Cyanotoxin Risk Management for Drinking Water Systems

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EPA’s Tools for Cyanobacteria and Cyanotoxins in Freshwater Systems
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Presentation Overview

- Brief overview of harmful algal blooms (HABs) and drinking water impacts
- Discussion of key support tools for cyanotoxin risk management in drinking water systems
Harmful Algal Blooms

- Naturally occurring cyanobacteria in surface water can rapidly form HABs
- Leading factors causing HABs:
  - Excess nutrient loadings and concentrations
  - Slow moving surface water
  - Elevated water temperature
- Some species of cyanobacteria produce toxic compounds, called algal toxins or cyanotoxins
- Significant impacts of HABs include:
  - Adverse human health effects
  - Adverse ecosystem impacts from toxins and hypoxia
  - Drinking and recreational water quality concerns
  - Economic losses
HAB-related Drinking Water Challenges

- Drinking water quality
  - Taste and odor problems
  - Human health effects from ingesting toxins: gastroenteritis, liver and kidney damage
  - Potential development of disinfection byproducts

- Public water systems
  - Increasing operational costs
  - Additional research needed on how to prevent, predict, analyze, monitor and treat toxins
  - Developing and implementing cost effective methods to reduce HABs in source waters
  - Determining how to communicate risk to the public
Highlights from Recent Bloom Seasons

Ohio River 2015
- Approximately 600 mile bloom
- Source of drinking water for over 5 million people

Lake Erie 2015
- Most severe bloom of this century in Lake Erie

Florida 2016
- Severe bloom impacted Lake Okeechobee, rivers, and estuaries

Utah 2016
- Severe bloom on Utah Lake
- Recreational waters and secondary water systems impacted (i.e. irrigation, gardening, livestock)

Recent Drinking Water Detects
- Ingleside, Texas (Jan./Feb. 2016)
  - Resulted in advisory
- Des Moines, Iowa (Aug 2016)
- Cayuga County, New York (Sept./Oct. 2016)
- Summit Lake (May 2017)

Citations:
Ohio River: Ohio River Valley Water Sanitation Commission [www.orsanco.org](http://www.orsanco.org)
• Tools for developing a cyanotoxin risk management plan framework:
  • Recommendations documents released for public water systems to manage cyanotoxins in drinking water—2015
  • Cyanotoxins Management Plan Template and Example Plans—2016
• Tools and information sources to support development of specific areas within a management plan framework:
  • Drinking water Health Advisories and Health Effect Support Documents for cyanotoxins—2015
  • Water Treatment Optimization for Cyanotoxins—2016
  • Cyanotoxin Risk Communication Toolbox—2016
  • HABs Funding Fact Sheet—2017
In June 2015, EPA released a support document titled *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*. The document is intended to assist interested states and utilities manage the risks from cyanobacterial toxins in drinking water, recognizing the most appropriate course of action will vary on a case by case basis.
Potential Cyanotoxin Management Steps

Step 1: System-Specific Surface Water Source Evaluation
- Source water vulnerable
- Source water not vulnerable

Step 2: Preparation and Observation
- YES, evidence indicates cyanotoxin occurrence
- NO, continue to assess evidence during vulnerable period

Step 3: Monitor for Cyanotoxins in Raw Water and Treatment Adjustments
- YES, toxins detected
- NO, toxin detected

Step 4: Monitor for Cyanotoxins in Raw and Finished Water and Treatment Adjustments
- Toxins detected in raw only, continue raw and finished water monitoring
- Toxins detected in finished water
- NO toxins detected in raw or finished water

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments/Additions, and Public Communications
Step 1: System-Specific Surface Water Source Evaluation

• Key objective: Determine if source water is vulnerable to harmful algal blooms

• Potential information to consider when conducting a system-specific evaluation:
  – Evaluation of source waters at or near the intake:
    • Source Water Characteristics
    • Water Quality Parameters
    • Source Water Assessment Information
    • Climate and Weather Information
    • Land Use
    • Nutrient Levels
Step 2: Preparation and Observation

Preparation

• Potential actions to consider if a system is determined to be vulnerable in Step 1:
  – Determine when (e.g., which seasons) systems are most vulnerable to HABs
  – System Evaluation
    • Assess status of treatment plant prior to harmful algal bloom season
      – If source water is vulnerable and existing treatment is not sufficient to remove cyanotoxins from peak blooms, evaluate whether supplemental treatment (e.g., coagulant) might be needed during bloom season, or
      – If source water is vulnerable and existing treatment is frequently challenged by cyanotoxins, consider whether long-term treatment enhancements are needed
Step 2: Preparation and Observation

Preparation (Cont’d)

– Monitoring
  • Prepare for possible future cyanotoxin monitoring by ordering necessary lab materials for screening tests or setting up contracts with outside labs

– Communication
  • Establish partnerships with primacy agencies, state, and local public health officials
Observation

• Key observation objective: Identify potential cyanotoxin occurrence in source and raw water

• 3 Key Potential Observations:
  1. Visual: Visually confirm the presence of a bloom at intake structure or confirm public reports of blooms near raw water intake
  2. System effects: Track changes in treatment plant operations, water quality parameters, etc.
  3. Indicators: Indicator occurrence in source water and raw water at intake
Step 2: Visible Observation of Blooms

• Potential actions to consider when assessing/collecting information on visible blooms (note, not all blooms are visible):
  – Location: Identify locations to monitor for presence of blooms and implications for the PWS (e.g., a bloom near a raw water intake vs. a bloom 50 meters away from an intake)
  – Evaluate whether the public can assist with collecting information on blooms
Step 2: Observation of System Operation

- Potential actions to consider when assessing/collecting information on changes in system operations:
  - Examine raw water quality parameters (e.g., pH changes, turbidity)
  - Evaluate potential treatment changes (e.g., shortened filter run times, increased chlorine demand, etc.)
  - Investigate consumer complaints (e.g., taste and odor concerns)
  - Communicate with nearby/upstream systems (e.g., blooms in source water or cyanotoxin occurrence in their raw water)
Step 2: Observation of HAB Indicators

- Information available on indicators of system vulnerability to HABs
  - Examine available data to determine if there has been an increase in nutrient concentrations (nitrogen or phosphorus) in source water
  - Examine other source water indicator data (pH, temperature, cyanobacterial cells, chlorophyll a levels, phycocyanin, phosphorus, nitrogen)
  - Participate/organize watershed monitoring programs collecting source water indicator data
  - Seek out secondary data on bloom occurrence in source water (e.g., satellite remote sensing, local or regional program surface water monitoring data) and information on intake characteristics
Steps 3-5: Monitoring, Treatment Adjustments, and Communication

• Key objectives:
  – Determine if cyanotoxins have reached or are likely to reach the raw water
  – Determine the effectiveness of cyanotoxin removal via drinking water treatment operations
  – Adjust or consider additional treatment to reduce risks from cyanotoxins in drinking water (as appropriate)
  – Confirm whether cyanotoxins are detection in finished water (as appropriate)
  – Reduce risks from cyanotoxins in drinking water
  – Inform the public of the need to take actions to reduce their risks
• Cyanobacterial blooms can cause water quality problems
  – Potentially producing cyanotoxins
  – Increasing solid loading
  – Increasing natural organic matter (NOM)
  – Producing unpleasant tastes and odors (T&O)

• Treatment strategies for cyanotoxins must also consider other treatment objectives
  – Turbidity removal
  – Disinfection
  – Disinfection by-products (DBPs) control
  – T&O control
  – Corrosion control
Two parts:

1. Template
   • Framework for public water systems (PWSs) to inform the development of their own cyanotoxin management plans as they deem appropriate

2. Five example cyanotoxin management plans
   • Examples from five partner PWSs representing diversity in system characteristics and geography
Cyanotoxin Management Plans: 5 Steps

1. Assess Source Water
2.1: Preparation
   - Begin any preparation, as needed, for monitoring, treatment and communication.

2.2: Monitoring the Early Warning Signs
   - Are there signs of a bloom or cyanotoxin occurrence?
     - Yes
     - Step 2.3: Immediate Actions if a Bloom is Suspected
       - Begin monitoring, communication, and source water mitigation actions.

3. Raw Water Cyanotoxin Monitoring and Treatment Adjustments

4. Finished Water Cyanotoxin Monitoring and Treatment Adjustments
   - Were toxins detected?
     - Yes
     - Step 5: Continued Finished Water Cyanotoxin Monitoring, Treatment Adjustments, and Public Communication
       - Continue monitoring, treatment, and communication activities as needed. Return to previous steps as appropriate.
     - No
       - Continue evaluating for possible bloom occurrence (Step 2.2).

5. If No, return to previous steps as appropriate.
Executive Summary
- A brief overview of the system and its source waters

Five step process
- Step 1: Assess Source Water
- Step 2: Preparation, Monitoring for Early Warning Signs and Immediate Actions
- Step 3: Raw Water Cyanotoxin Monitoring and Treatment Adjustments
- Step 4: Finished Water Cyanotoxin Monitoring, Treatment Adjustments
- Step 5: Continued Finished Water Cyanotoxin Monitoring, Treatment Adjustments and Public Communication

Long-term activities to prevent and mitigate impacts of blooms and cyanotoxins on drinking water
In order to provide a broad range of example plans, we partnered with five PWS treatment plants in different systems. In identifying partners, we considered:

- The previous history of harmful algal blooms in PWS source waters
- Variety of system sizes
- Variety of locations
  - Systems not using the same watershed
  - Different regions of the U.S.
- Variety of source water types (i.e. lakes/reservoirs, rivers)
- Variety of treatment (i.e. such as conventional treatment, GAC, capability of using PAC, pre-oxidation)
EPA’s Goals for Managing Risks of HABs in Drinking Water

- **Improving scientific understanding** of HABs and cyanotoxin production to better predict their occurrence;
- **Protecting human health** by identifying human health effects of current and emerging cyanotoxins;
- **Providing necessary technical assistance** to utilities so they can provide safe drinking water through effective HABs and cyanotoxin treatment in finished water;
- **Preventing HAB formation** with effective source water protection efforts and nutrient reduction strategies at the watershed scale.
Contact Information

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CyanoHABs website:
https://www.epa.gov/cyanohabs

Cyanotoxins in Drinking Water website:
https://www.epa.gov/ground-water-and-drinking-water/cyanotoxins-drinking-water