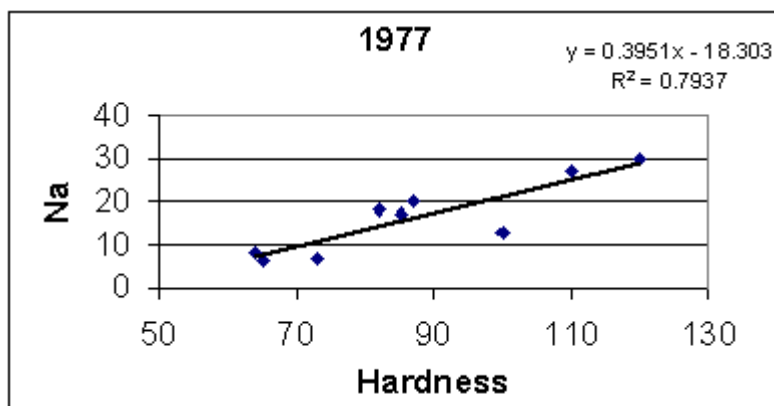
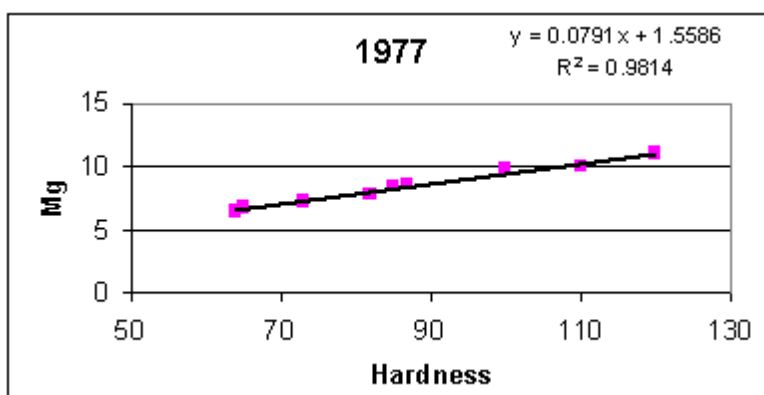
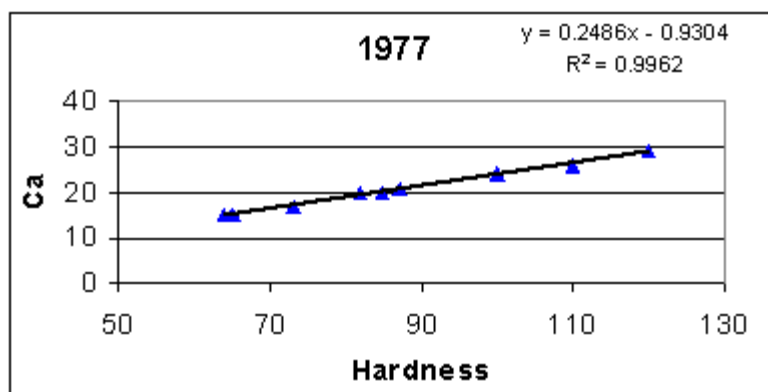
**Appendix D-6. Water Composition of St. Louis River, MN, from USGS NASQAN and
Select Relationships to Water Hardness**

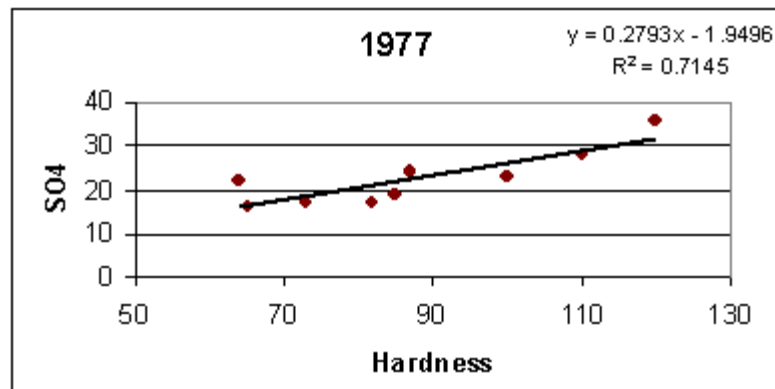
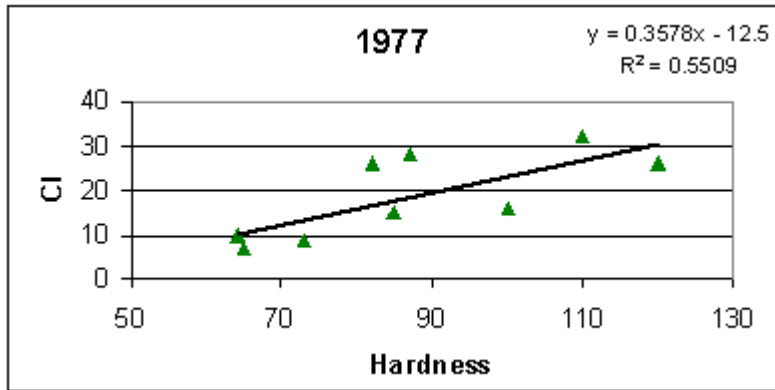
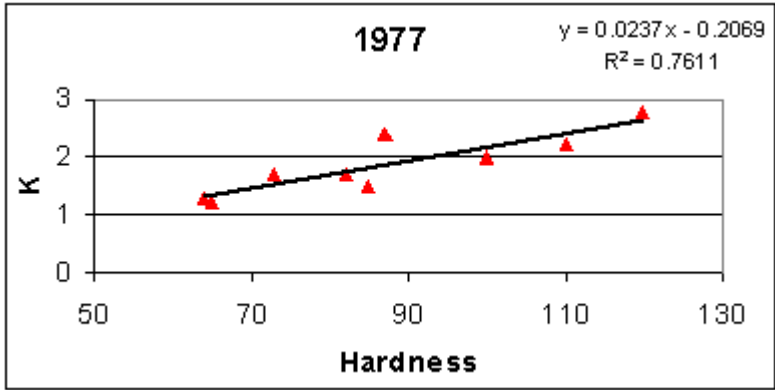
Date	pH	Hardness	Alkalinity	Ca	Mg	Na	K	Cl	SO ₄	NO ₃	DOC
19730222	6.8	68	53	17	6.3	11	1.6	14	14	0.19	
19730503	7.1	58	46	14	5.5	6.6	1.1	9.5	13	0.17	
19730816	6.9	70	51	17	6.6	7.6	1.2	9	20	0.01	
19731128	7	65	48	16	6.1	7.5	1.3	8.8	14		
19740221	7	64	48	16	5.8	8.9	1.3	12	14		
19740516	6.9	45	32	11	4.3	3.5	1.2	3.8	11		
19740919		88	60	21	8.6	12	1.8	17	23		
19741030	7.3	83	62	23	6.3	13	1.3	16	23		
19741209	7.4	86	62	22	7.6	12	1.6	15	18		
19750121	7.3	74	66	18	7	10	1.1	12	13		
19750303	7.3	74	68	17	7.6	10	1.7	11	12		
19750407	7.2	95	80	22	9.7	11	2	14	16		
19750527	7.5	63	50	15	6.1	8.5	1.5	9.2	12		
19750708	9.2	58	43	14	5.7	3.2	1	3.4	10		
19750818	7.2	73	56	18	6.9	12	1.3	16	16		
19750929	7.4	90	72	23	8	12	1.5	13	20		
19751110	7.1	90	63	22	8.4	12	1.7	15	24		
19751216	7.6	87	61	22	7.8	14	1.6	16	28		
19760209	7.5	72	59	18	6.6	13	1.6	13	18		
19760322	7.7	78	65	19	7.4	12	1.4	11	17		
19760503	7.6	59	43	14	5.8	7.9	1.3	8.6	15		
19760614	7.5	94	75	22	9.4	16	1.9	20	20		
19760726	7.4	93	80	22	9.3	21	1.9	25	24		
19760908	7.5	82	78	18	9.1	17	2.5	9.3	26		
19761019	7.5	83	72	20	8.1	21	1.6	24	21		
19761129	7.4	95	74	22	9.7	25	1.8	32	24		
19770110	7.3	85	88	20	8.4	17	1.5	15	19		
19770214	8.2	82	73	20	7.8	18	1.7	26	17		
19770404	7.3	87	67	21	8.5	20	2.4	28	24		
19770516	7.3	120	98	29	11	30	2.8	26	36		
19770628	7.8	100	75	24	9.9	13	2	16	23		
19770808	7.4	110	90	26	10	27	2.2	32	28		
19770919	7.4	73	44	17	7.3	6.6	1.7	8.9	17		
19771031	7.6	64	47	15	6.5	7.9	1.3	9.7	22		37
19771212	7.5	65	50	15	6.8	6.3	1.2	7.1	16		
19780123	7.3	71	52	17	6.9	12	1.5	9.4	18		
19780306	7.2	67	48	16	6.5	8.8	1.2	17	16		32
19780417	7.5	43	28	10	4.3	4.2	1.8	5.7	15		
19780530	7.9	64	54	15	6.4	5.7	1.5	7.1	14		33
19780710	7.4	53	44	13	5.1	4.3	1.3	5.3	8.9		
19780821	8.4	60	42	15	5.5	5.3	1.5	6.5	12		36
19781002	7.7	71	57	17	6.9	8.2	1.1	9.6	15		24
19781115	7.4	68	52	16	6.8	11	1.1	10	12		
19781218	7.4	68	55	16	6.9	11	1	9.2	14		
19790205	7.4	63	57	15	6.3	3.4	1	3.1	8		12

Date	pH	Hardness	Alkalinity	Ca	Mg	Na	K	Cl	SO ₄	NO ₃	DOC
19790329	7.6	80	63	19	8	8.4	2.3	7.8	13		
19790430	7.6	37	29	8.7	3.7	2.2	1.3	2.8	8.9		20
19790611	7.2	47	34	11	4.8	3.1	0.8	2.8	9.4		
19790723	7.6	73	55	17	7.3	3.9	0.9	3.7	8.9		30
19790827	7.2										
19791015	8.1	74	54	16	8.2	5	1.1	3.9	13	0.01	12
19791126	7.8	61	52	14	6.3	3.8	0.9	3.6	11	0.37	
19800121	7.6	60	53	14	6	3.8	0.9	3.2	9.9	0.15	
19800219	7.4	63	51	15	6.2	3.9	0.8	2.9	9.2	0.19	17
19800331	8.4	68	64	16	6.9	4.2	1.1	3.5	9.2	0.3	
19800602	8.3	84	72	19	8.8	6.4	1.2	5	15	0.01	21
19800630	8.3	93	68	21	9.9	7.9	1.4	6.7	24	0.02	
19800804	8.1	130	110	28	14	10	1.9	11	24	0.01	13
19800902	7.8	110	82	24	11	7.2	1.7	7.6	18	0.01	
19800929	7.6	73	54	16	8.1	5.7	1.4	5.8	14	0.12	
19801103	7	82	58	18	8.9	5.6	1.3	6.9	18	0.19	23
19801208		67	50	15	7.2	4.6	1	4.1	11	0.19	
19810105	7.6	70	55	16	7.2	4.2	1.1	4.1	13	0.23	
19810209	7.5	68	58	16	6.9	4.9	1	3.5	8.1	0.27	14
19810309	7.7	61	57	14	6.2	5.2	1.8	5.1	8.6	0.36	
19810504	7.3	42	40	9.6	4.3	3.7	1.2	3.6	9.6	0.18	21
19810706	7.4	51	39	12	5	3.5	1.2	3.2	7.5	0.14	10
19810908	7.9	73	64	16	8	4.2	0.8	4.2	8.3	0.11	
19811020	7.6	51	37	12	5.2	4.3	1.2	4.2	8.9	0.31	
19820113		62	52	14	6.5	4	0.9	3.7	9.3	0.24	
19820309	7.4	66	58	15	7	5.3	1	3.8	11	0.36	
19820420	7.2	32	25	7.5	3.3	2.1	1.3	2.3	6	0.19	
19820621	7.9	61	55	14	6.4	4.3	1.1	4	10	0.1	
19820809	7.4	66	54	15	6.9	3.9	0.6	3.5	9	0.25	
19821004	8	73	63	15	8.7	4.9	1	4.7	13	0.11	
19821207	7.3	55	43	12	6.1	4.2	0.8	3.3	16	0.24	
19830131	6.9	62	50	14	6.5	4.1	0.8	3.5	15	0.36	
19830328	7.5	68	56	15	7.3	4.5	1.2	4.1	15	0.35	
19830523	8.2	68	53	15	7.5	4	1.3	0.8	23	0.12	
19830718	7.6	67	53	15	7.2	3.7	1.3	3.7	22	0.15	
19831031	7.7	64	48	14	7	3.9	1.2	3.5	24	0.12	
19840109	7.4	57	50	13	6	3.6	0.9	3.4	13	0.23	
19840306	7.1	66	57	15	7	4.4	0.9	5.2	8.7	0.31	
19840424	7.2	51	39	11	5.6	3.1	1.4	3.2	14	0.12	
19840619	9.5	52	39	12	5.3	2.9	0.8	3.6	10	0.13	
19840822	6.4	70	58	15	7.9	4.7	1	3.8	17	0.1	
19841009	7.6	73		16	7.9	4.6	1	3.7	15	0.1	
19841120	7.1	64		14	7.1	3.9	0.9	3.7	14	0.24	
19850211	7	69		15	7.7	4.6	1.1	4	11	0.27	
19850325	7.3	61		13	7	5.6	2.5	6.6	16	0.31	
19850506	7.4	55		12	6	3.6	1.7	4.2	14	0.15	
19850730	7.6	62		14	6.6	3.2	0.9	4	9.8	0.1	
19851021	7.5	58		12	6.8	3.7	1.1	0.2	12	0.13	

Date	pH	Hardness	Alkalinity	Ca	Mg	Na	K	Cl	SO ₄	NO ₃	DOC
19851203	7.4	73		16	8	4	1	4.2	18	0.16	
19860303	7.4	66		15	7	4	1	3.4	10	0.24	
19860407	7.3									0.19	
19860602	7.5	58		13	6.3	3.5	1	2.8	15	0.1	
19860818	7.9	74		15	8.9	4.6	1.2	3.7	24	0.1	
19861112	7.5	55		12	6	3.4	1.4	3.8	19	0.27	
19861210	7.3	70	57	13	9	5	1	4.8	21	0.16	
19870218	7	66		15	6.8	3.7	0.9	3.1	12	0.24	
19870518	8	83		18	9.3	5.8	1.2	5	10	0.1	
19870622	7.8	75		16	8.5	6.2	1.1	5.2	19	0.1	
19870721	7.6	51		12	5.2	2.8	1.3	3.1	15	0.1	
19871028	8	82		17	9.6	6.8	1.4	1.3	19	0.1	
19871208	7.9	69		15	7.7	5.3	1.4	4.8	17	0.1	
19880119	7.4	73		16	8	5.1	1	3.6	15	0.15	
19880223	7.4	85		19	9.2	6.5	8.5	5.1	16	0.2	
19880412	7.4	42		9.2	4.7	3	2.8	5	20	0.25	
19880907	7.1	70		15	8	5.3	1.5	6.1	18	0.15	
19881031	7.6	100		21	12	9	1.9	7.8	27	0.1	
19881130	7.6	78		17	8.6	5.5	1.3	5.5	19	0.19	
19890221	7.1	77		17	8.4	6.3	1.3	4.4	17	0.25	
19890410	7.2	48		11	5	4.9	1.8	8.1	8	0.37	
19890626	7.4	63		14	6.8	4.6	1.1	5	12	0.15	
19890814	8.1	95		20	11	9.1	1.5	8.9	18	0.1	
19891101	8.1	110		20	15	7.8	1.9	6.3	31	0.1	
19891218	7.5	88		17	11	6.1	1.4	5	22	0.16	
19900123	7.3	100		18	14	7.2	1.7	5.2	28	0.23	
19900416	7.5	62		13	7.2	5.1	1.9	5.4	14	0.2	
19900716	7.7	70		15	8	5.7	1.3	5.4	11	0.2	
19900820	8.1	95		20	11	7.8	1.5	7.9	20	0.1	
19901009	7.3	81		18	8.7	5.4	1.5	5.7	13	0.1	
19910102	7.4	83		19	8.7	5.3	1.4	5	12	0.2	
19910212	7.1	80		18	8.5	6.8	1.3	3.9	11	0.2	
19910502	6.7	56		13	5.8	4	1	3.7	7.9	0.1	
19910610	7.3	64		15	6.5	4	0.7	4.1	6.9	0.12	
19910731	7.8	55		13	5.4	2.5	1	2.6	3.8	0.05	
19910801	7.3										
19911003	7.8	67		15	7.1	4.4	1	4.4	9.6	0.068	
19911204	7.4	61		13	6.9	4.8	1	3.5	7	0.18	
19920113	7.9	67		15	7.2	4.3	1.1	3.2	9.3	0.21	
19920413	7.7	30		7.8	2.5	2.5	0.3	2.4	4.8	0.16	
19920722	7.6	71		16	7.5	4.8	0.9	2.1	9.6	0.11	
19921026	8.2	86		18	10	5.3	1.2	5.4	14		
19921216	7.6	89		19	10	6	1.2	5.6	13	0.25	
19930201	7.2	83		18	9.1	7.3	1.2	7.3	12	0.28	
19930426	7.7	66		15	6.8	4.1	1.2	4.9	9.5	0.092	
19930722	7.5	64		15	6.5	4	0.2	3.9	7.7	0.079	
19931201	7.7	80		17	9	4.8	1	4	11	0.16	

Date	pH	Hardness	Alkalinity	Ca	Mg	Na	K	Cl	SO ₄	NO ₃	DOC
19940216	7.3										
19940511	7.7	51		11	5.6	3.7	1.1	3.4	9.4	0.076	
MIN	6.4	30	25	7.5	2.5	2.1	0.2	0.2	3.8	0.01	10
MAX	9.5	130	110	29	15	30	8.5	32	36	0.37	37
MEAN	7.52	71.11	56.94	16.16	7.46	7.09	1.37	7.39	15.04	0.17	22.19





Appendix D-7. Supplementary Data for Bennett et al. (1995)

Tank	Dose ($\mu\text{g Cu/L}$)	Conductivity ($\mu\text{mho/cm}$)	pH	Oxygen (mg/L)	Temp ($^{\circ}\text{C}$)	Alkalinity (as $\text{mg CaCO}_3/\text{L}$)	Hardness (as $\text{mg CaCO}_3/\text{L}$)
<u>0 hours 7/9/92</u>							
a	897	325	8.62	7.5	21	100	96
b	897	300	8.6	7.6	21	100	96
c	897	320	8.6	7.6	21	80	96
d	607	320	8.62	7.7	21	80	96
e	607	370	8.62	7.6	21	80	96
f	607	328	8.64	7.6	21	80	96
g	93	310	8.64	7.6	21	80	96
h	93	370	8.69	7.5	21	80	96
I	93	310	8.6	7.6	21	80	96
j	505	310	8.62	7.7	21	100	96
k	505	310	8.65	7.7	21	80	96
l	505	320	8.69	7.7	21	80	96
m	319	320	8.69	7.7	21	80	96
n	319	330	8.68	7.7	21	80	96
o	319	320	8.67	7.7	21	80	96
p	0	310	8.62	7.5	21	80	96
q	0	320	8.63	7.6	21	80	96
r	0	320	8.6	7.7	21	80	96
<u>24 hours 7/10/92</u>							
a	897	300	7.78	8.5	21.5	60	104
b	897	305	7.64	8.4	22	80	100
c	897	305	7.68	8.5	22	90	100
d	607	300	7.7	8.4	21.5	90	100
e	607	305	7.65	8.4	21.5	80	100
f	607	305	7.75	8.4	21.5	80	100
g	93	300	7.77	9.1	22	80	100
h	93	295	7.76	9.2	21.5	80	108
I	93	295	7.76	9	21.5	85	100
j	505	300	7.73	8.8	22	90	84
k	505	300	7.71	8.8	21.5	80	100
l	505	300	7.73	8.7	21.5	80	100
m	319	300	7.74	9.1	21.5	80	100
n	319	300	7.52	8.5	22	80	100
o	319	310	7.79	8.7	22.5	80	100
p	0	305	7.79	9.1	22	80	100
q	0	305	7.7	9.1	22	80	104
r	0	300	7.71	9.1	22	80	104
<u>48 hours 7/11/92</u>							
a	897	*	*	*	*	*	*
b	897	*	*	*	*	*	*
c	897	320	8.1	7.2	21.5	100	96
d	607	315	7.91	6.9	21.5	100	96
e	607	310	7.84	6.8	21.5	100	100
f	607	315	8	7	21.5	100	104
g	93	300	8.19	7.7	21.5	100	100

Tank	Dose ($\mu\text{g Cu/L}$)	Conductivity ($\mu\text{mho/cm}$)	pH	Oxygen (mg/L)	Temp ($^{\circ}\text{C}$)	Alkalinity (as $\text{mg CaCO}_3/\text{L}$)	Hardness (as $\text{mg CaCO}_3/\text{L}$)
h	93	300	8.13	7.7	21	100	100
I	93	300	8.16	7.6	21	100	104
j	505	310	8.1	7.5	21	80	100
k	505	310	8.12	7.4	21	100	100
l	505	310	8.13	7.4	21	80	100
m	319	310	8.12	7.4	21	100	100
n	319	310	7.8	6.4#	21.5	100	100
o	319	310	8.18	7.3	22	100	96
p	0	300	8.16	8	21.5	80	100
q	0	300	8.1	7.9	21.5	80	104
r	0	300	8.21	8	21.5	100	100

72 hours 7/12/92

a	897	*	*	*	*	*	*
b	897	*	*	*	*	*	*
c	897	*	*	*	*	*	*
d	607	310	8.02	8.9	21.5	100	100
e	607	315	8.04	8.8	21.5	100	100
f	607	315	8.02	8.7	21.5	80	100
g	93	310	7.92	9.1	21.5	100	104
h	93	305	7.91	9.1	21	100	100
I	93	310	7.91	9	21	80	106
j	505	315	7.97	8.9	21.5	100	104
k	505	310	7.96	8.9	21	100	100
l	505	310	7.96	9	21	80	104
m	319	310	7.91	9	21	100	100
n	319	310	7.97	9	21	80	100
o	319	320	7.99	8.8	22	100	104
p	0	300	7.86	9.3	21.5	100	104
q	0	300	7.81	9.1	21.5	80	100
r	0	305	7.93	9.3	21.5	80	100

96 hours 7/13/92

a	897	*	*	*	*	*	*
b	897	*	*	*	*	*	*
c	897	*	*	*	*	*	*
d	607	320	8.03	7.3	21.5	100	104
e	607	320	8.07	7.3	21.5	100	100
f	607	325	8.02	7.2	21.5	100	104
g	93	325	7.95	7.1	21.5	120	104
h	93	315	8.03	7.5	21	100	100
I	93	310	8.02	7.4	21	100	100
j	505	320	8.06	7.4	21.5	80	100
k	505	320	8.05	7.4	21	120	100
l	505	320	8.03	7.3	21	100	104
m	319	315	8.05	7.5	21	100	104
n	319	320	8.06	7.4	21	100	100
o	319	330	8.08	7.3	22	100	104

Tank	Dose ($\mu\text{g Cu/L}$)	Conductivity ($\mu\text{mho/cm}$)	pH	Oxygen (mg/L)	Temp ($^{\circ}\text{C}$)	Alkalinity (as mg CaCO_3/L)	Hardness (as mg CaCO_3/L)
p	0	330	7.78	8.1	21.5	80	96
q	0	325	7.75	7.9	21.5	80	104
r	0	330	7.86	8.1	21.5	80	100

* All fish dead, no water quality measured.

Air stone had fallen out of tank.

Appendix D-8. Supplementary Data for Richards and Beitinger (1995)

Acclimation Temperature	5°C		12°C		22°C		32°C	
Replicate	1	2	1	2	1	2	1	2
Sample size	30	36	30	36	36	30	33	29
pH	8.2-8.3	7.8-8.2	8.4-8.5	8.2-8.4	8.3-8.4	8.1-8.5	8.4-8.5	8.4-8.5
Hardness (mg/l CaCO ₃)	164-180	152-166	152-168	148-170	164-174	162-172	164-168	162-172
Alkalinity (mg/l CaCO ₃)	125-140	130-140	130-140	130-140	140-145	140-145	135-140	135-145
Weights of minnows (g)	0.62-3.23	0.42-2.64	0.56-2.38	0.30-1.93	0.66-1.15	0.13-1.55	0.26-1.36	0.23-1.32
Lengths of minnows (cm)	3.3-5.5	3.2-5.2	3.2-4.9	2.8-5.1	1.9-4.3	2.4-4.6	3.0-4.8	3.3-4.8

**Appendix D-9. Data for the American River, CA, for July 1978 Through December 1980
(data from the City of Sacramento, CA, Water Quality Laboratory; personal
communication). Units Are mg/L.**

Date	pH	Hardness	Alkalinity	Ca	Mg	Ca:Mg	Na	Cl	SO ₄
Jul-78	7.6	20	22	5.2	1.7	3.06	3.2	2.6	4
Aug-78	7.6	20	22	4.9	1.9	2.58	3.4	2.8	5
Sep-78	7.5	20	22	5.2	1.7	3.06	3.5	2.6	4
Oct-78	7.3	20	22	5	1.8	2.78	3.6	3	4
Nov-78	7.2	20		4.9	1.9	2.58	3.9		5
Dec-78									
Jan-79	7.4	23	24	5.1	2.1	2.43	3.2	2.9	4
Feb-79	7.5	24	25	6.5	1.9	3.42	3	3	5
Mar-79	7.6	26	27	7.4	1.8	4.11	3.3	2.7	6
Apr-79	7.7	27	27	7.5	2	3.75	3.6	2.7	7
May-79	7.6	25	26	5.7	2.6	2.19	3.4	2.4	6
Jun-79	7.7	22	24	5.7	1.9	3.00	3.1	2.5	4
Jul-79	7.6	21	22	5.3	1.9	2.79	3	2.7	4
Aug-79	7.5	21	22	5.6	1.7	3.29	3.2	2.4	5
Sep-79	7.3	20	21	5.7	1.4	4.07	3.5	2.5	3
Oct-79	7.2	19	20	5.5	1.3	4.23	3.1	2.8	3
Nov-79									
Dec-79									
Jan-80	7.5	23	23	6.1	1.9	3.21	2.4	2.6	4
Feb-80	7.4	23	23	6.1	1.9	3.21	2.7	2.3	2
Mar-80	7.5	24	26	5.8	2.3	2.52	2	2.3	2
Apr-80	7.7	25	25	6.4	2.2	2.91	1.9	2.5	3
May-80	7.5	22	21	6.1	1.6	3.81	2.4	2.4	3
Jun-80	7.3	19	21	5.1	1.5	3.40	2.3	2.4	2
Jul-80	7.4	18	20	4.6	1.6	2.88	2.6	2.1	3
Aug-80	7.5	18	21	5.2	1.2	4.33	3	2.7	2
Sep-80	7.3	18	20	4.9	1.4	3.50	2.9	2.4	4
Oct-80	7.3	18	20	5	1.3	3.85	3	2.7	2
Mean	7.5	21.4	22.8	5.6	1.8	3.2	3.0	2.6	3.8
max	7.7	27.0	27.0	7.5	2.6	4.3	3.9	3.0	7.0
min	7.2	18.0	20.0	4.6	1.2	2.2	1.9	2.1	2.0

Appendix D-10. STORET Data for Minnesota Lakes and Rivers

Date	pH	Hardness	Alkalinity	Ca	Mg	Ca:Mg	Na	K	Cl	SO ₄	NO ₃	TOC	DOC	Sulfide
Embarass River, MN														
3/22/76	7	133	103	27	16	1.69	2.5	2	11	34				
4/29/76	6.7	25.3	23	5.2	3	1.73	2.8	0.7	2.9	8.4	0.04	16		0.6
5/28/76	6.5		53						3.5	12				
6/28/76	6.9	44	36	9.9	4.6	2.15	3.9	0.3	5	13	0.04	37		
7/28/76	6.6		76	5.2					4.8	7.5				
8/26/76	6.9	100	110	24	9.9	2.42	9	1	8.4	5.6		21		0.6
Means	6.8	75.58	66.83	14.26	8.38	2.00	4.55	1.00	5.93	13.42	0.04	24.67		0.60
max.	7	133	110	27	16	2.42	9	2	11	34	0.04	37		0.6
min.	6.5	25.3	23	5.2	3	1.69	2.5	0.3	2.9	5.6	0.04	16		0.6
S. Kawishiwi River, MN														
10/16/75	6.4	21	14	4.9	2.1	2.33	1.3	0.4	0.5	4.4	0.01	12		0.2
11/6/75	6.9	24	19	5.5	2.5	2.20	1.2	0.4	0.6	4.1				
12/11/75		39	23	10	3.4	2.94	1.4	0.4	1.5					0.2
1/9/76	6.6	29	24	6.2	3.2	1.94	1.6	0.8	2.3	7				
2/4/76	6.3	24	20	5.2	2.7	1.93	1.7	0.6	0.9	6.3	0.16	16		0
3/9/76	6.9	23	23	5.7	2.2	2.59	1.5	0.5	0.9	4.9				1
4/23/76	6.6	14	8	3.4	1.3	2.62	0.9	0.4	0.7	4.8				0.2
5/25/76	6.8	16	11	4	1.5	2.67	0.9	0.4	0.7	4.8				
6/25/76	6.6		16						1.1	3.3				1.8
7/23/76	6.7		19						1.2	4.4				0.5
Means	6.6	23.75	17.70	5.61	2.36	2.40	1.31	0.49	1.04	4.89	0.09	14.00		0.56
max.	6.9	39	24	10	3.4	2.94	1.7	0.8	2.3	7	0.16	16		1.8
min.	6.3	14	8	3.4	1.3	1.93	0.9	0.4	0.5	3.3	0.01	12		0
Colby Lake, MN														
LCY2														
6/17/96	8.5	56	33	13	5.7	2.28	4.3	1.5	6.3	22	0.25	17		
6/17/96	6.8										0.25	17		
6/17/96	6.9	71	33	17	7	2.43	4.3	1.4	9.4	22		18		
LCY1														
6/17/96	6.8	54	33	12	5.8	2.07	3.9	1.4	6.6	26	0.3	16		
6/17/96	6.8											16		
6/17/96	6.5	41	34	11	3.2	3.44	3.6	1.3	6.8	22	0.33	17		
6/17/96	7.4	83	39	21	7.3	2.88			7.8	52	0.18			
Means	7.1	55.50	33.25	13.25	5.43	2.55	4.03	1.40	7.28	23.00	0.28	16.83		
max.	8.5	71	34	17	7	3.44	4.3	1.5	9.4	26	0.33	18		
min.	6.5	41	33	11	3.2	2.07	3.6	1.3	6.3	22	0.25	16		
Cloquet Lake, MN														
7/13/76	6.4	17	11	4	1.8	2.22			1.7	7.6	0	38		
Lake One, MN														
10/16/75	7.2	27	21	6.9	2.3	3.00			1.2	5.6	0.02	22		
Greenwood Lake, MN														
7/6/76	6.7	10	15	2.8	0.7	4.00	0.1	0.3	0.2	4.2	0	11		