

NC Nutrient Criteria Development Plan – Scientific Advisory Council (SAC)

12/3/2018 & 12/4/2018

Attendees

SAC members in attendance:

Lauren Petter	Marcelo Ardon
Bill Hall	Michael O’Driscoll
Linda Ehrlich	Martin Lebo
James Bowen	Nathan Hall (Han Paerl’s alternate)
Clifton Bell	
Astrid Schnetzer	

SAC meeting facilitator:

Jenny Halsey (Triangle J Council of Governments)

NCDEQ DWR staff in attendance:

Jim Hawhee	Pam Behm
Connie Brower	Leigh Stevenson
Christopher Ventaloro	Tammy Hill
Nora Deamer	
Brian Wrenn	

Criteria Implementation Committee (CIC) members in attendance:

In person:
Douglas Durbin

Meeting materials can be found on the Division of Water Resources Nutrient Criteria Development Plan Scientific Advisory Council webpage. Click [here](#) for a direct link.

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Meeting notes

All questions, comments and answers are paraphrased

This meeting was held over two days.

Day one – December 3, 2018

1. **Convene** (Jenny Halsey, Brian Wrenn)
 - a. Administrative business (Brian Wrenn)
 - i. September SAC meeting minutes provided to SAC
 - b. Desired outcomes for today's meeting:
 - i. Shared understanding and resolution of Chlorophyll-*a* criteria.
 - ii. Shared understanding and resolution of Nitrogen criteria.
 - c. Review of the non-binding decisions made during the November 2018 SAC meeting
 - i. Growing season = April 1 – October 31
 - ii. Clifton's screening approach chosen as framework for High Rock Lake (HRL)
 - iii. Use of 1-in-3 approach
 1. Martin L.: I believe we agreed to move the 1-in-3 discussion forward, not to necessarily move forward with using the 1-in-3 approach.
 2. Clifton B.: Some SAC members wanted to discuss magnitude prior to selecting frequency. I wanted to first show the basis of the final magnitude.
 3. Nathan H.: An averaging component should also be included.
 4. Clifton Bell.: A geometric mean should be included to provide context.
2. **Microcystin vs. Chlorophyll-a** (Nathan Hall)
 - a. See: "*Analysis of Total Microcystins versus Chlorophyll a from Lakes Sampled by the National Lakes Assessment 2007 and 2012*"
 - b. Intended to show a correlation between chlorophyll-a concentrations and microcystin concentrations. However, the analysis did not show such a correlation.
 - c. Analysis used data from the National Lakes Assessment Study.
 - a. About 1500 lakes had paired chlorophyll-a – microcystin data.
 - b. Looked at lakes on a national level and at lakes specific to the southeast U.S.
 - c. For the comparison of lakes at the national level, a chlorophyll-a concentration of about 80 ug/L corresponded to a microcystin concentration of about 4 ug/L.
 - d. For the comparison of lakes specific to the southeastern U.S., a chlorophyll-a concentration of about 250 ug/L corresponded to a microcystin concentration of about 4 ug/L.
 - d. Conclusion: could use 80 ug/L as an upper boundary but this relationship is not a strong one, especially for southeastern lakes.
 - e. Comments/questions:
 - i. James B.: Was there any resampling of data in the National Lakes Study to account for conditions over time?

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1. Nathan H.: The study used one sample per lake over a two-year period.
- ii. Hans P.: The weak correlation could be related to latitude. Some lakes in China show a strong correlation as do some lakes in Scandinavia which share characteristics of lakes in Canada and northern U.S. lakes.
- iii. James B.: Does the lakes study provide data to compare biomass with microcystin concentrations?
 1. Nathan H.: Yes. For HRL it is unknown how much toxin is produced by the species that inhabit the lake.
- iv. Marcelo A.: How many southeastern lakes were there data for in the study?
 1. Nathan H.: About 250-300. There were few natural lakes in the southeast. Most of those are in Florida.
 2. Marcelo A.: Is there something about reservoirs that might inhibit toxin production?
 3. Nathan H.: There is nothing about reservoirs that would inhibit toxin production.
 4. Bill H.: The cyanobacteria species in HRL are similar to the species in other North Carolina lakes.
 5. Nathan H. & Linda E.: HRL is unusual in the amount of certain species of cyanotoxin producing bacteria. Mostly we see filamentous water-column inhabiting species. Rarely see scum forming species in HRL.
 6. Hans P.: There is a theory that microcystin is produced to counteract super-oxygenated condition that occur during scum forming blooms. This would make sense for lakes like HRL where most blooms occur in the water column.

3. **SAC member chlorophyll-a magnitude proposals**

All chlorophyll-a criteria proposals submitted by SAC members can be found as part of the meeting materials located on the [NCDP webpage](#).

- a. Linda Ehrlich provided a proposal titled: *Chlorophyll a Magnitude Proposal (Spirogyra Diversified Environmental Services)*
 - i. There was no discussion of Linda's proposal.
- b. Martin Lebo provided a proposal titled: *High Rock Lake Chlorophyll a Evaluation for Key Locations (AquAeTer)*
 - i. Discussion:
 1. James B.: You started with 20-25 ug/L as a geomean based on literature and performed analysis on the distribution of chlorophyll-a based on available data for HRL. Based on this analysis, if we want 90% of the in-lake chlorophyll-a values to be below a certain target level, that target level needs to be 115% above the 90% value? Does the 115% apply for each of the four sampling stations?

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- Martin L.: The 115% applies at station 152C which is where we see the peak chlorophyll-a in the lake. A higher chlorophyll-a at station 152C still allows for the lake to be below the target level of 35 ug/L.
- 2. Brian W.: How is the long-term averaging period defined and how would compliance and assessment work?
 - Martin L.: Long-term average is based on the entire 2006-2016 distribution. For the assessment, data is collected as a seasonal geomean. The 35 ug/L shall not be exceeded in any part of the lake. The 35 ug/L corresponds to the level at the peak sampling station (Y152C) to keep the remainder of the lake at 20-25 ug/L. The existing assessment methodology can be used.
- 3. Bill H.: Does this include data from the continuous probes that were deployed in the 2016 summer study?
 - Martin L.: Only includes surface composites using the normal sampling procedure.
- 4. Lauren P.: Would the standard apply only at 35 ug/L? If samples at station Y152C are greater than 35 is the entire lake impaired?
 - Martin L.: If the critical point of the lake (station Y152C) meets the 35 ug/L, the lake will be meeting its uses. If samples are exceeding at station 152C that will require whole-lake treatment.
- 5. Bill H.: Can we support the 35 ug/L as a maximum value? We were considering 20-25 ug/L as the appropriate level to protect the fishery. If using 35 ug/L what impairment would we be protecting for?
 - Martin L.: The 20-25 ug/L was a minimum level to maintain the fishery. Below that level we see less fish production.
- 6. Clifton B.: Would there be an impairment if station Y152C was at 35 ug/L?
 - Martin L.: No, the target is a lake-wide average of 20-25 ug/L to maintain the fishery.
- 7. Clifton B.: Was data from the tributaries included in the analysis?
 - Martin L.: Station Y169A included tributary data.
- 8. Marcelo A.: Will using a geomean of 35 ug/L result in a standard that is less protective than the current standard of 40 ug/L (instantaneous)?
 - Yes, though not necessarily at all locations in the lake. If station Y152C is at 35 ug/L, the remainder of the lake would be around 20-25 ug/L.
- c. Bill Hall provided two proposals. They are titled *High Rock Lake Chlorophyll Criteria Box Model Proposal* and *High Rock Lake Chlorophyll Criteria Flow Chart Proposal*.
 - i. Discussion:

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1. Brian W.: What do you mean by “if it impairs a use”?
 - Bill H.: That would need to be defined. Ohio used existing state water quality standards, but you don’t have that here. NC has a definition for biological integrity, but no good way to apply that here in HRL as there is not a reference site for reservoirs.
2. Clifton B.: Would there be multi-year averaging or a frequency of exceedance?
 - Bill H.: It would be not to exceed more than once in three years.
3. Clifton B.: Do you have a magnitude to move forward with? What’s the status of your previous proposal for a chlorophyll-a criterion of 40 ug/L
 - Bill H.: These numbers are placeholders. Any value for chlorophyll-a would need to be somehow tied directly to use impairment. Chlorophyll-a itself does not impair uses.
 - James B.: It can have a direct impact on aquatic life by way of algal assemblage. We’ve seen that the assemblage can shift to less nutritious species as chlorophyll-a concentrations increase. There is no biomass indicator in the box model proposal. If biomass is too high or too low, it will impact aquatic life. Chlorophyll-a would be the best indicator of this.
- d. Lauren Petter provided two proposals titled “*Proposal for the December 2018 SAC Meeting (LP Proposal #1)*” and “*Proposal for the December 2018 SAC Meeting (LP Proposal #2)*”
 - i. Discussion:
 1. Clifton B.: is this meant to apply everywhere, at all times? This is presented as an arithmetic mean. An equivalent geometric mean would be around 20 ug/L.
 - Lauren P.: Yes, it applies for the whole lake.
 2. Bill H.: This appears to be based on historical performance.
 - Lauren P.: That as well as what has been shown from other lakes.
 3. Bill H.: Why wouldn’t the criterion be 5ug/L?
 - Lauren P.: The low values were not based on protection of aquatic life.
 4. Lind E.: Regarding assumption #5: chlorophyll-a + % blue-greens, I don’t think that chlorophyll-a less than 35 ug/L necessarily results in a decrease in blue-green dominance.
 5. Bill H.: Blue-green dominance has not been defined as an impairment and should not be used.
 6. Lauren P.: We have options as the SAC and can make recommendations. The concentration of blue-green cyanobacteria is tied to the risk of toxin production.

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7. Martin L.: A lot of the data in the literature is based on the forebay area of reservoirs. Coming to a single criterion value based on forebay data is not appropriate.
 - Lauren P.: Looking at data from different lakes showed that the numbers were similar.
 - Martin L.: Generating a whole-lake number and applying it to all stations in the lake is like comparing apples to oranges.
 - Lauren P.: The numbers here are supported by the literature.
- e. Clifton provided a proposal titled *“Proposal: Framework for Deriving Site-Specific Chlorophyll-a Criteria ...with Pilot Application to High Rock Lake (Brown & Caldwell)”*.
 - i. Discussion:
 1. Marcelo A.: Are you not defining impairment as risk of impairment?
 - Clifton B.: Risk is equal to a more indirect comparison of effects.
 - Marcelo A.: How does that tie into being at the threshold?
 - Clifton B.: The proposal includes a continuum of risk. This allows for more information to be brought in.
 2. Astrid S.: Can you look at the trends in HRL. Things might look okay right now but what is the current rate of change? Can we build that in to the proposal?
 - Clifton B.: You would want a robust data set to do that. Not a good idea to set standards based on previous conditions as those conditions may not be achievable now.
 3. Brian W.: Regarding the narrative criteria in the proposal, are those your proposal for the parameters?
 - Clifton B.: Yes.
 - Brian W.: The problem with narrative criteria is trying to define it. How do we back that with science?
 - Clifton B.: I’m trying to develop a better framework for how DWR does assessments based on narrative statements.
 - Jim H.: Is the idea that DWR will use this framework to develop criteria or that the SAC will use this framework to do that? Where does the burden of proof lay and how do we account for a lack of guidance?
 - Clifton B.: I’m putting forward the concepts.
 - Hans P.: These are two separate issues.
 - James B.: If the current condition does not fall in the “green” are then you are somewhere in the middle range. Your proposal does not provide information on how to determine a target number when in the range whereas Martin’s proposal does.

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- Clifton B.: Martin’s proposal might fit into this framework.
 - 4. Bill H.: I liked the slide comparing chlorophyll-a to pH. This shows a linkage.
4. **Chlorophyll-a magnitude & duration discussion** (SAC members)
- a. Clifton B.: At least three of the proposals are close to one another. Lauren’s is ~20 ug/L (as geomean), Clifton’s is 40 ug/L, Martin’s is 35 ug/L and Bill’s is 40 ug/L (all as geomeans). Lauren’s is on the low side; Martin’s and Clifton’s proposals can be combined and can also accommodate some of Bill’s concepts.
 - b. Hans P.: Martin’s proposal is a good compliment to Clifton’s and Bill’s proposals.
 - c. Linda E.: Likes Clifton’s framework approach.
 - d. Martin L.: Like the framework.
 - e. James B.: Like the framework but getting an actual number will bog us down.
 - f. Clifton B.: My proposal has four steps. If everyone agrees we can table this and move on to coming up with the number?
 - i. Bill H.: If below the lower bound do you not do steps 2, 3, and 4?
 - ii. Clifton B.: Might still use the narrative component to address existing nutrient issues.
 - iii. Astrid S.: Step #2 is cumbersome. The details of this step need to be fleshed out.
 - iv. Marcelo A.: What are we discussing then?
 - v. Clifton B.: Can we vote to have these as steps?
 - vi. Marcelo A.: What’s the point without developing numbers?
 - vii. Clifton B.: I liked the approach of developing a framework for developing criteria first before we started to look at coming up with numbers. I would like a vote on this.
 - viii. Jenny H.: A vote has been requested to agree on using Clifton’s framework in concept.
 - 1. Lauren P.: Need more details on the narrative component.
 - 2. Marcelo A.: There are four proposals for magnitude on the table. If we vote to go with this framework are we choosing Clifton’s proposal?
 - 3. Clifton B.: Can we do a straw poll?
 - 4. Jenny conducts straw poll of SAC members to adopt Clifton’s framework for developing chlorophyll-a criteria for NC lakes.
 - Results:
 - i. For: Clifton, Bill, Hans, James, Martin, Linda, Mike
 - ii. Against: Marcelo, Lauren, Astrid
 - iii. Absent: Deanna
 - iv. Straw poll to adopt Clifton’s framework does not meet the 70% supermajority per the voting requirements established in the SAC charter.
 - ix. Astrid S.: What is the alternative?

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- x. Jim H.: Move toward a HRL chlorophyll-a criterion. That comes straight out of the NCDP. DWR staff would like this.
- xi. Martin L.: I propose moving forward to discuss details of a chlorophyll-a criterion.
- xii. Jenny H.: Brings up a spreadsheet that compares all SAC member proposals for chlorophyll-a criteria (see meeting materials)
 - 1. Clifton B. requests that the frequency component in his proposal be changed to be a multi-year average.
 - 2. Clifton B.: Does anyone want to propose a hybrid chlorophyll-a proposal?
 - 3. James B.: Proposes a hybrid of proposal CB1 and the proposal by Martin L.
 - 4. Martin L.: If the only change to my proposal is that it would be considered a part of the reference framework for developing chlorophyll-a criteria I would accept that as my proposal.
- xiii. James B.: Asks Martin to review how the 35 ug/L chlorophyll-a value was derived.
 - 1. Martin L.: Don't want to go below 20-25 ug/L chlorophyll-a to maintain the fishery in HRL. Based on the assessment of the distribution of the long-term data at station Y152C, to protect the lake at a target value of 20-25 ug/L the criterion needs to be about 115% higher than the target value. This will also reduce occurrence of type I errors. If chlorophyll-a is at 35 ug/L at station Y152C, the long-term average in the remainder of the lake will be within the target range. This is a variability analysis.
 - 2. James B.: This is the method Florida used to assure how type I errors would be limited. If we don't want to mistakenly call HRL impaired and we aim for the 25 ug/L what should the criterion be? We've talked about 20-25 ug/L being protective of the uses.
 - 3. Martin L.: The 20-25 ug/L is what you don't want to go below. The origin of the 35 ug/L is that it will allow the other stations to be within the 20-25 ug/L range to protect the fishery. The important stations are at the transitional area in the lake.
 - 4. James B.: Regarding the controlling station, what if that station changes over time? Do different stations have their own numbers?
 - 5. Clifton B.: I don't think so. Martin's analysis shows where the stations would be. You would accept this proposal if you think that a maximum chlorophyll-a concentration of 35 ug/L is protective of the uses anywhere in the lake.
 - 6. Bill H.: The 20-25 ug/L range is the minimum level to protect the fishery in HRL. The 35 ug/L at station Y152C is the concentration that is consistent with a concentration of 20-25 ug/L throughout the remainder of the lake. If Y152C falls below 35 ug/L would the lake be impaired?

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7. Martin L.: The range to protect the uses in HRL is between 20-35 ug/L. If the majority of the lake is within this range the uses will be met. Y152C is the critical station.
8. Astrid S.: If a different station ends up having the highest chlorophyll-a values does that station then become the controlling station?
9. Martin L.: For example: If station Y 169A goes above Y152C, you would manage that tributary to control the nutrients.
10. Astrid S.: Would Y169A then be its own management unit? Don't you end up splitting the lake apart?
11. Lauren P.: If different stations increase above the 35 ug/L then that changes the underlying assumptions.
12. Martin L.: Trying to get a different number increases the type I error.
13. Pam B.: This makes sense in theory, but as you move down the lake you get different loadings. This may cause a problem in trying to manage the creek arms. May need to develop site-specific numbers for the creeks.
14. Lauren P.: Is there a bound that can be put on other stations to indicate that the distribution is maintained?
15. Clifton B.: This is getting too complicated. NC does not really do spatial averaging. When we set criteria, we set it at a maximum value that is protection of the uses. We shouldn't need to come up with additional numbers.
16. Lauren P.: Wouldn't that allow the chlorophyll-a concentration in the lake to go higher?
17. Clifton B.: Yes, we need to decide if that is ok.
18. Bill H.: Martin showed that when station Y152C is at 35 u/L the remainder of the lake will be lower.
19. Pam B.: How you determine how you come to this number will inform the EMC on a path forward. We want these decisions documented very well.
20. Lauren P.: This could be written as a two-part criterion. 35 ug/L at station 152C with the remainder of the lake between 20-25 ug/L.
21. Astrid S.: Yes, that would reflect on any changes to other stations throughout the lake.
22. Martin L.: If you include a lake-wide component it would need to be defined by the number of locations. If we agree that 35 ug/L is protective of the uses, then we are splitting hairs.
23. Clifton B.: This standard would require a huge reduction in chlorophyll-a to see any changes.
24. Martin L.: The 20-25 ug/L is not a regulatory value. It is the target to get to the 35 ug/L. The 35 ug/L was back derived to assure meeting the 20-25 ug/L throughout the majority of the lake.

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25. Bill H.: The 20-25 ug/L is important to consider as it is the basis of the 35 ug/L. The 35 ug/L is contingent on the 20-25 ug/L being the correct range to protect the uses. Is the 20-25 ug/L range appropriate to start with?
 26. Marcel A.: Of the five proposals, only Lauren's is lower than the existing chlorophyll-a standard.
 27. Pam B.: An analysis done back in the day when the current chlorophyll-a standard of 40 ug/L was established equated the 40 ug/L as about equal to a geometric mean of 25 ug/L.
- xiv. SAC votes to narrow down the number of chlorophyll-a proposals to focus conversations going forward. No proposals are being eliminated from consideration at this time. Each SAC member gets 2 votes.
1. Results:
 - Proposal CB1 = 6 votes
 - Proposal LP = 4 votes
 - Proposal BH = 1 vote
 - Proposal ML = 8 votes
 2. Jenny H.: Martin and Clifton's proposals have risen to the top. Bill's proposal is at the bottom.
 - Clifton B.: Bill's proposal contains some good recommendations.
 - Bill H.: Ok to gray out his proposal.
 - Jenny H.: Asks SAC if they want to remove Bill's proposal for consideration.
 - i. Clifton B.: Ok to gray it out.
 - ii. Astrid S.: Not comfortable getting rid of it yet.
 - iii. Linda E.: Ok to gray out.
 - iv. Hans P.: Ok with all the proposals
 - v. Martin L.: Ok to gray out.
 - vi. Bill H.: Gray it out.
 - vii. Marcelo A.: Keep it.
 - viii. Lauren P.: Keep it.
 - ix. James B.: Gray it out.
 - x. Michael O.: Keep it.
 - xi. Supermajority not met so Bills proposal is kept.
- xv. Brian W.: Asks which parts of Bill's proposal would fit in with Clifton's.
1. Bill H.: Looking at Clifton's framework, I want to make sure that the chlorophyll-a numbers that make up the upper and lower bounds are correct. Would want to have some confirmation that these numbers are not over or under protective. Ex: The 40 ug/L as the upper bound would require a 30% reduction of chlorophyll-a in HRL even though we have already determined that there are no use impairments.

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- xvi. James B.: Should we continue to discuss Martin's proposal? Some people seem to feel that 35 ug/L is too high, others that it is too low.
- xvii. Jenny H.: Asks SAC members for their thoughts on the 35 ug/L from Martin's proposal.
1. Michael O.: Would like to compare it to past data from HRL. Would this be different, would it offer the same level of protection?
 2. Clifton B.: The 35 ug/L is at the bottom end of what I could vote for. Lower would be over protective and unobtainable in HRL. The 35 ug/L falls with my framework.
 3. James B.: I like Martin's proposal as is. It requires a significant reduction of chlorophyll-a in the lake and falls within Clifton's framework. It's a good compromise.
 4. Lauren P.: I want to better understand it, but I like it overall.
 5. Marcelo A.: Feel that it is under protective. Would like to see a lower number.
 6. Bill H.: The 35 ug/L is too low. It will require 40-50% reduction in chlorophyll-a to show the same level of compliance as the current standard.
 - Marcelo A.: How do you come up with 40-50% reduction?
 - Bill H.: The geomean of chlorophyll-a in HRL is ~50 ug/L. To get down to 35 ug/L you would need 40-50% reduction.
 7. Martin L.: It's a great number. Regulatory mechanisms will drive it down.
 8. Hans P.: I can live with the 35 ug/L. Probably can't get any lower in the lake.
 9. Linda E.: I would vote for Clifton's proposal to maintain the fishery but can live with the 35 ug/L. Would like it to be higher.
 10. Astrid S.: I like the 35 ug/L. Would like to have a discussion concerning spatial and temporal components.
 11. Jenny H.: Most SAC members seem comfortable with the 35 ug/L with some areas still needing some discussion.
 12. Clifton B.: Possible path forward:
 - Do up/down vote on each proposal
 - Vote in reverse order of popularity (Lauren, Clifton, Martin)
 - Vote for preference out of Lauren, Clifton and Martin
 13. Jenny H.: Each SAC member votes once for their favorite.
 - Results:
 - i. Proposal CB1 = 3 votes
 - ii. Proposal LP = 1 vote
 - iii. Proposal ML = 6 votes

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14. Jenny H.: Each SAC member votes once for their favorite after removing Lauren’s proposal for consideration.
 - Results:
 - i. Proposal CB1 = 3 votes
 - ii. Proposal LM = 7 votes
15. Jenny H.: Each SAC member votes once for their favorite after removing Clifton’s proposal for consideration.
 - Results:
 - i. Proposal ML = 10 votes
16. Jenny H.: SAC members up-vote Martin’s proposal. Some parts of proposal need to be fleshed out still.

Day two – December 4, 2018

1. **Review of Designated Uses** (Jenny Halsey, Brian Wrenn)
 - a. Discussion to relate Martin’s proposal for a chlorophyll-a criterion to the designated uses for HRL. All uses need to be protected, the purpose of this discussion was to ensure that there is documentation showing all uses have been considered. The following designated uses of High Rock Lake were discussed:
 - i. Fishing
 1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect for fishing.
 - ii. Secondary recreation
 1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect for secondary recreation.
 - iii. Fish consumption
 1. SAC members agree that this use is not applicable for chlorophyll-a.
 - iv. Wildlife
 1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect for wildlife.
 - v. Aquatic life
 1. SAC agrees that the 35 ug/L is protective of aquatic life in HRL.
 2. Some discussion was had regarding the potential for limiting the dominance of cyanobacteria (blue-green algae) in HRL.
 - Linda E.: The 35 ug/L will not necessarily limit dominance of blue-green algae in HRL.
 - Hans P.: Agrees with Linda. Blue-greens are quite dominant in lakes and reservoirs.
 - vi. Agriculture

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1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect for agricultural uses.
 - vii. Primary recreation
 1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect for primary recreation.
 - viii. Water supply
 1. SAC members feel that Martin’s proposed chlorophyll-a criteria will protect HRL as a source of drinking water.
2. **Chlorophyll-a criteria proposal document development** (Jenny Halsey, Brian Wrenn)
 - a. Discussion to work out the details of the document describing the chlorophyll-a criteria proposal that the SAC has chosen to proceed with.
 - b. James B. has offered to be the lead for this.
 - c. SAC members go create an outline for the document and assign members to prepare sections.
 - d. James will distribute section for SAC members to write and will make sure that all sections are completed.
 - e. Timeline:
 - i. Working draft ready for the February 2019 SAC meeting
 - ii. Completed draft for the April 2019 SAC meeting
3. **Nitrogen discussion** (Jenny Halsey, Brian Wrenn)
 - a. Pam B. reviews the HRL model
 - i. HRL was grouped into three areas for model results evaluation (mid-lake, mid to lower lake, and lower lake)
 - ii. Discussion:
 1. Martin L.: Was the data used from the warm season?
 - Pam B.: It was for the entire 5-year modeling time period.
 2. Bill H.: Referring to the graph: It appears that the line for phosphorous is increasing as the line for nitrogen begins to decrease. Can you explain that?
 - Pam B.: Not sure. It may be an artifact of how the line was drawn.
 3. Hans P.: Does the model consider light input? You can have high nutrient loads in a system and not see increased chlorophyll-a downstream due to light being reduced by turbidity.
 - Pam B.: The model does use light, but incorporating turbidity is challenging.
 - James B.: How does the model incorporate light?
 - Pam B.: The model produces light limitation conditions. Also couples this with temperature.
 4. Bill H.: The upper portion of HRL is impaired for turbidity. Will this be addressed somehow?

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- Pam B.: Yes. It is on the 303(d) list. Might be addressed by load or as a watershed restoration project.
- 5. Bill H.: Can the model be converted to use geometric mean?
 - Pam B.: Yes. It is just a matter of changing how we process model output.
- 6. Marcelo A.: Does the model include sediment?
 - Pam B.: Yes, but we don't apply reductions based on sediment loading because we can't control the internal loading in HRL.
- 7. Clifton B.: This is a modeling judgement. Other models can provide other information.
 - Pam B.: We have discussed this for Fall's Lake, but there's not enough data for HRL.
- 8. Michael O.: Can the relationship between flow and chlorophyll-a be used to project scenarios for future changes?
 - Pam B.: We can look into this.
- 9. Martin L.: On a sensitivity basis, it may not be a one-to-one relationship. Also, to reduce total nitrogen and total phosphorous, management plan will have to consider reducing sediment load.
- 10. Jay S.: Can the model address the frequency of the new chlorophyll-a criteria being proposed by the SAC?
 - Pam B.: The model will predict chlorophyll-a concentrations four times per day. This can be adjusted.
- 11. Hans P.: Does the model consider regeneration rate of nitrogen and phosphorous?
 - James B.: That is in there. Inorganic N & P is ultimately what is modeled which is what phytoplankton growth is based on.
 - Pam B.: We haven't used the model yet to set N & P criteria.
- 12. Hans P.: Referring to the graph: Does this mean that P is very limited until periods of high growth when N kicks in? What is the green [phosphorous] line showing. Is it that P is limiting unless light is limiting until summer when N is then limiting?
 - Nathan H.: HRL is N limited in summer and either light or P limited in winter.
- iii. Brian W.: Part of the mission statement for the NCDP is to look at nutrient criteria. Does the SAC feel that there is a need for N & P criteria in HRL? There are many paths to address this. DWR has gone down the action level/threshold route before with limited effect. What does the SAC think about this?
 - Hans P.: We had some early discussion concerning nitrogen fixation. Do we need to be concerned with this or denitrification?

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- i. Linda E.: The dominant cyanobacteria taxa in HRL are, supposedly, not capable of fixing nitrogen. Does DWR have an idea of what the dominant taxa are?
 - ii. Leigh S.: I haven't looked at the taxa for HRL. Probably *Cylindrospermopsis*.
 - iii. Hans P.: This is important to know. If there is a lot of potential for nitrogen fixation that would impact the development of an N standard.
 - iv. Bill H.: Does the HRL model address nitrogen fixation?
 - v. Pam B.: Nitrogen fixation is not explicit in the model.
- Clifton B.: The question is should we develop N & P criteria for HRL? I think we already manage the system via permitting and watershed.
 - i. Lauren P.: Do you not want concentration values?
 - ii. Clifton B.: We don't need N & P concentrations. We need loads and management strategies. I don't know if we can establish load-based criteria. TMDLs have worked in the past to set load requirements without establishing new criteria.
 - iii. Lauren P.: Management strategies are usually legislative actions. Is the SAC able to make recommendations for these?
- Hans P.: Are we talking strictly about total N & total P or are we considering biological forms of nitrogen as well?
 - i. Clifton B.: This has typically been done for total N & total P.
- Pam B.: If a water body is impaired we need a TMDL or equivalent action. In HRL we can do a TMDL or a management strategy. Stakeholders prefer strategies because there are more players involved (point & non-point). This would require rule-making.
- Jim H.: Also consider that nutrient management strategies that we have developed have been on hold for a long time. Options for HRL are wide open. Could incorporate a load component.
- Martin L.: There are two cases we can consider:
 - i. Chlorophyll-a is in attainment – what N & P do we need to satisfy this?
 - ii. Chlorophyll-a in not in attainment – need to do something like a TMDL to address non-point sources.
- Bill H.: I agree with what Clifton said about setting N & P criteria. However, we are charged with setting numbers for N & P.

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- i. Clifton B.: I don't think we need to come up with N & P numbers.
 - ii. Bill H.: We would still need some justification for why we didn't come up with N & P values.
- Martin L.: The chlorophyll-a criteria we are considering will bring nutrient levels down to a sufficient level. Afraid if we adopt N & P numbers as well we may drive productivity down too low.
- James B.: Agree with Clifton. The chlorophyll-a criteria are sufficient. A translator would be a mechanism to back up from the chlorophyll-a target to get a measure of nutrients to relate to chlorophyll-a concentrations. This can be done via a mechanistic (stressor-response) or empirical model.
 - i. Connie B.: This is a challenge we constantly face. We have a control mechanism (the existing chlorophyll-a standard), but it is constantly challenged.
 - ii. Jim H.: Generally speaking, we've made a good effort with management strategies. EPA was pushing for the establishment of N & P criteria. We wanted to host this discussion. Maybe the current approach is enough, but there is room for discussion.
 - iii. Pam B.: Regarding the need of a translator: the curve from the model can be considered a translator. You can look at the existing science to help inform your discussions.
 - iv. Jim H.: Any selection on the curve gets us to compliance with the standard. Does the group agree that the curve is appropriate to use as a translator?
- Michael O.: I'm in favor of moving forward. There is a current water supply standard of 10 mg/L which is not nutrient based. This falls at the threshold for eutrophication.
- Lauren P.: What makes sense then? Without N & P concentrations how can nutrients be reduced when chlorophyll-a is too high? Is N off the table? Can it be approached as a load?
 - i. Brian W.: Does a numeric concentration help set load limits?
- Clifton B.: In-stream concentrations might be more appropriate by incorporating mixing. For a lake we would still need a model for the watershed.
 - i. Bill H.: It would be difficult to set a single concentration value based on a model.
- Lauren P.: Is there a scientific-based approach for addressing this?

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- i. Linda E.: Other states have worked under the assumption that only P was necessary to limit. New data is showing that there is a correlation with N as well.
 - ii. Hans P.: Based on our work in China, we can limit N and not have to worry about shifting phytoplankton species. There are now reservoirs of P in many lakes. We can start with limiting N in lakes and monitor the situation to see if changes need to be made.
- Bill H.: If P is reduced and N increases, will that affect phytoplankton populations?
 - i. Hans P.: There will be an increase in biomass.
 - ii. Nathan H.: Based on lab experiments and data from the National Lakes Assessment the highest biomass is seen in lakes with excess nitrogen.
- Bill H.: If we make HRL P-limited, would that reduce occurrence of cyanotoxin events?
 - i. Nathan H.: Possibly (based on the National Lakes Assessment data).
- Jim H.: It sounds like there is some buy-in for going the route of establishing a P-reduction for HRL. It will be helpful for us to know what scientific support there is for this.
 - i. Hans P.: May not actually see water quality benefits. This happened in Lake Erie. P was limited, but N increases. Now the lake experiences blooms of non-nitrogen fixing *Microcystis*. Need to control both N & P.
 - ii. James B.: HRL has a low residence time. Expect that sediments/nutrient reservoirs are less important to N loading. Need a model that can help to look at this instead of just guessing. Even with a model we would still be guessing somewhat.
 - iii. Pam B.: Keep in mind that this reservoir is about 100 years old now.
- Bill H.: How does the model handle sediment loading?
 - i. Jing L.: There is not enough data to develop a spatial distribution. P values from the sediment are applied seasonally to the segments in the region.
- Hans P.: Even with the short residence time there is still a lot of P in the system. Denitrification is important to know to be able to set a load. Nitrogen fixation is typically low in these systems due to light limitation resulting from high turbidity.

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- i. Michael O.: Looking at the data from HRL the dry periods that have lower residence times are associated with higher chlorophyll-a values. This may be a good place to start.
 - ii. Nathan H.: There is a negative relationship between nitrate and chlorophyll-a. Nitrate is most of the load going into HRL.
 - iii. James B.: High N in winter is ok because it is cold and dark, hence less plankton production. In summer, N is low, but chlorophyll-a is high. This is why regulating based on an N concentration is not good.
- Brian W.: Trying to gauge how we spend our time going forward.
 - i. How many SAC members feel that we need numeric N & P concentrations for HRL?
 - 1. 2 SAC members agree that N & P numeric criteria are needed.
 - ii. How about a concentration or a loading requirement?
 - 1. 2 SAC members agree that either a concentration or loading requirement is needed.
 - iii. How about those that do not want numeric N & P criteria for HRL?
 - 1. 6 SAC members agree that no numeric criteria are needed.
- Linda E.: If implementing concentrations may want to go back to the assessment units.
- Martin L.: Loads are useful for tracking. Criteria require looking at long periods of time. Tracking chlorophyll-a and applying a nutrient management is a good strategy. Might be hard to translate this to a state-wide application though.
- Bill H.: If going with concentrations would need to set concentration for both N & P not for just one of them.
- Hans P.: It is difficult to equate primary production to N & P concentration in light limited systems.
- Martin L.: Are there gaps in the current approach using chlorophyll-a with nutrient management strategies?
 - i. Jim H.: We have not been successful in doing this where we have tried. I don't think that would change if we have different criteria.
- Hans P.: Concerned with have a P only reduction strategy.
 - i. Martin L.: Are you asking the group to consider both N & P criteria?

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- ii. Hans P.: Yes.
- Clifton B.: N & P concentration could be part of the answer. Are there concerns with the model? It is conservative in its prediction of a response curve, but it does not consider internal cycling.
- Jing L.: Only loading is reduced. The model is good for predictions but is not perfect. It is based on what we can do.
- Martin L.: I am comfortable with both N & P being considered as part of a management plan.
- Brian W.: Do we need to take time to consider this? If the SAC does not desire to set N & P criteria, then we can move on.
 - i. Lauren P.: I feel like we are missing some academic representation. I would like to put something together based on what other states have done.
 - ii. Brian W.: Let's return to this discussion during the February SAC meeting then. For now, we can take the remainder of the day to further discuss the chlorophyll-a proposal document, decide which water body to focus on next, circle back to the other HRL parameters...
- James B.: We may be ready to look at state-wide lakes.
 - i. Brian W.: That is an option. Something to consider is that the Albemarle Sound is currently experiencing nutrient related problems. We have a lot of information available for this system.
- Hans P.: The reason for the dual N & P approach is the connection between lakes and rivers and coastal areas. State-wide N & P criteria could have ramifications.
- Bill H.: Concerned with fate issues. N & P may not make it downstream.
- Martin L.: Concerned about being overly prescriptive.
- Hans P.: Fresh water systems intimately tied to salt water systems. Anything that we decide for reservoirs will impact estuaries.
- Clifton B.: We already dedicated time through October for working on HRL. We can flesh out some of the state-wide concerns. More likely to use other parameters in a state-wide framework.
- Brian W.: Regarding the schedule:
 - i. February 2019: Complete N criteria
 - ii. April 2019: Complete P criteria, bioconfirmation component, and working draft for the chlorophyll-a proposal

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iii. June 2019: Revisit other HRL parameters

iv. August & October 2019: Open

4. **Chlorophyll-a proposal document outline** (Jenny Halsey, SAC)
 - a. Section 1 - Introduction
 - i. James B. will serve as chapter lead.
 - ii. Lauren P. and DWR staff will contribute.
 - iii. Part 1.1 – Existing chlorophyll-a standard (DWR staff)
 - iv. Part 1.2 – Overview of SAC approach
 - b. Section 2 – Literature review of chlorophyll-a and use attainment
 - i. Nathan H. will serve as chapter lead.
 - ii. Part 2.1 – Fish & aquatic life (Marcelo A., Nathan H., Hans P.)
 - iii. Part 2.2 – Potable water supply (Bill H.)
 - iv. Part 2.3 – Recreation (Linda E., Astrid S., Bill H., James B.)
 - v. Part 2.4 – Other uses (no one assigned)
 - c. Section 3 – Current conditions in High Rock Lake
 - i. James B. will serve as chapter lead.
 - ii. 3.1 – Spatial patterns (no one assigned)
 - iii. 3.2 – Temporal patterns (Marcelo A.)
 - iv. 3.3 – Relation with other indicators:
 1. 3.3.1 – DO (Clifton B.)
 2. 3.3.2 – pH (Martin L.)
 3. 3.3.3 – Clarity (Michael O.)
 4. 3.3.4 – Algal taxonomy (Linda E.)
 5. 3.3.5 – Algal toxins (Astrid S.)
 - d. Section 4 – Narrative use attainment in High Rock lake
 - i. Part 2.1 – Fish & aquatic life (Marcelo A., Nathan H., Hans P.)
 - ii. Part 2.2 – Potable water supply (Bill H.)
 - iii. Part 2.3 – Recreation (Bill H.)
 - iv. Part 2.4 – Other uses (no one assigned)
 - e. Section 5 – Recommended framework for site-specific criteria
 - i. Clifton B. will serve as chapter lead.
 - f. Section 6 – Proposed site-specific criteria for High Rock lake
 - i. Martin L. will serve as chapter lead.
 - g. Section 7 – References
 - i. No one assigned as chapter lead.
5. **Wrap-up** (Jenny Halsey, Brian W.)
 - a. Next SAC meeting will be February 26th, 2019.
 - b. Upcoming CIC meeting will be January 23rd, 2019.

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