CYANOTOXINS IN DRINKING WATER

PREPARED BY CWWA DRINKING WATER QUALITY COMMITTEE

Purpose of this Info-Sheet

This information sheet was prepared by the CWWA Drinking Water Quality Committee to address concerns about the potential for cyanotoxins in drinking water. This sheet is intended to provide general information to CWWA members, while also referencing more detailed sources of information that will help members and their associated utilities prepare their own responses to questions about cyanotoxins that they may encounter from their customers, municipal leaders, political leaders, media, and other concerned stakeholders.

CWWA INFO-SHEET

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Background on Cyanotoxins

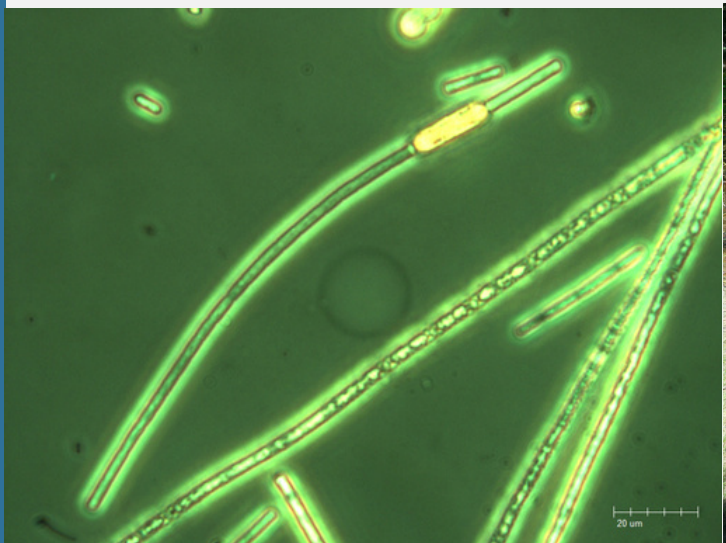
Cyanotoxins are toxins produced and stored in the cells of cyanobacteria, commonly known as blue-green algae. Exposure to cyanotoxins occurs primarily through surface-source drinking waters and during recreational water activities, such as swimming.

Cyanotoxins are harmful secondary metabolites produced by certain cyanobacteria that proliferate typically in nutrient-rich and warm surface waters. Cyanobacteria are among the oldest known life forms on Earth, with fossil evidence indicating they emerged more than 3 billion years ago. These microorganisms can form dense blooms when conditions such as high phosphorus and nitrogen, elevated temperatures, and strong sunlight align. The cyanotoxins of greatest concern for drinking water include microcystins, anatoxins, saxitoxins, and cylindrospermopsin - each with distinct toxicological profiles.

Cyanobacteria can produce toxins through natural biochemical pathways encoded in their genomes both within intact cells and as dissolved compounds. Toxin levels can shift rapidly as bloom conditions change. Environmental factors such as nutrient availability, light, temperature, and biological competition can “switch on” or intensify these biosynthetic pathways and strongly influence toxin production and bloom behaviour. As cyanobacteria blooms grow or collapse, toxins may remain inside intact cells or be released into the surrounding water, causing concentrations to shift rapidly. Climate change and increasing nutrient loads are expected to intensify cyanobacteria bloom frequency and severity, elevating long-term risks for public health. As a result, cyanotoxins are now recognized as an emerging contaminant requiring proactive monitoring and clear response protocols to protect public health.

Health Risks from Cyanotoxins

Health impacts range from gastrointestinal illness to liver and neurological damage, depending on toxin type and concentration. Note that the presence of cyanobacteria can also produce taste and odour causing compounds. Taste and odour in drinking water is not specifically addressed in this information sheet.



Additional Sources of Information on Cyanotoxins

Our understanding of the environmental and health effects associated with cyanotoxins continues to evolve as new research emerges. To stay up-to-date, note the publication date of reference materials and be sure to reference the most up-to-date versions.

- Guidelines for Canadian Drinking Water Quality Cyanobacterial Toxins
- Guidelines for Canadian Recreational Water Quality - Cyanobacteria and their Toxins
- Public Health Ontario Facts on Cyanobacterial Toxins in Drinking Water
- Summary of Cyanotoxins Treatment in Drinking Water | US EPA
- Cyanobacteria and Drinking Water- Occurrence Risks Management and Knowledge Gaps for Public Health
- Algues bleu-vert (French) (Gouvernement du Quebec)

Health Canada Activity on Cyanotoxins

In 2017, Health Canada established a seasonal guideline maximum acceptable concentration (MAC) of 0.0015 mg/L (1.5 µg/L) for total microcystins in drinking water. The guideline value was determined through an assessment of identified health risks and in consideration of limitations in analytical methods and treatment technologies. Guidelines are not established for other cyanotoxins, including anatoxin-a and cylindrospermopsin, as health and exposure data on these toxins are limited. Canadian data indicates that exposure to microcystins from municipally-treated drinking water supplies generally occurs over a short duration - this is because algal blooms are seasonal (typically spring to fall) and generally short in duration (usually lasting less than 30 days). Some water sources have experienced an increase in cyanobacteria bloom frequency, severity and duration likely due to impacts of climate change and increasing nutrient loads. The MAC is consistent with the duration and exposure scenarios for microcystins in Canadian drinking water during a typical cyanobacterial bloom season. The MAC is based on health effects in adults and considered protective of all Canadians. The Health Canada objective document can be accessed via the following link: Guidelines for Canadian Drinking Water Quality Cyanobacterial Toxins

Although not directly related to municipal drinking water systems, in 2022 Health Canada also published Guidelines for Canadian Recreational Water Quality for Cyanobacteria and their Toxins. This technical document provides guideline values for specific parameters used to monitor water quality hazards, and recommends monitoring and risk management strategies. These guidelines may be a useful reference for utilities and can be accessed via the following link: Guidelines for Canadian Recreational Water Quality - Cyanobacteria and their Toxins

Note that the Guidelines for Canadian Drinking Water are developed by the Federal-Provincial-Territorial Committee on Drinking Water and published by Health Canada – while the provision and regulation of drinking water fall under provincial jurisdiction and regulatory enforcement. These federal guidelines are considered by the provinces and territories as they each establish their own water quality guidelines and regulations.

Water Quality Monitoring

Utilities should develop an appropriate cyanobacteria and cyanotoxins monitoring, assessment and response strategy for their source water and treatment system. A combination of observations, screening tools, and analytical testing provides the most robust framework for assessing algal bloom risk and quantifying toxin concentration in a drinking water source. A progressive strategy includes the following:

Visual Observations and Water Quality Monitoring: Making regular visual observations at the source and/or throughout the treatment plant is a good practice to help identify blooms or conditions that could be indicative of algal activity. Visual observations can be used as an immediate, inexpensive, early warning indicator of algal activity and can trigger the escalation of targeted sampling and additional monitoring. Sudden shifts in raw water quality, including changes in raw water organic matter, increases in pH, turbidity and temperature can also be used to inform the need for further sampling.Similarly, sudden required changes to process chemistry or operation can also be indicative of the need for further sampling and investigation. Impacts on the treatment process may include increased chlorine demand, increased coagulant demand, and/or decreased filter efficiency. Operators may need to respond by increasing chlorine and/or coagulant dosing as well as increasing the frequency of filter backwashing and rinsing/washing of screens.

Screening Indicators: Screening indicators offer an early warning of cyanobacterial growth and rising algal bloom risk. These indicators can be measured either in situ or from grab samples collected directly from the source. They include pigment-based metrics that help assess cyanobacterial biomass, microscopic analyses that characterize cyanobacterial types, and genetic screening tools that detect total cyanobacterial presence as well as specific toxin-producing genes.

Quantitative Toxin Measurement: Various methods are currently available for quantitative toxin measurement - each offering different levels of sensitivity, specificity, and practicality for in-house or external testing. Screening methods that can be completed in-house include ADDA ELISA and rapid test strips (e.g., ABRAXIS). More advanced and accurate analytical methods include Liquid Chromatography coupled with Tandem Mass Spectrometry (LC/MS/MS) as well as quantitative molecular methods for toxin production genes (qPCR). Any analysis of your water supply for cyanotoxins should be completed by an ISO/IEC 17025:2017 accredited laboratory.

Additional details on developing an appropriate cyanobacterial bloom monitoring and action plan, as well as additional details on quantitative methods for the analysis of cyanotoxins in water, are outlined in the Health Canada guideline technical document: Guidelines for Canadian Drinking Water Quality Cyanobacterial Toxins

What Water Utilities Can Do:

As the science around cyanotoxins and related guidelines continue to evolve, there are several steps that water utilities in Canada may want to consider. These include:

Understand the issue: Become familiar with the risks and concerns around cyanotoxins and the background information in the various sources cited above.

- Share accurate information: Be prepared to answer questions from customers and municipal leaders, politicians, and other stakeholders on cyanotoxins and related topics (e.g., harmful algae blooms). This may include preparing media briefs.
- Know your source: Confirm the minimum relevant monitoring requirements for your jurisdiction and your water source. This may include, for example, developing and implementing a harmful algal bloom monitoring and sampling program. Health Canada recommends that visual monitoring of source waters for evidence of increasing algal bloom development be conducted routinely. Samples can also be collected for analysis if an algal bloom is detected or suspected through visual inspection.

What CWWA Drinking Water Quality Committee is Doing:

- Monitoring updates to guidance and guidelines related to cyanotoxins in drinking water
- Communicating routinely with Health Canada experts on this topic
- Providing current information and reference to additional sources of information to our membership to enhance understanding of this topic and provide support in communicating this topic to stakeholders