NEW WATER QUALITY CRITERIA FOR ALUMINUM

USEPA Draft Implementation Guidance

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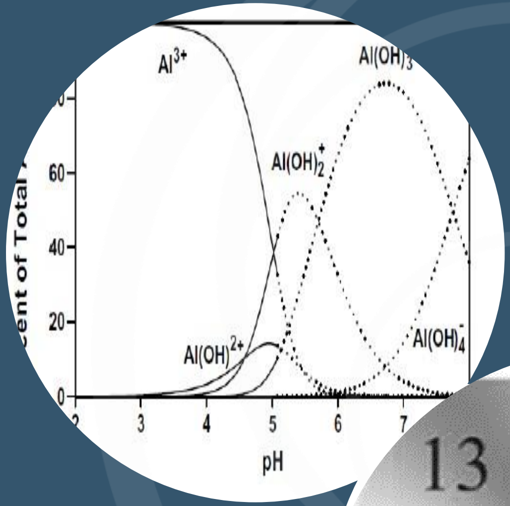
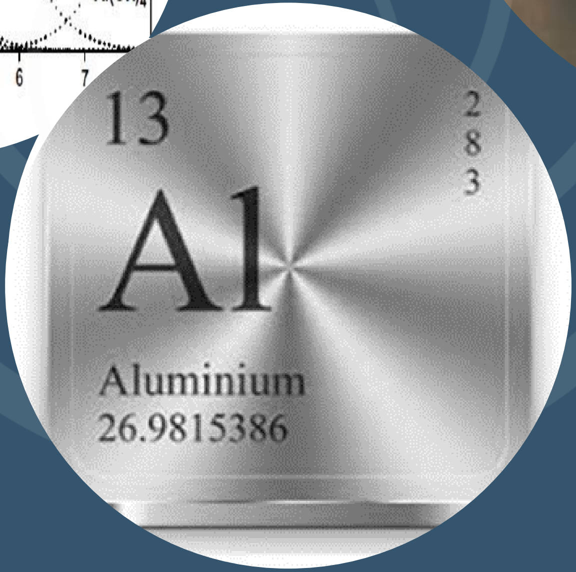
WESTCAS 2019 Fall Conference
Tucson, AZ
October 23, 2019





A BRIEF HISTORY OF ALUMINUM CRITERIA

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1988

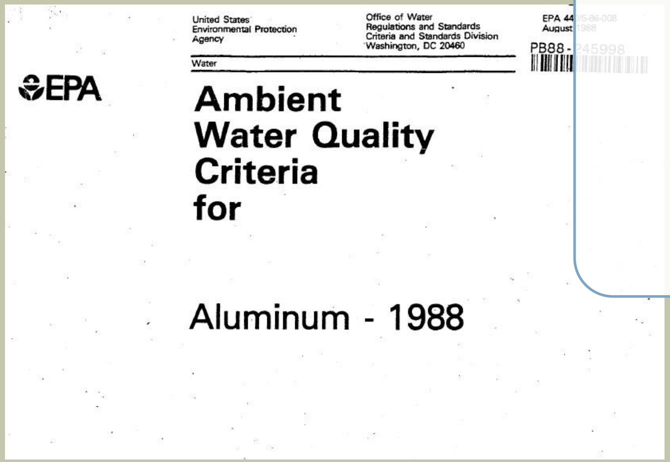
- Original Criteria
- Acute = 750 µg Al/L
- Chronic = 87 µg Al/L
- Not all states set Al criteria

2009-2010

- NM & CO shifted to hardness-based criteria*
- Equations rather than fixed value; CO and NM use diff equations for chronic criteria

2010-2018

- New studies show pH, DOC, & Hardness impact Al toxicity
- Development of Bioavailability Models


United States Environmental Protection Agency

Office of Water Regulations and Standards Criteria and Standards Division Washington, DC 20460

Water

EPA

Ambient Water Quality Criteria for

Aluminum - 1988

* Based on studies from Arid West Water Quality Research Program

2018 NATIONAL ALUMINUM CRITERIA

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Larger Database

- 2018: 22 spp from 20 genera
- 1988: 15 spp from 14 genera

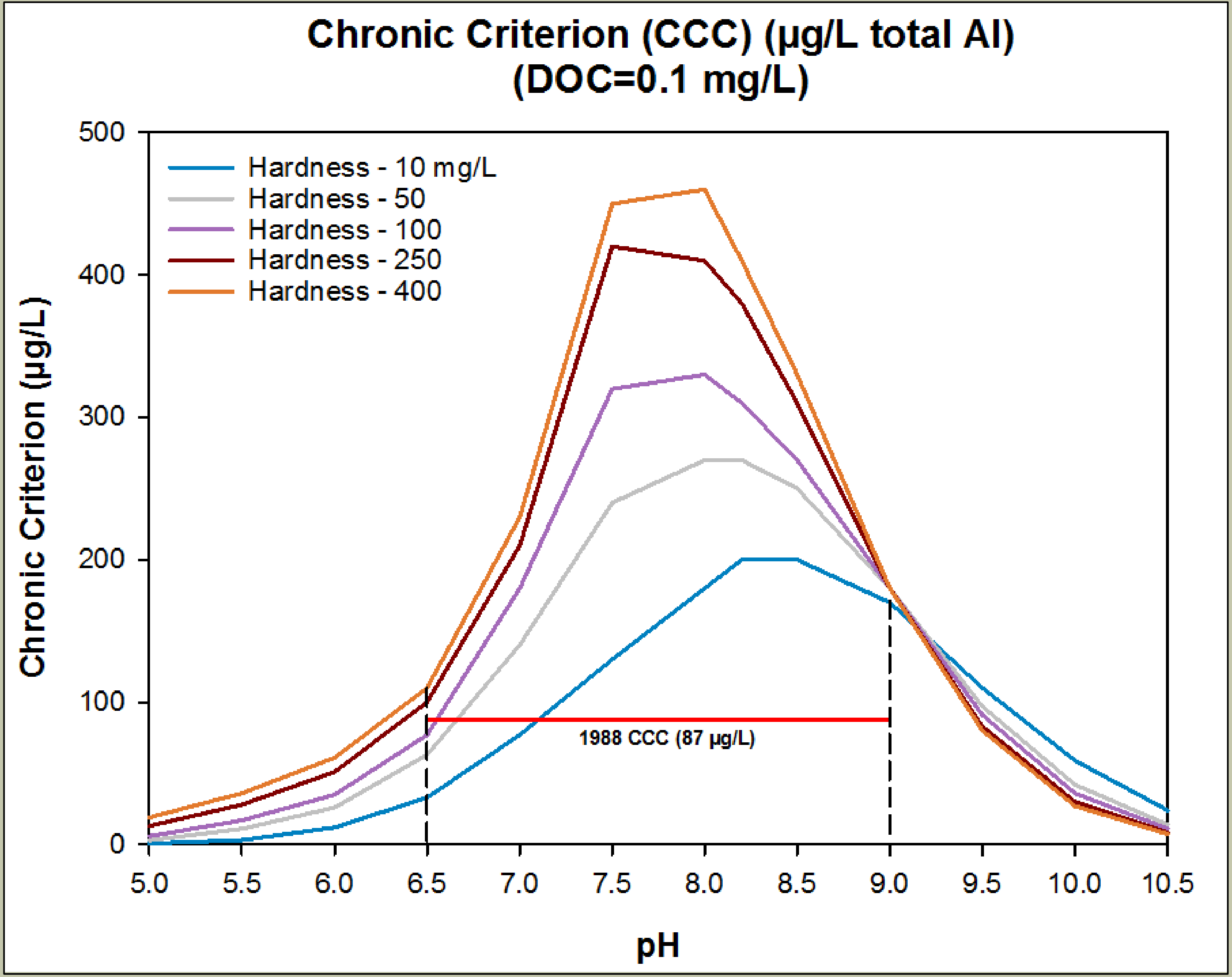
Multiple Linear Regression

- pH (5.0 to 10.5 SU)
- Hardness (0.1 to 430 mg/L)
- DOC (0.08 to 12 mg/L)

EPA | United States Environmental Protection Agency | Office of Water 4304T | EPA-822-R-18-001 December 2018

FINAL
AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR ALUMINUM
2018

ALUMINUM CRITERIA – 0.1 mg/L DOC



USEPA DRAFT IMPLEMENTATION GUIDANCE

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- Released for public comment on July 31, 2019
- FWQC submitted comments on September 13
- Future status unknown, but other states are considering their own guidance
  - *Oregon (statewide criteria by 2020)*
  - *Triennial Reviews:*
    - Iowa
    - Missouri

Draft for Public Comment, do not cite (7/31/2019)

EPA United States Environmental Protection Agency

Office of Water
EPA- 823-D-19-001
July 2019

Draft Technical Support Document:

Implementing the 2018 Recommended Aquatic Life Water Quality Criteria for Aluminum

APPROACHES FOR ADOPTION INTO WQ STDS.

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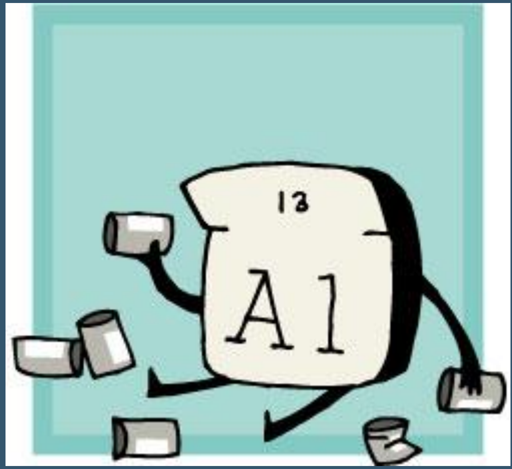
- Adopting the criterion as a model
  - – *Reference the 304(a) criteria document*
  - – *Reference the aluminum criteria calculator (Excel spreadsheet)*
- Adopting selected criteria concentrations
  - – *Adopting criteria value lookup tables (Appendix K of criteria document)*
  - – *Adopting ecoregional "default" values*
    - USEPA 2017 draft guidance for missing Biotic Ligand Model (BLM) input parameters (not finalized)
    - Some states developing their own
      - Oregon (for copper BLM implementation)
      - Iowa (was considering similar approach)

METHODS FOR CRITERIA DERIVATION

- Need to reconcile multiple MLR outputs from multiple sites and samples
- USEPA recommendations:
  - *Method 1: select one or more model outputs*
    - ?
  - *Method 2: protective criterion = 10^{th} percentile of model outputs*
    - For larger data sets
  - *Method 3: select lowest criterion concentration*
    - For smaller data sets
- Good geographic and temporal representation is key!
  - *Ex: seasonal criteria may be reasonable*

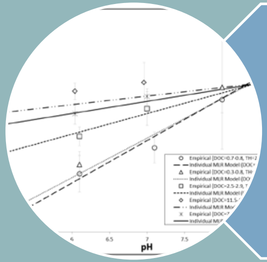


TECHNICAL CHALLENGES NOT ADDRESSED IN GUIDANCE

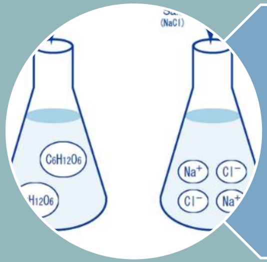
pH extrapolation

Analytical methods for Aluminum

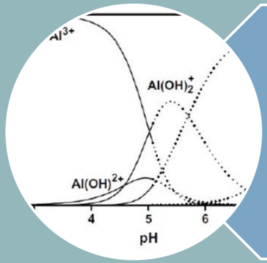
CHALLENGES WITH THE 2018 CRITERIA



Unknown if MLR can predict toxicity outside pH range of 6.0 to 8.7



Only dissolved and precipitated forms of Al are toxic, so measuring total or dissolved Al does not provide a good measure of toxic Al



Total Recoverable digestion measures non-toxic mineral particles and, thus, overestimates the toxic portion of Al in a sample

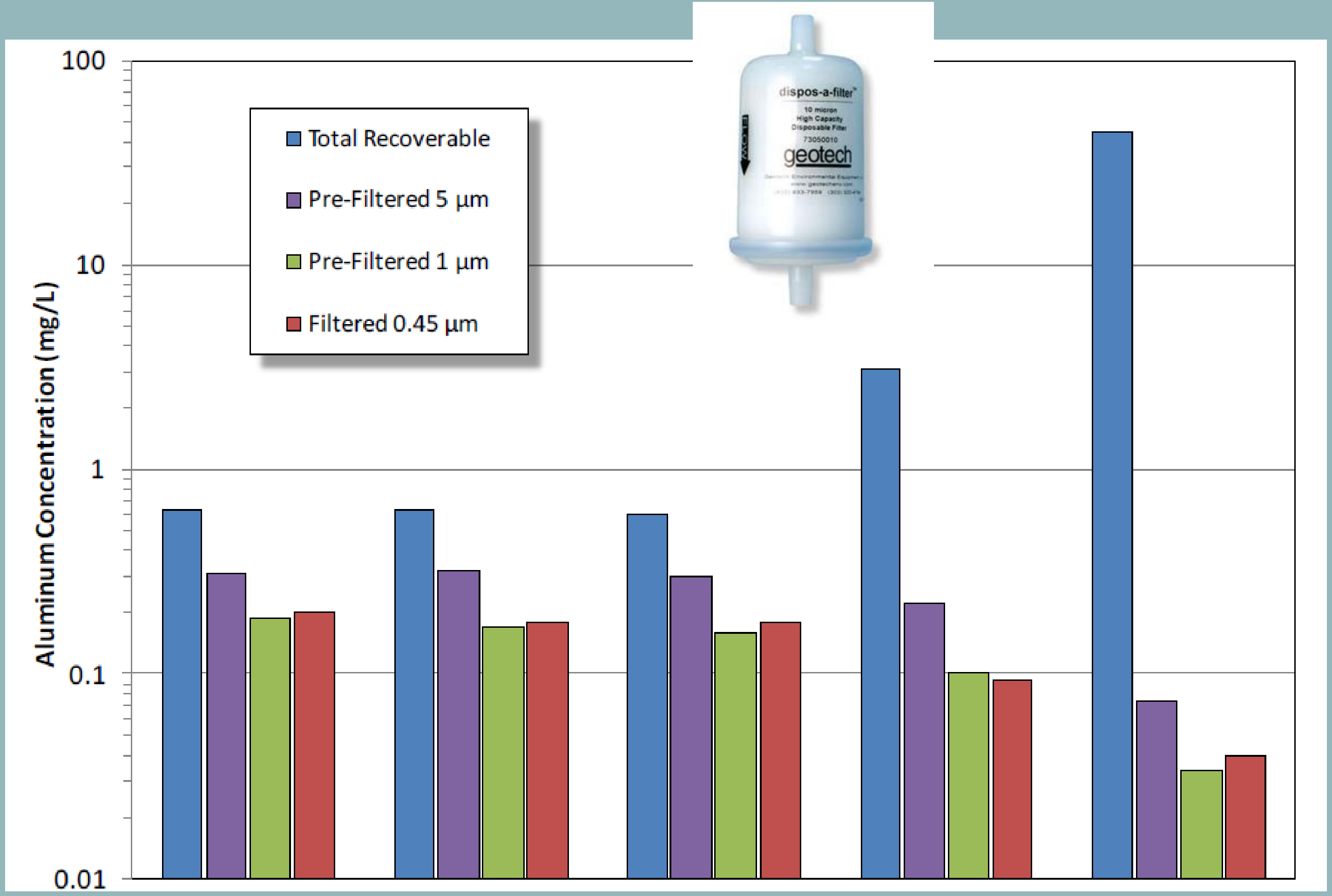
SOLUTION #1: COARSE PRE-FILTRATION*

New Mexico Method:

Measure Turbidity and if >30 NTU then…

Pre-filter sample w/ 10 µm capsule then…

Analyze for TR Al



* 20.6.4.900 NMAC

PREFERRED METHOD: "BIOAVAILABLE ALUMINUM"

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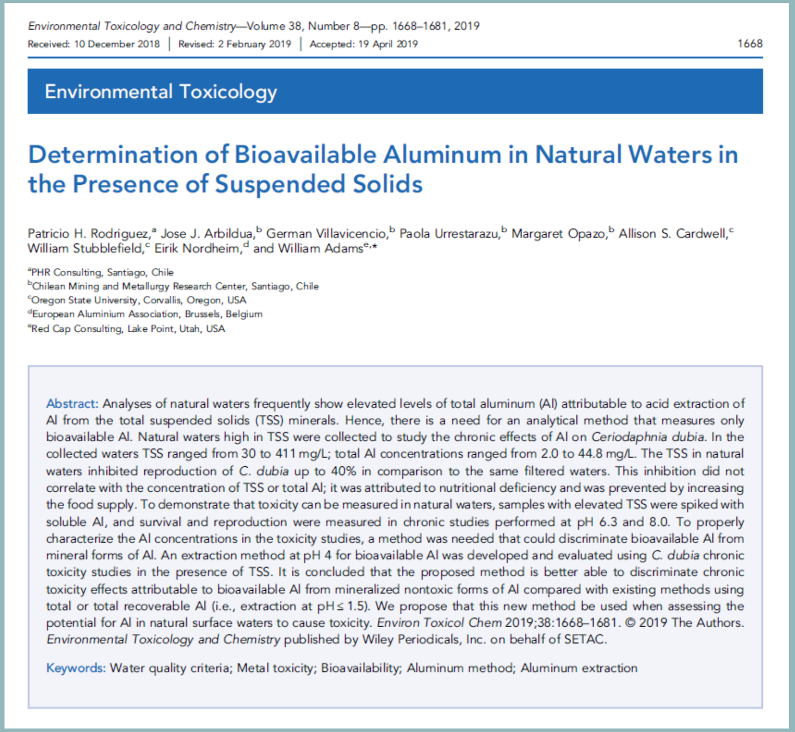

Environmental Toxicology and Chemistry—Volume 38, Number 8—pp. 1668–1681, 2019
Received: 10 December 2018 | Revised: 2 February 2019 | Accepted: 19 April 2019 1668

Environmental Toxicology

Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids

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Abstract: Analyses of natural waters frequently show elevated levels of total aluminum (Al) attributable to acid extraction of Al from the total suspended solids (TSS) minerals. Hence, there is a need for an analytical method that measures only bioavailable Al. Natural waters high in TSS were collected to study the chronic effects of Al on *Ceriodaphnia dubia*. In the collected waters TSS ranged from 30 to 411 mg/L; total Al concentrations ranged from 2.0 to 44.8 mg/L. The TSS in natural waters inhibited reproduction of *C. dubia* up to 40% in comparison to the same filtered waters. This inhibition did not correlate with the concentration of TSS or total Al; it was attributed to nutritional deficiency and was prevented by increasing the food supply. To demonstrate that toxicity can be measured in natural waters, samples with elevated TSS were spiked with soluble Al, and survival and reproduction were measured in chronic studies performed at pH 6.3 and 8.0. To properly characterize the Al concentrations in the toxicity studies, a method was needed that could discriminate bioavailable Al from mineral forms of Al. An extraction method at pH 4 for bioavailable Al was developed and evaluated using *C. dubia* chronic toxicity studies in the presence of TSS. It is concluded that the proposed method is better able to discriminate chronic toxicity effects attributable to bioavailable Al from mineralized nontoxic forms of Al compared with existing methods using total or total recoverable Al (i.e., extraction at pH ≤ 1.5). We propose that this new method be used when assessing the potential for Al in natural surface waters to cause toxicity. *Environ Toxicol Chem* 2019;38:1668–1681. © 2019 The Authors. *Environmental Toxicology and Chemistry* published by Wiley Periodicals, Inc. on behalf of SETAC.

Keywords: Water quality criteria; Metal toxicity; Bioavailability; Aluminum method; Aluminum extraction

pH 4 Extraction

- Buffer Sample to pH 4 & mix
- 0.45 µm filter & acidify
- Measure Al

Correlates well w/ toxicity

- Only measures dissolved and precipitated phases
- Better than T, D, or TR alone

Method Recently published

- EPA acknowledged method, but slow to implement
- Implementation more likely via individual states for now

OTHER METHODS?

- Texas
  - *For stormwater, if > 50% of TR aluminum is particulate, and if process water is not the source, no limit is needed*
  - *WQS implementation guidance: if the no-observed toxicity effect concentration (NOEC) is greater than the proposed effluent limit, then the limit is assumed to be protective of aquatic life*
- Navajo Nation
  - *For TSS, but applicable to aluminum:*
  - *Samples collected within 48hr after a precipitation event are excluded*

FOR MORE INFORMATION

https://www.epa.gov/wqc/aquatic-life-criteria-aluminum#2018

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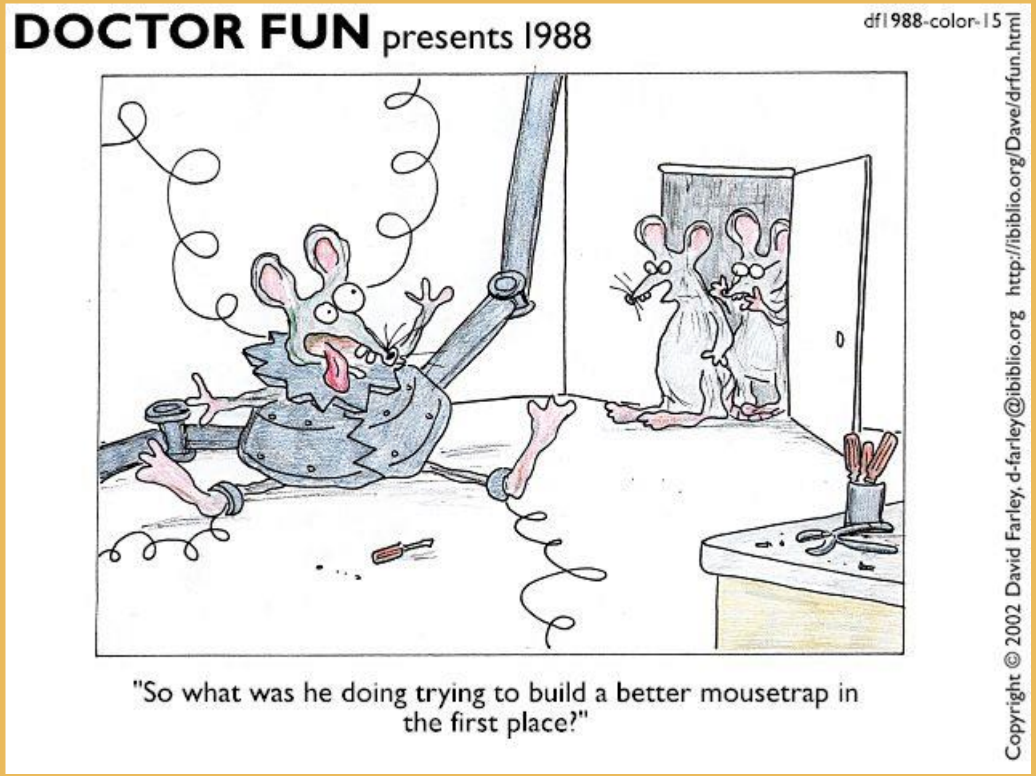
Thank you!



RESERVE SLIDES

CRITERIA CALCULATOR

aluminum-criteria-calculator-v20.xlsm - Last Saved 12/20/2018 7:59 AM

G26 1960.72539362413

All concentrations reported are µg/L total Aluminum

Run Scenarios <-----Click Button after entering data

ENTER DATA HERE

SiteName	DOC (mg/L)	Total Hardness (mg/L as $CaCO_3$)	pH	FAV	CMC	CCC	Flag
Site 1	1.0	25	7	1235.09	620	300	
Site 2	1.0	50	7	1572.91	790	340	
Site 3	1.0	100	7	1960.73	980	380	
Site 4	1.0	150	7	2210.75	1100	400	
Site 5	1.0	100	7	1960.73	980	380	
Site 6	1.0	100	7	1960.73	980	380	
Site 7	1.0	100	7	1960.73	980	380	
Site 8	1.0	100	7	1960.73	980	380	
Site 9	1.0	100	7	1960.73	980	380	
Site 10	1.0	100	7	1960.73	980	380	
Site 11	1.0	100	7	1960.73	980	380	
Site 12	1.0	100	7	1960.73	980	380	
Site 13	1.0	100	7	1960.73	980	380	
Site 14	1.0	100	7	1960.73	980	380	
Site 15	1.0	100	7	1960.73	980	380	
Site 16	1.0	100	7	1960.73	980	380	
Site 17	1.0	100	7	1960.73	980	380	
Site 18	1.0	100	7	1960.73	980	380	
Site 19	1.0	100	7	1960.73	980	380	
Site 20	1.0	200	7	2448.75	1200	420	

ACUTE

SiteName	Rank 1 Genus	Rank 1 GMAV	Rank 2 Genus	Rank 2 GMAV	Rank 3 Genus	Rank 3 GMAV	Rank 4 Genus	Rank 4 GMAV
Site 1	Daphnia	1,196.8	Micropterus	2,148.0	Oncorhynchus	2,381.3	Ceriodaphnia	4,000.0
Site 2	Daphnia	1,668.0	Micropterus	2,533.3	Oncorhynchus	2,808.4	Ceriodaphnia	5,575.1
Site 3	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 4	Daphnia	2,823.2	Micropterus	3,290.3	Oncorhynchus	3,647.6	Ceriodaphnia	9,436.2
Site 5	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 6	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 7	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 8	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 9	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 10	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 11	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 12	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 13	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 14	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 15	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 16	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 17	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 18	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 19	Daphnia	2,324.8	Micropterus	2,987.6	Oncorhynchus	3,312.1	Ceriodaphnia	7,770.5
Site 20	Daphnia	3,240.3	Micropterus	3,523.5	Oncorhynchus	3,906.1	Salmo	10,191.6

CHRONIC

SiteName	Rank 1 Genus	Rank 1 GMCV	Rank 2 Genus	Rank 2 GMCV	Rank 3 Genus	Rank 3 GMCV	Rank 4 Genus	Rank 4 GMCV
Site 1	Salmo	312.3	Salvelinus	458.8	Daphnia	507.2	Lampsilis	528.2
Site 2	Salmo	368.3	Salvelinus	541.1	Daphnia	706.9	Lampsilis	736.2
Site 3	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 4	Salmo	478.4	Salvelinus	702.8	Daphnia	1,196.5	Lampsilis	1,246.1
Site 5	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 6	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 7	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 8	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 9	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 10	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 11	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 12	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 13	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
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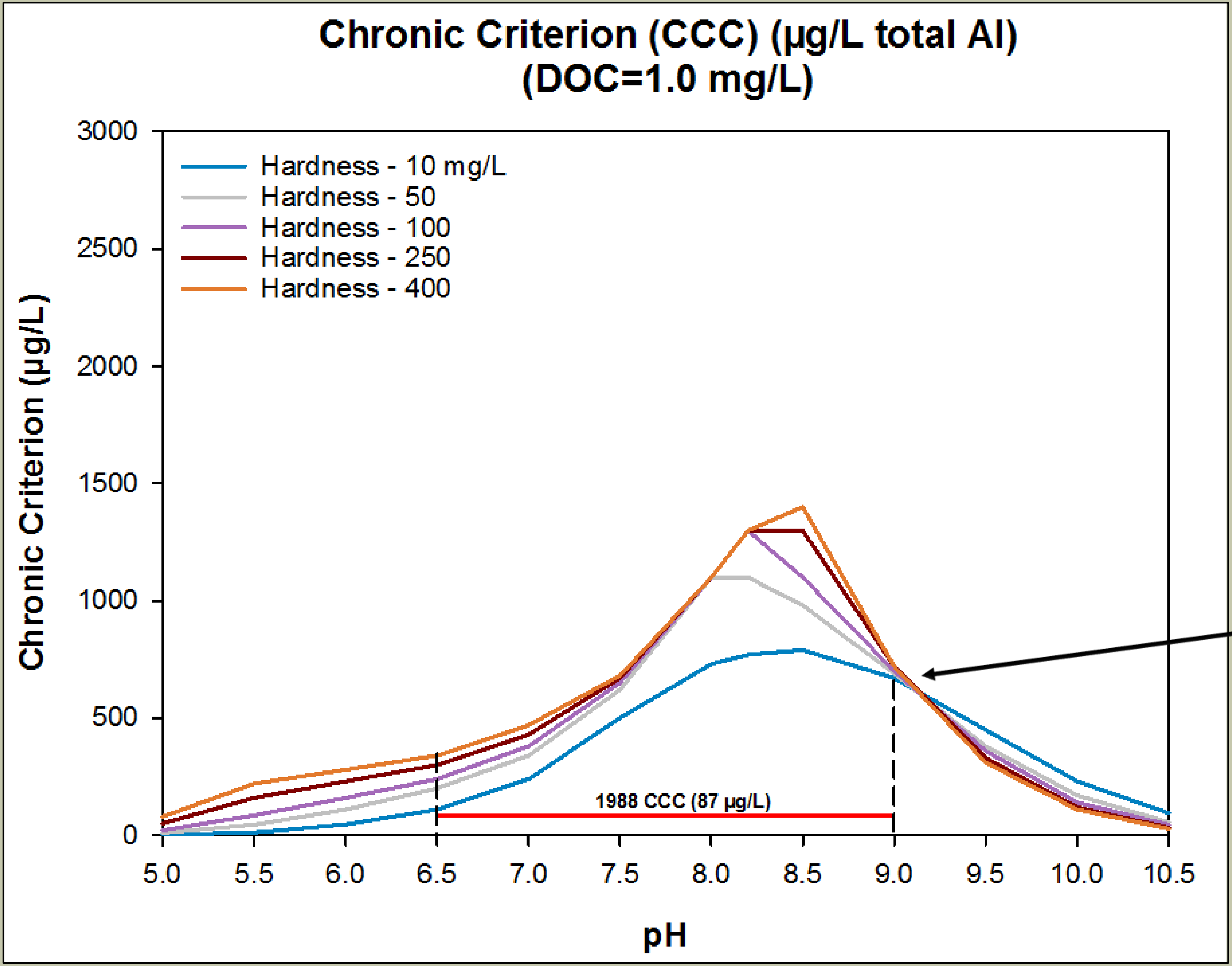
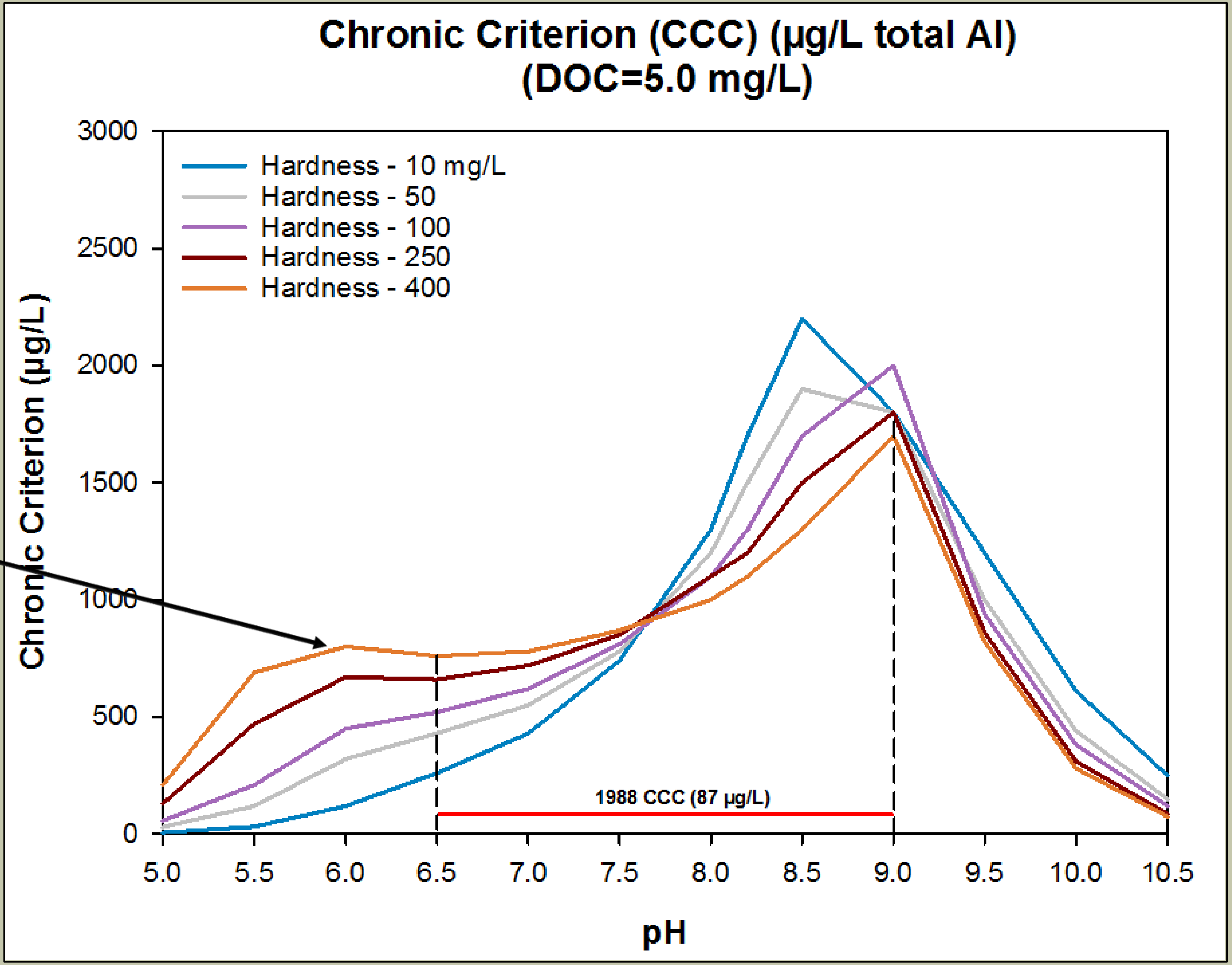
Site 15	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 16	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 17	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 18	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 19	Salmo	434.4	Salvelinus	638.2	Daphnia	985.3	Lampsilis	1,026.1
Site 20	Salmo	512.3	Salvelinus	752.6	Daphnia	1,373.2	Lampsilis	1,430.2

ALUMINUM CRITERIA – 1 mg/L DOC



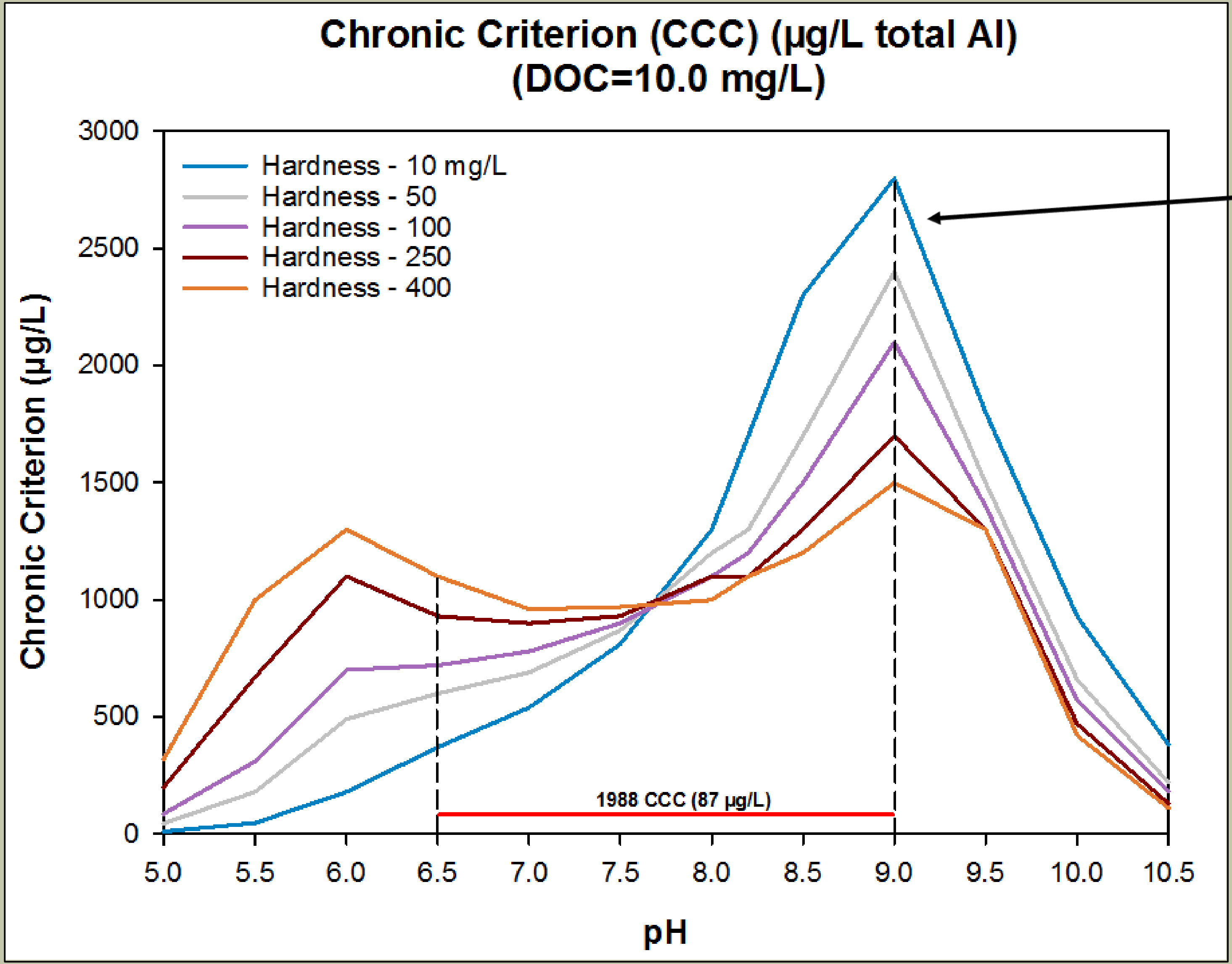
Minimal hardness effect at high pH

ALUMINUM CRITERIA – 5 mg/L DOC



Stronger hardness effect at low pH

ALUMINUM CRITERIA – 10 mg/L DOC



Reverse hardness effect at high pH

2018 CRITERIA VS. PREVIOUS CRITERIA - CO

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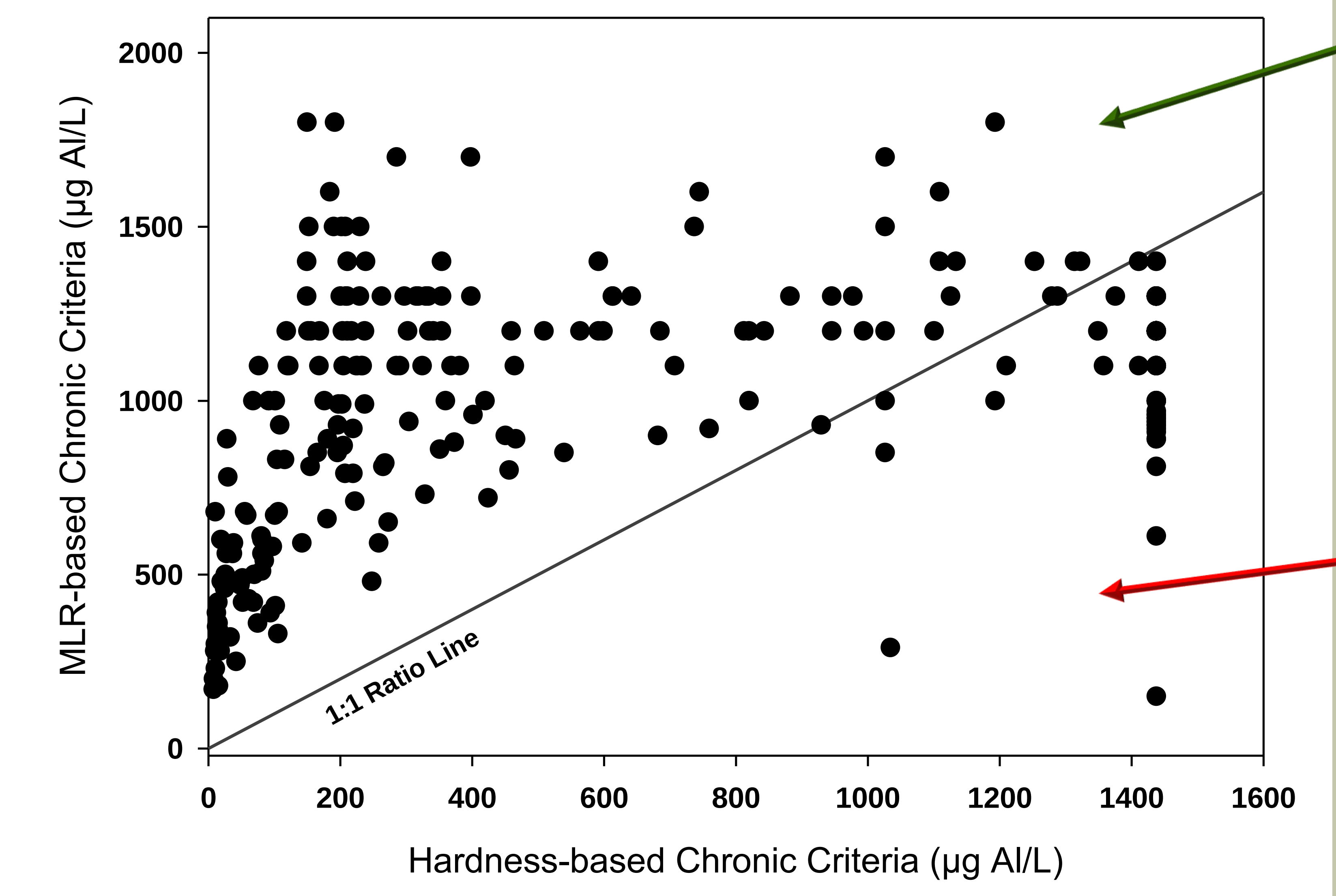

74% MLR less stringent than hardness-based criteria

26% MLR more stringent than hardness-based criteria

Source: NWQMC, 2000 – Present
N = 250

2018 CRITERIA VS. PREVIOUS CRITERIA - NM

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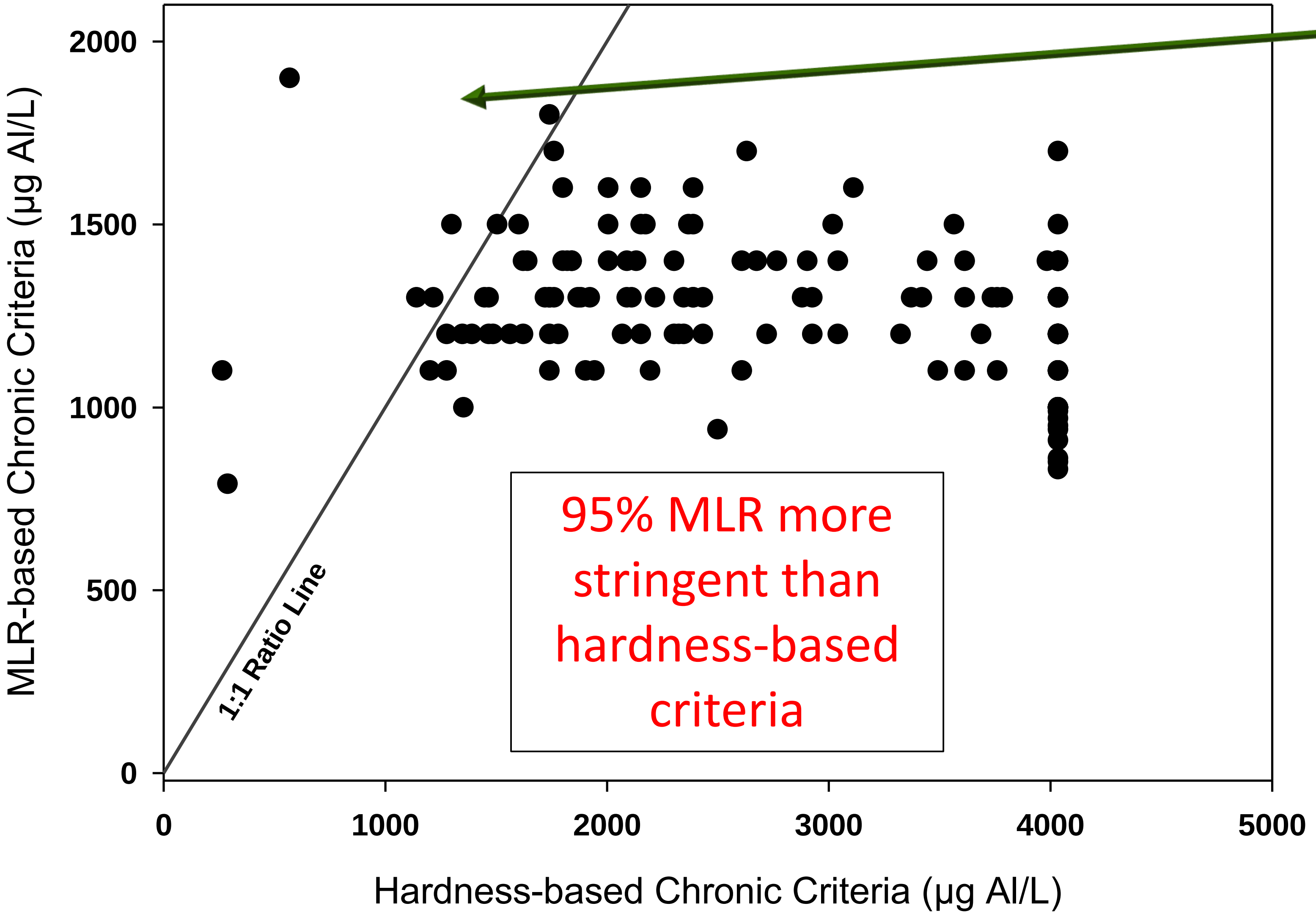

5% MLR less stringent than hardness-based criteria

Source: NWQMC, 2000 – Present
N = 145