

WSA 512 Cyanotoxin/Microcystin Fact Sheet

What are Cyanotoxins and Microcystins, and where do they come from?

Cyanotoxins comprise a large group of naturally occurring toxins that may be present in surface waters. The toxins are formed by ubiquitous aquatic species of photosynthetic bacteria called cyanobacteria (also referred to as blue-green algae), and are generally produced and stored within the bacterial cells. When the cells rupture and die, the toxins are released into the surrounding water where they pose a potential threat to human health. Importantly, the presence of cyanobacteria does not necessarily mean that cyanotoxins are being produced. Multiple species of cyanobacteria may be present in a cyanobacterial “bloom” (a bloom is visual evidence of rapid, excessive growth of cyanobacteria), but not all species produce harmful toxins and of those that do, certain environmental conditions are required for toxin development. Microcystins are water-soluble toxins that do not readily break down, even during boiling, and are the most prevalent, best studied group of cyanotoxins. The Water Research Foundation has produced a [short you-tube video that provides a good overview of the cyanobacterial problem](#).

What are the human health risks associated with microcystins?

Microcystins are liver-damaging toxins that resist degradation through natural biological and chemical means in the environment. There are currently believed to be more than 160 variants of the toxic microcystin peptide, with the identity of each being

related to two variable amino acids in the structure of the peptide. Worldwide, the most commonly observed of these is the microcystin-LR variant. Across Canada, these toxins have been associated with freshwater algal blooms, and may reach quite high concentrations. The toxins interfere with biological processes within the human liver that may cause liver cells to collapse, leading to liver bleeding, liver damage, and potentially liver failure and death. In drinking water, toxin levels >1.5 $\mu\text{g/L}$ are considered dangerous.

Source Water Management

A good understanding of the local source water allows a waterworks owner/operator to understand the conditions that may precede a potentially troublesome cyanobacterial bloom. Depending on the source water, blooms may be associated with increases in water temperatures, the beginning of thermocline destratification (turnover), a substantial rain event, or a series of sunny days. Active monitoring and recording of source water conditions is, therefore, recommended to help predict blooms. Where possible, controlling nutrient levels within the source water has been shown to be the most effective means of controlling the growth of cyanobacteria in surface water sources. However, for many Saskatchewan operations, this is impractical. Algaecide applications may also not be the most effective approach to reducing cyanotoxins. This is because the algaecide may cause the cyanobacteria to break open, releasing cyanotoxins; however, algaecides are often used in certain circumstances. Although cyanobacteria may be unevenly distributed, both vertically and horizontally, within a surface water body, the Water

Security Agency currently recommends sampling of source waters for cyanotoxins after the visual detection of a bloom.

Surface water treatment

Fortunately, commonly employed surface water treatment methods are effective at removing cyanotoxins from municipal water supplies. To remove both intracellular and extracellular microcystins from drinking water, a multi-barrier approach is required. For intracellular microcystin removal, conventional filtration, involving coagulation, clarification, and rapid granular filtration can be effective for removing intact cells and the majority of intracellular toxins. However, clarifiers should be monitored to ensure that cyanobacterial cells are not accumulating and possibly leading to their breakthrough into filtered water. Conventional filtration is ineffective for removing extracellular microcystins that are dispersed in the water. To effectively remove these, an absorption process may be employed, such as the use of granular activated carbon or powdered activated carbon. Chemical oxidation using chlorine, potassium permanganate, or ozonation can also be effective at removing dissolved microcystins. In operations where peroxidation is practiced, it may need to be discontinued during a bloom (or adjustments to the oxidant type and doses) to minimize cell rupture during filtration.

Membrane processes can also effectively remove microcystins. Microfiltration and ultrafiltration are generally better at removing intracellular microcystins. However, reverse osmosis and nanofiltration processes are effective at removing both intra- and extracellular microcystins.

Microcystin levels in water

A variety of methodologies are available for detecting and quantifying microcystin levels in water. An enzymatic detection method, such as an enzyme-linked immunosorbent assay (ELISA) test kit, is an appropriate screening methodology. Depending on population size, communities relying on surface water sources of drinking water are required to sample for

microcystins on a permit-defined basis. As a first step, analysis of the source water at the point at which it enters the plant (levels near the banks of the source may not be representative) is appropriate. Depending on specific permit to operate requirements, periodic samples will be submitted for microcystin level determinations. Sampling should be conducted according to the instructions provided by the accredited laboratory performing the analysis. If the detected concentration is $>1.5 \mu\text{g/L}$ (0.0015 mg/L), the treated water will need to be tested (see Figure 1). If levels $>1.5 \mu\text{g/L}$ are confirmed in the treated water, a “do not consume” advisory will be issued by your Environment Project Officer (EPO) and additional testing will be required. Please notify your EPO as soon as possible of all results $>1.5 \mu\text{g/L}$. Communities relying on surface water for their drinking water, especially if the source water is known to be subject to algal blooms, are recommended to include a microcystin response procedure in their Quality Assurance/Quality Control documentation.

Further information

Further information is available in the Water Research Foundation’s [“Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals”](#).

Microcystin (MC) testing recommendation

1



Continue to visually monitor for bloom formation throughout season

2



Bloom is spotted
Signs of bloom potentially affecting intake? If yes, sample source water at the point where it enters WTP and analyze for total MC.

3



Is total MC concentration >1.5 $\mu\text{g/L}$?
If yes, sample treated water, analyze for total MC and alert your EPO.
If no, continue to monitor for blooms.

4



Is total MC concentration >1.5 $\mu\text{g/L}$?
If yes, re-sample and re-analyze treated water.
If no, re-sample and re-analyze treated water.

5



Is total MC concentration >1.5 $\mu\text{g/L}$?
If yes, notify WSA.
Do not consume.
Advisory will be issued.



Notify WSA. Do not consume. Advisory will be rescinded.

