1. Overview

Ponds, lakes, streams, and estuaries may take on unusual appearance and color—greens, reds, and browns are common—due to suspended algae or cyanobacteria. This document has been specifically developed to address accumulations of cyanobacteria because of their frequent occurrence in water bodies and the ability of some species to produce toxins that are harmful to humans and animals.

Cyanobacteria are photosynthetic organisms that live in a wide range of aquatic and terrestrial environments. Many forms are microscopic and live in the water column or at the bottom of freshwater aquatic systems such as lakes, reservoirs, and streams. Most of the time they go unnoticed.

Cyanobacteria play an important role in aquatic ecosystems. They provide food and oxygen and may also bring nitrogen into systems where it is in short supply. Under certain environmental conditions such as still water, abundant sunlight, high temperatures, and excess nutrients, cyanobacteria can grow, accumulate, and become extremely abundant. These dense populations are known as *blooms*. We use the term *harmful cyanobacterial blooms* (HCBs) to refer to these accumulations of potentially toxic cyanobacteria. They are also called *harmful algal blooms* (HABs) or *cyanoHABs*.

HCBs may produce potent toxins, referred to as *cyanotoxins*. For this reason, HCBs are a concern to human health, animals, aquatic ecosystems, and the economy. HCBs can negatively impact drinking water systems and water supplies, recreational uses, commercial and recreational fishing, and property values. These effects often mean that immediate response and communication are very important. In some cases, physically disrupting or removing the HCB might be appropriate. In others, natural decay and dispersal makes more sense. In all cases, the potential for the release of cyanotoxins inside the cells (intracellular toxins) into the water (extracellular toxins) must be considered. Once the blooms subside, you can consider how to reduce the magnitude, frequency, and extent of HCBs in the future.

1.1 Our Goals in Developing this Guidance

Many water resource plans now include cyanobacteria prevention and management as a high priority. In the federal, state, academic, and private sectors, development of solutions to address HCBs in water bodies have been long underway. This guidance is focused on strategies that you may use in response to cyanobacterial blooms that are found in freshwater aquatic environments, including lakes, streams, rivers, reservoirs, ponds, and freshwater-influenced estuaries.

Furthermore, the guidance is intended to help you select monitoring, excess nutrient reduction, management, and communication approaches that may be suitable for use in your water body. The guidance also highlights the need for rapid response and identifies important information and tools that can be used when time is critical.

In this document, *prevention* is defined as proactive steps that you can take to make it more difficult for cyanobacteria to grow (for example, reducing excess nutrients in water bodies). *Management* is defined as a physical intervention of ongoing HCBs. Water body characteristics, environmental triggers, and human activities must all be considered in order to use prevention and management strategies successfully. Monitoring is key to characterizing the health risk, communicating the severity of risk, and evaluating whether response and management strategies have been successful. Consistent, informative, and effective communication helps protect your community and builds support for implementation of your HCB management plan.

Our document covers the following topics:

1.1.1 Introduction to Cyanobacteria – Section 3

Cyanobacteria are found in most aquatic ecosystems and may be present in terrestrial ones as well. The introduction discusses the important roles cyanobacteria have in ecosystems and key aspects of cyanobacteria ecology that may be influenced by management approaches. We also include an overview of the human and animal health impacts that may occur from exposure to cyanobacteria and resources that will help you learn more about these topics.

1.1.2 HCB Monitoring – Section 4

Data on cyanobacteria populations and the presence of cyanotoxins are needed to better understand current conditions and trends over time. Your monitoring approach should organize your efforts, meet your data needs, and support your response strategies. This Section includes common monitoring approaches and resources that may be useful as you develop a cyanobacteria or cyanotoxin monitoring program. We have also developed a simple tool and metrics to help you decide which monitoring approaches may be suitable for your water body and monitoring budget.

1.1.3 Strategic Communication and Response Plans – Section 5

How you respond to and communicate information about HCBs is important. You should share observations and results from testing or monitoring with your partners and the public in a uniform and consistent way. Your results should also be incorporated into broader actions at the local, state, and regional level for better overall communication about HCBs and potential HCB-related illnesses. Section 5 provides a framework to help you identify key partners, determine which tasks are important to do during HCB events and those that can be postponed, and build a strategic communication and response plan for HCBs. Examples of existing plans and communication approaches are shared throughout the Section so you can see how other states and regions respond to HCBs.

1.1.4 HCB Management and Control Approaches – Section 6

Although the ultimate goal of lake management is bloom prevention, sometimes it may be appropriate to manage active HCBs by physical or chemical control. This Section focuses on strategies for cyanobacterial management in water bodies. Due to the large number of potential approaches, this Section includes a summary of peer-reviewed studies, history of use, a cost estimate, and a general explanation of how the technique works to control cyanobacteria. This information is shared in fact sheet format for easy download. We also provide a tool that helps you compare strategies and select those that may make sense for your water body.

1.1.5 HCB Prevention Through Nutrient Reduction – Section 7

Water quality protection and restoration has focused on nutrients for decades. Limiting nutrients like phosphorus and nitrogen that serve as food for cyanobacteria is key to reducing future HCBs. Land use activities are very important sources of nutrients that may eventually reach surface waters. Section 7 includes a review of common nutrient management approaches used in agricultural, forest, urban or suburban, and rural environments. Our summary graphic organizes nutrient management approaches by land use sector and may help you identify areas that warrant investigation in the watershed surrounding your water body. This Section also includes resources and examples of nutrient reduction strategies in use across the United States and elsewhere.

1.1.6 Recommendations – Section 8

Our understanding of cyanobacteria ecology, the production of cyanotoxins, and the triggers that encourage HCBs continues to evolve. There are many unanswered questions and a lot of research underway. New approaches to control HCBs in the water or catch nutrients flowing off the land are in development. This Section includes information gaps and needs identified during the development of this guidance document, as well as recommendations that will inform and support future management of HCBs.