



## Criteria Assessment Protocol Workgroup (CAP) Meeting

Thursday, March 07, 2024  
1:00-3:10PM

### [Meeting Materials](#)

*This meeting was recorded for internal use to assure the accuracy of meeting notes.*

### Participants

VA DEQ: Tish Robertson, Bryant Thomas, Cindy Johnson, Joe Morina, Amanda Shaver  
VIMS: Carl Friedrichs, Cassia Pianca, David Parrish, Willy Reay  
Brown & Caldwell: Clifton Bell  
North Virginia Regional Commission: Norm Goulet  
MDE: Becky Monahan, Jacob Greene, Melinda Cutler, Matthew Stover  
MD DNR: Andrew Keppel, Renee Karrh, Mark Trice  
USGS: Peter Tango, Breck Sullivan, Gary Shenk  
EPA: Kaylyn Gootman, Juan Vicenty-Gonzalez, Suzanne Trevena, Lew Linker  
UMCES: Richard Tian, Rebecca Murphy, Qian Zhang  
Tetra Tech: Jerry Diamond  
ICPRB: Claire Buchanan  
Independent Statistician: Elgin Perry

### Action Items/Next Steps

- ✓ The Criteria Assessment Protocol Workgroup will use the work that Carl Friedrichs presented on as an approach for discussing development of salinity-based thresholds for chlorophyll, and translating narrative to quantitative criteria.
- ✓ The Criteria Assessment Protocol Workgroup will get a smaller working group together to work on methods for the short duration criteria.
- ✓ Discussions will continue on the issue of significant figures and rounding, with the next step to move forward being an independent review or workshop conducted by the Technical Advisory Committee (STAC) with input from water quality standards experts.

### Minutes

**1:00 PM**      **Welcome, Introductions & Announcements – Peter Tango (USGS), Chair**

#### **Upcoming Conferences, Meetings, Workshops and Webinars:**

- [National Conference on Ecosystem Restoration](#) – April 14-19, 2024, Albuquerque, New Mexico.

- Chesapeake Community Research Symposium – June 10-12, 2024, Annapolis, Maryland.

The meeting opened with a round of introductions as everyone stated their names, roles and agencies/organizations.

**1:20 PM**      [Combined In-Situ and Remote Sensing of Water Quality in Virginia Tidal Waters](#)  
– Carl Friedrichs, Willy Reay, Dave Parrish (VIMS)

#### Presentation Summary

Carl opened his presentation by thanking everyone who has worked on this project and sharing a little bit about the organizational structure of Chesapeake Bay National Estuarine Research Reserve (CB NERR). CB NERR and Virginia Institute of Marine Science (VIMS) have been working to balance and optimally combine two in-situ water quality sampling techniques: long-term, spatially distributed fixed monitoring stations with high resolution in time (continual monitoring, CMON or con-mon), and monthly Chesapeake Bay segment-focused, boat-mounted sampling with high resolution in space (DataFlow). Both of these techniques depend on YSI sondes calibrated with field water samples and lab standards, and data from both are posted on the Virginia Estuarine and Coastal Observing System (VECOS). The parameters measured are salinity, temperature, pressure, turbidity, pH, dissolved oxygen (DO), fluorescence (calibrated to chlorophyll), and they are starting to add fluorescent dissolved organic matter (FDOM). The CMONs are measured every 50 minutes, and DataFlow is sampled every 25 meters. NERR has been supporting the Chesapeake Bay Program (CBP) with CMON and DataFlow data since around 2003. Different segment groups have typically been sampled for around 3 years at a time. Carl showed the locations of past and present stations along with who runs them.

He then explained how shallow water monitoring is of value to both the modeling community and aids in better understanding of habitat suitability. The modeling community is interested in the value of fixed sites for long term reference in calibration and verification (i.e., CMON), and seasonal data (i.e., DataFlow) is more of interest for those wanting to better understand habitat suitability. The research question this project addressed was how to meet both of these data needs from shallow water and near-surface water quality parameters. One way to do so is by combining CMON, DataFlow, and water sampling with drone and satellite-based remote sensing; and utilizing machine learning to optimize remote sensing calibration and temporal interpolation.

Carl then discussed the proposed plans for 2024. VIMS/CB-NERRS Virginia talked with VA DEQ about building out a VA CMON network. Carl showed the map of proposed locations for CMON sites. They found from their own VECOS sites that long-term data has been used much more than the data that is only 3 years old at one place. The 3-year data is still important for the attainment and evaluation standards, though. It might make sense to concentrate the CMONS in places they've been in the past using long term sensors. Carl also showed the sites of the

Chesapeake Bay Interpretive Buoy System (CBIBS) locations in VA that CB-NERR has been maintaining the water quality sensors on for the last 10 years, and they have YSI EXO2s on all four of the VA CBIBS buoys. Long-term, VIMS-supported stations were added at two VA oyster hatcheries in 2020 and two Elizabeth River Project sites in 2021. In 2024, four additional, long-term CMONs will be deployed along the Rappahannock River. Future expansion is then likely to focus on the James River.

Carl then went into more detail on planned sites along the Rappahannock. Kendale Farm, Bowlers Wharf, & Christchurch would continue sites occupied in the Rappahannock during 2021-2023. Bowlers Rock is the location of a platform in the middle of the Rappahannock at the site of the former Bowlers Rock lighthouse. Carl then showed what a 2017 NASA DEVELOP program (a partnership between university students, NASA scientists and other scientists including those at the CBP) worked on. Using satellite sources (Landsat A and Sentinel 2), they examined satellite remote sensing of surface reflection and compared the turbidity results from the CMONs to in-situ measurements at the CMON stations. The results were promising but had limitations due to the shallow depth of the CMONs causing some bottom reflection, and shoreline affecting pixels close to shore. The return interval of the satellites was also relatively long (though since 2017 they have increased in resolution).

Carl then shared some ways to supplement satellite remote sensing with drones. NERRS put in an order for a 10 band multi-spectral drone camera with which to conduct a proof of concept. This has application to plankton blooms as well as turbidity. They plan to combine DataFlow EXO2 cruises in the York River estuary with simultaneous drone flights and satellite images. As an example, with data collection  $\pm 2$  hours around satellite passage (though this is an ideal scenario), DataFlow could calibrate drone images that then calibrate a swath of the satellite pixels. Carl showed a comparison of the overlap of MicaSense drone camera's 10 spectral bands with satellite bands from various satellites. Satellite data are freely available for research purposes for academic researchers, and even more data is available with a federal grant, depending on use of the data.

Carl shared how there has been an explosion of work in the past several years that is utilizing empirical algorithms for satellite driven water clarity products. Carl's PhD student had looked through all of the papers that had satellite water quality derivation in the Chesapeake Bay and the Mid Atlantic Bight. There are quite a few different components of the spectral bands that have been shown to be useful for water quality products. It may make more sense to use multiple bands at once and even use machine learning to look for several of them rather than home in on just one. Carl then shared the work of another PhD student who used optical equations to model  $K_d$  (diffuse attenuation coefficient), Secchi depth and turbidity from the constituents of the water column. This student used the data from the York River estuary and looked at how contributions changed based on the modeling to  $K_d$ , Secchi depth and turbidity. As the load of Total Suspended Solids (TSS) changes, the relative contribution to  $K_d$ , Secchi

depth and turbidity change. It makes sense to use all the information available in the different spectral bands.

Carl wrapped up his presentation by sharing his planned approach for transforming remote sensing reflectance into water clarity parameters: Utilize machine learning applied to all spectral bands shown to be relevant for water clarity; apply same methodology to bands from multiple satellites (expect > 15 clear sky images per month); apply machine learning to spectral bands from drone (albeit more “proof of concept” stage); and use DataFlow, CMON, and CBP “deep water” monitoring data to train machine learning. Dave Parrish started a PhD at VIMS and will be contributing to this work through his planned dissertation work.

### Discussion

KC Filippino (Hampton Roads Planning District) commented in the chat that it looks like some of those new (starred on the map) stations in the James previously had CMONs nearby, part of an old Hampton Roads Sanitation District/Old Dominion University initiative. Willy Reay (VIMS) clarified that only two of the buoys are operational with the full suite of water quality: Stingray Point and York. They’re hoping the DO arrays will pick up that lower section in the Rappahannock. When the DO arrays come to VA waters, they’ll be located a little lower than that and the channel will be covered. Dave Parrish (VIMS) added that on the slides there was an older map of 2024 planned con-mon locations that extended into the James, but the updated 2024 plan is just the Rappahannock. Dave also shared they are working on version two of DataFlow to allow better relationship building between fluorescence and actual chlorophyll levels. He said to stay tuned as will be tested this spring.

Low Linker (EPA) said it was a very encouraging presentation, and the proposed integration of data flow and shallow water monitoring is interesting.

Tish Robertson (VA DEQ) said she saw Carl’s presentation before and was very impressed. This approach would be excellent for the Criteria Assessment Protocol Workgroup (CAP WG) to use to come up with salinity-based thresholds for chlorophyll. They have the narrative criterion for chlorophyll in the Bay Waters and have not implemented that. The CAP needs to start thinking about how to start developing those thresholds. Spatially and temporally intensive approaches and developing data sets that tie chlorophyll to effects like turbidity would allow for the development of sensible thresholds. This is the right time to start thinking about how to do this. Dave Parrish has been doing the water clarity assessments for VA DEQ for many years, so Tish considers him the expert on this assessment. Tish suggested that CAP should revisit some of the procedural steps and equations that go into the assessment this year.

Peter agreed with Tish, saying that was a great concept and said there is a paper from Davis & Stumpf on how to translate narrative to quantitative criteria based on spatial and temporal density of detected data, after looking at a 12 or 15 year time set and agreeing what the no effects level was in that spatial assessment. That could maybe be used as a jumping off point in

the chlorophyll discussion. Revisiting the clarity procedures from the Advanced Monitoring STAC workshop is needed as well.

**1:50 PM**      [Technical Documentation Outline](#) – *Peter Tango (USGS)*

#### Presentation Summary

2017 was the last addendum and since then there are new tools and questions. There are a suite of tools and analyses typically documented, reviewed, and approved to form reference foundations. It's time for the next technical addendum to be developed, including the 4-Dimensional (4-D) interpolator, and other items. The timeline of when this technical addendum needs to be developed is now through 2026 so that it is available for 2027 when the 4-D interpolator will be available for use.

Peter then went through an outline of what this technical addendum could look like.

#### Discussion

Lew Linker (EPA) commented this is an excellent, timely and well thought out outline. The goal is to be completely open and transparent and have an assessment that anyone can do. Lew said that Tish has been very helpful in taking an early look. Looking at the original research and documentation, it has something like 6.0. It's a common mistake to say that 6.0 is the same as 6 but everyone on this call knows that is not true. This has particular standing going forward.

Bryant Thomas (VA DEQ) suggested that standards people are needed to be engaged in this work moving forward (in an activity such as a STAC workshop) as they are very specific regarding their application and expression.

Peter agreed.

**2:00 PM**      [Virginia Province approach to setting water quality dissolved oxygen \(DO\) criteria](#) – *Jerry Diamond (Tetra Tech)*

#### Presentation summary

The Virginia Province approach is the same as what EPA has used for toxics, with slight modifications. It relies on acute and chronic lab data for DO sensitivity that is very controlled, on four of the most sensitive species. Like all criteria it should have a frequency and duration associated. It is not necessarily a site-specific approach; in fact it is difficult to make it a site-specific approach due to data limitations. It requires knowledge of species that could occur, and DO sensitivity data for each species, or a taxonomically close surrogate. However, a taxonomically close species may not guarantee ecological similarity. Available DO sensitivity data is a major limiting factor in developing site specific DO criteria using the Virginia Province approach.

Jerry went over the steps to deriving the criteria using the Virginia Province approach. Most of the DO data used in the Virginia Province approach was from the 1970s. By 2000, there weren't as many publications looking specifically at DO. For the surrogates, they are up to family level of taxonomic similarity. The 4 most sensitive endpoints for acute and chronic sensitivity are identified, and DO criteria are calculated for those. A larval recruitment curve is also produced to guard against cases where the chronic criteria are not protective of larval stages of fish and invertebrates depending on their life history. Jerry then showed how surrogate selection works, using the San Francisco Bay slews and south San Francisco Bay as examples. Jerry explained the Criterion Minimum Concentration, Criterion Continuous Concentration, and Larval Recruitment Curve along with examples of these criteria and how they are calculated using Genus Mean Acute Value (GMAV). He showed a list of species with valid DO sensitivity data, both acute and chronic, although there is more data available for acute. The GMAV's significant digits vary; since they all come from a variety of investigators/researchers who may have followed different significant digit guidelines.

Jerry also pointed out that in the 2000 EPA VPA document, they list the salmonids as 5-6 mg/l. That is odd because it's a range, not one number. They didn't know what to do at the time. Salmonids were not in the acute database because there is not published appropriate lab acute data for sensitivity. There are limitations in the method based on the data available, and what data is considered usable by the Virginia Province approach and in criteria setting in general.

Jerry then went into the significant digit question, sharing guidelines from EPA criteria methodology from 1985 and VPA criteria methodology from 2000. Since 2000, instrumentation has gotten better so it is a good time to re-examine this question. Finally, he shared that an instantaneous DO acute criterion does not necessarily represent actual potential for harm to aquatic life, and chronic DO criterion should not be expressed as an instantaneous value. This is where continuous monitoring can be very helpful to inform the frequency and duration of low DO events. This data can be used in conjunction with lab data to develop averaging periods. Jerry wrapped up the presentation by giving an overview of the pros and cons of the VPA method for criteria setting.

### Discussion

Peter Tango commented in the chat: Amazing on the salmonids given their importance recreationally, commercially, culturally, and ecologically. Jerry - it sounds like you have teed up research opportunities regarding acute and chronic responses to D.O. for many unrepresented species!

**2:30 PM**      [Bay DO Assessment: DEQ's Near Term Plan and Looking Ahead to the 4-D Interpolator](#) – Tish Robertson (VA DEQ)

### Presentation summary

Tish started by providing a background of VA's water quality standards and assessment process. Over the past year DEQ did a self-examination of its Bay DO monitoring and assessment programs. This was driven by the desire to improve monitoring programs, incorporate all available data into Bay DO assessments, and assess all DO criteria so that the progress of TMDL implementation can be fully realized. DEQ does an excellent job of utilizing the discrete data, but there is some continuous data that is not be used for DO that could be. Tish shared the DO criteria that are currently assessed by the CBP and that were adopted by jurisdictions in 2005. She then went over DEQ's continuous planning process for water quality standards and all of the programs driven by these standards. These standards are regulation in Virginia. The VA State Water Control Board is the legislative body for water quality standards in VA; they approve all standards, and the EPA has to sign off on standards as well.

Monitoring data gets pulled together every two years. A team analyzes the data with respect to water quality criteria and puts together an Integrated Report as required by the Clean Water Act. Section 305b is the requirement to describe the state of the surface water with respect to water quality standards, and Section 303d is the impaired waters list, which is the first step of a clean up plan. The permit limits that are assigned to dischargers are also derived from water quality criteria. The scientists and engineers running the programs provide feedback every 3 years on the water quality standards, and that feedback is used to make modifications to the standards.

DEQ publishes assessment methodologies along with their Integrated Report published every two years. The Bay DO assessment methodology has not been updated since 2010, when Jeni Keisman developed the bioreference curve for the 30-day mean criterion. Last year the CAP Workgroup brought up the question of rounding in the context of the cumulative frequency distribution or CFD. Tish had expressed support for rounding. However, the procedure in the Bay assessment code does not have any rounding. At DEQ they consider rounding to be an essential step in criteria assessment. They have language in the water quality standards regulation that talks about significant figures, and it says that for DO criteria, the numbers that appear in the criteria are the significant figures. They interpret that to mean the figures that do not appear in the criteria are not significant and thus should not be used for decision making purposes. DEQ's water quality program guidance are built around this language. They also think rounding makes sense based on best practices in data science, applied chemistry and regulatory science.

The Bay DO criteria have a mix of precision; some have one significant figures and some have two. The 2003 technical support document explains why this is the case. Tish then went over Bay DO assessment methodology and where VA DEQ believes rounding should occur. DEQ has written an R script that runs the Bay DO assessment procedure. The code follows the same basic procedural steps as the Bay Program with a key difference, which is that in DEQ's program they have a rounding procedure. They round the assessment values to the number of significant figures in the applicable criterion. The other difference is instead of using the

bioreference curve that Jeni Keisman developed, DEQ uses the default 10% curve for the deep water 30 day mean criterion. They do this because the bioreference curve that DEQ was using was based on the assumption that the criteria have infinite precision/infinite number of significant figures, which is not consistent, in DEQ's belief, with how the criteria were developed. Until they can develop a bioreference curve based on a rounded value, DEQ will continue to use the more stringent 10% curve.

DEQ's plan is to publish Bay DO assessment results for the 2020-2022 period in the 2024 Integrated Report (planned to be released in April 2024). These results will represent a process that respects significant figures. However, going forward, they plan to conduct DO assessments in-house using the tool they developed. DEQ will continue to work with the CBP partnership on assessment tools and methodologies, including the development of the 4-Dimensional interpolator which they still support. The issues DEQ would like to work out with the issue of criteria significant figures. DEQ would not be able to use the 4-D interpolator if it does not take into account criteria significant figures. DEQ would like to be a part of deciding where rounding occurs in the analysis. They believe the precision of the criteria is baked into the magnitude of the criteria. EPA does not recommend criteria with infinite precision. If there is a plan to make an alteration to Bay DO criteria precision, it would necessitate a rulemaking, as this would constitute an adjustment to the magnitudes of the criteria. It would not be a procedural change.

### Discussion

Peter Tango commented in the chat: It seems a helpful question could be that when criteria are set, are they set understanding the influence of the analysis process in how it influences interpretation of final results as a general criteria setting to reflect anticipated protections as expected?

Peter also commented in the chat: USEPA 2003 and 2017 proposed methods for covering more of the criteria durations than we have thus far. Points to visit in our first small team meeting on considering methods to move ahead with while also considering the 4D interpolator vision of attainment assessment.

Gary Shenk (USGS) thanked Tish for the presentation and said he agrees it is necessary to push to assess all criteria. He expressed appreciation for how Tish clearly explained the assessing procedure. Gary then shared that there is significant disagreement about that rounding step and this has been an ongoing discussion. It's a very significant change in how far out of attainment these areas are. In the deep channel, it would involve cutting the DO necessary coming out of the interpolator in half from 1 to 0.5. Gary said he was speaking for a few at the CBPO in saying that VA DEQ's interpretation is not consistent with the 2003 criteria document. He said that the intentions of this document were that 1 was a relatively bright line whether it's infinite precision or the 3 significant figures in CBP's current process, and that's how the interpolator always has been run. Gary added that criteria assessment procedures call for



assessing the amount of space and time that are below that criterion, and doing the rounding introduces a bias in that fraction of space and time below the criterion. He said his intention is to be consistent with what Peter originally brought up in that conversation in the CAP WG last year, which is that if there is to be rounding it should be done at the end of the calculation, which is all the way through the CFD. Gary wrapped up his comment saying that he agrees with Tish and Bryant's assertion that it is important to come to an understanding on this. He said he thinks a way forward is an independent review administered by STAC with standards folks having input in it. There is scientific opinion and then there is what regulators do with that information.

Bryant Thomas (VA DEQ) responded to Gary's comment saying the process for moving forward (via a STAC workshop) sounds good. There's some difference in how toxics are addressed vs how DO is addressed. He thinks there is a need for broader representation in the process. Bryant added that any new data, even if it is limited, should be brought into the process, because the Bay of the future won't necessarily be the Bay of the past, looking at warmer temperatures, for example. Are there different species that should be considered? It's been over 20 years, so it's worth considering new information even if that information is limited.

Peter said some of those programs out in California that Jerry spoke about had similar considerations and approach to using the best data available. He said he will call for a smaller group to dive into the methods of the short duration criteria to give direction to the 4-D interpolator and make sure everyone's needs are being met. There are the 2017 and 2003 methodologies to provide ideas about how to approach that. Peter said this small group will be a starting point and help with moving forward, both in the interim before the 4-D interpolator is available, and to set the stage for everything that it will need for support.

**3:00 PM**      **Next Steps** – *Peter Tango (USGS)*

**3:10 PM**      **Adjourn**