August 20, 2020

David Ross
Assistant Administrator, Office of Water
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code: 4101M
Washington, DC 20460

Attention: Docket ID No. EPA-HQ-OW-2019-0675
Re: *Draft Ambient Water Quality Criteria Recommendations for Lakes and Reservoirs of the Conterminous United States: Information Supporting the Development of Numeric Nutrient Criteria* ("Draft LNNC")

Dear Assistant Administrator Ross:

The Association of Clean Water Administrators (ACWA) and the Association of State Drinking Water Administrators (ASDWA) are nonpartisan organizations representing the voices of state and territorial ("states") clean water and drinking water agencies. As the primary entities responsible for carrying out Clean Water Act ("CWA") and Safe Drinking Water Act ("SDWA") programs on a daily basis, we are obligated as provided in CWA Section 304(a) to consider the Draft National Recommended Numeric Nutrient Criteria for Lakes ("Draft LNNC") when final. We comment here with particular interest in the possible use of the finalized Draft LNNC to protect recreators, aquatic life, and drinking water sources from excessive nutrients and harmful algal blooms (HABs) that have the potential to adversely impact human health and drinking water treatment processes and costs. Therefore, states are keenly interested in the science and technical approaches used in the Draft LNNC.

In partnership with the U.S. Environmental Protection Agency (EPA), states have committed to support nutrient management in waterbodies around the United States. States appreciate the assistance that EPA has provided in support of regulatory and non-regulatory tools to track, manage, and mitigate the effects of nutrient pollution, including hypoxia, stressed or reduced populations of key aquatic species, proliferation of algal biomass with public health, aesthetic, and cost implications, and reduced opportunities for recreation in our nation's communities. Many states have made significant progress in implementing narrative and numeric nutrient criteria, and targeted watersheds are demonstrating the benefits of such efforts. We applaud EPA for releasing the Draft LNNC, which states view as a major step forward in managing nutrient concentrations and interrelated parameters of concern in lakes and reservoirs. ACWA and ASDWA believe it is appropriate for EPA to develop risk-based modeling approaches that account for the complexities of food web connectivity. Coupling this approach with new data and the latest science on nutrient management addresses the site-specific nature of the lakes and reservoirs that Americans rely on for recreation, aquatic life resources, and drinking water.

EPA began updating its recommended approach for deriving numeric nutrient criteria for lakes and reservoirs after establishing a reference-percentile approach that employed a simplified representation of lake dynamics using then-available data and geographic homogeneity. Since then, EPA has invested resources into the National Lakes Assessment (NLA) to gather more comprehensive data on lake and reservoir composition and quality. EPA integrated this data, and emerging science, to develop a Bayesian (probabilistic) approach to numeric nutrient criteria. The models potentially provide states with a tool yielding probabilistic understanding of their lakes and reservoirs and a method of deriving numeric criteria that will support states meeting their water quality standards goals. We appreciate EPA for their efforts and for reaching an important milestone in the development of nutrients management approaches.

In comments dated June 26, 2020, we requested additional time and support from EPA to allow state review and comment on the Draft LNNC. We would like to thank EPA for granting a 30-day comment extension and for EPA staff providing two webinar overviews of the Draft LNNC in early July, as well as for their responsiveness to states who have contacted EPA directly about specific aspects of the Draft LNNC. Please bear in mind that ACWA, ASDWA, and individual states may identify further questions about the Draft LNNC after August 20th, and we hope EPA will remain responsive and earnest in working with states to address these inquiries.

Nonetheless, states have many clarifying questions and concerns. Foremost, that the Draft LNNC may impact the progress of ongoing or planned nutrient criteria implementation, particularly where states have already adopted numeric criteria. Absent a clear description of the modeling assumptions employed, states are concerned that implementing the provided methodology could result in adverse outcomes, and also question whether EPA will be able to fully support those states seeking to integrate the modeling into their lake/reservoir and nutrient management approaches. The materials provided make it difficult to assess whether the Draft LNNC may excel or underperform towards EPA’s stated objectives, or if the approach EPA has selected may yield unintended consequences.

We must reiterate—as mentioned in our prior comments dated June 26, 2020—that states and EPA are presently operating in an environment of unprecedented change and constraints. This reality has rendered review of the Draft LNNC difficult. It is our shared view that affirming the scientific and technical approaches in the modeling is central to its efficacy and success. Addressing specific concerns about the Draft LNNC and the related materials necessary for its implementation will help make it a useful tool into the future. We urge EPA to collaborate closely with ACWA, ASDWA, and individual states to maintain dialogue, address concerns identified in these comments and elsewhere, and work together towards an effective and implementable Final LNNC.

EPA Should Clarify the Nature of the Draft LNNC

During the limited review that states have been able to conduct to date, a consensus concern has been how EPA describes the nature of the publication. 40CFR§ 131.11 (b) provides that states should (1) establish numerical values based on (i) 304(a) Guidance or (ii) 304(a) Guidance modified to reflect site specific conditions. In the past, this has led EPA to provide recommended criteria values, even if derived from advanced statistical techniques commensurate with available science. However, the Draft LNNC represents one methodological approach, among several existing approaches, that could be used to derive numeric nutrient criteria and related parameters. Providing a methodology for deriving a value (a methodology that may change, along with the resulting criteria values, as additional data becomes available and models are iteratively improved) is not the same as providing criteria values. However, the text provided leads readers to conflate the Draft LNNC with a national recommended criteria.

Other recent, model-based criteria published under 304(a) have included criteria values for the parameter addressed, making the Draft LNNC a distinctly precedent-setting "304(a) Recommendation." Traditionally, criteria values have been evaluated based on best available science—in tandem with CWA goals and requirements—rather than a selected methodology or approach in conducting that work. So, if states choose not to adopt the Draft LNNC, must they prepare a scientifically defensible case defending their choice not to adopt a recommended methodology? This would establish a potentially labor-intensive precedent and should be carefully considered by EPA.

> **Recommendation: EPA should explicitly state that it has published information and guidance for a methodology to derive numeric nutrient criteria, not national recommended criteria.**

EPA Should Continue Working with States Prior to Finalization

States have identified numerous general, technical, and specific questions related to the Draft LNNC. These are provided later in this comment letter, but one important example is:

Criteria Period: Growing season only, or all year?

The models are based on seasonal risks to human health and aquatic life and use trends and thresholds from the growing season to establish relationships that can be used to derive criteria values. However, it is unclear whether the Draft LNNC are applicable year-round or just seasonally, or whether criteria values could be applied as a state so chooses. States need to understand the applicability of tools like the Draft LNNC so they can identify the most appropriate means of managing lake and reservoir nutrients.

> **Recommendation: EPA should clarify whether the methodology in the Draft LNNC is to derive seasonal (i.e., growing season) criteria values, or are expected to provide criteria values that apply year-round, or whether some hybrid approach is allowed**. EPA should clarify the applicability of the recommended approach described in the Draft LNNC and the data that would best support intended applicability.

EPA Should Provide States the Model Code They Need, More-Accessible Model Formats, and Model Clarity

EPA has provided the model equations and the national models written in R. These purportedly are not to be used to incorporate state data. States are disappointed that versions enabling local data input, as EPA recommends the models be used and as states hoped to review them, were not provided. Nor were the models provided on other modeling platforms that may allow access across technology platforms. Inclusion of state data may require model adjustments, particularly to *a priori* assumptions, and these adjustments will be highly dependent on available data to be incorporated. Examining available data with states would help states and EPA understand what adjustments may be warranted and ensure usability across state technology platforms. As provided, states are unable to determine whether their information systems can integrate and operate the model approaches or verify that attempts to translate the model equations into other platforms have been achieved accurately. States appreciate EPA providing some related examples and technical resources in the current Draft LNNC, such as the hypoxia model's inclusion of Missouri data and the provisions and comments in the published R code. However, far more clarity and capability are required to support potential implementation.

Additionally, the provided R code is not the version used for the interactive model tool ("R Shiny App"). Of note, outputs for the microcystin and hypoxia models do not derive criteria values, but figures and a model fit that require additional code to yield a criteria value. Most of the models also do not set a random seed value for any unknown values, resulting in slightly different outputs when the model is run using the R code in comparison to the R Shiny App. <u>These technical limitations leave states unable to detect scientific or technical errors or inconsistencies, potential criteria values that are inconsistent with the objectives of the CWA or state law, or other issues of importance relating to the Draft LNNC</u>. Providing the equations associated with the national modeling is not helpful if states are unable to verify the results of the calculations.

> **Recommendation: Provide the code that states will need to incorporate their data and independently operate the models (for example, state-specific R code used in the appendices, as well as code used for the R Shiny Apps) prior to finalization of the Draft LNNC.**
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> **Recommendation: Set random seed value(s) across model runs and provide states the random seed value used in the R Shiny App and underlying code.** This will ensure consistency and reproducibility of the models across runs, whether conducted by states or EPA. This will be a critical aspect of the methodology's future use and scientific defensibility.

EPA Should Provide Targeted Support for Exploring or Adopting the Models

EPA has opportunities in the near- and long-term to support states use of the models, and address current uncertainties related to the models and their implementation. Below are specific forms of support and collaboration that EPA should consider, in tandem with the requests of individual states, that will aid state review and implementation of the Draft LNNC. These are elaborated further in the section "Detailed Comments" below.

a. Provide targeted training sessions to states.

b. Provide clearly outlined procedures and processes related to EPA providing support and collaborating with states to include their data.

c. Provide linkages to existing standards and models, to aid state understanding of how the form and function of the Draft LNNC methodology relates to existing approaches for deriving criteria for nutrients and other parameters implicated in the model.

d. Provide a data dictionary.

e. Publish Draft Technical Guidance prior to finalization, with explicit identification of points of subjectivity in site- or state-specific use or calibration of models, as well as the underlying statistical methodology(s).

f. Publish Draft Implementation Guidance prior to finalization.

Towards Numeric Nutrient Criteria

As provided, it will be difficult for states to consider or adopt the LNNC based on the proposed methodology. The recommended models will only be an effective step for CWA and SDWA programs if the models for the Draft LNNC can be evaluated using state data and if the document clearly explains the development and implementation of the models. At present, states cannot determine if or how the models will reflect and address site-specific conditions, state-specific nutrient management goals, and the protection of designated uses. Some states are especially concerned that the models have the potential to derive less-protective nutrient criteria than criteria currently established.

Some states may choose not to adopt the Draft LNNC methodology for scientifically defensible reasons. Others may be unlikely to adopt the Draft LNNC without a clear explanation of the criteria models and how to derive criteria values. Moreover, all states need to understand how applicable the Draft LNNC are for all lakes and reservoirs within the state. EPA can take concrete steps, as identified in these comments, to avoid uncertainty about the effectiveness of the methodology provided in the Draft LNNC. The National Water Program has established an important goal of supporting and increasing adoption of numeric nutrient criteria. Addressing the issues identified in these comments will be central to achieving that long-term objective.

Although ACWA and ASDWA's process to develop comments is comprehensive and intended to capture the diverse perspectives of the states that implement the CWA and SDWA, EPA should also consider all recommendations provided directly by states, interstates, territories, and tribes. We hope that EPA will continue to include states in discussions regarding the Draft LNNC, specifically with regard to EPA's review of all comments submitted during the public comment period, and the finalization of recommended supporting documentation and materials. We appreciate EPA's review of our comments above and our detailed comments below and remain eager to work with EPA on our recommendations and the Draft LNNC generally going forward.

We appreciate the opportunity to comment on the Draft LNNC and we look forward to continuing our discussions and work with EPA on this topic. Please contact Julia Anastasio, ACWA's

Executive Director at (202) 756-0600 or janastasio@acwa-us.org; or Alan Roberson, ASDWA's Executive Director at (703) 812-9507 or aroberson@asdwa.org with any questions regarding these comments.

Sincerely,

Tom Stiles
ACWA President
Director, Bureau of Water
Kansas Department of Health and Environment

Shellie Chard
ASDWA President
Director, Water Quality Division
Oklahoma Department of Environmental Quality

cc: Deborah Nagle, Director, Office of Science and Technology

Detailed Comments

States believe the Draft LNNC represents an opportunity to develop a new era of collaboration on numeric nutrient criteria for lakes and reservoirs (hereafter, "lakes"). EPA has opportunities to support states' use of the models by addressing the current uncertainties related to the models and their implementation. Below are several specific forms of support and collaboration that EPA should consider—in tandem with the requests of individual states—that will aid states in their review and implementation of the Draft LNNC. We also note unaddressed state questions and concerns that EPA needs to address and/or clarify, as well as detailed recommendations regarding specific aspects of the Draft LNNC relating to the applicable designated uses, model design, and the document as drafted.

EPA Should Provide the Following Targeted Support to Enhance States' Exploration and/or Adoption of the Models

Provide targeted training sessions to states.

Provide clearly outlined procedures and processes for EPA to provide support and collaborate with states to include their data.

States appreciate stressor/response models designed to encourage the use of national, state, and site-specific data. Effective nutrient management requires the ability to account for site-specific conditions, and the model offers states the potential to improve the precision of derived numeric criteria. Although states and EPA have partnered on nutrients management in the past, the level of complexity in the Draft LNNC leaves states unable to determine the requisite level of effort to derive LNNC using the recommended methodology, in addition to how appropriate and effective the resulting criteria values may be with respect to their nutrient management strategy. States need to be able to anticipate the work that will be required to calibrate the models using state- and site-specific data. EPA should work in collaboration with states and provide a procedure or detailed vision for collaborative refinement and application of the Draft LNNC prior to finalization. The level of detail and clarity currently provided in Section 4.2 Incorporating State Data does not sufficiently address state questions nor illustrate how an EPA and state collaborative process would work. This is one of the most important sections for state regulators—the primary audience of the document—but also one of the shortest in the document.

Provide linkages to existing standards and models to aid state understanding of how the Draft LNNC methodology relates in form and function to existing approaches for deriving criteria for nutrients and other parameters used in the model.

The current documentation does not provide details on how states will be able to "plug in" localized datasets to derive site-specific criteria values. Thus, states are unable to conduct a sensitivity analysis using site-specific data to evaluate which variables have the greatest effect on the derived criteria values. EPA can support states' evaluation of the Draft LNNC by linking the provided methodology to other existing methodologies. This will help states individually and collectively understand potential implications of Draft LNNC-derived criteria in relation to other methodologies and approaches – most importantly, those already operational.

Develop a data dictionary.

EPA can support states and their use of the Draft LNNC by providing a data dictionary for users of the code and app. This dictionary should explain the R scripts and input datasets, including field names and descriptions, contents, units, formatting for each field, along with abbreviations, ordering, and details necessary to process the R code and data files. EPA should also specify in a summary list the exact R packages and minimum R version required to run the scripts. Further, states will require all R code—not just the national model—necessary to work with the models. Without these, states cannot produce state-specific outputs based on scripts that are customized for their data. Although EPA has relied on an open-source software, R, to develop the models, they are currently considered "closed-source" because EPA has not provided the information necessary to work with them independently, or work with them such that EPA and states can be confident in independent deployment and calibration of the models.

Publish Draft Technical Guidance prior to finalization, with explicit identification of points of subjectivity in site- or state-specific use or calibration of models, as well as the underlying statistical methodology(s).

States believe that a technical guidance document further detailing the assumptions and functions of the model will promote a better understanding of the resultant criteria. This understanding has short and long-term implications. In the short-term, it is a prerequisite to full review and collaboration with EPA on the criteria; in the long-term, it is prerequisite to adoption. No state should be asked to spend taxpayer resources considering or adopting a methodology that is not usable, reviewable, or explainable due to a lack of materials. These and other reasons identified in these comments hamper states' ability to evaluate whether to implement the Draft LNNC prior to the next triennial review.

The narrative describing the model development discusses several junctures at which EPA used specific statistical techniques to address data gaps, reconcile data inconsistencies, and fit available data. Generally, the narrative names the statistical technique used, but does not explain why it was chosen and what assumptions underlie the choices made. For example, various distributions were modelled as normal or lognormal distributions (e.g., VOD as normal, DOC as a lognormal). What were the bases for these distribution assumptions, and what supporting statistical analyses were conducted to confirm the assumptions? EPA needs to clarify.

> **Recommendation: EPA should clearly explain the assumptions made, as well as the alternative approaches that were considered, but not chosen.** This will help users understand how the models reflect lake and aquatic life conditions, as well as help states and other users better understand what future assumptions may need to be made during implementation of any model-derived criteria. This will also facilitate collaboration between EPA and state partners when deploying the models.

During review, states have found that the R Shiny App does not appear as responsive or consistent in its outputs as indicated in the Draft LNNC. In some cases, multiple criteria values have been derived from the same inputs, and some users have experienced unresponsiveness in the critical features of the Shiny App, such as data plots. (Note: choice of internet browser appeared to have no effect on these apparent glitches.)

> **Recommendation**: **EPA should document all issues raised about the models/R Shiny App, whether these reflect inconsistencies in derived values, difficulty in using the App, or other limitations that required a fix or adjustment**. This will help users assess specific aspects of the models that may require attention during use of the models.

Publish Draft Implementation Guidance prior to finalization.

States greatly appreciate EPA's willingness to collaboratively consider implementation-related questions towards robust implementation guidance. Publishing this guidance—in addition to technical guidance—prior to the Final LNNC will help states understand what implementation-related questions remain unaddressed and if the derived criteria have issues in form, function, or implementation expectations. States cannot understate the importance of collaboratively developed, technically robust implementation guidance.

Drinking Water Use

EPA applied a risk assessment approach to link nutrient concentrations to the protection of drinking water sources and human health. Numeric nutrient criteria can help prevent excessive amounts of nitrogen, phosphorous and organic matter; the development of algal blooms and cyanotoxins; and the mobilization of sediment-bound manganese and arsenic from impacting drinking water sources.

Drinking water utilities across the nation have assumed substantial costs to install, update, and operate additional treatment systems and protocols (that are beyond standard treatment) needed to address these nutrient related impacts and the associated human health risks, including those from the formation of disinfection by-products (DBPs) as well as taste and odor issues. It is very difficult to show the full magnitude of drinking water impacts from nutrients based on nitrate maximum contaminant level (MCL) and Stage 1 DBP Rule violations because many drinking water utilities have undertaken additional actions to avoid Safe Drinking Water Act (SDWA) violations and only conduct finished water sampling after treatment rather than raw water sampling at the intake. Additional utility actions and costs to address nutrients have included those for increased monitoring, taking wells offline, finding alternative sources, blending sources, installing treatment, and/or connecting to other utilities. Utilities have also had to conduct enhanced public education campaigns to issue notices for exceedances, inform vulnerable populations on potential risks, and restore public trust in the drinking water after experiencing HAB events that compromised the safety of the community's tap water.

Providing flexibility for states to apply the Draft LNNC to include drinking water and recreation as designated uses (in addition to site-specific circumstances which are very different for each lake and reservoir depending on depth, land use, soil and sediment, weather, etc.) will be essential for protecting public health and the economy and will provide additional water quality and environmental benefits. Two examples of significant impacts to drinking water sources and the economy include the HABs that occurred in 2018 that resulted in Salem, Oregon issuing a drinking water advisory for an entire month and spending $75 million to install drinking water treatment;

and in 2014 in western Lake Erie, resulting in a "do not drink" order impacting ~500,000 residents in Toledo, Ohio with an estimated economic impact of $65 million.

Using microcystin as the toxin of focus for human health endpoints

The Draft LNNC recommends Total Nitrogen (TN) and Total Phosphorous (TP) criteria based on EPA's 2015 *Drinking Water Health Advisory for the Cyanobacterial Microcystin Toxins* as the designated beneficial use of drinking water supply. Although waters attaining these nutrient criteria are expected to result in no adverse effects from cyanotoxins in drinking water sources, the EPA model does not account for the known occurrence of other cyanotoxins such as cylindrospermopsin, saxitoxin, and anatoxin-a; impacts from algae blooms and organic matter without the presence of cyanotoxins (non-HAB blooms); observations of blooms below the surface layer; or increased concentrations of disinfection by-product precursors or taste and odor chemicals due to the lack of available data (on page 61). States are interested in the potential for regional cyanobacteria models commensurate with EPA's approach here, to the extent regional data on specific cyanobacteria are available.

> **Recommendation: EPA should add information about how these national data gaps can potentially be offset by using state and local data, and where EPA can aim to include them in future national datasets and models**. The models have been formulated to consider state and local monitoring data for refining the estimates of state-specific coefficients, while remaining consistent with national trends. It will also help if EPA clarifies how it may adapt the models in the future to reflect improved understanding of these dynamics, and at what data thresholds EPA may choose to expand the functionality of the models. With this clarity, states can assist EPA and others in closing gaps towards comprehensive data-driven management of nutrient concentrations.
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> **Recommendation: EPA should clarify the parameters and data collection that would enhance continental scale characterization of cyanotoxin and disinfection by-product precursors or taste and odor chemicals abundance**. States cannot assist EPA and the water quality community in addressing these gaps without explicit clarification.
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> **Recommendation: EPA should include the ability to establish a risk metric related to the microcystin model that also supports reduced DBPs as a function of TN and TP limits that hinder algal biomass and resulting organic matter**. DBPs are another critical risk metric to the drinking water management community. DBP's relationship with organic matter could have been included in the model using the existing stressor/response relationship between nutrients and Chlorophyll *a* (Chl *a*) algal biomass. With model modifications, users could select TN and TP criteria that are both protective against microcystin concentration *and* lie below some algal biomass threshold metric as established by a state's risk management decision-making criteria.
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> **Recommendation: Clarify scale relating to cyanotoxins.** On page 61, EPA writes, "For recreational and drinking water source uses, the effects of other cyanotoxins (e.g. cylindrospermopsin) might be important for certain lakes, but continental-scale data for those other cyanotoxins were not available at the time of this analysis." It would be more accurate for EPA to state that other cyanotoxins might be more important for certain lakes, basins, or regions, as trends in cyanotoxin occurrence are assessed at these various scales.

Source water protection and benchmarks for drinking water designated uses and outcomes

The threshold concentrations for microcystin are expected to guide the use of the models to derive Chl *a* criteria for drinking water as a designated use. The EPA Health Advisory recommends a threshold concentration for microcystin of 0.3 μg/L for preschool children less than 6 years old for finished drinking water to protect human health. EPA acknowledges that treatment technologies to remove microcystin are too variable for the EPA to set a national recommendation for a protective ambient source water concentration that would yield a protective concentration after treatment, but that some states may account for expected treatment and use a higher microcystin concentration in the ambient source water that would result in the targeted microcystin concentration in the finished drinking water.

> **Recommendation: EPA should add information to acknowledge that some states set water quality criteria based on the assumption that drinking water utilities should only need to use standard treatment protocols to protect human health from contaminants in drinking water sources.** For example, Ohio and Oregon set water quality criteria for the public water supply use with the assumption that only conventional drinking water treatment is needed to meet water quality standards. In the case of pollutants for which EPA has not published criteria, Ohio and Oregon may base their criteria on SDWA MCLs unless more conservative criteria are available for other designated uses. This acknowledgement and explanation would also help address state concerns about public perception if state criteria for drinking water sources are more stringent than the criteria calculated by the EPA model.

> **Recommendation: Account for potential future drinking water designated uses.** EPA should consider that some states may apply drinking water designated uses and criteria for water bodies that are currently not drinking water sources but may have the potential to become drinking water sources in the future and conversely, that some states may not have applied drinking water designated uses for all of their drinking water sources.

Importance of using state and local data to fill gaps in the model

There are several places in the Draft LNNC where EPA should more specifically address whether (and if so, should clarify that) state and local data can be used to develop criteria that the EPA models may not account for. An important example in the drinking water context is consideration of yearly (non-summer) data**.**

The Draft LNNC model is limited to nutrient and response data collected only in the summer, so monitoring data assessed with respect to these draft recommended criteria should also be limited to summer data. Nutrient concentrations in some lakes can vary considerably between summer and winter, and states may specify assessment protocols to ensure that only data collected in the summer are compared with criterion concentrations. However, this leaves a large gap for states to consider TN/TP loads throughout the rest of the year, including in winter when HABS have been documented underneath the ice on frozen lakes.

As an example of this point**,** Oregon has noted a number of recreational HAB advisories between October and January. Hagg Lake (the drinking water supply for the Joint Water Commission) had a bloom in February last year, although it was not above the advisory level. There are a number of other lakes with winter or early spring recreational advisories listed on Oregon Health Authority's

Recreational HABs website.[1] Upper Klamath Lake has bloomed as late as October/November, Silcoos Lake has had recreational advisories between October and January, Sru Lake in Southern Oregon has had blooms in November, and Lost Creek Lake had an advisory in December. Detroit Lake is typically active early in the season (typically early May.) Another example is the Snake River where load allocations for total phosphorus are applied year-round instead of just during the summer out of algal bloom concerns.

Recreational Use

Chl *a* is used to model acceptable levels of microcystin, but the provided data do not appear to fully substantiate that approach.

In Section 3.2.2.2, Figure 22 shows that only a small fraction of the data points for microcystin meet or exceed the 8 µg/L threshold, even as Chl *a* rises to 1000 µg/L. In addition, low concentrations (<1 µg/L) of microcystin are shown to occur across the range of Chl *a* concentrations (0-1000 µg/L). This suggests that other factors are involved in triggering production of microcystin, and that these may not be accounted for in the Chl *a* model. This also acknowledges the limited efficacy in controlling Chl *a* as a means of abating production of microcystin. Indeed, EPA's own advisories[2] acknowledge several other drivers behind the production of microcystin. It is not clear whether or how these other drivers may be accounted for in the recommended model.

Temperature has been recently noted by EPA as one driver: "In addition, potential warming of surface waters and changes in precipitation could result in changes in ecosystem dynamics that lead to more frequent formation of cyanobacteria blooms and their associated toxins (Paerl et al. 2011; Paerl and Huisman 2008; Paerl and Otten 2013b)" (EPA 2019, 30). Another set of drivers may be, "…concurrent increases in temperature and phosphorus concentrations yielded the highest growth rates of toxic Microcystis cells, which led them to conclude that eutrophication and warm temperatures may promote the growth of toxic, rather than nontoxic, populations of Microcystis leading to blooms with higher microcystin content" (EPA 2019, 33).

> **Recommendation: Before states are asked to consider the model-derived criteria for Chl *a* as a tool for minimizing microcystin concentrations to protect recreational uses, EPA should provide an assessment explaining how other drivers of microcystin production have been accounted for**. EPA should explain what type of model is being fit to create the relationship in Figure 22, and whether EPA investigated the other contributing factors to determine that the Chl *a* relationship with microcystin is not being driven by other factors that EPA and states should consider. Furthermore, EPA should explain why the model is sufficiently robust to use for criteria derivation. This is especially important because microcystin is the selected risk metric in the Draft LNNC, despite it not being the most prominent algal toxin of concern in each state. Nor is it the most prominent algal toxin

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[1]https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/HARMFULALGAEBLOOMS/Pages/archive.aspx

[2]*Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin* (2019).

> in some ecoregions, such as the Northern Appalachians, Western Mountains, and Southern Plains.

Dermal contact vs. ingestion needs further explanation.

Cyanotoxin-related skin irritation and allergic reactions have been noted without ingestion, making them additional recreation-related health effects of importance to states and their stakeholders. If the microcystin concentration metrics in the Draft LNNC protect against skin contact reactions as well, EPA needs to elaborate how. EPA notes in the Draft LNNC that data to support an EPA-recommended model are not available. Clarifying the data needs here may allow states to help close that gap.

Aquatic Life Use

Important pathways need to be considered and accounted for.

EPA acknowledges some limitations relating to potential pathways to address nutrient proliferation and impacts to aquatic life. EPA writes on page 61, "For example, scientific consensus is currently lacking on the precise level of cyanobacteria that is harmful to aquatic life. That information gap limited the utility of using cyanobacteria abundance as a final response measurement, despite the fact that increased cyanobacterial abundance occurs frequently with nutrient pollution (Dolman et al. 2012)." The latter point here is of importance to states. Some state water quality programs may wish to address anthropogenic contributions of a pollutant (in this case, overabundance of nutrients) and corresponding direct and indirect changes to waterbody condition (for example, cyanobacteria or algal biomass proliferation) regardless of known toxicity or affects to aquatic life. The models can be adapted to address states' own risk management metrics related to microcystin and nutrient concentrations, while documenting and quantifying harms to other aquatic life related to cyanobacteria remains an ongoing effort in the water quality community.

> **Recommendation: EPA should work with states to adapt the model to generating state- or lake-specific metrics, even when the underlying relationships are not sufficiently quantified for EPA to feel compelled to include under CWA 304(a) at this time**. States appreciate EPA's discretion in providing only data-based criteria methodologies; however, the potential power of the modeling can greatly assist states if they are modified to derive certain types of values as requested by states.

Linkage between future lake warming and protection of fish propagation needs inclusion or clarification.

The assessment endpoint for aquatic life use focuses on zooplankton population shifts due to cyanobacteria proliferation, but the model does not appear to capture zooplankton population shifts due to trends in ambient lake temperature over time. As EPA notes, the lack of fatty acids in cyanobacteria negatively affects growth rates of zooplankton. However, it is well established that not only do N:P encourage proliferation of cyanobacteria, but so does ambient temperature. This may well be captured in the models in some way, but as written, it is unclear. States know that temperature is an important driver in two contexts: seasonally, as high temperatures in the growing season foster cyanobacteria, as the Draft LNNC captures; and average ambient air and lake tributaries' temperatures, which also affect mean lake temperature. Accounting for these drivers, lake temperatures are expected to generally rise into the future, which may surpass thresholds that alter food web dynamics as they are currently understood. These alterations may be inconsistent with the current set of ecoregions and model inputs EPA has identified.

> **Recommendation: EPA should articulate if and how a long-term lake warming trend—and the accompanying alterations in food web dynamics—is accounted for in the models.** If not, this should be incorporated, and limitations related to the methodology's efficacy in managing these dynamic shifts should be acknowledged.

Refugia: Temperatures may exceed levels that support fish reproduction.

The Draft LNNC describes the preservation of at least a thin layer of refugia for cool- and cold-water fish, where temperature and dissolved oxygen are sufficient to support survival through the warmest periods of the growing season. States expect that long-term trends of increased temperatures in ambient air and lakes will push supporting temperatures for cool- and cold-water fish further down the water column, where DO also decreases in stratified lakes**.** As written, the model allows states some flexibility to account for these changes, within some confines.

Beyond mere seasonal survival, warm temperature stress is known to reduce or eliminate reproduction among *spawning* fish, a phenomenon that is projected to worsen over time as mean lake temperatures increase. For example, Dahlke et al.[3] recently found, "…spawners and embryos [are] the most temperature-sensitive stages in the life cycle of fish" (69) and generally, breeding is the life stage in freshwater and marine fish that is most vulnerable to increases in mean water temperature over time.

Thus, if the model cannot ensure a refugia of sufficient DO where spawning-sufficient cool temperatures exist in the water column, the propagation of fish is inherently jeopardized. If the refugia layer is expected to become impossible to attain in the future and the models do not provide an alternative approach to ensure fish survival and propagation, EPA must acknowledge this for states' nutrient management planning.

> **Recommendation: EPA should adjust the endpoint and risk metric for cool- and cold-water fish to ensure support of fish propagation, rather than adult survival through the warmest summertime periods only**. EPA should also revise the model inputs (R Shiny App) to allow more deviation of temperature and depth, in anticipation of future increases in lake temperatures and commensurate adjustment of the modeled relationship between DO, refugia depth, critical temperature, and the propagation of such fish in dimictic lakes. EPA should articulate whether and how the model accounts for temperature change beyond the growing season-only data gleaned in the NLA, or adjust the model accordingly; and EPA should also acknowledge any limitations to achieving fish refugia for survival and propagation with the future in mind.

It is not clear how accurately the models capture the relationship between lake temperature and DO concentration.

In Section 3.2.2.2, following Equation (13), it is stated that (1) the DO concentration at time of stratification was not measured for any lake, and (2) the saturated DO concentration at the minimum annual air temperature provided an estimate for DO_0. It is also stated that (3) deepwater lake temperatures at the time of stratification were approximated as the minimum annual air

[3] Dahlke et al. July 2020. "Thermal Bottlenecks in the Life Cycle Define Climate Vulnerability of Fish." *Science* 369 (6499), 65-70. DOI: 10.1126/science.aaz3658

temperature at the lake location. Because lake geomorphology, depth, and upstream waters play a role in temperature and dates of stratification, states are concerned that the models use an assumed date of stratification based on these assumptions rather than specific observations of stratification and accounting for geomorphological affects. It may also be the case that EPA did not attempt to use a small set of such data to address this aggregated data need.

Science affirms the importance of sufficient DO for the balance of aquatic life in lake ecosystems, not only for cool- and cold-water fish. States continue to evaluate the DO relationship with the aquatic communities in their lakes, and the models have the opportunity to assist risk management decision-making.

> **Recommendation: EPA should clarify the uncertainty of these estimates and provide an assessment of effects that these assumptions have on the model output(s), and whether/how EPA validated assumptions using data**. EPA should consult states on how the models can be adapted to account for, or help evaluate, protection of other aquatic life with respect to DO.

States encourage the non-growing season be addressed.
The provided draft derives numeric criteria as seasonal mean values. Although some nutrient-related issues occur during the summer months, states are concerned about recreation and aquatic life nutrient-related impacts regardless of season, and work to manage microcystin and nutrient concentrations year-round. As noted, algal blooms are increasingly occurring outside the growing season (which itself is occupying more calendar days per year in many regions), and potentially toxic blooms beneath lake ice have been observed. In many states, seasonal lake temperatures sufficient to sustain typical warmth-requiring harmful algae realistically represent less than ¼ of the year, whereas conditions for cool-tolerant, potentially harmful algae are prevalent most of the calendar year. As such, states would appreciate more clarity and latitude related to the Draft LNNC's "off-season" utility.

> **Recommendation**: **EPA should clarify the seasonal applicability of the models and whether states may have the ability to "mix and match" seasonal and year-round values in part derived using the Draft LNNC methodology**. EPA should further explain whether and how the models account for risks to human health and aquatic life during "off-season" months, when human exposure or departures from designated uses are possible.

Recommendations Related to Model Specifications, Sensitivity, and Uncertainties

The zooplankton model is very sensitive to lake depth at the shallow end of the spectrum. For example, a 1-meter depth change in inputs produces a substantial change in criteria values compared to changes in other model variables. The hypoxia model is very sensitive to lake depth, but not other variables. EPA should provide the results of the underlying sensitivity analyses and work with states towards collective understanding about the models' particular sensitivity and/or variability. Other examples of uncertainties that need to be addressed include:

a. Variability is more pronounced here than the document narrative suggests. Are the sample methods (depth-integrated) contributing factors?
b. Equation 11 is very important, so please provide more information on how it was built and could be used.

c. Lake depth is central to all the models. But depth itself has variability, which does not appear to be reflected in the equations provided.
d. In some configurations, TP and TN criteria become less stringent with increasing lake depth, but zooplankton becomes more stringent with increasing depth. States are uncertain whether this indicates that the criteria gradient relative to depth varies, or whether this reflects limited configurations of inputs. EPA should work with states to explore the specific variability and the direction of the modelled relationships.
e. As discussed, geomorphology affects HABs—shallow lakes are drivers more so than deep lakes—but the microcystin model does not account for depth. EPA should clarify why.
f. States are interested in whether EPA considered setting DO saturation values for the deepwater hypoxia model. State review suggests the model may be improved by setting model to saturation values, especially for high-elevation lakes.

TN model's national average of DOC inhibits site-specific TN criteria.

The ambient DOC concentration for a lake is required to generate a TN candidate criterion value. However, the Draft LNNC does not recommend DOC values to "plug in," but rather uses the mean concentration of DOC across all NLA lakes (5.6 mg/L) for the purposes of illustration. Defaulting to a national average will not be satisfactory for states wishing to adopt site-specific criteria. EPA should provide for lake- or state-specific DOC values in the model(s).

Lake depth has inherent variability, and it is not clear if models capture this or typical lake management approaches.

It is not clear what summary statistic (maximum, minimum, average, 90^{th} percentile, etc.) would best represent lake depth. The Draft LNNC sometimes uses the term "maximum depth" when referring to lake depth, which is assumed to mean the deepest point observed on the day of sampling. However, when a lake was visited for sampling in two different years, and when conditions at the lake suggest the two lake depth values would be significantly different, the lake depth recorded in each observation is the same in the input data file. This is problematic since lakes vary in depth from year to year—some substantially so—and many reservoirs are managed using supply and flow forecasting methods that may render stark changes in depth even within a single growing season, much less across years. EPA should explain how states should approach depth profiles, and whether and how the models accurately account for changes in depth due to natural or manmade conditions.

EPA should specify the data beyond TN, TP, and Chl *a*—in an index of parameters, with suggested frequency—towards deriving each recommended criteria, if additional types of data are necessary or useful in improving the model accuracy.

Per the conceptual models provided, it appears color, pH, acid-neutralizing capacity (ANC), and Secchi depth are parameters needed to use or refine the models. EPA should indicate whether states should focus on collecting such data to develop improved or site-specific criteria using the models. An additional parameter of interest may be zooplankton, but because this is very resource-intensive to monitor, EPA needs to clarify if this was the intent.

Model-derived criteria may render management guidelines counter to a lake's natural conditions.

As mentioned in these comments, it is unclear where a state-derived criterion value may fall in relation to an existing range of criteria and management benchmarks. States are especially concerned that the models may be biased against eutrophic lakes' natural conditions, rendering criteria that are not reflective of reality nor realistically implementable or achievable. States are also concerned that derived criteria may not reflect conditions or desired conditions in lakes that are naturally low in nutrients. States and EPA have a responsibility to maintain water quality under CWA for all applicable waterbodies, including those that remain "pristine" in the nutrients context.

The stressor response approach can be enhanced by accounting for all known factors to the extent data are available.

Other factors in the stressor/response relationships in aquatic communities may affect microcystin-bearing algal biomass. Our reading of the Draft LNNC suggests that the following factors are not accounted for by the model, but are acknowledged as stressors by EPA recently[4]: "Other factors include water turbulence, mixing, and flushing, oxidative stressors, and interactions with other biota (e.g., viruses, bacteria, and animal grazers), as well as their combined effects (Paerl and Otten 2013a, 2013b)" (EPA 2019, 28). The science of algal blooms is also clarifying that nutrient ratios (N:P) in a given lake have an effect on the type and severity of blooms experienced (EPA 2019, 31), but it is unclear how ratios are addressed in the models, or how the models could be revised to account for nutrient ratios using state data.

General Applicability

It is unclear if the Draft LNNC apply to some coastal lakes influenced by salinity.

Salinity is not addressed in the Draft LNNC with respect to intermittently estuarine lakes subject to some frequency of tidal action**.** EPA needs to indicate a salinity threshold for states to differentiate freshwater lakes from estuarine/marine lakes for the application of the Draft LNNC, rather than reference the 2001 Nutrient Criteria Guidance.[5]

Lake water quality can vary while still meeting water quality goals.

Natural and healthy lakes can span the range of lake trophic conditions. While the EPA criteria builds on relationships between various water quality parameters to establish conditions to meet designated use goals for aquatic life and human health in lakes, the criteria does not consider that the natural tendencies within lakes might not support attainment of the modeled conditions within all lakes, yet could still support attainment of designated uses. The consideration of natural trophic tendencies in lakes is predicated on the premise that watershed and lake characteristics and the natural trophic progression of lakes combine to influence the trophic status of each lake, and by extension, the levels of nutrients, dissolved oxygen, clarity, chlorophyll a and frequency of harmful algal blooms. The key to setting nutrient targets in lakes is to focus on excess anthropogenic contributions of nutrients and set lake targets based on environmental conditions that would occur absent these excesses. This consideration is foundational and should come before the development of lake specific criteria. While the attainment of designated uses is a key element in numeric lake nutrient criteria development, there is a wide range of environmental conditions that could support

[4] *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin* (2019).
[5] *Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters* (EPA-822-B-01-003).

designated use attainment. There should be a consideration of how to set the natural trophic tendencies for individual lakes and impoundments, which then informs the development and application of stressor-based relationships for lake nutrient criteria development.

EPA should specify the definition used to determine if a lake is "dimictic" so that a state may easily determine applicability of the hypoxia model.

Related issues of note include:

a. The hypoxia model does not appear applicable in states lacking cool water fish.
b. Some lakes are connected such to allow fish to escape anoxic conditions, but as mentioned in our comments regarding geomorphology, it is not clear whether or how this is captured in the Draft LNNC.
c. The DO for dimictic lakes does not appear to capture other holomictic lakes that may be shallow or exist at low elevations.

Available broad and site-specific data may limit model utility.

Because site-specific information is required to generate candidate criteria (especially for TP and TN), states will not be able to use the models to develop criteria for broad groupings of waterbodies (e.g., "Piedmont/coastal lakes supporting warm-water fisheries") unless some procedure for categorization and data grouping in relation to the Draft LNNC is provided. When clarifying how the Draft LNNC is to apply to lakes (regionally, groupings, per-lake depending on some decision criteria, etc.), EPA should also clarify (or consider) whether the models can accommodate a groupings approach, which some states may favor.

States need clarity about the role of elevation in the Draft LNNC.
Elevation is a variable used in the Draft LNNC, and has applicability and implications to some extent for all states—not merely those with stark contrasts in elevation. To increase clarity, EPA should note the source of the elevation data and units in the Draft LNNC, and clarify which methods states should use to determine the elevation for state-specific modeling. Additionally, EPA should clarify how states are to address lakes within a single ecoregion that have different elevations. Although lake temperature and elevation are discussed in Section 3.2.2 on "Deep Water Hypoxia," the use of ecoregions in the model does not account for lakes in high elevations that may be significantly different from those in the same ecoregion at lower elevations; and, the TN/TP models do not use elevation as an input.

Further Clarify the Use of NLA Data in the Draft LNNC

States appreciate EPA's use of data from the NLA program in the model described in the Draft LNNC. However, states would appreciate more discussion on any limitations of the NLA data, as applied in the modeling, and in merging of NLA data with site-specific data. ACWA and ASDWA recommend the following:

Describe updates to NLA data and the Draft LNNC.

As states work to understand the Draft LNNC, they are concerned whether emerging data may compel EPA to revise the models, potentially *after* model-derived criteria have been adopted by states. States believe EPA should incorporate 2017 NLA data into the models and accommodate public comments thereafter. States do not believe EPA should finalize and encourage model-derived criteria if the model is to be updated (with 2017 NLA or other data) not long after finalization. If EPA intends to modify the models per 2017 NLA data, it should explicitly state this in the draft.

Develop a table summarizing NLA usage.

EPA describes the NLA data used in the modeling and how the data from the 1800+ lakes were binned and processed in specific sub-analyses within the Draft LNNC. We request EPA also include a table near the front of the document outlining the lake data analysis approach and corresponding values (e.g. information in Section 3.1; Figure 7; Number of lakes fitting analysis-specific categories; etc.).

Develop an example of NLA-only-based criteria value(s).

The current draft Appendix A and Appendix B includes case examples featuring Iowa and Missouri, which (1) help states understand how criteria may be derived from the provided draft, and (2) more explicitly illustrate the strengths and limitations of a derived criteria values based solely on the NLA data-informed modeling. Some states expect they may lack sufficient data to refine the models (pending EPA's clarifications), and as such, providing an NLA-specific case study will help them weigh the models' operationalization and accuracy, compared to their existing criteria approaches for nutrients management.

Provide a summary of NLA data used in the Draft LNNC and flag important strengths and limitations in NLA data of concern to states and EPA.

To save state staff time during review of the modeling, states recommend EPA identify the strengths and limitations of the NLA data as they relate to the priorities of federal and state water quality officials. For example, Great Lakes data are not included in the modeling. This is a critical caveat, especially given the substantial investment in HAB and nutrient related activities those state and federal partners are conducting. This oversight is not immediately obvious as the Draft LNNC is written.

NLA data have other limitations relating to applicability that should be further explored. In Section 3.2.2.1, lakes designated as "seasonally stratified dimictic lakes" from the NLA appear to be spatially biased and concentrated in New England and the Midwest. However, there are large areas of the U.S. with many dimitic lakes (for example, the eastern Great Lakes Basin states) that are greatly under-represented in the NLA data set. While the NLA data bears important information for many users around the United States, some states were caught off guard that the NLA methodology is not more representative of the distribution of dimitic lakes. EPA should provide an assessment of the implications of this bias on the final statistical modeling and assumptions.

EPA should clarify how and why two sets of water quality sampling at the national scale are nationally representative.

EPA should clearly indicate how two growing-season-only sampling regimes were determined to be representative for use in developing national models to derive nutrient criteria applicable to lakes and reservoirs nationwide, year-round. The most significant weakness of the models is that they were developed using only two years of data (2007 and 2012), which consist mostly of singular snapshots in time rather than repeated site visits. Both 2007 and 2012 were extreme drought years in the southeast and in other regions of the country, while in other areas, major flushing and abnormal lake conditions occurred due to rare regional precipitation events prior to sampling. It is reasonable to expect more pronounced algae blooms during periods characterized by low flow, high temperature, and little wind-mixing. Likewise, there could be uncharacteristic changes to bloom patterns and zooplankton populations after abnormally high contributions of sediment and pesticides from the watershed due to anomalous precipitation events.

EPA should provide more rationale and verification to states in demonstrating that the model-derived criteria are neither overprotective nor unprotective. This will be important when evaluating the most scientifically defensible and appropriate criteria for a given lake, as well as when states must engage with stakeholders. As it stands, each of these tasks will be very difficult to do.

Questions about the Draft LNNC's Approach, Implementation, and Anticipated Outcomes

In addition to questions posed already in these comments, states have numerous detailed questions relating to the LNNC's science and approach, expectations and vision related to implementation, and potential outcomes. Those questions are provided in an Appendix beginning on page 24 of these comments. We request that EPA review and consider those questions carefully, and work with ACWA, ASDWA, and states to address them.

Recommendations on the Clarity and Usability of the Document

Know the audience: Revise the document to accommodate broader subset of water quality professionals.

ACWA and ASDWA typically refrain from comprehensive editorial recommendations when commenting on EPA actions or publications. However, because of the novel and complex nature of the Draft LNNC, and because of the difficulty states have experienced in understanding its form and potential operationalization in a time-efficient manner, we are providing editorial suggestions below that we believe will enhance user-friendliness of the document.

Generally, states recommend revising the document to facilitate understanding by a wider range of environmental scientists. The Draft LNNC is structured as a risk assessment document, and EPA has even suggested that review and use of the models may require staff with specialized statistical modeling expertise that some states will almost certainly lack. States support EPA's utilization of risk-based approaches; however, state staff who are charged with implementing water quality standards may be geologists, engineers, hydrologists, biologists, geochemists, etc., rather than statisticians, ecotoxicologists, or risk assessors. An executive summary written for a broader array of environmental professionals, as well as alterations to the body of the document as we identify below, would enhance usability of the document.

Include typical executive summary components to aid understanding of criteria methodology, variables and parameters, and expectations.

Early in the document, EPA should succinctly describe the intended use of the Draft LNNC and how it is to be used. EPA should clearly state, in a summary table near the head of the document, the actual parameters for which they are recommending criteria and how those criteria are derived (i.e., inclusion of a graphic of the R Shiny app indicating where the ultimate criteria values lie), as well as listing hyperlinks to the associated models. EPA should also consider including a simplified decision tree related to implementation. This would enhance understanding of the document's intent not only for states, but those typically involved in water quality standards actions, such as other water quality practitioners and managers, legislative bodies, and stakeholders.

The Executive Summary should clearly state how the Draft LNNC are EPA's recommended methodology to derive criteria for a limited set of parameters, depending on the designated uses of said lakes. For example, "per Table 1, users can derive a criteria for [parameters] that protects cool- and cold-water fish (one of four assessment endpoints incorporated into these Recommendations) from insufficient DO (daily depth-averaged) below the thermocline (the Risk Metric EPA has selected towards measuring protection of cool- and cold-water fish)." Users should not need to read beyond the executive summary to arrive at this understanding.

Some existing figures and tables can be easily adapted to enhance understanding. For example, Table 1 should include a column listing the possible parameters/criteria derived relating to each Designated Use, since that is the desired outcome of the Draft LNNC.

A summary table containing all acronyms and hyperlinks in the document should also appear adjacent to the table of contents for quick reference.

Model equations need quick reference.

All model equations in the document (n=46) are included in-line with text and adjacent is a number in parentheses as a reference. We recommend that equations also be compiled into a table that notes the equation's title or purpose, the model in question, the equation, and the reference (number) assigned to them in the document. An expanded version of this table could appear in an appendix that also notes each variable's value.

We also recommend adjustments to the R Shiny App to enhance use and reference. EPA should insert language from the document that details the model and its functionality, variables, etc. into the R Shiny App description tab(s). EPA should insert a table into the document and the R Shiny App that lists each risk management decision that states will need to weigh when evaluating or deploying each model. In the R Shiny App, this could be in a new metadata/description tab.

Use groupings for clarity.

It will ease review of the draft and resulting final criteria if figures are placed adjacent to their first mention in document, or referenced with page numbers in-text. Many figures appear long after their first mention. Our suggested approach can minimize time spent cross-referencing during review and use of the finalized LNNC.

Revise document structure to reflect conceptual models (Figure 1 and Figure 2) and operation of the Draft LNNC modeling.

In general, paragraphs concerning any of the designated uses or associated measures should begin by explicitly stating the designated use, assessment endpoint, risk metric, and applicability. The narrative rationale should follow. Currently, many paragraphs in the document are written inversely. Our recommended approach would help users quickly link the narrative rationale with the overarching paradigm (i.e., Table 1) and quickly reference what they need within the document.

Note what plays a role in the Draft LNNC models.

EPA can increase understanding of what aspects in aquatic systems play a role in the modeling approach. In Figures 1, 2, and 3, it would be helpful to mark each conceptual model such that readers can quickly identify which relationships the Draft LNNC does and does not seek to address and/or have a role in the Draft LNNC's methodology.

Ensure Parallel Construction throughout the document.

Heading structure is not consistent in the document. For example, Sections 2.2.1.1 and 2.2.1.2 are intended to be Assessment Endpoints. However, 2.2.1.1 addresses the Assessment Endpoint "Zooplankton Biomass" and 2.2.1.2 addresses "Dissolved Oxygen" rather than its parallel Assessment Endpoint, "Cool- and Cold-water Fish." The 2.2.1.2 text discusses risk metrics to those populations of fish as they relate to the Draft LNNC, namely risks per hypoxia, and concludes that dissolved oxygen below the thermocline is an appropriate risk metric towards managing to protect [the Assessment Endpoint] cool and cold-water fish. The header and paragraph should be revised to reflect this. Parallel construction should be used in all aspects of the document to prevent confusion and ensure consistency.

Use headings as opportunities to enhance conceptual clarity.

There are several empty headings in the document where conceptual clarity or the steps involved in a process can be explained, such as Sections 3.2, 3.2.1, and 3.2.3; Section 2 and 2.4; and Section 4. As an example, in Section 3.2, Stressor-Response Models, EPA could state:

> *The objective of analyzing stressor-response relationships is to provide evidence that organisms at impaired sites are exposed to the candidate cause at quantities or frequencies sufficient to induce observed biological effects. Although these relationships most frequently have been used to evaluate chemical stressors, a similar approach can be used for other stressors, such as sediment, water, and temperature. In a stressor-response model, the cause must be at levels associated with related biological effects observed in studies.*

And in Section 2.4, Analysis Plan, EPA could state:

> *An analysis plan outlines the scope, approaches, and methods to be used in the risk assessment. The plan involves evaluating exposure to stressors, and the relationship between stressor levels and ecological effects. This means acquiring appropriate data and estimating relationships between phytoplankton biomass and each of the risk metrics, as well as between phytoplankton biomass and concentrations of N and P. The critical measurement in all these relationships is Chl* a*, which is closely associated with phytoplankton biomass.*

Clarify Section 2.2.2., recreational use.

The first sentence of this paragraph should begin by explaining that EPA selected the microcystin concentration as the risk metric and human health as the assessment endpoint, and then elaborate why. No mention is made of the assessment endpoint. The paragraph should be revised to clearly explain that Human Health is the Assessment Endpoint, and that microcystin concentration to prevent liver toxicity in children is the Assessment Endpoint's Risk Metric.

Ensure consistency in Section 3.1.1, biological data.

The text switches from “biomass” to “biovolume” without defining the relationship or difference between these two terms. Begin this section with the definition that was included:

> *The biomass of bacterial populations in aquatic ecosystems is typically estimated by measuring bacterial biovolume and converting this into biomass in terms of carbon. For this study, biovolume measurements were converted to biomass using a density of 1 gram per milliliter (g/mL) (Holmes et al. 1969).*

Address Minor Error in Section 3.2.1.2.

Figure 6’s caption should say “*open circles (left and **center** panels):* average of five…” rather than “…*left and **right** panels*”.

Appendix: Questions about the Draft LNNC's Approach, Implementation, and Anticipated Outcomes

1. What are the national outcomes EPA anticipates per the Draft LNNC's widespread adoption, and how are they improved relative to the prior nutrient criteria approach? Has EPA assessed how outputs from the prior criteria and this Draft LNNC compare, and what the implications are?
2. Are derived criteria to be very broadly, or very narrowly, applied? For example, is a state to run the models and determine the protective criteria for the most sensitive use for each lake within a state, or model ecoregional or other categories of lakes to develop a broadly applicable criteria value within the state? If the latter, does EPA envision a broadly applicable criteria values that are implemented in some lakes but also site-specific criteria being developed at a state's discretion based on local data integration into the EPA model?
3. Does EPA envision that a suite of existing or future state-developed criteria approaches and the Draft LNNC approach could be used in tandem, with the former or latter applying at some but not all lakes? Will states need to forgo all other nutrient criteria approaches if they adopt the Draft LNNC? For example, will states have the flexibility to adopt candidate chlorophyll criteria per the Draft LNNC while declining to adopt candidate TP and TN criteria? Will states have the flexibility to revise existing chlorophyll criteria with the candidate chlorophyll criteria while declining to revise existing TP criteria? Please note that some states are barred from addressing deep water dissolved oxygen.
4. If states adopt candidate Chl *a*, TP, and TN criteria, will they be allowed to give primacy to Chl *a* criteria for assessment—the current practice for some states' lakes?
5. What would EPA consider an unacceptable justification for not revising existing criteria? What does EPA consider acceptable reasons for non-adoption?
6. If states have already developed numeric nutrient criteria, must they go through the effort to derive criteria using the recommended methodologies so they can compare them to their adopted criteria?
7. How does EPA recommend states account for differences between state sampling and data vs. EPA NLA sampling and data, as states evaluate the models and look towards incorporating their data into them?
8. For the microcystin/Chl *a* model and Figure 22, please clarify why 50% of curves are selected which have a 1% possibility of exceedance, and provide a figure showing the complete range. As states are bound to 75% or more confidence (Credible Intervals) in their decision-making using the models, why did EPA select to apply a range of 50% of curves here?
9. On page 36, relating to the DO_m threshold value: how did EPA arrive at these values and assumptions? Please explain how EPA arrived at these values in greater detail; provide figures for DO; and describe a methodology and basis for the decisions and assumptions made.
10. Will EPA be developing a desktop or web-based application that allows users to include other datasets besides the NLA datasets?

11. May a state develop and implement a plan to take some specified amount of time to monitor specific lakes of interest for parameters used in the national model, to then integrate the captured data into the model?

12. Lake data are site-specific. How does the Draft LNNC address larger geographic areas? What about unmonitored lakes? Even if a distribution of lake depths is used to refine the model, how could such a distribution capture natural or anthropogenic changes in depth and DOC?

13. What if a state lacks cool- or cold-water fish but seeks to protect fish via DO thresholds? May the Draft LNNC apply? If so, how?

14. What are states to do about known "outlier" lakes within a specific ecoregion?

15. Does the modeling account for lakes with aerators? Consider the vast number of reservoirs with aeration treatment. Would aeration not change a lake from its natural or typical condition and skew the model methodology and resulting criteria?

16. All nutrients and half of all Chl *a* model data are from depth-integrated samples. Did EPA evaluate the number of states that monitor through depth-integrated samples and in the center of a lake?

17. Is EPA intending that states should now sample lakes according to NLA guidelines for assessment purposes, in order to implement the provided models? What if states do not follow NLA data collection protocol – would states have to adopt NLA data collection protocols into their monitoring programs to proceed in implementation of the Draft LNNC? That proposition would require restructuring of data collection strategies, which would require years of additional data collection to purse the Draft LNNC's methodology.

18. If a state has some data but lacks model-critical data (for example, Chl *a* data) to integrate, how does EPA expect implementation to proceed?

19. In Section 3.2.1.1, how were measurement errors in phytoplankton biovolume explicitly modeled? What assumptions were made in this modelling? How are the posterior simulations being conducted?

20. In Section 3.2.1.3, the chlorophyll criteria based on the zooplankton model are sensitive to the slope factor selected. The documentation explains the basis of the slope factor and how it is calculated; however, it provides little guidance on how to determine the appropriate threshold. The slope is to predict the proportional increase in zooplankton biomass with different increases in phytoplankton biomass, but it is not clear how users would select a slope to maintain a specific trophic condition. Please explain. Further, can the slope factors be tied to specific trophic conditions such as oligotrophic (m=0), mesotrophic, eutrophic, and hypereutrophic?

21. In Section 3.2.1.3, the Chl *a* criteria based on the zooplankton model allows users to select credible intervals from 0.01 to 0.25. It is stated elsewhere that critical interval decisions are subject to state risk management decisions. As such, would states have the flexibility to select a credible interval anywhere within this range, or would EPA be provided a recommended critical interval range (or, is .01 to .25 the recommendation and "limit" to the credible interval range)? In either scenario, what documentation or justification will be required to support the state's decision?

22. In Section 3.2.2.2 following Equation (16), the draft LNNC states that, for the DO depletion model, EPA assumed that measurements of DO_m less than 2 mg/L are unknown because the estimates of the linear relationship are more strongly determined by the higher DO_m concentrations, and samples with DO_m less than 2 mg/L exert a weak influence that is still consistent with the overall relationship. However, the Draft LNNC provides no proof for these justifications. Furthermore, no explanation is provided for why a linear model based on a partial dataset is superior to a non-linear model using more-complete data. EPA should explain the science behind this decision, as well as how "unknown" values were modeled, what assumptions were made in modelling the unknown models, and what was the model sensitivity to these assumptions. Ultimately, lakes with low DO_m do need representation in any useful modeling regime of scale.
23. The interactive tool used for estimating candidate Chl *a* criteria using the hypoxia model allows users to calculate Chl *a* criteria for lakes in the southern U.S. However, cold-water fish species and dimitic lakes do not exist in these states. What is the justification for extrapolating the model well beyond its calibration range and to lakes that do not have a cold-water fish use? Does EPA intend for the model application to be limited to lakes with a cold-water fishery and bounded by the latitude and longitude of the calibration data set? EPA should clarify its reasoning here and provide an assessment of implications.
24. In Section 3.2.3.1, the draft LNNC states that "as Chl *a* increases, the relative biovolume of cyanobacteria has been observed to increase." However, this has not been the experience of some states. The relationships between Chl *a* and cyanobacteria abundance and between cyanobacteria abundance and cyanotoxin concentrations are often more complex than depicted in Figure 20. What is EPA's justification to support this simplified relationship?
25. In Section 3.2.3.2 and Figure 21, the relationships shown in Figure 21 are stronger than some states have ever observed. EPA should provide an assessment that identifies the underlying data (NLA or otherwise) and a description of the data handling methods used to develop these relationships.
26. Per Section 3.2.3.3, what justification or documentation should a state provide to support selection of specific credible interval and allowable exceedance frequency limits? What is the complete range of values states may select as part of their risk management decisions?
27. Per Section 3.2.4.2 and Figure 26, the Ecoregions may be too broad to adequately characterize values of log(*d1*), P bound to non-phytoplankton suspended sediment. Some states and/or geographic regions contain subregions with phosphate deposits that most likely have significantly higher P bound to non-phytoplankton suspended sediment than is predicted by the draft LNNC model. Should this be addressed using site-specific state criteria; possibly refined within the EPA-provided model per state or regional data; or some other recourse?
28. Per Section 3.2.4.2 and Figure 26, EPA should provide a list of the d_2 values estimated for each Ecoregion along with the description for the estimation process, what data were used to validate the estimates, and whether approaches to account for within-Ecoregion variability were incorporated into the model or considered by EPA during development.
29. How can the models be used by states that collect data in multiple seasons? Does EPA intend to evaluate seasonal trends or is that evaluation left up to the states? If seasonal data are

incorporated, would criteria change substantially, and would the models need to be reworked in any way?

30. Appendix D begins to imply a frequency of data collection once P or N criteria are established. There is mention of collecting data at a frequency that provides a geometric mean. How does this apply to states with a "99% of the time" rule?

31. If states have Total Suspended Solids (TSS) data to provide a more predictive relationship between P and nonplankton sediment, could TSS data be substituted for turbidity data? It is more representative of non-plankton sediment. How would this change the model, if at all?

32. Did EPA use a validation data set using a subset of the NLA dataset to ensure models do in fact predict accurately? If so, what was the process?

33. The TP model assumes algal composition changes with lake trophic condition, and this assumption is integrated into the TP model. Did EPA evaluate this assumption using the NLA data to confirm its applicability to the TP model? Would an analysis of the data be beneficial to improving the model?

34. TN and TN-DIN appear to be used interchangeably in the discussion of the TN criteria. For example, Figure 31 is labeled "TN" whereas the discussion of Figure 31 in the text uses "TN-DIN." The interchangeable use of TN and TN-DIN appears to be done because DOC only predicts organic N, and concentrations of ammonia and NOx are assumed to be negligible due to their preferred uptake by phytoplankton. Additionally, the criteria predicted by the model are labelled as TN-DIN, not TN. Are the estimated criteria only intended to be applied to organic N data? If the TN-DIN criteria are intended to be applied to TN data, the implication is that any measurable levels of ammonia or NOx would be indicative of a nutrient impairment. Otherwise, the estimated criteria would be overly stringent. Please provide a justification for deriving the criteria solely based on TN-DIN and explain how it is intended to be applied. A summary of the NLA data set showing the concentrations of organic N compared to ammonia and NOx would also be helpful in addressing this question.