Attendees

**SAC members in attendance:**

Lauren Petter

Bill Hall

Linda Ehrlich

Clifton Bell

Deanna Osmond

Michael O’Driscoll

James Bowen

Martin Lebo

Astrid Schnetzer

**SAC meeting facilitator:**

Andy Sachs

**NCDEQ DWR staff in attendance:**

Jim Hawhee

Tammy Hill

Mike Templeton

Connie Brower

Pam Behm

Jing Lin

Christopher Ventaloro

Mark Vander Borgh

Jeff Manning

Jucilene Hoffman

Bonghi Hong

Nora Deamer

Brian Wrenn

Elizabeth Fensin

Christofer Vande Zande (DWR intern)

**CIC members in attendance:**

In person:

Andy McDaniel

Anne Coan

Doug Durbin

**Participating audience members:**

Jay Sauber

Forest Westall

**Meeting materials** can be found on the Division of Water Resources Nutrient Criteria Development Plan Scientific Advisory Council webpage. Click [here](https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/nutrient-criteria-development-plan/scientific-advisory-council) for a direct link.

Meeting notes

\*\*\*All questions, comments and answers are paraphrased\*\*\*

1. **Convene** (Andy S. Sachs)
	1. SAC members, DWR staff and audience attendees provide names and affiliations.
	2. Facilitator asks for approval on meeting notes from March 22, 2017 SAC meeting (meeting #12)
		1. Bill H. has comments and will email them to Brian. Comments are mostly focused on discussions surrounding topics.
	3. September 27 & November 15, 2017 have been identified as the best dates for the next SAC meetings.
2. **Presentation: *Preliminary Analysis of Microcystin and Cylindrospermopsin Dynamics in High Rock Lake during Summer of 2016*** (Astrid S. Schnetzer)
	1. Overview:
		1. Analysis was done for main stem of HRL using Solid Phase Adsorption Toxin Tracking Samplers (SPATTs) & grab samples
		2. SPATTs provide a semi-quantitative measure of a cumulative signal of cyanotoxins over the exposure period
		3. SPATTs are analyzed using ELISA test kits
			1. Pros: Time-integrated analysis of cyanotoxins, Easy to deploy and recover
			2. Cons: Semi-quantitative, over saturation of resin may occur, results reflect an average of the period of exposure, cannot link results to current regulatory guidelines.
	2. Comments/questions:
		1. James B.: Can volume be accounted for?
			1. Astrid S.: No, not for SPATTs measurements, but values for dissolved levels are normalized for volume for grab samples
		2. Mike O.: What is the minimum time that the SPATTs should be deployed?
			1. Astrid S.: Can be done weekly at a minimum. If the concentrations in the water are high enough there might be a measurable result in less than a week. We have no experience with this.
		3. Bill H.: Are there known interferences that may affect results?
			1. Astrid S.: From what we have seen so far, no. We continue to investigate this.
		4. Linda E.: Can biofouling be an issue?
			1. Astrid S.: Yes.
		5. Jim H.: Will toxins leach out from the resin during the deployment period?
			1. Astrid S.: This is likely negligible. It would depend on the toxin and/or resin. Ammonium acetate is required to extract the toxins from the resin.
		6. Jay S.: Are the results as total or dissolved toxin and are they for more than one congener?
			1. Astrid S.: SPATTs are accumulated dissolved, grab samples are dissolved, ELISA kits can test for multiple congeners.
		7. James B.: Did each of the SPATTs have the same deployment time?
			1. Astrid S.: Yes.
		8. Bill H.: Do each of the SPATTs have the same volume of resin?
			1. Astrid S.: Yes. They each contain ~ 3 grams of resin. We weigh them prior to deployment to be sure.
		9. James B.: Do you have any thoughts on why the grab sample results tend to be lower than the results from the SPATTs?
			1. Astrid S.: It’s hard to make direct comparisons between grab samples and SPATTs. Since the SPATTs are accumulating toxin over time, they often need to be diluted prior to analysis. Grab samples can be run straight. This may account for differences in results.
		10. Bill H.: Can you make direct comparisons for different toxins detected by the SPATTs?
			1. Astrid S.: Not really. Different toxins are different molecules. They adsorb and elute at different rates. Based on our preliminary analyses, recovery of microcystins is the most efficient.
		11. Deanna O.: Do you have thoughts on why toxins show up in some areas and not others?
			1. Astrid S.: Don’t have the data to say for certain, but probably due to natural variability. Studies have not provided information on this yet.
		12. Anne C.: Are studies being done to consider this?
			1. Astrid S.: Yes.
		13. Doug D.: Is there companion data for chlorophyll-a and algal volume?
			1. Astrid S.: Yes. We will be looking at this data.
		14. Forest W.: Have you considered doing more intensive sampling?
			1. Astrid S.: Yes. The information from this analysis will help guide future sampling efforts.
		15. Jay. S.: The results of this analysis would suggest that this is good news. Microcystin levels are lower than current guidelines which also have added protections built in. Food web exposures can be difficult to assess. Would tissue analysis pose problems?
			1. Astrid S.: Word of caution: SPATTs are done as single toxins and do not consider the effects of combined toxins.
		16. Jay S.: Is there information on the degradation pathways of these toxins?
			1. Astrid S.: Not sure if there is information on this.
		17. Bill H.: Have sediment level studies been done to see what, if any, concentration of toxin may settle out with algal cells?
			1. Astrid S.: Studies are being done to look at toxin levels in deeper waters and in sediment.
		18. Linda E.: Do we know which species produce which toxins?
			1. Astrid S.: It is difficult to say at this point.
		19. Connie B.: Do you have a sense of the reproducibility of the results obtained through analysis of SPATTs?
			1. Astrid S.: It comes down to laboratory practices. The microcystin and cylindrospermopsin ELISA test kits have been sanctioned by EPA for use in toxin analysis, though they have not yet been adopted into the 40 CFR methods.
		20. Forest W.: Reproducibility is important when considering regulatory implications. May need different monitoring protocols to protect for different uses.
			1. Connie B.: To EPA’s credit they are allowing for the recreational cyanotoxin criteria to be adopted as either criteria or swimming advisories.
			2. Astrid S.: Everything I have seen so far regarding reproducibility is very conservative.
		21. Bill H.: Is any of the fouling that has occurred on the SPATTs been due to cyanobacteria?
			1. Astrid S.: We’ve checked for that and no, it hasn’t.
			2. Mark V.: Most of the fouling is due to bryozoans. Toxin producing species are not periphyton-like.
		22. Jim H.: We are not seeing a concern with the level of toxins being reported using these SPATTs. Is there an opportunity to poll the group on whether we should move toward establishing criteria for toxins vs. going the route of swimming advisories?
			1. Andy S.: Last thoughts?
				* Linda E.: These levels are not concerning. No need to proceed with toxin criteria.
				* Martin L.: Agreed. No need for regulatory criteria for toxins.
				* Mike O.: I’d be interested to see other similar systems to get an understanding of where HRL falls.
				* Clifton B.: We should look at this beyond HRL. I recommend we keep algal toxins on the list as a possible criterion for future discussion. We should not attempt to develop numeric criteria for toxins, but maybe develop a narrative statement for all lakes.
				* Bill H.: Agree.
				* Astrid S.: The SPATTs show that it is there and accumulating. The chance that we hit a bloom event is unlikely.
				* Jim B.: There is uncertainty with what’s being measured with SPATTs and grab samples. This may not necessarily be an issue for HRL, but it may be for reservoirs in general.
3. **Evaluation and Resolution: DO criteria qualifier for “natural conditions”** (Clifton B. Bell, Bonghi H. Hong)
	1. Clifton B.:
		1. Follow-ups to March 22, 2016 Nutrient Science Advisory Council Meeting – see meeting materials
		2. From March SAC meeting: We agreed to maintain the existing criteria, but there was discussion around further defining “natural conditions”.
		3. Proposed strawman narrative provides a starting place to discuss how we might define “natural conditions” for the DO standard. The strawman narrative is:
			1. “For reservoir waters that exhibit thermal stratification, the dissolved oxygen criteria only apply to the epilimnetic waters. In practice, dissolved oxygen criteria in High Rock Lake will be assessed using surface samples. For epilimnetic waters, natural conditions might also lower DO concentration due to meteorological or hydrologic events that cause sudden destratification or loss of light in the photic zone. Other natural conditions may also be considered.”
			2. This narrative:
				* Expands on the current language for bottom waters
				* Specifies that only surface water sampling should be done
				* Reflects on our discussion concerning the impact of various naturally occurring events on DO concentrations in HRL
	2. Bonghi H.:
		1. High Rock Lake “Turnover”: Frequency and Spatial Extent – see meeting materials for presentation.
		2. Data obtained from Ambient Monitoring System
			1. Include surface to bottom measurements
			2. Focused on mainstem monitoring stations
			3. Can illustrate frequency of turnover events
			4. In growing season, temperature and DO stratification are expected, but can be difficult to identify the epilimnion and thermocline
	3. The main message from the presentation is that destratifications (mixing events estimated from the surface-to-bottom temperature differences) happen quite often in High Rock Lake, even during growing season, especially in the shallow portion of the lake However, surface low DO (<4 mg/L) that occurred together with these destratification events are very rare, less than or equal to 2% of the entire observational data at the main stem stations shown in the presentation.
	4. Comments/questions:
		1. Andy S.: What is the implication of this to the SAC’s decisions regarding a DO criterion?
			1. Clifton B.: Should avoid criteria that involves determining the depth of the thermocline.
			2. James B.: There needs to language that’s says that natural conditions can reduce epilimnetic DO.
			3. Bill H.: To use this strawman language, we need to address the thermocline
			4. Brian W.: From the previous discussion, I was under the impression that we would be discussing the different types of meteorological conditions that might influence DO. The existing DO standard already addresses natural conditions. Also, do we want to address these rare events when our monitoring methods cannot resolve them?
			5. Jim H.: Any language that gives us more discretion would have a difficult time passing through the Rules Review Committee (RRC)
			6. Martin L.: Assess surface water for frequency of excursion, not bottom water. We have a low frequency of events that occur at the epilimnion. The current assessment methodology (>10% exceedance with 90% confidence) will capture these rare events.
			7. Jing L.: Two things, (1) turnover is not a good expression to use here since destratification events shown in the presentation are often local phenomena, not the seasonal spring/fall systematic turnover (2) if we exclude occurrences of low DO at the surface due to mixing from bottom waters, shall we also address what is going on in the bottom waters?
			8. Bill H.: I presented some of this at the last meeting. A lot of sampling showed that DO was < 4 mg/L at the surface. It does occur. I also discussed frequency of sampling.
			9. Lauren: I like the idea of not trying to control for these rare meteorological events.
		2. Andy S.: Do we have consensus to maintain the current DO standard for HRL?
			1. SAC members: Consensus reached. The existing DO standard will remain in place without modification.
4. **Evaluation and Resolution: pH proposals** (Clifton B. Bell, Jing L. Lin)
	1. Clifton B.: Quick recap of discussion from previous SAC meeting. Some things to follow up with:
		1. Keep existing pH standard of 6.0-9.0
		2. Proposed site-specific pH standard of 6.0-9.5
		3. Lauren P. discussed examples from other states
		4. Literature reviewed showed that pH of 9.5 is OK for non-salmonid species
		5. There is little correlation between chlorophyll-a and pH. Changes to chlorophyll-a standard may not impact lake pH levels
	2. Jing L.:
		1. pH Considerations in High Rock Lake
		2. See meeting materials for presentation
		3. Summary of presentation:
			1. Many references show harmful physiological effects to various fish species when exposed to high pH
			2. Documented avoidance behavior by fish exposed to high pH
			3. Ammonia toxicity becomes a concern as pH increases
			4. Rapid pH changes also cause impacts to fish health, especially as pH reached the upper tolerance limits
			5. Considerations when choosing pH criteria for HRL
				* Assessment methodology allows for 10% exceedance prior to declaring impairment
				* Criteria assessed using small sample sizes
				* Multiple stressors will also be a factor
				* Consideration of other uses 🡪 is the fishery the most sensitive use, downstream uses?

Per the Wildlife Resource Commission Portal Access to Wildlife Systems (P.A.W.S.) database, freshwater mussels have, in the past, been observed in two locations in the northern part of HRL and in one location in the waters just below the dam.

* + - 1. Water quality standards are established to prevent impacts to uses and should not be established near the threshold of impact.
	1. Clifton B.:
		1. Follow-ups to March 22, 2016 Nutrient Science Advisory Council Meeting – see meeting materials
		2. Comments on Jing L.’s presentation:
			1. Using tabular summaries, as Jing L. and I have done, can pose some problems:
				+ As summaries, they are not necessarily based on original research.
				+ They may also be summaries of summaries.
				+ A lot of these summaries are of older literature that we may not be able to locate and refer to.
			2. Concerning averaging periods:
				+ Averaging period used in reservoirs vary a lot.
				+ A 30-day average may be appropriate especially considering the potential for ammonia toxicity.
				+ Impacts to aquatic life would be mostly due to chronic exposure
				+ Acute impacts occur at pH >10.0.
			3. I’m not seeing information to suggest that a pH ceiling of 9.5 would be inappropriate in HRL.
	2. Comments/questions:
		1. Pam: A possible explanation for the poor correlation between pH and chlorophyll-a may be that different algae produce varying levels of chlorophyll-a.
		2. Martin L.: A lot of the pH rise would be countered by CO2.
		3. Doug D.: When you get to pH close to 10.0, there may be carbon limitations. Also, could be light limitation effects.
		4. Lauren: How many animals are stocked to replace die-off in HRL?
			1. Clifton B.: Only striped bass is stocked because they do not naturally reproduce in the lake.
		5. Jim B.: My take on Alabaster (see the meeting materials for this paper) is that there is uncertainty on the pH range of 9-10.0. Also, Alabaster was a summary of research. We would need to go back to the original papers to evaluate further.
		6. Jing L. (question to Clifton B.): Regarding the way you determined averages, what was your basis for dividing the lake into upper and lower regions?
			1. Clifton B.: Exploratory analysis. You can look at the lake in different ways and make divisions based on upper, lower, riverine. I don’t think that it would have changed the averages to do it differently.
		7. Jing L. (question to Clifton B.): Regarding the 3-meter depth. Do you assume that to be the mixing layer? What was the basis for choosing this depth?
			1. Clifton B.: I didn’t have the time to investigate this. I chose what I thought was a conservative value.
		8. Jucilene: How has the pH in HRL been changing over the years? Also, what species may have been there in the past?
			1. Clifton B.: My analysis was based on the 2016 summer study. I did not look at historical pH in HRL. Regarding the fishery, I think that the state has presented information that concludes that the fishery is in good health.
		9. Jim H.: How do you square away the pH ceiling of 9.5 with how we assess waters for impairment?
			1. Clifton B.: (Refers to the temporal analysis slide) There are not many excursions of the 9.5 and none >10.0.
		10. Bill H. (shows a plot of data from the 2016 summer study) A 30-day average is appropriate. The 2016 data shows that even when pH goes above 9.0, the 30-day average was below 9.0.
		11. Andy S.: What use are you all protecting?
			1. Clifton B.: If considering downstream uses, might have a different number right at the dam.
			2. Connie: I’m confused. The data that was proposed earlier suggested that harmful effects begin to appear at a pH of 8.5. Now that data is being questioned?
				+ Clifton B.: I’m not suggesting that I disagree with the older literature, I am suggesting that we use the literature that discusses direct effects on fish as opposed to that literature which only reports on broad effects (measured health effects to a specific species vs. decrease health of “warm-water fish”, for example).
			3. Astrid S.: There is also a difference when considering aquatic life that is mobile vs. that which is stationary. If freshwater mussels are in HRL then we need to consider that as well.
				+ Some discussion of mussels at this point. Refer to meeting materials for map that shows survey sites where mussels have been found in the past per the Wildlife Resources Commission Portal Access for Wildlife Systems (P.A.W.S.). DWR staff will follow up on the following questions by contacting Tom Augsperger (U.S. Fish & Wildlife Services):

Could we expect to find mussels living in HRL?

What types of habitat would they occupy in HRL?

Is there literature that discusses the pH tolerance of freshwater mussels?

* + - 1. Lauren: Echo’s concerns of multiple stressors and states that criteria should consider this.
		1. Bill H.: From the 2016 HRL summer data, the long-term average exceeded 8.5 through entire study. Also, pH needs to be considered separately for ammonia.
		2. James B.: I will need to review the literature before I can be comfortable increasing the pH standard to 9.5.
		3. Clifton B.: EPA’s “Red Book” refers to Alabaster which is derived from salmonids. It also discusses other stressors.
		4. Mike O.: Regarding flow: If the flows in HRL are trending towards being lower, then we might want to be more conservative.
		5. Linda E.: I can go either way. Keeping the current pH standard may be more appropriate as it already allows for some exceedances.
		6. Astrid S.: Eutrophication in HRL will not decrease. Temperature will also increase. May be best to stay conservative and keep the current pH standard.
		7. Jeff: Are we comfortable with calling the current conditions “natural”?
			1. Deanna: That goes back to considering a man-made system “natural”. Also, reservoir are known to change over time as they age.
		8. Martin L.: I’m more concerned about the potential 9.5-10.0 occurring. A water quality standard is not meant to be set at the threshold of effect, but before the effect with some degree of buffer built in.
		9. Jim B.: I see some possibility of using spatial averaging if the fish can move to unimpacted areas.
		10. Deanna: Need to consider if a pH of 10.0 will actually be seen if the pH standard is raised to 9.5.
		11. Linda E.: I’m confused about why we now need to consider mussels. I thought we were talking about the fishery. Do we know if they are still there?
			1. Pam: The point is that we have to consider all uses. This gets back to setting the management goal for criteria. What are we trying to manage for?
		12. Jay S.: Comments:
			1. Mussels live in the bottom waters, not in the surface waters.
			2. pH is a log scale. As pH increase one standard unit, there is a 10-fold change. You want to be sure that if you are going to increase the pH standard that this is considered.
			3. Regarding ambient monitoring system data: we made great improvement to the quality of the data starting in 2005.
		13. Connie: If it is decided to use seasonal averaging we could potentially write a rule to change the way we assess pH in HRL.
		14. Clifton B.: I don’t think that the current pH of HRL is impacting the fishery. If we can reflect that in a way that doesn’t increase the standard to 9.5, that is fine.
		15. Mike O.: Regarding other uses: We don’t have information to inform us if the pH of HRL is impacting the recreation use.
		16. Andy S.: Thoughts going forward?
			1. Lauren: Can we table this topic for now and move on? Maybe we can all look at the literature and other supporting information and continue this discussion via email?
			2. James B.: I think we need to carry on with this process and discuss how to move forward.
			3. Brian: Everyone go back, read through the literature sources that Clifton B. will provide, and develop proposals for pH. We will group them and then have a conference call to discuss. I will propose some dates for June.
			4. Clifton B.: I may not be able to get the documents out by that deadline.
1. **Preparation for chlorophyll-a discussion** (Andy S. Sachs, SAC members, DWR staff)
	1. Comments/general discussion:
		1. Brian will send out previous chlorophyll-a documents
		2. Clifton B. will share the write-up that he has.
		3. Astrid S.: It will be very important to consider how sampling was done. Was it 2x Secchi depth?
		4. Connie: The current standard is 40 ug/L. There was no indication of how this should be measured or of spatial or temporal considerations. This will need to be addressed.
		5. Pam: We can distribute the WRRI chlorophyll-a primer document.
		6. Mike O.: We need to look at the residence times in HRL. Lower flow results in more chlorophyll-a issues.
		7. Lauren: There is also an N-STEPS paper on this.