



Potential Impacts of Nutrient Pollution on Drinking Water Supplies

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Jake Crosby, EPA Region 8
303.312.6389
crosby.jake@epa.gov

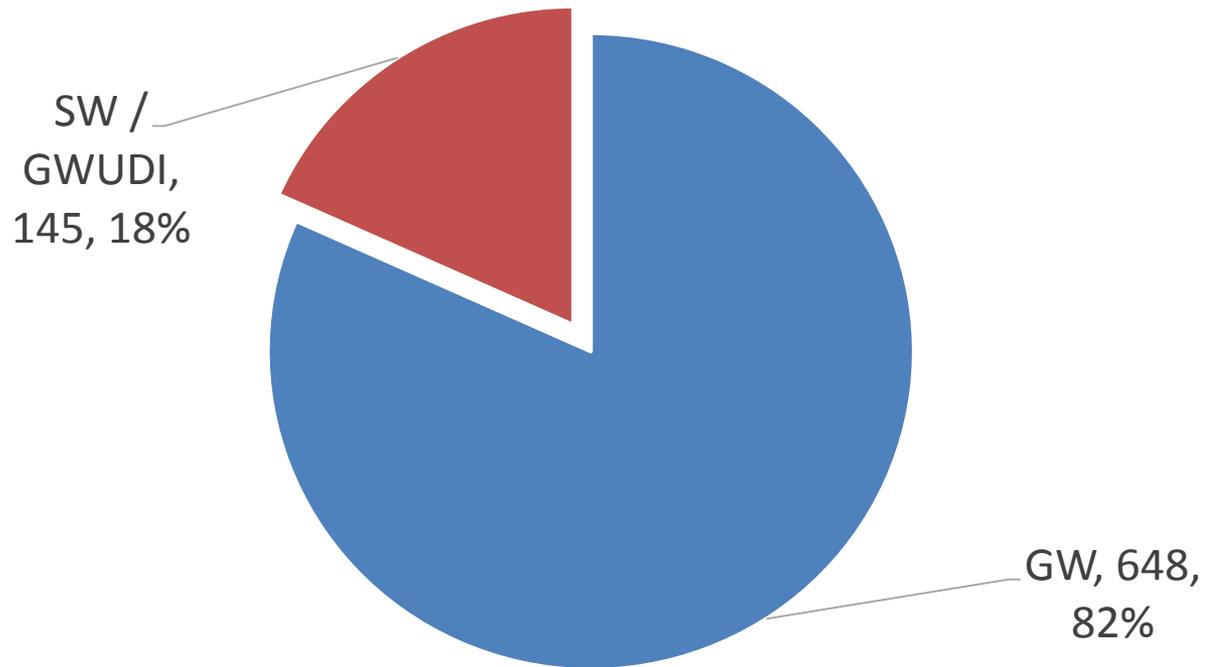


Outline:

1. Wyoming drinking water systems by source type.
2. WY surface water systems with possible HAB concerns.
3. Impacts of Nutrients on drinking water supplies.

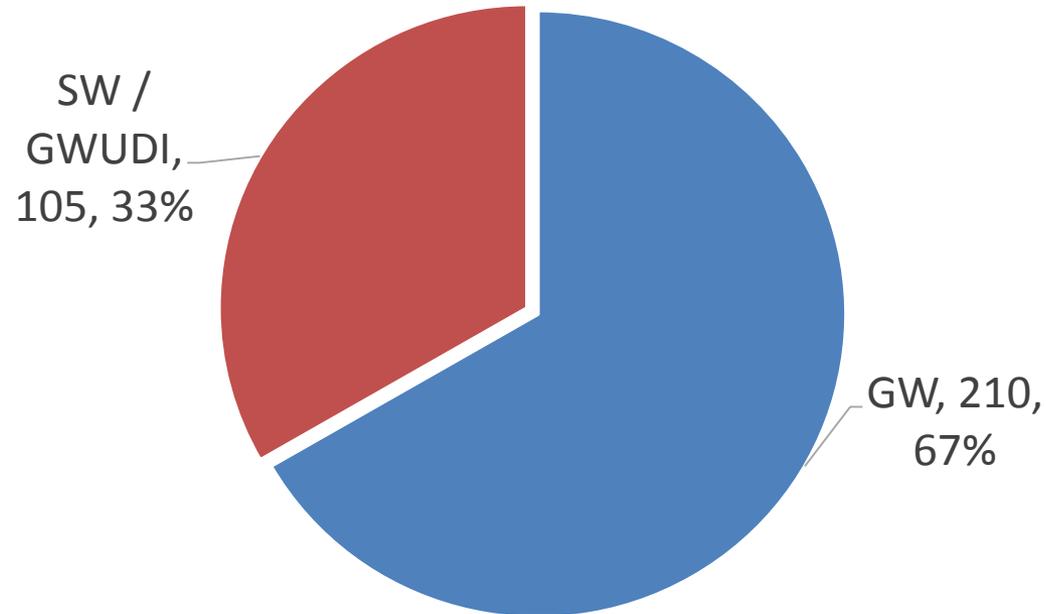


Wyoming drinking water systems by source type: All Systems (including consecutives)



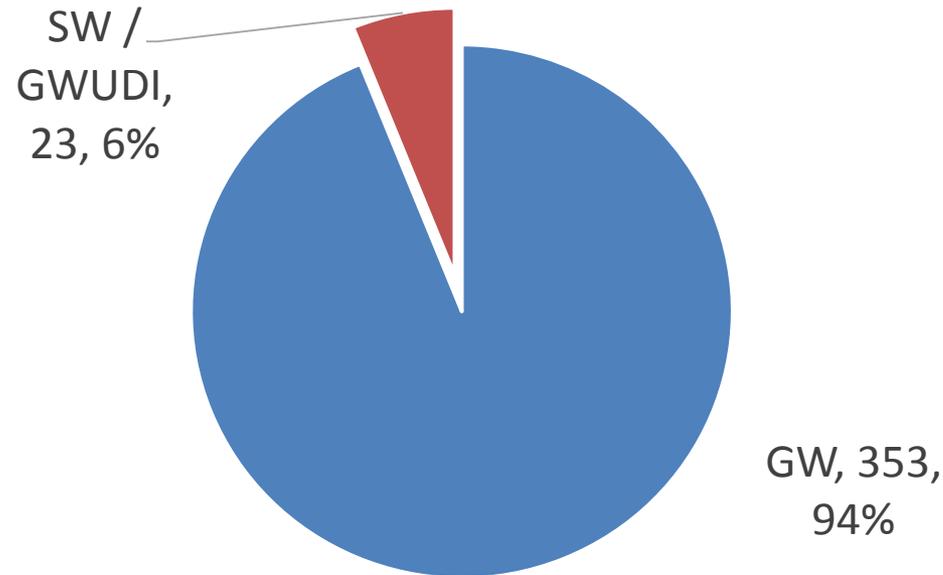


Wyoming drinking water systems by source type: Community Systems (including consecutives)



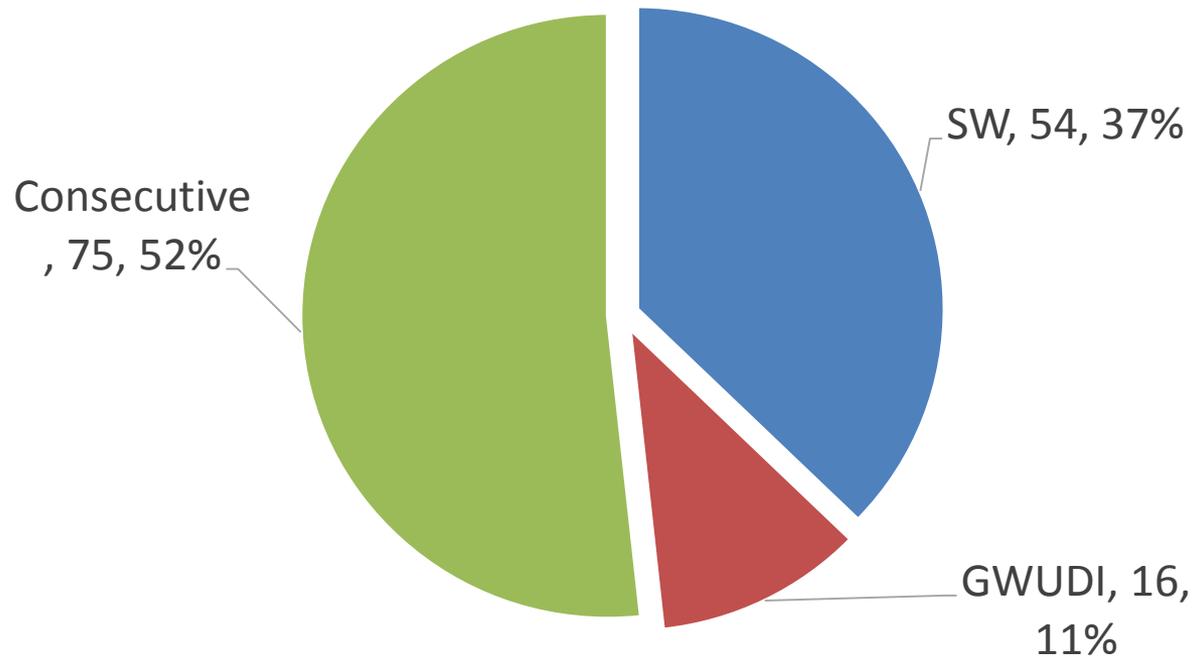


Wyoming drinking water systems by source type: Transient Non-Community Systems (including consecutives)





Wyoming "SW / GWUDI" water systems by type:



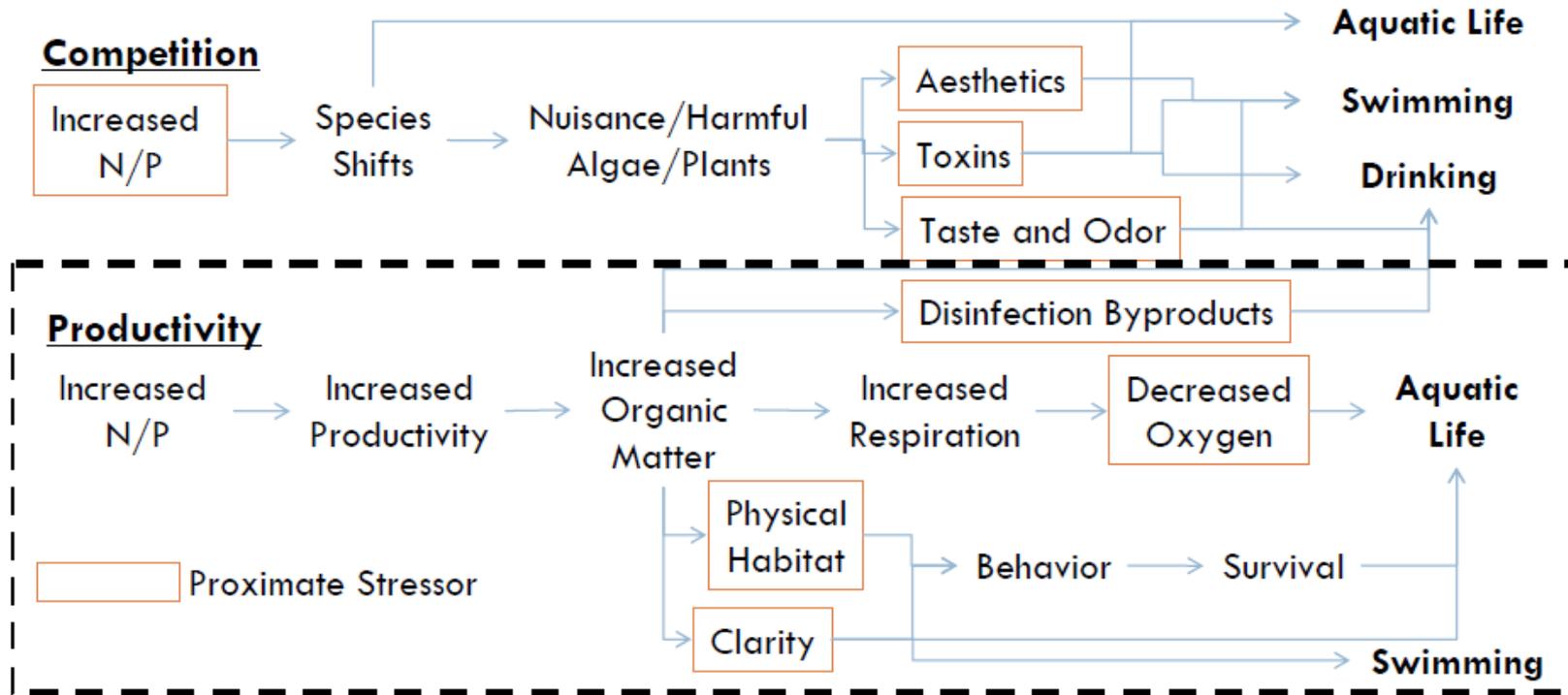


Wyoming DW systems with possible HABs concerns:

1. Total of 54 systems that treat surface water sources.
2. HABs risk of all systems not well studied.
3. Systems with known algal issues in source:
 - a. Boysen State Park HQ (Boysen Reservoir)
 - b. Kemmerer-Diamondville JPB (Hams Fork River downstream of Viva Naughton and Kemmerer Reservoirs)
4. Systems with possible issues:
 - a. Chevron Carter Creek (Woodruff Narrows Reservoir)
 - b. All surface water systems in Green River drainage.
 - c. Systems with pre-sedimentation basins or uncovered pre-treatment processes.
 - d. Others?



Impacts of Nutrients on drinking water supplies:





Impacts of Nutrients on drinking water supplies:

Nuisance / Harmful Algae Plants:

- A. HABs / Cyanotoxins.
- B. Taste and Odor (MIB and Geosmin).

Increased Organic Matter

- A. DBPs
- B. Treatability



HABs / Cyanotoxins

- Some high profile incidents in recent years (City of Toledo 2014, Ohio River algal bloom 2015)
- No current MCL, EPA published health advisory levels for microcystin and cylindrospermopsin in 2015.
- No federal health advisories or MCLs for saxatoxins or anatoxin-a, however, EPA Region 8 plans to enforce the State of Ohio health advisory limits.
- Commonly detected in raw water sources, but infrequently above threat levels.
- The EPA Region 8 Lab is available to provide labs with analytical services (currently free of charge).
- There are also test strips available to get a rough approximation of cyanotoxin levels in both raw and finished water (currently available for microcystins only).
 - A. Current detection levels for these test strips limit their usefulness, but they can be a good screening tool.



HABs / Cyanotoxins (cont'd)

- Almost all surface water treatment trains can remove the whole cell cyanobacteria (when properly operated).
 - A. Sludge recycling at conventional coag / flocc / sediment processes negatively impacts removal.
 - B. DAF is more effective than gravity sedimentation.
 - C. Frequency of backwashing for filters (membranes and rapid sand) may need to be increased.
- Extra-cellular toxins are generally not removed by filtration.
 - A. Addition of oxidants / algaecides prior to filtration during a HAB is discouraged.
 - B. Many strong oxidants “inactivate” the toxins, some research has been done to develop “CT” tables for different oxidants.
 - Effectiveness of a specific oxidant depends on the type of cyanotoxin.
 - Both UV and chloramination are ineffective.
 - C. Activated carbon (PAC and GAC) is effective at adsorbing extracellular toxins.
 - Efficiency is specific to the type of activated carbon and the target toxin.
 - C. NF / RO membranes can also be effective at removing extracellular toxins.

Cyanotoxin thresholds and analytical methods (for EPA Region 8)

| Type of notice | Total Microcystins ² | Cylindrospermopsin | Anatoxin-a ¹ | Total Saxitoxins ^{1,2} |
|---|---|--|--|---|
| Do not Drink: children under 6 and sensitive populations ³ | 0.3 ppb (EPA Health Advisory value) | 0.7 ppb (EPA Health Advisory value) | 20 ppb (Ohio Health Advisory value) | 0.2 ppb (Ohio Health Advisory value) |
| Do not Drink: Children 6 and older & adults | 1.6 ppb (EPA Health Advisory value) | 3.0 ppb (EPA Health Advisory value) | 20 ppb (Ohio Health Advisory value) | 0.2 ppb (Ohio Health Advisory value) |
| Do not use ⁴ | 20 ppb | 20 ppb | 300 ppb | 3 ppb |
| Test Strip Monitoring | Abraxis dip strips ⁵ | When available | When available | When available |
| Toxin Monitoring and Repeat Sampling | ELISA-ADDA and/or LC-MS/MS ⁶ | ELISA and/or LC-MS/MS | ELISA and/or LC-MS/MS | ELISA ⁷ and/or LC-MS/MS |

1. Documentation of the calculations of the threshold levels for anatoxin-a and saxitoxin are found in Appendix C of Ohio EPA's Public Water System Harmful Algae Bloom Response Strategy, July 2015. The link to this document:

http://epa.ohio.gov/Portals/28/documents/HABs/PWS_HAB_Response_Strategy.pdf

2. Microcystins and saxitoxins thresholds are intended to be applied to total concentrations of all reported congeners/variants of those cyanotoxins.

3. The USEPA health advisories identify potentially sensitive populations to include pregnant women, nursing mothers, those receiving dialysis treatment, those with pre-existing liver conditions, the elderly and immune-compromised as individuals who may want to consider following the recommendations for children.

4. The drinking water "do not use" thresholds are based on the recreational no contact advisory thresholds. These values are from Ohio EPA's Public Water System Harmful Algae Bloom Response Strategy, July 2015.

5. Use for raw water only.

6. ELISA-ADDA tests for all variants of microcystins but currently only has a detection level around 0.3 ppb. LC-MS/MS tests for a subset of the variants but has a very low detection level. Higher levels are typically found with ELISA as it is a measure of total microcystins. ELISA is the preferred method since the health advisory value is for total microcystins.

7. Unlike the ELISA method for microcystins, ELISA for saxitoxins tests for many of the variants but not all.



Taste and Odor

- Taste and Odor
 - Several nuisance taxa can produce chemicals that create taste and odor issues for drinking water and in fish tissue – at very low concentrations
 - 2-Methylisoborneol (MIB) and geosmin
 - Produced by actinomycete fungi (*Streptomyces*) and filamentous cyanobacteria (*Oscillatoria*, *Phormidium*, *Anabaena*, *Pseudanabaena*, *Lyngbya*, *Aphanizomenon*, *Planktothrix*, etc.)
 - Wines, cheese, beets, forest etc. – earthy/musty smell
 - Cyanobacteria linked to taste and odor
 - Infrequent in oligotrophic waters



DBPs

- Disinfection By-products
 - Algae are “leaky” and also release DOC when they die
 - Natural DOC reacts with halides to form a variety of DBPs
 - Halides used in water treatment/disinfection stage (mostly Cl and Br)
 - Trihalomethanes, haloacetic acids, bromate, chlorites
 - Carcinogenic and teratogenic (reproduction/development)



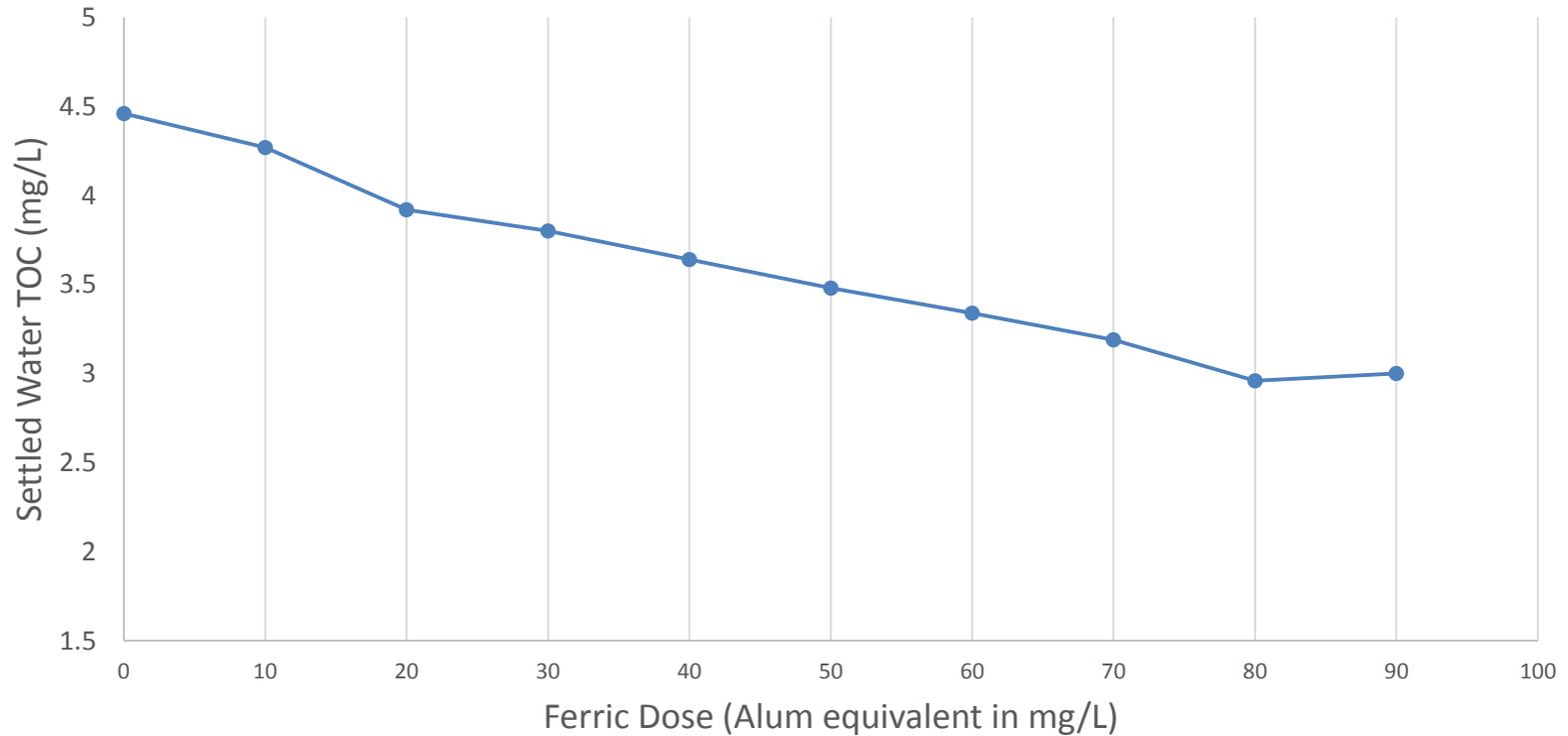
Treatability

- Clogging of intake screens due to excess organic matter.
- Increase in coagulant demand.
- Increase in chlorine demand.
- Decreased UV transmittance (possible compliance issues for systems with required UV treatment).
- Shorter filter runs / increase in filter backwash water requirements.
- Rapid pH swings, requiring frequent chemical adjustments



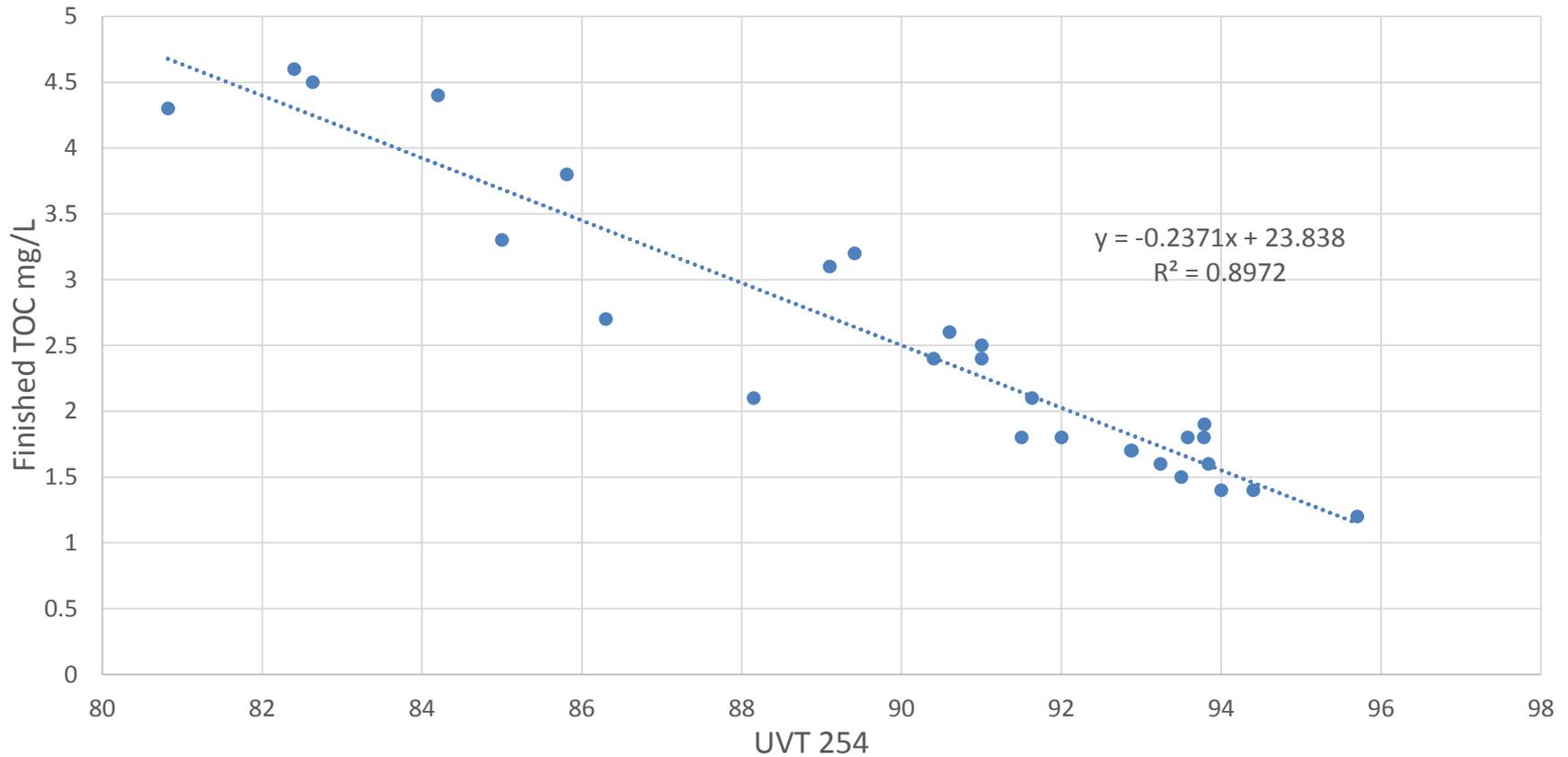
Treatability: TOC and coagulant dose

Settled Water TOC vs Ferric Dose



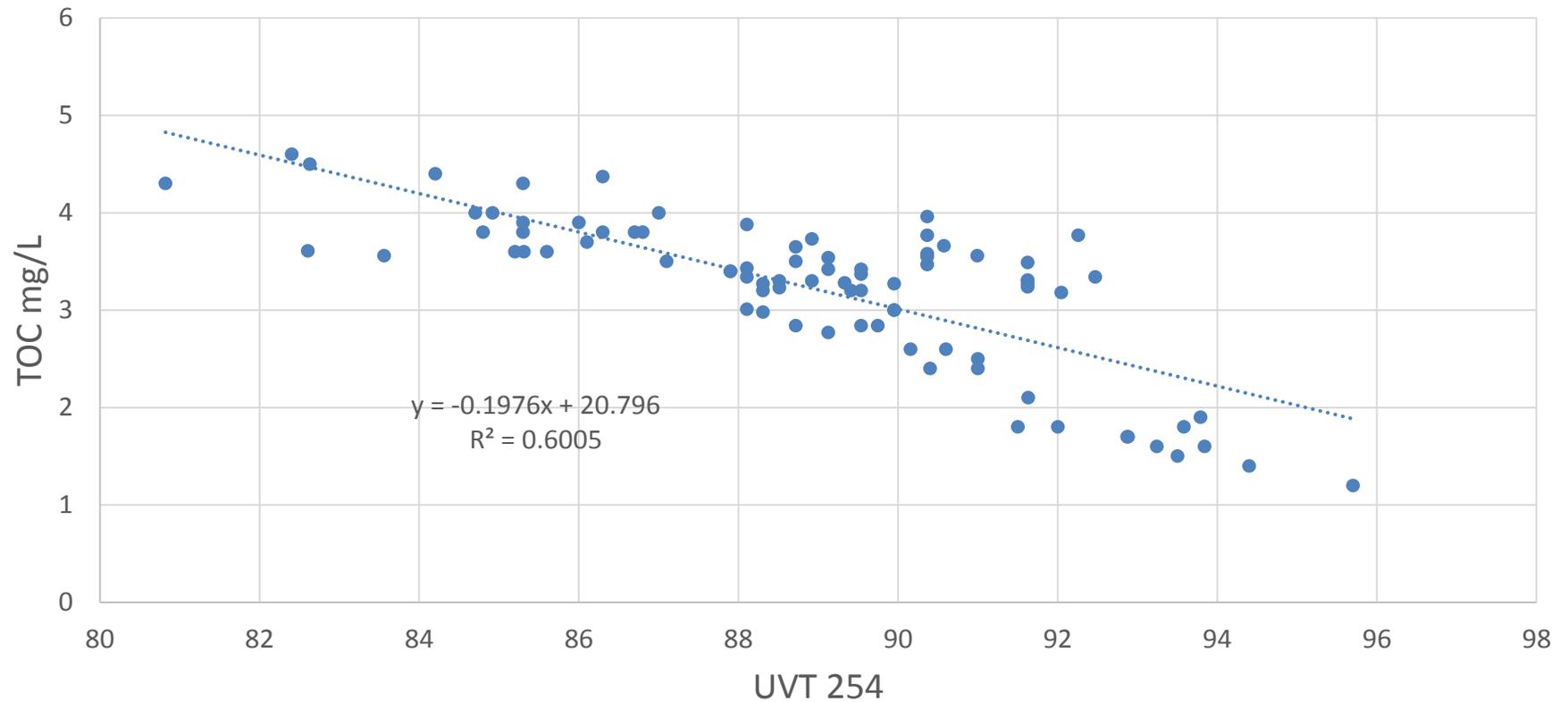


Treatability: Organics effect on UV transmittance (one water system)





Treatability: Organics effect on UV transmittance in Finished Water (combined data)





Treatability: UVT254 and DBP formation

HAA5 vs UVT (assume three day residence time)

