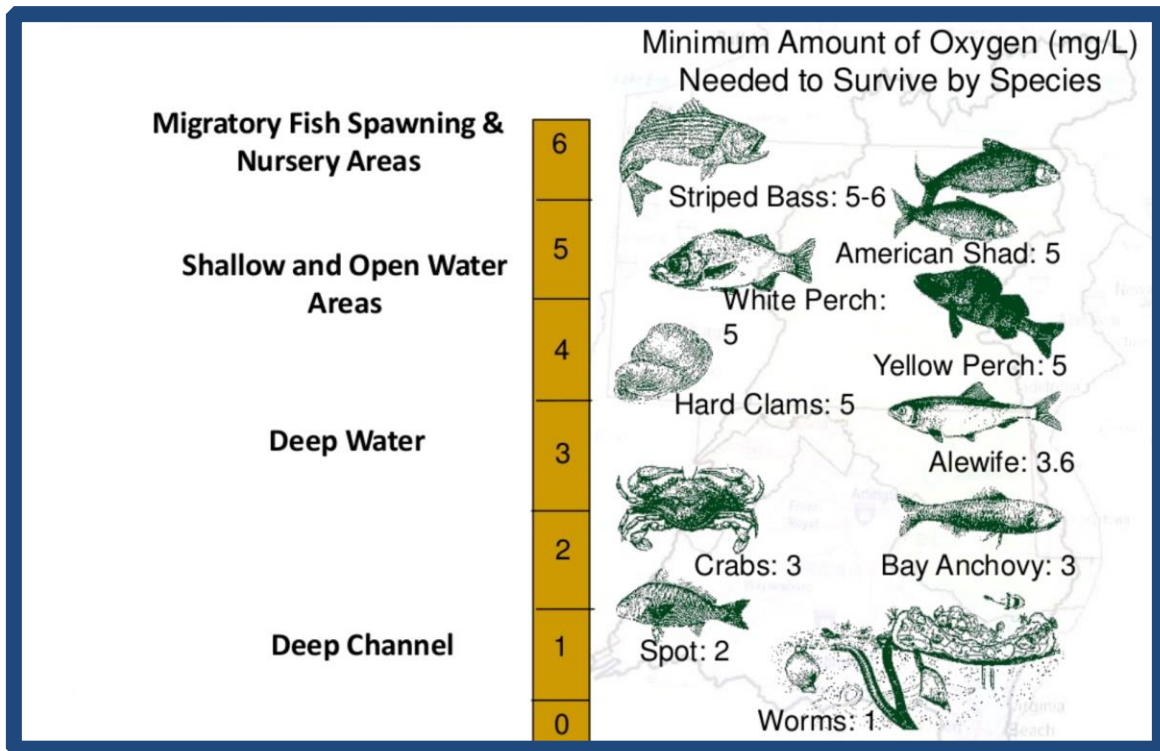


STAC Criteria Addendum Review:

Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries: 2017 Technical Addendum



STAC Review Report July 2017



STAC Publication 17-005

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Table of Contents

Executive Summary	5
Introduction and Background	6
Review of Chapter II	8
Review of Chapter III.....	11
Review of Chapter IV	12
Review of Chapter V.....	13
Review of Chapter VI.....	15
Literature Cited	17
Appendix A	18
Appendix B	22

Executive Summary

The Chesapeake Bay Program (CBP) partnership requested that the Scientific and Technical Advisory Committee (STAC) provide a scientific review of the 2017 Technical Addendum to the document: “Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll-*a* for the Chesapeake Bay and Its Tidal Tributaries.” This addendum was developed by the Criteria Assessment Protocol Workgroup of the Scientific, Technical, Assessment and Reporting (STAR) team, and provides refinements and clarifications to the previously published Chesapeake Bay water quality criteria assessment procedures.

The Criteria Addendum Review Team was selected based on their expertise in estuarine dissolved oxygen, submerged aquatic vegetation (SAV), chlorophyll, water clarity, statistics and application of water quality criteria in the context of a total maximum daily load (TMDL). The team was asked to address questions regarding the overall appropriateness and justification of the approach taken, the clarity of the document in providing a complete set of guidance for assessing water quality standards attainment, the scientific rigor of the methods used, and provide recommendations to the CBP about potential future enhanced criteria-assessment procedures.

As a general comment, the Review Team notes that a clearly written and complete documentation of the water quality criteria is extremely critical, given that billions of dollars are being spent on the basis of their development. The major findings and recommendations are summarized below, with details specific to each chapter provided later within this document.

Findings:

- The approaches taken in each chapter are generally appropriate and necessary, and will indeed lead to assessment of water quality attainment that is protective of aquatic life.
- In multiple instances, however, the panel found the rationale behind proposed changes and approaches to not be sufficiently well explained, and in some cases, the scientific rigor of the approaches were found to be weak and in need of correction in either the short or long term.
- The explanations of the approaches in some chapters were poorly defined, considering the many legal implications of the various criteria described.
- In some cases inadequate detail was provided, such that after reading the document two independent groups could interpret and calculate the criteria differently.

Recommendations:

- Whenever possible, new technologies should be incorporated into the criteria assessment procedures.
- The document must not provide disincentive for collecting high-frequency data that would allow Bay jurisdictions to better assess whether the standards are being achieved.

- Thorough justification for the water quality criteria assessment procedures should be clearly documented.
- Water quality criteria documentation should be written clearly enough for two independent readers to implement the procedures identically.

Introduction and Background

In early 2016, the Scientific and Technical Advisory Committee (STAC) of the Chesapeake Bay Program (CBP) assembled a team of scientists to provide a scientific peer review of the Technical Addendum to the document: “Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll-a for the Chesapeake Bay and Its Tidal Tributaries,” hereafter referred to as the Criteria Addendum document. This document provides refinements and clarifications to the previously published Chesapeake Bay water quality criteria assessment procedures. Specifically, the Criteria Addendum document:

- Provides a scientific basis for using a conditional attainment approach to assess short duration (e.g., 7-day mean, 1 day mean and instantaneous minimum) dissolved oxygen criteria,
- Provides support for an approach to sub-segmenting open water habitat that may be used to complete a dissolved oxygen assessment,
- Provides recommendations for assessing an instantaneous minimum dissolved oxygen criterion within sub-segments of open water habitat using best available assessment methods and associated attainment decision rules,
- Documents the basis for the development of a multi-metric Chesapeake Bay Water Quality Indicator for tracking progress,
- Establishes volumes for three Bay segments where no volumes were previously assigned - which created an assessment gap for the regulatory community,
- Aligns CBP’s Bay grasses goal with the goals defined by the water quality standards-based grasses goal adopted by state’s and the District of Columbia, and
- Provides an interim decision rule on defining a water quality standards attainment status for the designated use of “aquatic life” using the BIBI (Benthic Index of Biotic Integrity) as it pertains to 4 segments with anomalous results.

In February 2016 the CBP held an information session for the Criteria Addendum Review Team assembled by STAC. Each Review Team member was assigned the responsibility of being primary reviewer of one chapter (detailed in Appendix A), and secondary reviewer of a second chapter, based on their specific area of expertise. Reviewers were provided with the “STAC Review Panel Questions for 2016 Chesapeake Bay Criteria Addendum” document (attached as

Appendix B), in which they were asked to address the following questions (with the CBP acknowledging that not all questions are relevant for all chapters):

- Please comment on the overall appropriateness of the approach taken and the level of documentation provided given the document's objective (as an addendum) of filling in the gaps (when used in combination with the original criteria documentation) of providing the three states and the District with a complete set of guidance for assessing attainment of all their adopted previously published Chesapeake Bay dissolved oxygen, water clarity/underwater bay grasses, and chlorophyll a criteria.
- How justified are the recommended criteria assessment procedures, given the approach used and data available?
- Please comment on the scientific rigor of the methods used and whether application of the criteria assessment procedures will lead to assessment of attainment in regard to achieving conditions protective of aquatic life.
- Are there any additional technical data or types of scientific information that should be included in the document and, if so, what are they and how would they help improve the scientific rigor of the methods?
- Given anticipated continued advances in estuarine monitoring techniques and capabilities as well as continued evolution of statistical science, what future alternative or enhanced criteria assessment procedures should be Chesapeake Bay Program partners consider developing and adopting into the future?

In March 2016, the Review Team held a virtual meeting to discuss the panel's comments on each chapter. At this time, the Review Team concurred that the Criteria Addendum document was necessary and critical for review but they found the written documentation was such that it was difficult for the team to fully understand the procedures being documented. The Review Team provided a brief outline of the primary issues and points of confusion in each chapter. In response, the CBP provided an extensive separate written response to the issues raised, as well as a modified version of the Criteria Addendum document. Although the Review Team appreciated the responses, which indeed clarified many issues, they felt that the document itself was not revised to the extent that it could be understood by readers who did not have the advantage of seeing the response document. The Review Team therefore requested that the CBP once more edit the document to improve the writing style and organization of each chapter. Specifically, the team recommended removing description of procedural options that were considered but not eventually used, as this was only causing confusion. They also suggested that the first section of each chapter describe the changes being made to the criteria, clearly differentiating from extant criteria, and that a separate section of each chapter provide implementation recommendations, clearly distinguishing requirements from options. Finally, they recommended that a third section of each chapter should provide the rationale and justification for the proposed changes to the criteria.

In early 2017, the Review Team received an updated version of the Criteria Addendum document for final review. The Review Team held a conference call in March 2017 to discuss each chapter. The summary of their findings and recommendations are included in the following five sections, organized by the chapter of the Criteria Addendum document being reviewed.

Review of Chapter II

This chapter of the Criteria Assessment document includes three proposed changes/clarifications to the dissolved oxygen criteria. Each of these suggested changes is briefly described below and is followed by the Review Team's assessment of the proposed changes.

First Proposed Change:

The CBP's first proposed change is in recognition of an inconsistency between the criteria and the data available to apply those criteria. Several criteria are expressed on short time scales, whereas most of the monitoring is conducted monthly. As such, the extent to which oxygen conditions are being met cannot currently be assessed for a large portion of the Bay. The CBP is proposing to leverage the distributional properties they obtained from continuous monitoring data to assess the likelihood that high-frequency (i.e., instantaneous) oxygen criteria are being met using low-frequency data records.

The concept underlying this proposed change is reasonable, and will allow for a more complete assessment as to whether appropriate water quality standards are being met. The analyses on which the proposed changes are based are appropriate; however, the Review Team identified a number of concerns that they believe the CBP should address before releasing the addendum. These are each specifically described below.

- **How the procedure will be used:** The first concern is that the document does not provide context for how the proposed assessment procedure will be used. For example, will failure based on a modeled data set be the basis for a criteria failure and a subsequent 303(d) impaired listing? Similarly, can a site or segment be justifiably delisted based on a modeled data set, as seems to be suggested (but not explicitly stated) by some of the wording in the document? This context is critical as it directly addresses the acceptable level of uncertainty in developing relationships between the continuous and intermittent data.
- **Site-specificity concerns:** The Review Team is concerned about the site-specific nature of the relationships among short-term and long-term monitoring data upon which the approach is based. If the intent is to apply the relationships presented in the document broadly across different Chesapeake Bay geographies, the document needs considerably more development

describing the level of variation that may exist in those relationships among different sites.

- **Conditional attainment is improbable:** The Review Team is also concerned that the examples illustrate that conditional attainment is improbable for most sites. Specifically, the 30-day and 7-day mean oxygen levels for some sites would need to be almost 100% of saturated concentration during the summer, nearly guaranteeing non-attainment. Again, without context for the application, the Review Team is concerned about the implications of non-attainment with this high threshold. Is the intent to classify a site as impaired because the data do not demonstrate full saturation? In essence, who has the burden of proof and is the intent to list sites as impaired wherever data are scarce?
- **Time and depth bias:** The document is devoid of information pertaining to bias associated with the time of day on which samples are collected. Collections made during the middle of the day are more likely to meet the criteria and there is opportunity to “game the system” when limited data are used to make the assessment. Furthermore, it is unclear whether the models used to arrive at the solution actually used all available data, or only the data collected during daylight hours, which would be appropriate for developing relationships that will be applied to infrequently collected daylight data. The guidance part of the document also does not address the bias associated with the depth within the water column at which the samples were collected. Surface samples, particularly if collected during the middle of the day, are more likely to meet the criteria, again providing the opportunity for use of carefully selected subsets of data to misrepresent the full condition of the segment. Implementation guidance should be added to address this concern.
- **Disincentive for collecting high frequency data:** The Review Team is perhaps most concerned that although the document describes a procedure that is a reasonable interim measure to use when the most appropriate data are unavailable, it essentially provides disincentive for collecting higher-frequency data that would allow the jurisdictions to better assess whether the standards are actually being achieved. The Review Team feels that the proposed assessment process is most applicable as a screening strategy to differentiate those sites that are either clearly meeting or failing water quality standards that no additional monitoring data are required to make a management decision, as well as identifying those sites where high frequency data collection are most needed. If the intent is to use it as a screening tool (which the Review Team recommends) this should be clearly stated within the documentation.

Second Proposed Change:

The CBP’s second proposed change is to sub-segment the existing Chesapeake Bay open-water habitats when assessing whether water quality criteria are being achieved. Specifically, the

suggestion is to separate the open-water habitats into three zones: 1) well-mixed mainstem and tidal tributary waters, 2) shallow waters < 2 meters (m) deep, and 3) isolated waters off of the mainstem and tidal tributaries.

The Review Team supports the CBP's proposed concept of sub-segmentation. The three proposed Bay zones have different physical and biological drivers, leading to different relationships between short-term and continuous oxygen data. However, the Review Team has two reservations about specific aspects of the sub-segmentation process.

- **Sub-segmentation into three Bay zones:** In particular, the document includes rationale for why three segments is an improvement over the present two segments, but provides no analysis indicating why three segments are superior to other options (e.g., four, five or six segments). Given the importance of the issue, and the infrequency with which such changes to the assessment process are adopted, the Review Team would like rationale for why three segments, specifically, are optimal.
- **Varying definitions of three Bay zones:** The specific zones that encompass the new segmentation are not clearly defined. Figure 11-1 calls zone 3 "Tributaries of Tributaries" whereas the table below refers to zone 3 as "Isolated waters off of the mainstem Chesapeake". The meanings of these two different names for zone 3 could be interpreted very differently. In addition, the document indicates that the delineation between the three zones will be determined on a case-by-case basis. The Review Team understands the desired flexibility associated with this approach but is concerned that this could potentially lead to legal disputes when local stakeholders prefer to be assessed as part of a different segment than regulators select.

Third Proposed Change:

The Criteria Addendum document also describes how to interpret continuous monitoring data in a water quality criteria context. The CBP proposes three potential rules and indicates that Rule 2-Alternate is the best option for separating a random event from a more persistent event. The Review Team feels that Rule 2-Alternate seems like a reasonable approach, however, more detail regarding how the options were determined are important for the documentation process.

- **Continuous Monitoring Based Assessment:** Although Rule 2-Alternate seems like a reasonable approach, the document does not fully identify the process by which the three options were developed and why just those three particular options were examined. Moreover, it fails to quantify exactly how the preferred option confers an advantage. The Review Team is concerned that the documentation provides insufficient rationale to serve as the foundation for a legally defensible document.

Review of Chapter III

Chapter III provides documentation to provide missing volumes of three Chesapeake Bay assessment segments: the Western Branch Patuxent River Tidal fresh (WBRTF), the Anacostia River Tidal Fresh Maryland (ANATF MD), and the Upper Patuxent River Tidal Fresh (PAXTF). These missing volumes have been limiting reporting in Maryland's Clean Water Act 303(d) listing assessments. The document provides the background of the CBP for applying a segmentation scheme for organization and collection, analysis, and assessment of water quality standards, for which segment volumes are needed. This chapter provides the history of the inability to estimate these three segments due to unavailable bathymetric data. The chapter also establishes a volume for WBRTF based on available bathymetric data. In addition, interim segment volumes are provided for PAXTF and ANATF MD, as they are expressed in the Chesapeake Bay Water Quality/Sediment Transport Model (U.S. EPA 2010) to support the 2017 Mid-Point Assessment of the Chesapeake Bay TMDL. The documentation is concise and provides the needed information. The Review Team suggests the minor edits listed below to further clarify and improve the documentation.

- The Review Team suggests adding a few sentences in Appendix D to explain how the volume is computed. For example: “The area of each cross-section is computed by an integration method. The volume between two cross-sections is computed by multiplying the average area of two segments and the distance between them. The total volume is the sum of all the volumes within the segment.”
- Page 31, 1st paragraph: “water volumes are assigned and the basis for decisions on the volume assignments are provided in Appendix D.” Since Appendix D only provides data and not decisions, this should be changed to “water volumes are assigned and the data used to determine the volume assignment are provided in Appendix D.”
- Page 31, second paragraph: Delete “(Appendix D) used” because the data in Appendix D are only used to determine WBRTF.
- Page 31, second paragraph: For consistency, change “ANATF-MD” to “ANATF MD”.
- Page 33: Change “of” to “is” in the item PAXTF bullet: “volume is 11,025,000 m³”
- Appendix D: Please add information regarding units and datum for depth. Also, please indicate that the segment starts from the Southern Bank.

- Appendix E is not mentioned in the text. It needs to be either specifically mentioned or the content needs to be added to Appendix D. The former is preferred, unless it is not necessary at all.
- At the beginning of the Appendix, it would be helpful to add: “The Chesapeake Bay Western Branch Patuxent River Tidal Fresh (WBRTF) segment is represented by 45 Cartesian grid cells, each with dimensions 50 m x 50 m.”

Review of Chapter IV

The goal of Chapter IV is to propose and document a single integrated water quality metric to track attainment of multiple water quality standards (dissolved oxygen, chlorophyll and water clarity/underwater grasses) in Chesapeake Bay. The overall motivation for a single metric is sound, and a reasonable formulation is proposed. However, there are a number of aspects that the Review Team concludes should be clarified. These are described in detail below.

- **Designated Use surface area:** It was not clear to the Review Team whether every designated use in a given segment is assigned the same surface area, which is set as equal to that segment’s open-water designated use surface area. We believe this to be the case, however, statements such as “each designated use within each segment has been assigned its own unique surface area” (page 39) seem to contradict this interpretation and refute the equation on page 41. Similarly, the statement at the bottom of page 39: “while dissolved oxygen is evaluated for its volume-based attainment” also needs clarification in this regard.
- **Chapter II versus Chapter IV:** The relationship between Chapters II and IV is not clear. In some respects, the content of these two chapters seems contradictory. How do the three zones in Figure II-1 relate to those in Figure IV-1? The former contains a designated use for “tributaries of tributaries” (also called “isolated waters off the mainstem Chesapeake”) whereas the latter figure contains a “Migratory Fish Spawning and Nursery” habitat. In addition, Rule 2 states: “Until Delaware, the District of Columbia, Maryland and Virginia’s existing Chesapeake Bay water quality standards regulations are revised to reflect the assessment procedures for the full array of applicable dissolved oxygen criteria described in Chapter II of this document, ...” leading the reader to wonder what Rule 2 will be after the regulations are revised. How long until the regulations will be revised? The relationship between these two chapters needs to be clarified.

- **Summer Season criteria:** Rule 1 states “if a segment met its summer season criteria, it was considered to meet all its applicable criteria for the year” (page 41), yet figure IV-2 and IV-4 list other attainment seasons. Additionally, Rule 3 lists other criteria for non-summer seasons. This was unclear to the Review Team and the documentation should be clarified.
- **Contradiction between Rules 2 and 3:** Rule 2 states that: “for the presentation of this indicator, it is assumed that attainment of the 30-day mean summer open-water and deep-water dissolved oxygen criterion can serve as an “umbrella” assessment protective of the remaining short duration dissolved oxygen criteria in each designated use”. However, immediately below in Rule 3, it states that there is a 1 mg/L instantaneous minimum dissolved oxygen criteria for the Deep-Channel Seasonal Refuge designate use. How will this be assessed for this metric? As a 30-day mean? If so, this should be stated clearly. Additionally, it would be much clearer to simply state that the Migratory Fish and Spawning Nursery designated use must have a 6 mg/L 30-day mean (Rule 3).
- **Figures IV-2 and IV-4:** Including both figures IV-2 and IV-4 is redundant and confusing. The Review Team suggest removing figure IV-2 and adding a more complete explanation of figure IV-4 to the caption. It would be helpful to explain in the caption that only the bold criteria under “Criteria Duration” will be assessed for this metric.

Review of Chapter V

Chapter V documents an update to the Chesapeake Bay underwater grasses restoration goal and provides recommendations for alignment of the goal with the jurisdictions’ Chesapeake Bay water quality standards submerged aquatic vegetation (SAV) restoration acres.

In general the Review Team felt that the approach taken for updating the underwater grasses restoration goal was reasonable. Specifically, the inclusion of the detailed Table V-1 as requested in our initial comments now provides a detailed record of the differences in the SAV restoration acreages on a segment by segment basis. The Justification Column in this table provides the rationale for differences between the states’ goals and the CBP restoration goals. Much of this information was provided in the EPA 2004 Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability – 2004 Addendum, however, this Table V-1 provides important updates to this earlier document.

There are, however, several issues that the Review Team suggests to make this chapter stronger and easier for future readers to understand, if addressed.

- **Model attainability issues:** The document states (page 48): “With few exceptions, the jurisdictions’ Chesapeake Bay water quality standards segment-specific SAV restoration acreages are equal to or greater than the segment-specific acreage goals supporting the original 185,000 acre goal (Table V-1).” The text should be made clearer that these “few exceptions” are significant. For a number of segments in Virginia, the state’s SAV restoration acreages are lower than the CBP water quality specific acreages. These lower restoration goals, which total over 4,000 acres, are justified as being based on “model attainability”. There is no discussion or mention of this model attainability other than in the Justification column of Table V-1. Was the model attainability used for all segments in the Bay? If the state’s restoration goals are incorporated into the CBP goals, will the CBP restoration acreages for these segments be reduced to equal the lower Virginia acreages? If so, what will be the implications of this change?

Additionally, in the Conclusion section it states: “If, for example, Maryland adopted the Virginia methodology, the additional deep water acres beyond the application depth in Maryland beyond their existing goal acreages would increase the 192,000 acre goal by about 14,000 acres to 206,000.” This is incorrect as the 206,000 acre goal as summarized in Table V-1 also includes increasing SAV acreages to the “Actual Mapped SAV (up to 2000) Not Clipped” for those Virginia segments where “model attainability” was used to reduce the goals for a number of segments. This clarification needs to be made.

Although not specifically the focus of this chapter, segment-specific SAV acreage goals addressed here and water clarity acre standards based on those goals have only been assessed together for one period for the overwhelming majority of Bay segments. Therefore any progress towards Bay improvements in water quality is only based on indirect SAV abundance evidence. There are many reasons why SAV acreages may not be the best metric by which Bay water quality improvements can be assessed. In many regions, SAV recruitment can be limited by factors other than water clarity. However, the combination of advanced monitoring techniques, including spatial water clarity mapping and continuous fixed station water clarity monitoring, have been demonstrated to provide direct, accurate, and enhanced assessments of water clarity conditions in both space and time. These approaches should be reapplied and targeted first to regions where water quality standards have been close to attainment in the past and it is anticipated that watershed improvement efforts targeted to those regions will result in attainment. A note to this effect in Chapter IV would be helpful.

Review of Chapter VI

Chapter VI documents decisions to modify the method of classifying water bodies for water quality status based on the Benthic Index of Biotic Integrity (B-IBI) and recommends interim rules for water quality listing status. Historically, B-IBI scores had been calculated for each water segment using the approach of Weisberg et al. (1997), which was updated in Alden et al. (2002). In short, the change to the traditional approach for classifying water segments based on B-IBI scores was to re-classify three segments as Category 3 (from presumably Category 2) based on the fact that the B-IBI scores for those three segments are associated with strong variability.

The chapter correctly identifies shortcomings of the existing benthic assessment tool, which was developed more than 20 years ago with a much more limited data set than is presently available. The Review Team concludes that taking the proposed precautionary approach is a reasonable one, given uncertainties about the B-IBI index.

- **Longer-term solution needed:** The Review Team is concerned that this approach is proposed as a temporary solution, pending a revision of the index, yet there is no indication as to when such a revision will be completed. In other words, the Review Team is concerned that this interim method, which may be reasonable for the short-term, will become the standard approach and the shortcomings of the current B-IBI approach will not be addressed. The Llanso et al. (2016) appendix (which is erroneously referred to as Appendix H but is actually Appendix F) indicates that as of 2016 they were unable to materially improve upon the existing index. As such, what is proposed as a ‘temporary solution’ is not truly temporary. At a minimum, the authors need to modify the text to identify and document the steps required to develop a new longer-term solution, whether it is a modification of the existing B-IBI or the development of a completely new approach to assess the status of the benthos.
- **Flaws in Appendix F:** There are two substantial flaws in Appendix F. First, it concludes that the index does not calibrate well, but the reviewers have concerns about the validation procedure. The rules used to create the validation data set are based on meeting many criteria for what constitutes a reference site, and a bad site is defined by failure of any criterion. As a consequence, sites that are not clearly degraded are classified as such, leading to the result that the indices did a particularly poor job validating purportedly bad sites.

Second, the only attempt at an index update was to repeat the B-IBI approach. While this is a generally acceptable approach and was the leading approach at the time when the index was first developed, it is not the only approach presently available and has been consistently found to underperform in low salinity environments. Given the poor performance found with

the attempted update, the appendix should have explored other approaches, such as the multivariate ones used by EMAP (Environmental Monitoring and Assessment Program) or the AMBI (AZTI Marine Biotic Index) approaches popular in Europe (Paul et al. 2001, Gillet et al. 2015).

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Appendix A

Request for Scientific and Technical Advisory Committee Peer Review of Criteria Assessment Protocol Workgroup’s Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries technical addendum.

July 2015

The Chesapeake Bay Program’s Criteria Assessment Protocol Workgroup, under the Scientific, Technical Assessment and Reporting Team (STAR), requests a review by the Scientific and Technical Advisory Committee (STAC) of the following Criteria Assessment Protocol Workgroup’s technical report:

U.S. Environmental Protection Agency. 2015. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2015 Technical Addendum. EPA 903-R-XX-XXX. Region III Chesapeake Bay Program Office, Annapolis, MD.

Since 2007, through the work of its Criteria Assessment Protocols Workgroup, the Chesapeake Bay Program (CBP) partnership has an established forum for resolving issues, factoring in new scientific findings, and ensuring implementation of consistent bay-wide water quality criteria assessment procedure development and implementation. The Workgroup draws upon the talents and input from state, federal, river basin commission and academic partners as well as local government and municipal stakeholders. This 2015 Chesapeake Bay Criteria addendum provides previously undocumented features of the present procedures as well as refinements and clarifications to the previously published Chesapeake Bay water quality criteria assessment procedures.

- Chapter 2 documents recommendations for assessment of short duration Chesapeake Bay dissolved oxygen criteria based on sub-segmenting open-water designated use segments in up to three possible zones and applying the assessment procedures protective of each zone.
- Chapter 3 documents previously undocumented water volumes in three Chesapeake Bay segments: Western Branch Patuxent River Tidal Fresh, Maryland portion of Anacostia Tidal Fresh and Patuxent River Tidal Fresh, where volumes were missing and, therefore, limiting reporting in Maryland’s Clean Water Act 303d listing assessments.
- Chapter 4 documents the development of a multi-metric Chesapeake Bay water quality indicator using the water quality standards attainment assessment results for dissolved

oxygen, water clarity/underwater grasses and chlorophyll a, to support tracking progress toward achievement of the jurisdictions' Chesapeake Bay water quality standards.

- Chapter 5 documents an update to the Chesapeake Bay underwater grasses restoration goal and provides recommendations for alignment of the goal with the jurisdictions' Chesapeake Bay water quality standards submerged aquatic vegetation restoration acres.
- Chapter 6 documents refinements to the Chesapeake Bay benthic index of biotic integrity assessment of the aquatic life use and recommends interim rules for water quality 303d listing status supporting aquatic life use assessments.
- ****Chapter 7¹** documents monitoring support and recommended protocols for incorporating nontraditional partner water quality monitoring program data into regulatory Chesapeake Bay dissolved oxygen criteria attainment assessments.

Appendices to these chapters provide more detailed documentation on derivation of the recommended, refined criteria assessment procedures.

Background:

In April 2003, the U.S. Environmental Protection Agency (EPA) published the Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries which was the foundation document defining Chesapeake Bay water quality criteria and recommended implementation procedures for monitoring and assessment (U.S. EPA 2003a). In October 2003, EPA published the Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability which defined the five tidal water designated uses to be protected through the published Bay water quality criteria (U.S. EPA 2003b):

- Migratory fish spawning and nursery habitat;
- Open-water fish and shellfish habitat;
- Deep-water seasonal fish and shellfish habitat;
- Deep-channel seasonal refuge habitat; and
- Shallow-water bay grass habitat.

The detailed procedures for assessing attainment of the Chesapeake Bay water quality criteria continued to be advanced through the collective EPA, States and District of Columbia partnership efforts. These partners continue to develop and apply procedures that incorporate the most advanced state-of-the-science, magnitude, frequency, duration, space and time considerations of, as available, biologically-based reference conditions and cumulative frequency

¹ ****This chapter was subsequently removed from the revised addendum document in early 2017. Therefore, this chapter was not reviewed by the panel and no responses are included in this report.**

distributions. As a rule, the best test of any new method or procedure is putting it to application with partner involvement and stakeholder input.

A total of seven addendum documents have been published by EPA since April 2003. Four addenda were published documenting detailed refinements to the criteria attainment and assessment procedures (U.S. EPA 2004a, 2007a, 2008, 2010) previously published in the original April 2003 Chesapeake Bay water quality criteria document (U.S. EPA 2003a). One addendum published Chesapeake Bay numerical chlorophyll a criteria (U.S. EPA 2007b). Three addenda addressed detailed issues involving further delineation of tidal water designated uses (U.S. EPA 2004b, 2005, 2010) building from the original October 2003 tidal water designated uses document (U.S. EPA 2003b). Finally, one addendum documented the 92-segment Chesapeake Bay segmentation scheme (U.S. EPA 2008) after refinements to the Chesapeake Bay Program analytical segmentation schemes were documented (U.S. EPA 2005) building from the original U.S. EPA 2004 document (U.S. EPA 2004b). This 2015 Chesapeake Bay Criteria addendum provides previously undocumented features of the present procedures as well as refinements and clarifications to the previously published Chesapeake Bay water quality criteria assessment procedures.

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Appendix B

2016 Chesapeake Bay Criteria Addendum Review Questions:

The Chesapeake Bay Program (CBP) partnership, through the STAR team and the CAP Workgroup, requests an independent scientific peer review that directly addresses the following questions. The review panel is strongly encouraged to also make recommendations for future work by the CBP partnership that build on these questions or are related to the scientific or management issues raised in the review. The review panel will be provided with the relevant documentation and will be given direct access to the involved CBP partners, via webinar format, to facilitate the review. The review panel will generate a written report addressing the questions. The partnership will then produce a written response to the review.

For each of the six chapters, please answer the following questions. Given the purpose of some chapters (e.g., chapters 4 and 5) are more ‘documentation for the record’ in nature; not all the questions need to be addressed for each of the chapters.

1. Please comment on the overall appropriateness of the approach taken and the level of documentation provided given the document’s objective (as an addendum) of filling in the gaps (when used in combination with the original criteria documentation) of providing the three states and the District with a complete set of guidance for assessing attainment of all their adopted previously published Chesapeake Bay dissolved oxygen, water clarity/underwater bay grasses, and chlorophyll a criteria.
2. How justified are the recommended criteria assessment procedures, given the approach used and the data available?
3. Please comment on the scientific rigor of the methods used and whether application of the criteria assessment procedures will lead to assessment of attainment in regard to achieving conditions protective of aquatic life.
4. Are there any additional technical data or types of scientific information that should be included in the document and, if so, what are they and how would they help improve the scientific rigor of the methods?
5. Given anticipated continued advances in estuarine monitoring techniques and capabilities as well as continued evolution of statistical science, what future alternative or advanced criteria assessment procedures should the Chesapeake Bay Program partners consider developing and adopting into the future?