Through the creation of this guidance, the Benthic HCB team has identified several information gaps and research needs related to benthic HCBs. In this section, we provide a series of recommendations for policy makers, researchers, states, and others that will inform and support future monitoring, response, management, and prevention of HCBs and that build on the recommendations in Section 8 of HCB-1 (ITRC 2021).

We have several overarching recommendations:

- Develop a common language to be used by all involved in HCB management and response. The common language should be applied to identifying cyanobacteria, describing prevalence or abundance of cyanobacteria, defining events of concern, and taking protective actions.
- Establish a national HCB freshwater response, management, and control planning structure like that which exists for the marine ecosystem. The funding and coordination such a structure brings would tremendously expand future management and response to HCBs that threaten our water resources and public health, especially as we seek to understand the implications of a warming planet. The need for a national freshwater HCB response structure is currently being discussed for inclusion in the national, multiagency Harmful Algal Research and Response National Environmental Scientific Strategy (HARRNESS).
- Better understand how drinking water source waters are affected by cyanotoxins produced in benthic mats.
- Continue to identify, characterize, and assess the impacts of cyanobacteria and cyanotoxins on drinking water treatment. Areas of specific interest include:
    - appropriate treatments for emerging cyanotoxins
    - effect of cyanotoxin treatments on other aspects of drinking water treatment
    - disinfection by-products and degraded cyanotoxin compounds
    - guidance for homeowners and small facilities on appropriate treatments for HCBs and cyanotoxins
    - development and certification of cyanotoxin removal efficiency for cyanotoxins in drinking water treatment systems ranging from private home systems to portable backpacking filters

The team has several more specific recommendations to offer.

6.1 Cyanotoxin-related (Applicable for Planktonic and Benthic Sources Unless Specifically Noted)

- Develop estimates of exposure of humans to benthic cyanobacteria, including incidental ingestion of mat material during water recreation and potential hand-to-mouth behavior of children with stranded mat material.
- Continue to research the human health impacts of ingestion, inhalation, and dermal exposure to cyanobacteria, cyanotoxins, and cyanopeptides.
    - Conduct critical assessments of toxicities of known and emerging cyanotoxins, cyanopeptides, and other cyanobacteria compounds to inform health advisory guidance.
    - Conduct research on additive, synergistic, and chronic effects of exposure.
    - Continue to research the impacts of cyanobacteria and cyanotoxins on domestic animals.
- Develop a greater understanding of the movement of cyanotoxins through the environment and food web (such as by species or trophic level) and predictors based on concentrations observed in the field. It is also important to understand how timing and succession of the HCB taxa and cyanotoxin production may affect organism accumulation and depuration. Specifically:
    - Fish and shellfish: Learn more about factors that affect the uptake and fate of cyanotoxins in fish and shellfish tissue, including whether biomagnification occurs, accumulation in muscle tissue versus organs, and trophic-level differences.
    - Plants and fruit: Learn more about the uptake and fate of cyanotoxins in food crops and agricultural soils.
    - Human consumption of livestock and wildlife: Learn more about the uptake and fate of cyanotoxins in animal-based foods.
    - Irrigation and nonpotable waters: Learn more about how cyanotoxins may move through water distribution systems, how irrigation system type (for example, drip versus spray) may influence exposure, and persistence of cyanotoxins within the system.
- Continue work developing national advisory levels and health guidance for cyanobacteria and cyanotoxins.

6.2 Monitoring-related

- Continue to develop and validate genetic primers for cyanotoxin biosynthesis genes, including benthic and planktonic species. For example, lyngbyatoxin- and guanitoxin-producing potential. This allows determination of the potential for cyanotoxin production in the absence of actual cyanotoxin production.
- Develop and make widely available analytical chemical standards for additional cyanotoxins (e.g., guanitoxin) and metabolites (e.g., glutathione derivatives).
- Develop a standardized reporting metric for benthic cyanobacteria to allow spatial and temporal comparisons.
- Develop standardized collection methods for benthic cyanobacteria to build consistency and consensus in data across the world.
- Continue to support the development of rapid field tests for cyanotoxins, particularly those that may detect multiple cyanotoxins.
- Continue to support development of remote sensing technologies for benthic cyanobacteria, potentially building off satellite methods currently used for the filamentous green alga *Cladophora* sp. or using submersible sensors.
- Continue researching the ecology of benthic cyanobacteria to improve understanding and predictions about what causes benthic proliferations to occur.

6.3 Management-related

- Publish case studies of treatment successes and lessons learned for benthic cyanobacteria management techniques.

6.4 Communication-related

- Develop programmatic outreach and education for drinking water utilities to understand the potential of benthic cyanobacteria to impact drinking water, particularly in drinking water sources with high water clarity.
- Develop guidelines for homeowners and others who use private drinking water sources, particularly with direct water body intakes, to assist them in determining appropriate protective actions to take before, during, and after HCB events.
- Develop recreational communication resources for cyanotoxins produced by benthic cyanobacteria.