Protecting Our Water Supplies: Nutrient Criteria

2010 Sustaining Colorado Watersheds Conference

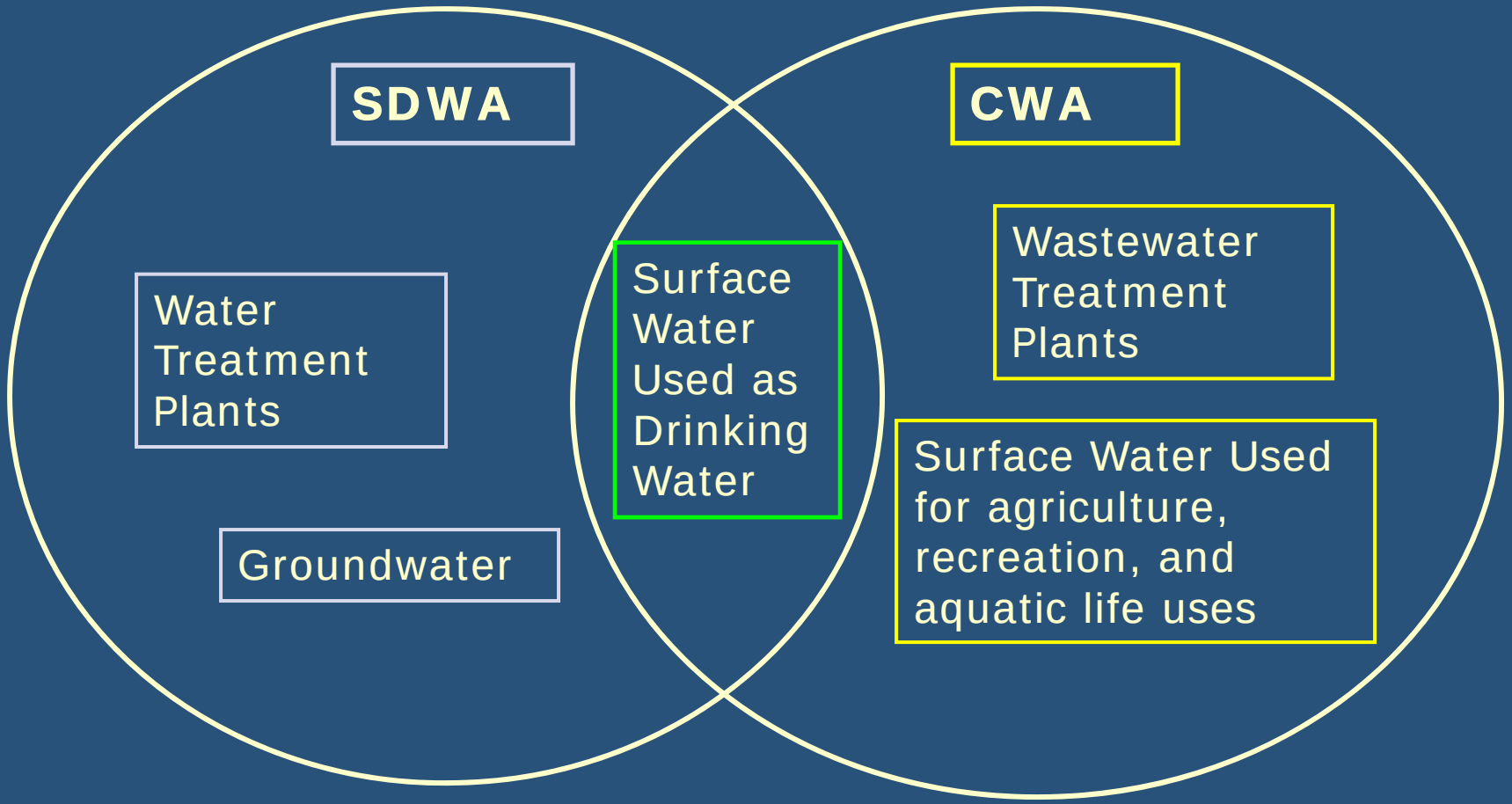
October 6, 2010

Mary Fabisiak, City of Westminster

Chair, Nutrient Criteria Subcommittee of the Colorado Water Utility Council

It is our responsibility to provide safe, clean drinking water to our customers.

Two Major Water Statutes



Safe Drinking Water Act

- Originally passed in 1974 to protect public health.
- Amendments in 1986 and 1996 require many actions to protect drinking water and its sources.
  - 1996 amendments greatly enhanced the existing law by recognizing source water protection

Safe Drinking Water Act

- 16 separate "rules" and one secondary rule set.
- 119 different parameters that we have to analyze for and demonstrate compliance with, some on a continuously-measured basis.
- Treatment optimization to fix one problem often causes problems elsewhere in the system
- Non-compliance with any one of these parameters constitutes a reportable violation of the Safe Drinking Water Act requiring us to notify the Public.

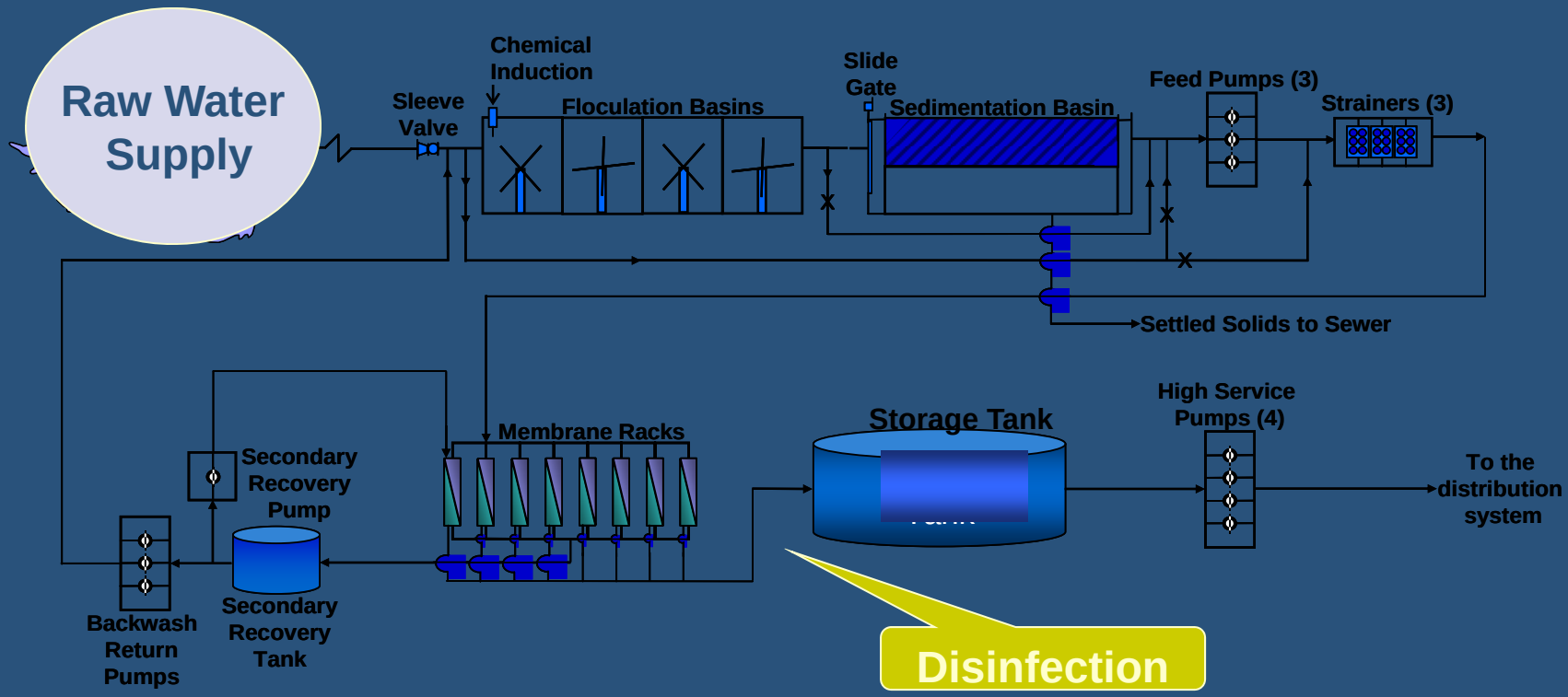
AWWA Draft Policy Statement

- The quality of existing and all potential sources of drinking water supply shall be actively and aggressively protected, enhanced and maintained.
- When public drinking water supply is among multiple uses for a single water source, the public water supply use should be of the highest priority.

Regulations = Rules

- 2005 - Long Term 2 Enhanced Surface Water Treatment Rule
- 2005 - Stage 2 Disinfectants and Disinfection Byproducts Rule
- 1998 - Stage 1 Disinfectants and Disinfection Byproducts Rule
- 1998 - Interim Enhanced Surface Water Treatment Rule
- 1989 - Surface Water Treatment Rule
- 1989 - Total Coliform Rule

Water Treatment



CHEMICALS						
Aqueous Ammonia	Sodium Hydroxide	Sodium Hypchlorite	Coagulant	Powdered Activated Carbon	Potassium Permanganate	Citric Acid

Disinfection By-products

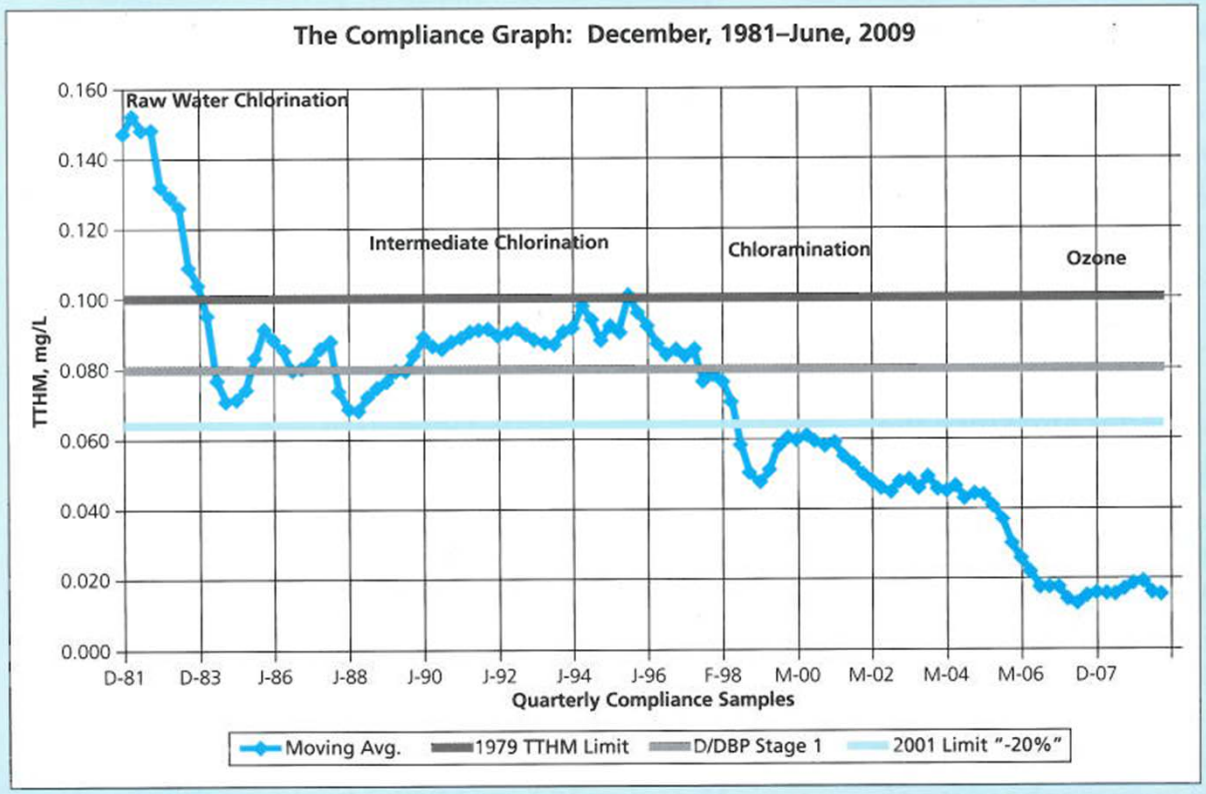
- Recent estimates put the number of individual DBP compounds between 600-700.
- We are regulated on 11 of these.
- We are required to sample for a number of other DBPs
- Efforts to reduce some DBPs may cause an increase in other DBPs

CASE STUDIES AND VALUE OF RESEARCH

DBP Minimization Strategies

Michael Hotaling, Newport News, Virginia

Newport News Waterworks (Waterworks) treatment choices over the last thirty years have been driven primarily by compliance with the family of DBP regulations. The following graphic displays the annual average total trihalomethane



(TTHM) concentration and subsequent treatment choices made to reduce those levels.

Summary of Impact of Treatment Processes on THMs and N-DBPs

DBP	Coagulation/ Softening	Ozone	Filtration/ Biologically Active	Chlorine	Chloramines
THMs	Remove FP	Destroys some FP	Small impact	Forms	Minimizes formation
HANs	Remove FP	Destroys some FP	Small impact	Forms	May minimize formation

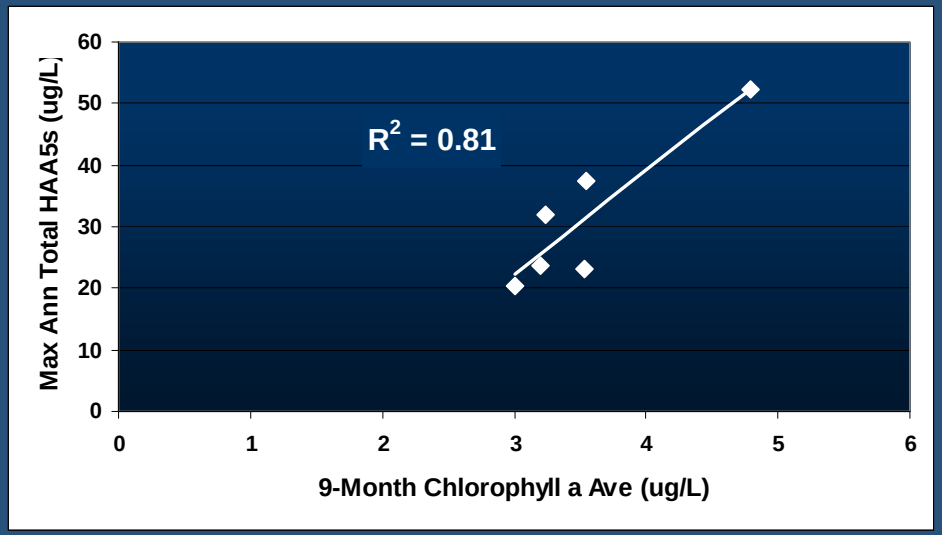
High Chl*a* is Problematic

- ↑ Disinfection By-Products
- ↑ Total Organic Carbon
- ↑ Arsenic

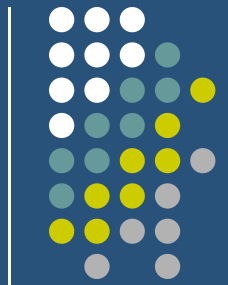
Regulated by SDWA

- ↑ Taste and Odor

Public Confidence



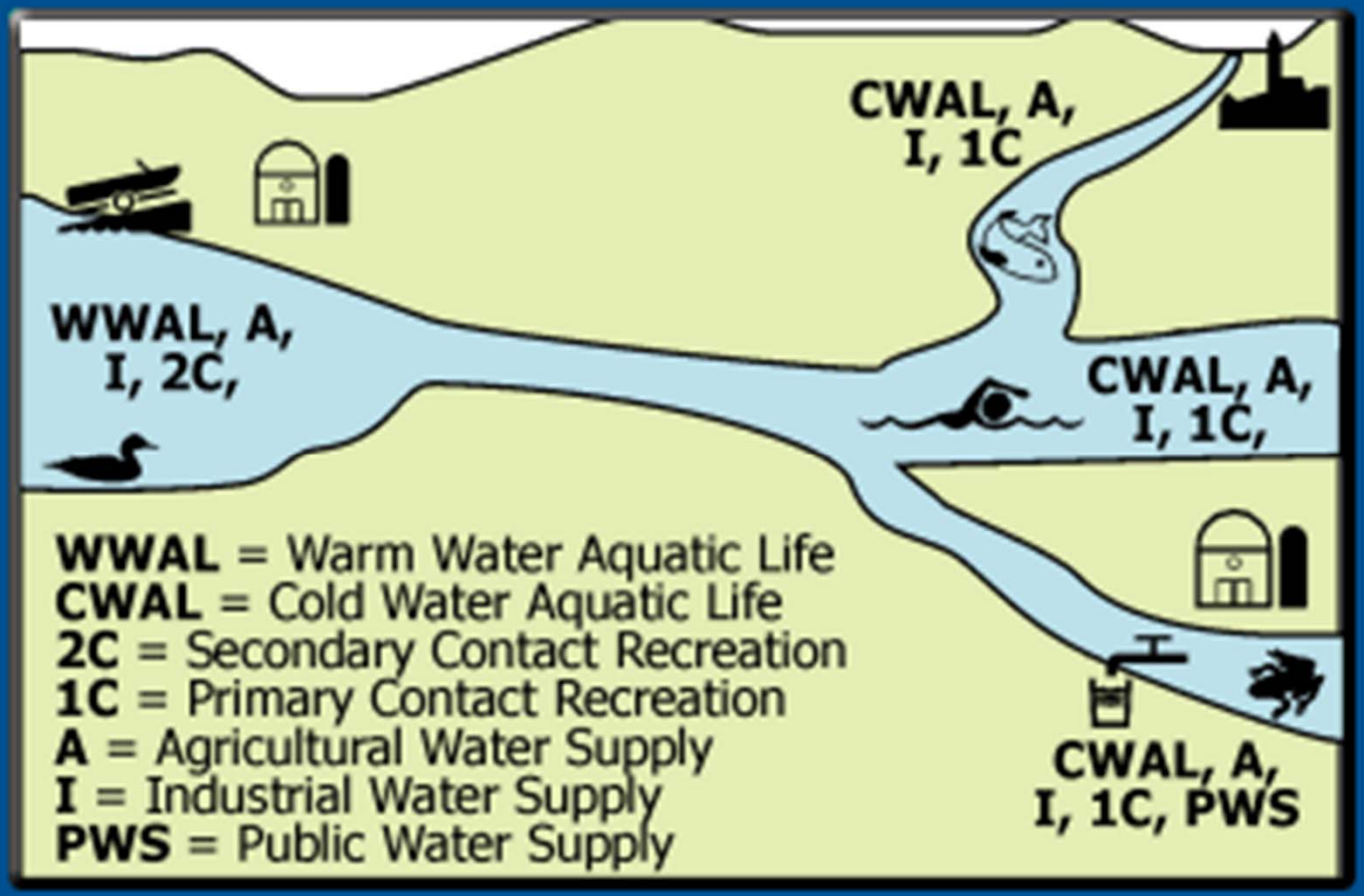
Clean Water Act



- Just as old as the SDWA
- Basic standards
- Designated uses
- Table Value standards

Designated Uses

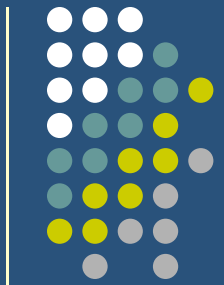
Set Goals and Water Quality Standards



Considerations in Assigning Classifications

- 31.6(1)(e) Classifications should be for the highest water quality attainable.

Necessity of proposed changes



- Need to protect most sensitive use
- Nutrient criteria based on optimizing productivity for aquatic life would not be protective of drinking water use

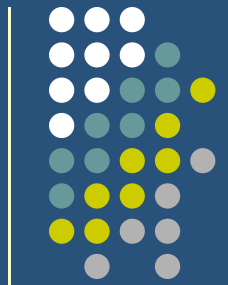
Domestic Water Supply

- 31.13(1)(d) These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.

Free Froms

- 31.11(1)(a)(iii):
  - Produce color, odor, or other conditions in such a degree as to create a nuisance or harm existing beneficial uses or impart any undesirable taste to significant edible aquatic species or to the water;

Table Value Standards

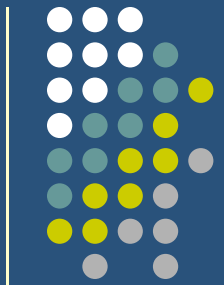


- Arsenic
- Nitrate
- Organic MCLs

Source Water Protection

- It is more effective to protect the source water than to add treatment
- Stage 1 DBP rule requires enhanced treatment when source water TOC is greater than 2 mg/L.

TMDLs and Drinking Water Utilities



- WRF and WERF, 2005, 91049F
- Experts workshop
  - Explore links between CWA and SDWA
  - Relationship to TMDL program

WQ standards vs. MCLs

- SDWA regs focus on finished water
- CWA focuses on surface water
- “Allowable values established for these two sets of regulations are often completely different because they have very different goals and protect different resources that may be at risk”

91049F

Water Quality Standards vs. Maximum Contaminant Levels

CWA - WQ Standards:	◆ Surface Waters ◆ Use, criteria, anti-degradation policy ◆ Can be based on aquatic life, public health, or other ◆ Emphasis on aquatic life & recreation
SDWA - MCLs:	◆ Drinking Water ◆ Measured at tap ◆ Public health based only
SDWA Supplies:	◆ ESWT Rule ◆ Turbidity levels ◆ Crypto, Giardia, Others

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Example
Pollutant Levels Allowed

	SDWA	CWA - MI *examples*
Copper	1.3 mg/L	0.009-0.027 mg/L (Freshwater CCC & CMC)
Coliform	0	130-1000 #/100mL
TDS	500mg/L	125-750 mg/L
Mercury	0.02 mg/L	0.0000013-0.0028 mg/L
Nitrate	10 mg/L	No standard

Cont.

"Water utilities have always considered the source water concentration from the perspective of what must be done to bring them under the MCLs."

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Cont.

"Reducing nutrient loads through TMDLs can reduce risks by reducing natural organic matter (NOM), precursors to disinfection by-products that can be carcinogenic. Hence reducing nutrients can reduce NOM, which can reduce cancer risks."

Designated Water Supply Use

- “CWA is effective in addressing “fishable and swimmable” uses for our waters, but protecting safe drinking water, although a bonafide use, is not adequately addressed.”
- “Waters need to be designated “protected for drinking water” …that serve to protect this use.”

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Drinking Water Standards for Source Water

"Participants did not feel the CWA water quality criteria were adequately comprehensive and specific to address drinking water needs."

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Limiting P has benefits from water treatment perspective

- Limiting Phosphorus results in
  - limiting algal growth results in
    - limiting disinfection byproduct precursers,
      - which limits formation of disinfection byproducts

http://n-steps.tetratech-ffx.com/

Welcome

- Clifford W. Callinan, P.E.
- NY State Dept. of Environmental Conservation, Division of Water (Albany)
- Engineer/Limnologist
- Education (Cornell)
  B.S. Biology/Chemistry
  M.S. Environmental Engineering
- cwcallin@gw.dec.state.ny.us

Eutrophication Driven Cascade

15 2 8 5
Phosphorus
P
30.974

Step A

Step B

NOM

Step C

8 2 6
Oxygen
O
15.999

Step D

Benthic
P & As
Release

Positive
Feedback

Eutrophication Driven Cascade

15 ↑ 2 8 5
Phosphorus
P
30.974

NOM ↑

Cl_2

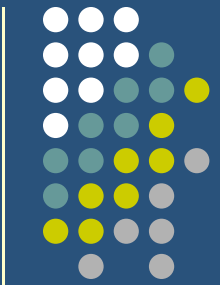
DBPs ↑

Benthic
P & As
Release

8 ↓ 2 6
Oxygen
O
15.999

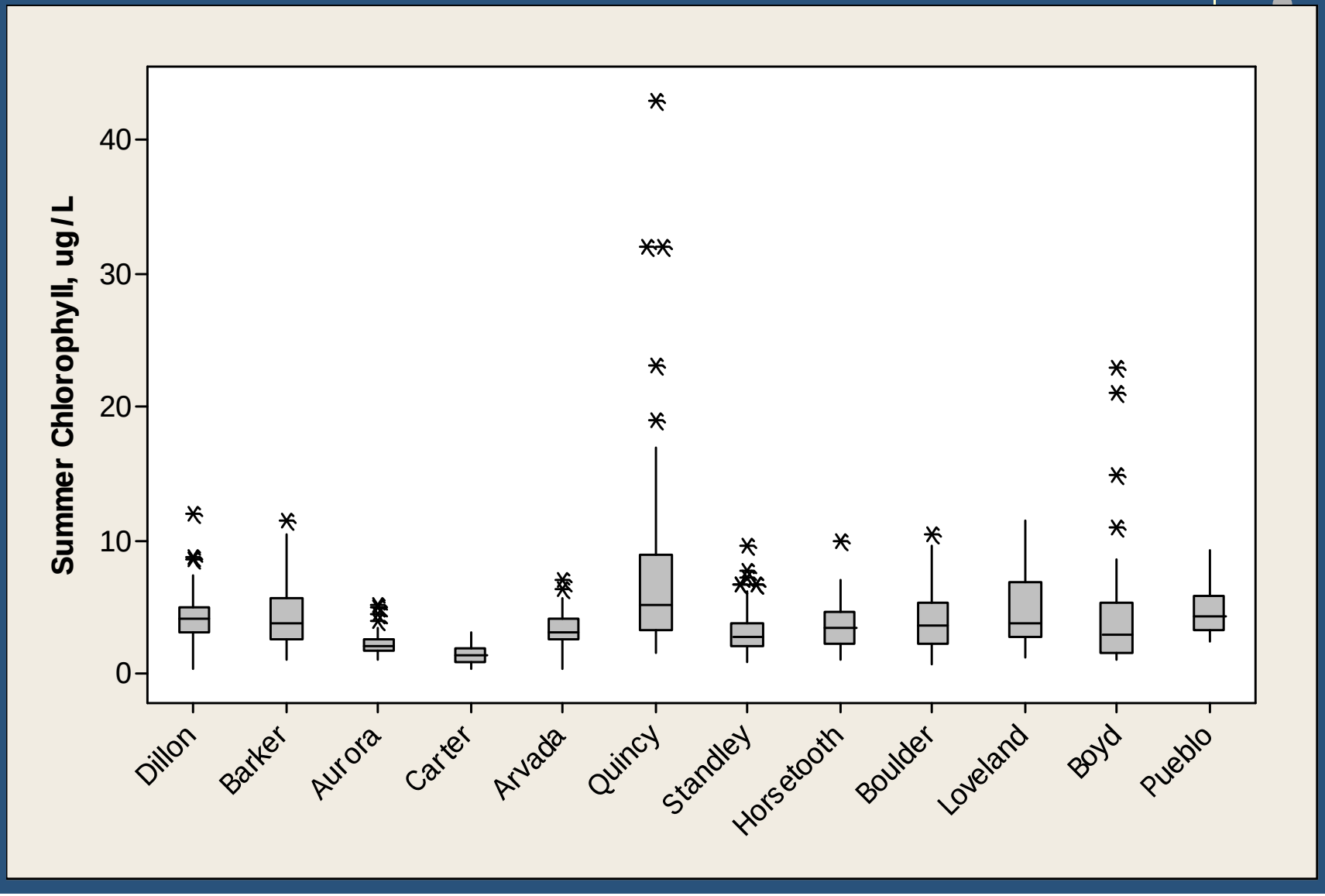
As ↑

Findings from DW Use Studies



- NY Study (2008)
- Quantified Chla Needed to Stay Within Regulatory Limits
- Concluded TTHM Regulation Most Stringent
- **Found Chla of 4-5 ug/L to be Protective of Use**

Protect our Water Supplies



Use Clean Water Act to protect the use

- Drinking water is a classified use
- Fishable and swimmable, but what about treatable and drinkable?

Significance of eutrophication in water supply reservoirs; Walker 1983 AWWA

- “Watershed management for control or reduction of phosphorus export is a potentially significant and cost-effective means of dealing with organics-related problems.”
- “THMs generally constitute only a fraction (typically about 20 percent) of total organohalogens that are formed when chlorine reacts with natural organic compounds. The remaining, generally nonvolatile compounds are still poorly identified and may contain compounds that are more hazardous than THMs.”

Impacts of Major Point and Non-Point Sources on Raw Water Treatability

- AWWARF 2003 90959F
- Source water protection measures that decrease concentrations of DBP precursors, pathogens, and pesticides in source waters have public health benefits that are not adequately expressed in strict economic terms.

EPA Technical Guidance for Lakes and Reservoirs (2000)

- Recognizes there are different categories of lakes and reservoirs

- Grumbles memo (2007) strongly recommends that States adopt numeric nutrient criteria for their priority waters (such as drinking water) first.

High Quality Water Supply Study

- Reservoirs are different than flowing water
- Many of our reservoirs used for drinking water supply already have good quality water that we should protect
- Develop nutrient criteria protective of that use
- Collecting samples this summer
- Looking for correlations

Water Treatment Costs

TABLE 1 Capital cost comparisons—2005 and 2009

Treatment Technology	Capacity Cost—$					
	1 mgd		17 mgd		76 mgd	
	2005	2009	2005	2009	2005	2009
Alternate disinfectants						
Chloramine	53,396	62,608	98,772	113,899	397,173	451,036
Chlorine dioxide	40,035	47,531	268,223	302,344	603,425	683,678
UV disinfection	317,091	359,359	1,418,926	1,625,710	3,569,168	4,078,398
Ozone	804,614	974,973	3,946,957	4,865,079	12,628,950	15,996,225
Organic removal technologies						
Granular activated carbon (annual exchange)	783,808	863,696	6,140,593	6,902,107	18,311,317	20,481,136
Nanofiltration	912,423	1,057,344	15,546,118	17,948,220	57,558,238	67,328,295
Microfiltration/ultrafiltration	1,594,911	1,786,445	15,991,348	17,940,217	61,150,358	69,100,740

AWWA Journal March 2010

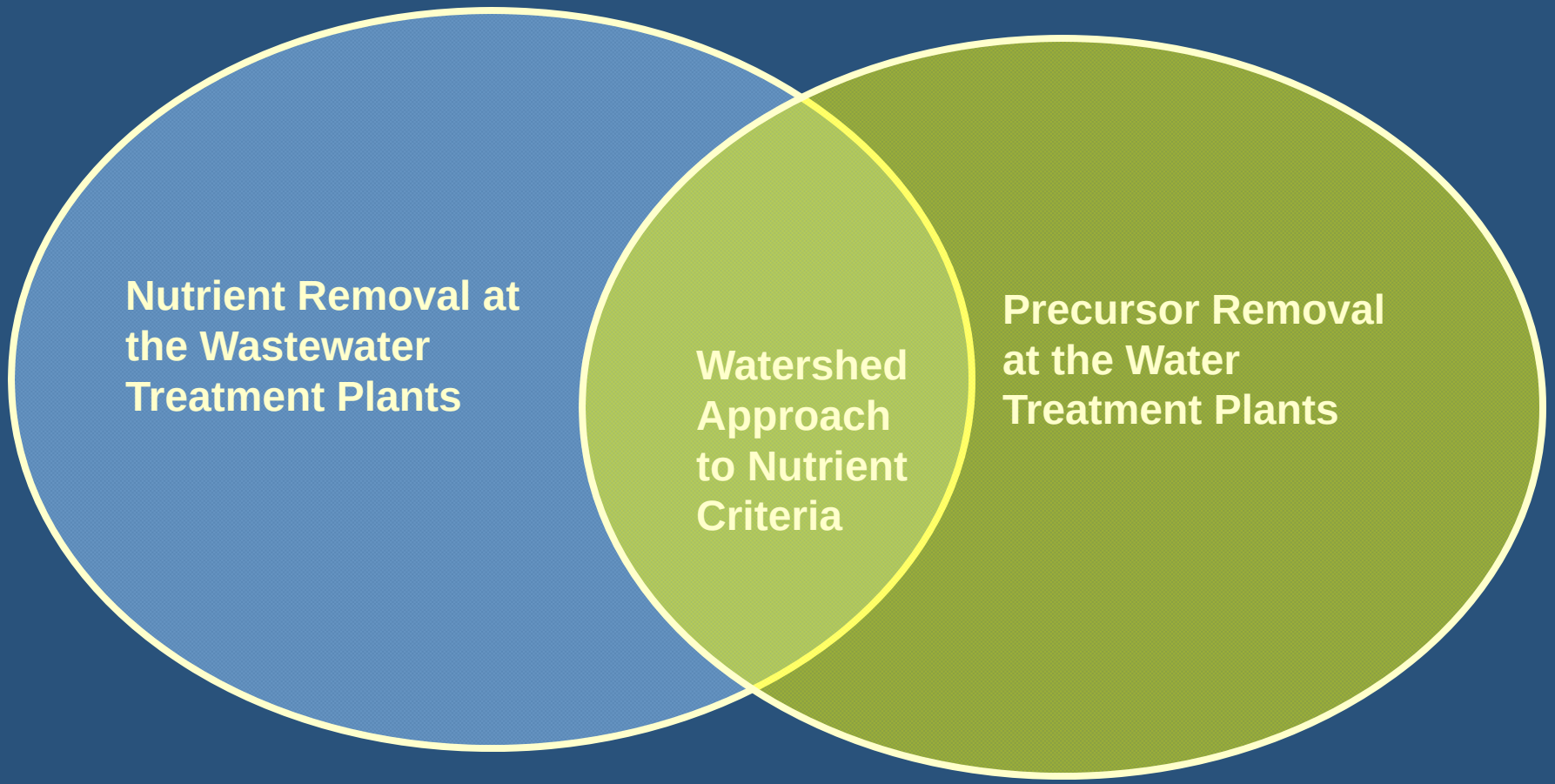
Annualized Costs

TABLE 3 Annual costs (based on a 10-year life cycle)—2005 and 2009

Treatment Technology*	Capacity Cost—$					
	1 mgd		17 mgd		76 mgd	
	2005	2009	2005	2009	2005	2009
Alternate disinfectants						
Chloramine	9,800	11,122	21,210	24,918	70,800	86,182
Chlorine dioxide	22,600	25,970	62,700	72,052	147,300	170,588
UV disinfection	40,200	46,791	164,800	189,442	423,700	485,863
Ozone	156,900	189,359	850,300	1,138,642	3,237,000	4,505,864
Organic removal technologies						
Granular activated carbon (annual exchange)†	135,500	147,900	841,100	941,248	2,539,000	2,825,826
Nanofiltration	203,000	239,126	3,326,000	3,956,051	13,660,000	16,417,703
Microfiltration/ultrafiltration	228,700	257,218	2,385,000	2,696,154	9,420,000	10,710,148

*Additional details regarding each treatment technology are available from the author upon request.
†Recent developments regarding the custom reactivation of activated carbon would result in decreases of approximately 20% in the operations and maintenance costs for that technology versus what is shown in Tables 2 and 3 for 2009.

Balance the issues

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