MOTT MACDONALD

UCMR4 Cyanotoxins

What Will You Do If You Find Them?

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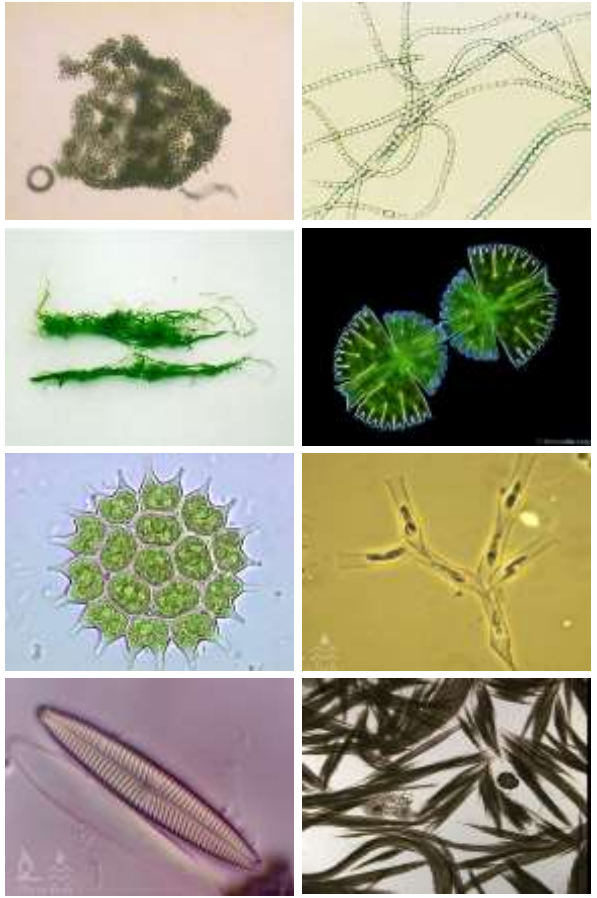
What are algae?

- Most are microscopic, photosynthetic organisms
- More of an ecological term than taxonomic
- Base of the aquatic food web; many algae are necessary and good
- However, some algae, particularly the blue-green algae (cyanobacteria) are a nuisance (surface scums, taste and odor, cyanotoxins)

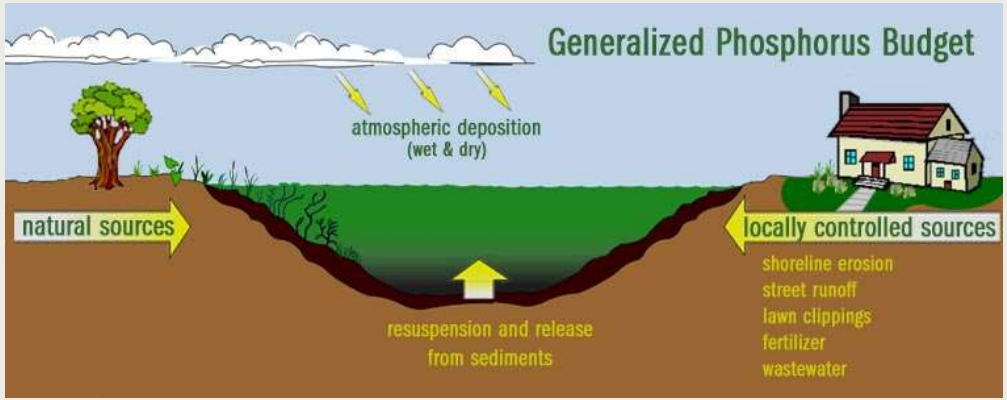


What do cyanobacteria need to grow?

- Light / Temperature / Carbon Dioxide
- Macro-Nutrients (Nitrogen, Phosphorus)
- Micro-Nutrients (Iron, Silica, others)
- For most Mid-Atlantic freshwater systems, phosphorus is the primary limiting nutrient

1 lbs of phosphorus has the potential to generate up to 1,100 lbs of wet algae biomass

More phosphorus means more algae



Nuisance freshwater algae

Planktonic Bloom

Filamentous Mat Algae

- What caused this?
- Is this bloom harmful?
- How do I manage it?
- How do I prevent it?

What's driving the concern?

EPA Health Advisories (2015)

10-DAY HEALTH ADVISORIES	LEVEL
Microcystins	
Children pre-school age and younger (under 6 years old)	0.3 µg/L
School-age children (6 years and older)	1.6 µg/L
Cylindrospermopsin	
Children pre-school age and younger (under 6 years old)	0.7 µg/L
School-age children (6 years and older)	3.0 µg/L

Table 1. U.S. EPA's National 10-Day Health Advisories

UCMR4

Assessment Monitoring (Cyanotoxins)

Freshwater cyanobacterial blooms may be composed of a single-species or variety of toxic and non-toxic strains. Cyanotoxins are produced and contained within the actively growing cyanobacterial cells, and can be released into the surrounding water.

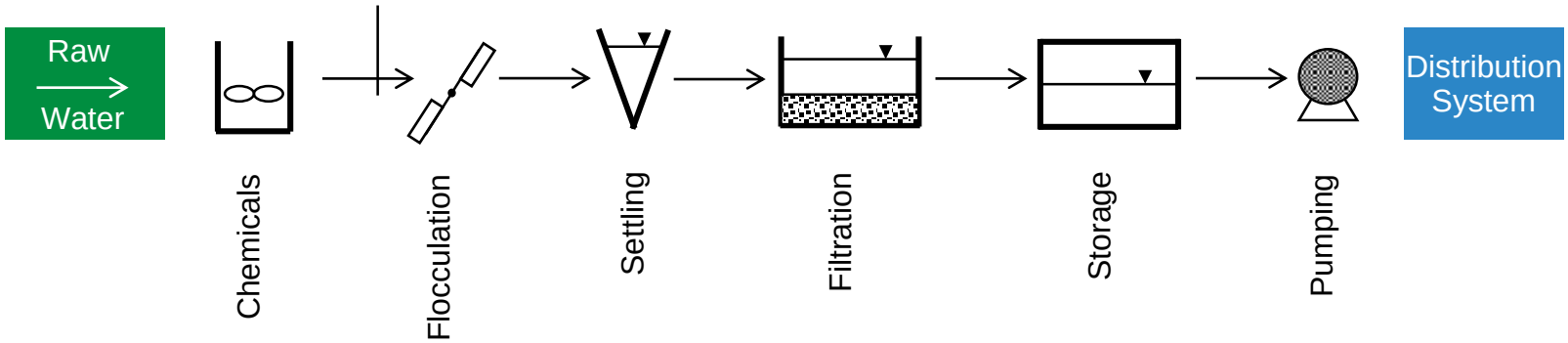
Contaminant	CASRN[1]	MRL[2] (µg/L)	Method
"total microcystins"	N/A	0.3	EPA 546
microcystin-LA	96180-79-9	0.008	EPA 544
microcystin-LF	154037-70-4	0.006	EPA 544
microcystin-LR	101043-37-2	0.02	EPA 544
microcystin-LY	123304-10-9	0.009	EPA 544
microcystin-RR	111755-37-4	0.006	EPA 544
microcystin-YR	101064-48-6	0.02	EPA 544
nodularin	118399-22-7	0.005	EPA 544
anatoxin-a	64285-06-9	0.03	EPA 545
cylindrospermopsin	143545-90-8	0.09	EPA 545

1. CASRN - Chemical Abstracts Service Registry Number
2. MRL - Minimum Reporting Level

- **Applicable Water Systems**: Community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) serving more than 10,000 retail customers (i.e., large systems) and a representative sample of 800 CWSs and NTNCWSs serving 10,000 or fewer retail customers (i.e., small systems). Systems using surface water or ground water under the direct influence of surface water are required to sample; **ground water systems are excluded from cyanotoxin monitoring**.

Managing algae and cyanobacteria and controlling toxins
(Intra-cellular and Extra-cellular toxins)

- Understanding your water supply
- Monitoring, triggers and management protocols
- Controlling algae and cyanobacteria in water supply
- Intake options
- Pretreatment options
- Treatment process modifications (avoid unintended consequences)
- Capital improvements
- Alternate water sources



‘Just a few drops’

Date posted: Thursday, January 17, 2013 9:05 AM EST

- ***To express my reaction to the knowledge that Anabaena is present in our water is in one word called “scared.”***

- ***It takes only a few drops of this toxic water for it to be harmful to people and pets***

Monitoring, **M**anagement and **T**reatment plan

Monitoring: Collect site-specific data in the reservoir to assess and respond to conditions (not just pH, DO, temp – but PO4, phycocyanin, cell counts)

Management: Implementation of in-lake and watershed-based measures to improve water quality

Treatment: Develop more of a proactive than reactive treatment strategy for the reservoir and implement control measures at the WTP

Monitoring – indicators and triggers

Monitoring and response strategies will be system-specific

Indicators are an important tool

- Selected parameters
- Frequent monitoring
- Developing “triggers”

Monitoring location, timing, and frequency must balance competing objectives

- Practical within utility operating constraints
- Provide actionable information

What might result from a trigger?

- Increased monitoring
- Monitoring of additional parameters
- Increasing coordination with other PWS
- Modification of treatment

Indicators and triggers – example

Parameter	Units	Range of Results	Action Trigger
Total Phosphrous (P)	mg/L	0.03 - 0.09	Greater than 0.05 mg/L; trigger to treat lake with nutrient inactivator NOT chelated copper product
Chlorophyll a / Phycocyanin (PC) fluorescence	ug/L	Chl-a 3.1 - 340	20 to 30 ug/L Chl-a; trigger to perform algae/cyanobacteria cell counts to determine the dominant algal group
Secchi Depth (Water Clarity)	M	1.0 - 6.6	Less than 1 meter; trigger to perform algae/cyanobacteria cell counts, and possible lake treatment
Cyanobacteria Cell Counts	cells/mL	0 - 493,469	5,000 cells/mL; trigger to treat lake with chelated copper product, however, lower thresholds may apply depending on season/ species 15,000 cells/mL; trigger to test for cyanotoxins (raw first)
Geosmin	ng/L	< 5 - 61.7	> 10 ng/L (Implement PAC)
MIB	ng/L	< 5 - 17.7	> 10 ng/L (Implement PAC)

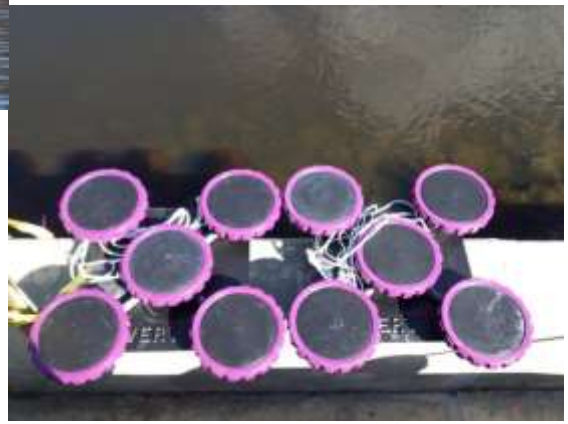
Monitoring for cyanotoxins

Will be needed to determine treatment needs and process adjustments Currently required for many systems during UCMR4 testing (2018 - 2020)

- ELISA (total Microcystins) – EPA Health Advisories (10 day HAs) – Some issues with the ELISA test
- LC/MS/MS (Individual cyanotoxins and congeners)
  - Microcystin (LR, LA, LF, LY, RR, YR)
  - Nodularin
  - Anatoxin-a
  - Cylindrospermopsin
- Strip test kits and automated readers for Microcystins and Cylindrospermopsin. Also the CAAS system – Cyanotoxin Automated Assay System

In-lake management measures

- De-stratification / aeration system
- Use of nutrient inactivation (early in the season)
- Floating wetland islands (by feeder streams)
- Biomanipulation (fish stocking, etc.)
- Ultrasonic treatment



Aeration helps maintain measurable amounts of dissolved oxygen throughout the water column

Reducing release of phosphorous from bottom sediment, which can fuel algae growth

Watershed based management measures

- Streambank / shoreline stabilization
- Creation / expansion of riparian / wetland edge
- Possible stormwater management of residential / agricultural lands (nutrient control)
- Preserve / protect forested lands within the watershed

Treatment strategy for the reservoir

- Use water quality data to determine when to treat as opposed to sticking to regularly scheduled treatments (e.g. twice a month starting in June)
- Make an effort to treat during/ just prior to the log phase of a bloom (i.e. high rates of growth) – don't wait too long, and monitor frequently
  - Copper based algaecides will lyse cells
- Use of liquid chelated copper-based algicides may work better than copper sulfate in shallow reservoirs. Copper sulfate may sink to reach deeper blooms.
- Low reservoir levels and no flow can be challenging
  - – You may lose the battle
  - – Reservoir treatment normally restricted by permit requirements

Water treatment plant modifications and upgrades

- Intake gate changes to avoid blooms
- Cessation of any pre-oxidation (chlorine, ozone, etc.)
- Optimization of coagulation/flocculation
- Better utilization of existing CT disinfection potential to inactivate toxins (CyanoTOX Calculator)

- Improved removal of intact cyanobacteria cells (Dissolved Air Flotation or DAF)?
- Installation of powdered activated carbon (PAC)
  - 10 to 20 ppm, high CT. Watch the sludge!
- Installation of biologically active filters
- Nano-filtration (up to 80% removal of MCs)
- Alternate water source?

Things to keep an eye on

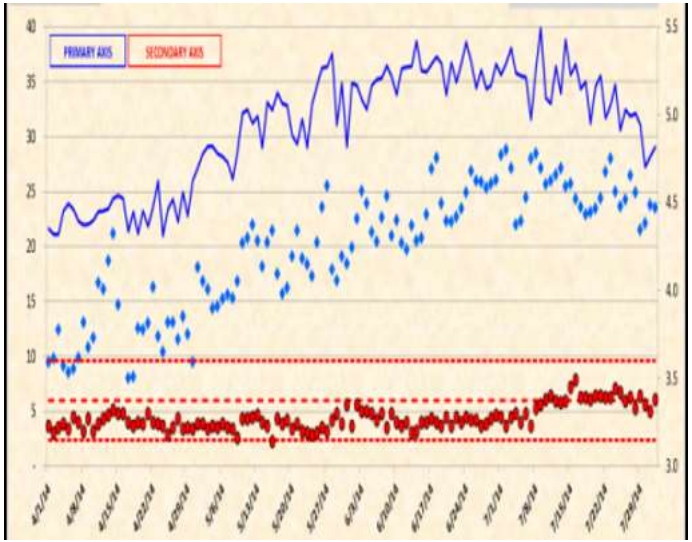
- Continue to develop your monitoring program with increased monitoring/ treatment during the early / mid-summer period, along with further development of the treatment strategy table
- Encourage EPA and state agencies to develop and implement agricultural management practices to reduce nutrients and runoff
- Remain aware of developing technologies and treatment strategies
- What does a 10-day Health Advisory really mean?

Online monitoring

Using multi-parameter probes – at your intake or on a buoy(s) – or a drone?

Multi-probe to simultaneously measure:

- Phycocyanin (PC) fluorescence
- Chlorophyll-a (Chl-a) fluorescence
- pH, temperature
- Dissolved oxygen
- Conductivity
- Turbidity



Some AWWA tools…

CYANOTOXINS RESOURCE COMMUNITY

- A spreadsheet tool to assess removal of extracellular cyanotoxins by chlorine, ozone, chlorine dioxide and potassium permanganate
- A PAC Calculator tool to assess proper dosages for toxin removal

http://www.awwa.org/resources-tools/water-knowledge/cyanotoxins.aspx

AWWA cyanotoxin resource community (cont.)

CYANOTOXINS ESSENTIALS

⊟ AWWA Technical Resources

- **Cyanotoxin Oxidation Calculator - CyanoTOX, Version 2** (XLS)
- **Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals** (PDF)
- **Water Utility Managers Guide To Cyanotoxins** (PDF)
- **Cyanotoxins in US Drinking Water: Occurrence, Case Studies and State Approaches to Regulation** (PDF)
- **Testing Protocols for Site-Specific Oxidation Assessments** (PDF)
- **Testing Protocols for Site-Specific Powdered Activated Carbon Assessments** (PDF)
- **Powdered Activated Carbon Calculator for Site-Specific Assessments** (XLS)
- **AWWA testimony on 2015 Drinking Water Protection Act** (PDF)
- **Enactment of 2015 Drinking Water Protection Act**

⊞ AWWA Policy Statements

⊞ Get Involved

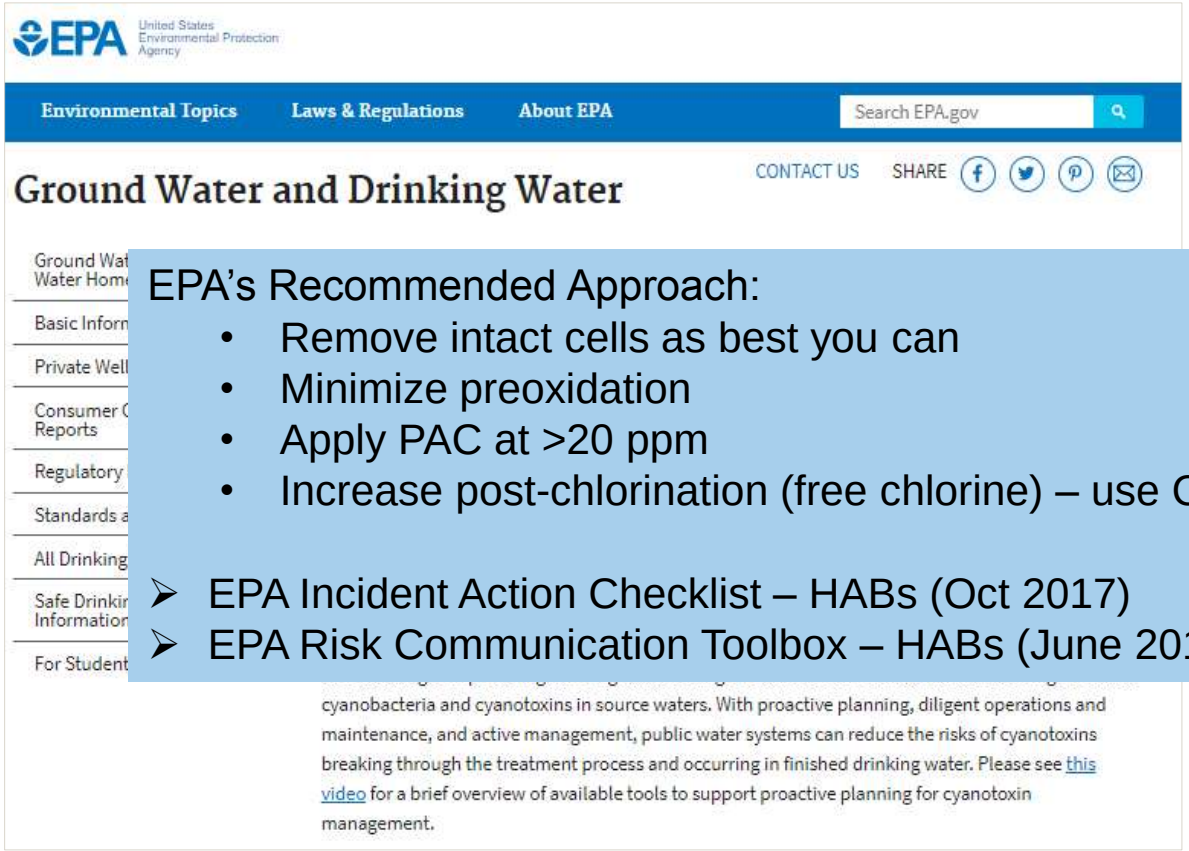
⊞ Related Resources

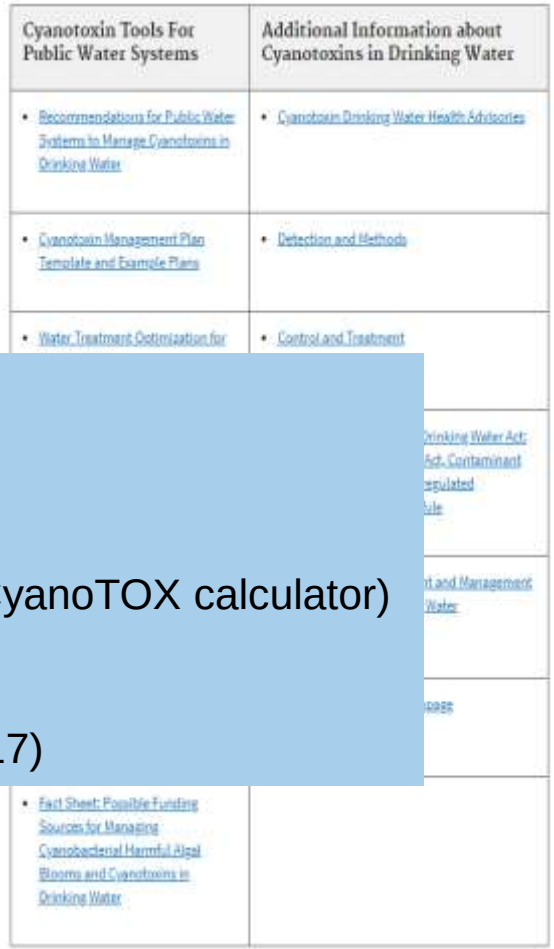
⊟ Related Resources

- **USEPA Resources on Cyanotoxins in Drinking Water**
- **Water Research Foundation Report Managing Cyanotoxins** (PDF)
- **Water Research Foundation Projects**
- **Health Canada: Cyanobacterial Toxins in Drinking Water**
- **World Health Organization: Toxic cyanobacteria in water - A guide to their public health consequences, monitoring and management**

AWWA PUBLICATIONS

EPA resources and tools





EPA's Recommended Approach:

- Remove intact cells as best you can
- Minimize preoxidation
- Apply PAC at >20 ppm
- Increase post-chlorination (free chlorine) – use CyanoTOX calculator)

- ➢ EPA Incident Action Checklist – HABs (Oct 2017)
- ➢ EPA Risk Communication Toolbox – HABs (June 2017)

Addressing Multiple Objectives

Systems must simultaneously manage and address a number of issues:

- Provide an adequate supply of potable water
- Remove / disinfect microbes
- Control formation of disinfection byproducts
- Prevent/ achieve removal of taste and odor causing compounds
- Maintain corrosion control
- Maintain reliable treatment under a wide range of conditions

Managing cyanotoxins effectively requires identifying recognition & response strategies that do not create unintended consequences

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Thank you

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