Virginia Regulatory Town Hall

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Final Regulation
Agency Background Document

Approving authority name	State Water Control Board
Virginia Administrative Code (VAC) citation	9 VAC 25-260
Regulation title	Water Quality Standards
Action title	Amendments to Special Standards (9 VAC 25-260-310) for Numerical Water Quality Criteria for Chlorophyll *a* in the James River and Dissolved Oxygen in the Mattaponi and Pamunkey Rivers and associated references in the River Basin Tables 9 VAC 25-260-410 and 530
Document preparation date	June 2005

This information is required for executive review (www.townhall.state.va.us/dpbpages/apaintro.htm#execreview) and the Virginia Registrar of Regulations (legis.state.va.us/codecomm/register/regindex.htm), pursuant to the Virginia Administrative Process Act (www.townhall.state.va.us/dpbpages/dpb_apa.htm), Executive Orders 21 (2002) and 58 (1999) (www.governor.state.va.us/Press_Policy/Executive_Orders/EOHome.html), and the *Virginia Register Form, Style, and Procedure Manual* (http://legis.state.va.us/codecomm/register/download/styl8_95.rtf).

Brief summary

Please provide a brief summary of the proposed new regulation, proposed amendments to the existing regulation, or the regulation proposed to be repealed. Alert the reader to all substantive matters or changes. If applicable, generally describe the existing regulation. Also alert the reader to changes made to the regulation since publication of the proposed. Do ***not*** *state each provision or amendment or restate the purpose and intent of the regulation.*

The rulemaking consists of amendments to the site specific water quality standards for numerical water quality criteria for chlorophyll *a* in the James River and dissolved oxygen in the Mattaponi and Pamunkey Rivers. Changes made from the proposed include the clarification of the chlorophyll *a* criteria as ‘seasonal means’ and the adjustment of the criterion in the James lower tidal fresh region of the river from 20 micrograms per liter (µg/L) to 25 µg/L. The existing water quality standards regulation contains water quality criteria (including for dissolved oxygen), use designations and an antidegradation policy for all state waters but there are no numerical criteria for chlorophyll *a*.

In response to public comment from the Virginia Association of Municipal Wastewater Agencies (VAMWA) and inquiries from Senator Martin E. Williams during the 2005 General Assembly, DEQ committed to conduct an alternatives analysis to evaluate the benefits, detriments and costs of a range of nutrient loading scenarios and the corresponding predicted chlorophyll *a* levels. The purpose of the modeling efforts was to identify levels of nutrient reduction that might result in significant environmental benefits and to distinguish these alternatives from efforts that show diminishing returns or potential adverse effects. The results of this analysis necessitated changing the criterion in the James lower tidal fresh region to 25 micrograms per liter (µg/L).

Statement of final agency action

Please provide a statement of the final action taken by the agency including (1) the date the action was taken, (2) the name of the agency taking the action, and (3) the title of the regulation.

These amendments to the *Water Quality Standards* were adopted on June 28, 2004 by the State Water Control Board and the effective date was suspended under Section 2.2-4015.A.4 of the Virginia Administrative Process Act to allow time for a 30-day public review and comment period on changes made to paragraph bb of 9 VAC 25-260-310 (numerical chlorophyll *a* criteria for the James River) and the impact that the details and the conclusions of the James River loading alternatives analysis conducted by the Department of Environmental Quality have on the criteria in paragraph bb of 9 VAC 25-260-310.

These three sections (9 VAC 25-260-310, 410 and 530) were originally part of a larger rulemaking regarding the control of nutrients and sediments to the Chesapeake Bay and tidal tributaries that was deferred by the Board at the March 15, 2005 State Water Control Board meeting (9 VAC 25-260-5, 10, 50 185, 186 and 350). Those amendments were published final in the Virginia Register on May 16, 2005 (21:18 VA.R. 2374-2379) and effective on June 24, 2005.

Legal basis

Please identify the state and/or federal source of legal authority to promulgate this proposed regulation, including (1) the most relevant law and/or regulation, including Code of Virginia citation and General Assembly bill and chapter numbers, if applicable, and (2) promulgating entity, i.e., the agency, board, or person. Describe the legal authority and the extent to which the authority is mandatory or discretionary.

If the final text differs from the text at the proposed stage, please indicate whether the Office of the Attorney General has certified that the agency has the statutory authority to promulgate the final regulation and that it comports with applicable state and/or federal law.

The most relevant law is § 62.1-44.15(3a) of the Code of Virginia, as amended, which mandates and authorizes the State Water Control Board to establish water quality standards and policies for any State waters consistent with the purpose and general policy of the State Water Control Law, and to modify, amend or cancel any such standards or policies established. The federal Clean Water Act at 303(c) mandates the State Water Control Board to review and, as appropriate, modify and adopt water quality standards. The corresponding federal water quality standards regulation at 40 CFR 131 requires the states to adopt criteria to protect designated uses and describes the minimum requirements for water quality standards. The minimum requirements for water quality standards are use designations, water quality criteria to protect the designated uses and an antidegradation policy. All of the citations mentioned describe mandates for water quality standards.

The Office of the Attorney General has certified that the agency has the statutory authority to promulgate final text of the regulation.

Purpose

Please explain the need for the new or amended regulation. Describe the rationale or justification of the proposed regulatory action. Detail the specific reasons it is essential to protect the health, safety or welfare of citizens. Discuss the goals of the proposal and the problems the proposal is intended to solve.

This rulemaking is needed to define the most accurate living resource and water quality goals for tributary strategy development (see Code of Virginia § 2.2-219) and development of total maximum daily loads (TMDL) under Section 303(d) of the Clean Water Act for the James River and the Mattaponi and Pamunkey Rivers as the existing criteria do not adequately or accurately protect these waters from the effects of nutrient pollution. The chlorophyll criteria are also needed to meet water quality standards which designate all waters for “balanced” aquatic life populations (9 VAC 25-260-10) and control of substances which “nourish undesirable or nuisance aquatic plant life” (9 VAC 25-260-20). These requirements are currently not met in the tidal James River as demonstrated by high levels of undesirable algae, (i.e., phytoplankton, specifically cyanobacteria) particularly in the Upper James and degrading trends toward these same imbalances in the lower James River. The dissolved oxygen criteria for the Mattaponi and Pamunkey Rivers are also needed to reflect seasonal lower dissolved oxygen concentration due to natural oxygen depleting processes present in the extensive surrounding tidal wetlands.

The rationale and justification behind these amendments is to establish proper water quality standards in order to protect water quality and living resources of Virginia's waters for consumption of fish and shellfish, recreational uses and conservation in general. Protection of water quality and living resources for food and recreation are essential to help maintain the health and welfare of the citizens of the Commonwealth.

The Bay partners with the U.S. Environmental Protection Agency (EPA) Chesapeake Bay program have worked together to publish nutrient related criteria specific to the Chesapeake Bay. The goals of the proposal are to use these criteria in calculating load allocations for the James, Mattaponi and Pamunkey Rivers in the Chesapeake Bay Tributary Strategies, setting Virginia Pollutant Discharge Elimination System Permit limits and for evaluating the waters of the Commonwealth for inclusion in the Clean Water Act 305(b) report and on the 303(d) list. Waters not meeting standards will require development of a TMDL under section 303(d) of the Clean Water Act. In May 1999, EPA Region III included the James, Mattaponi and Pamunkey Rivers on Virginia's 1998 Clean Water Act section 303(d) impaired waters list. The Chesapeake

2000 Agreement specifies a goal to remove the Chesapeake Bay and its tidal tributaries from the list of impaired water bodies for nutrient and sediments by 2010. Thus, the development of a TMDL for these rivers is not being scheduled until 2010 anticipating that the Chesapeake Bay Program partners can cooperatively reach their goals and achieve water quality standards by that time making a bay wide TMDL unnecessary.

Substance

Please identify and explain the new substantive provisions, the substantive changes to existing sections, or both where appropriate. A more detailed discussion is required under the "All changes made in this regulatory action" section.

This provision adds numerical chlorophyll *a* criteria for the James River. These criteria are added to the special standards and designations (9 VAC 25-260-310) and listed in the river basin sections table for the James River (9 VAC 25-260-410). The criteria apply during the spring and summer months.

This provision also adds numerical dissolved oxygen criteria for the Mattaponi and Pamunkey Rivers. These criteria are added to the special standards and designations (9 VAC 25-260-310) and listed in the river basin sections tables for the York River (9 VAC 25-260-530). The criteria apply during the summer months and supersede the open-water criteria in subsection A of 9 VAC 25-260-185 that apply year-round to all tidal open-waters.

Issues

Please identify the issues associated with the proposed regulatory action, including:
1) the primary advantages and disadvantages to the public, such as individual private citizens or businesses, of implementing the new or amended provisions;
2) the primary advantages and disadvantages to the agency or the Commonwealth; and
3) other pertinent matters of interest to the regulated community, government officials, and the public.
If there are no disadvantages to the public or the Commonwealth, please indicate.

The public will benefit as implementation of these amendments will result in nutrient reductions in the James, Mattaponi and Pamunkey Rivers. This will result in protection of living resources and restoration of water quality in these rivers that are impacted by nutrient enrichment. Clean water with improved living resources can benefit the public through better recreational opportunities, employment opportunities (through tourism and commercial fisheries improvements), improvements in property values and quality of life in general to those who enjoy these tidal tributaries. The disadvantage is that certain sectors of the public may see these as too difficult and expensive to meet. However, the goal is to set realistic, protective goals in water quality management and to maintain the most scientifically defensible criteria in the water quality standards regulation.

The advantage to the Commonwealth is that the adoption of these criteria will define the necessary water quality and living resource goals needed for the development of tributary strategies as specified in the Code of Virginia § 2.2-219 and for the development of total maximum daily loads (TMDL) under Section 303(d) of the Clean Water Act.

There is no disadvantage to the agency or the Commonwealth that will result from the adoption of these amendments.

Pertinent matters of interest to the regulated community, government officials, and the public are the potential costs to meet the requirements of this regulation. The agency has also produced an analysis of alternative nutrient reduction loading scenarios for the James River and their corresponding chlorophyll *a* concentrations and environmental benefits. This alternatives analysis was the basis for the adjustment of the criterion in the lower tidal fresh James and is of interest to the regulated community, government officials, and the public.

Changes made since the proposed stage

Please describe all changes made to the text of the proposed regulation since the publication of the proposed stage. For the Registrar's office, please put an asterisk next to any substantive changes.

Section number	Requirement at proposed stage	What has changed	Rationale for change
9 VAC 25-260-310 paragraph bb	Averaging period for chlorophyll *a* criteria not specified.	Averaging period for chlorophyll a criteria specified as seasonal mean.	Public comment indicated the averaging period was not understood.
9 VAC 25-260-310 paragraph bb *	Chlorophyll *a* criterion in the lower tidal fresh James River is 20 µg/L	Chlorophyll *a* criterion in the lower tidal fresh James River is 25 µg/L *	Public comment indicated an analysis of alternative loading scenarios and chlorophyll *a* concentrations should be evaluated against environmental benefits. This analysis showed that an alternative criterion for the tidal fresh James was appropriate.

Public comment

Please summarize all public comment received during the 60-day period following the publication of the proposed stage, and provide the agency response. If no public comment was received, please so indicate.

Public comment and agency responses attached.

All changes made in this regulatory action

Please detail all changes that are being proposed and the consequences of the proposed changes. Detail new provisions and/or all changes to existing sections.

Current section number	Proposed new section number, if applicable	Current requirement	Proposed change and rationale
9 VAC 25-260-310 paragraph aa		In subsection A of 9 VAC 25-260-185 the current requirement is: Open-water year-round 30-day mean dissolved oxygen ≥5.5 mg/L in low salinity waters 30-day dissolved oxygen instream criteria ≥5 mg/L in higher salinity waters (≥0.5 parts per thousand) 7-day mean ≥ 4 mg/l Instantaneous minimum > 3.2 mg/l at temperatures <29°C Instantaneous minimum > 4.3 mg/l at temperatures > 29°C	In paragraph aa of 9 VAX 25-260-310 the proposed change is: Open-water summer (June 1 – September 30) 30-day mean dissolved oxygen ≥ 4.0 mg/l Instantaneous minimum ≥ 3.2 mg/l at temperatures <29°C Instantaneous minimum ≥ 4.3 mg/l at temperatures ≥ 29°C These site-specific criteria supersede the current requirements in the summer. The rationale of this proposed change is described in the 'Need' section above.
9 VAC 25-260-310 paragraph bb		None	In paragraph bb of 9 VAC 25-260-310 the proposed change is: Open-water numerical chlorophyll *a* criteria apply spring (March 1 - May 31) and summer (July 1-September 30) as seasonal means to the tidal James River (excludes tributaries) segments. James River Segment (spring criterion µg/l/summer criterion µg/l) JMSTF2 (10/15) JMSTF1 (15/25) JMSOH (15/15) JMSMH (10/10) JMSPH (10/10) The rationale of this proposed change is described in the 'Need' section above.

Impact on family

Please assess the impact of the proposed regulatory action on the institution of the family and family stability including to what extent the regulatory action will: 1) strengthen or erode the authority and rights of parents in the education, nurturing, and supervision of their children; 2) encourage or discourage economic self-sufficiency, self-pride, and the assumption of responsibility for oneself, one's spouse, and one's children and/or elderly parents; 3) strengthen or erode the marital commitment; and 4) increase or decrease disposable family income.

The development of water quality standards in general is for the protection of public health and safety, which has only an indirect impact on families. However, the regulatory action may decrease the disposable family income as localities upgrade their treatment facilities and pass the increased water and sewer costs to the ratepayers.

Summary and Response to Public Comment
Amendments to Water Quality Standards for the James, Mattaponi and Pamunkey Rivers
June 2005

Comments to 9 VAC 25-260-310 paragraph aa

1. Comment (Dr. Land):
Supports the more stringent dissolved oxygen criteria. These limits should pertain to all tidal waters, recognizing that it is normal for storms to discharge low-oxygen waters from inland swamps, but that oxygenated conditions should normally be rapidly re-established.

DEQ Response:
Site-specific criteria for dissolved oxygen in the Mattaponi and Pamunkey Rivers are needed because of the natural oxygen depleting processes present in the extensive surrounding tidal wetlands. This has been documented through modeling and observations of the natural water quality conditions in EPA's Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries–2004.

2. Comment: (USFWS)
The Service agrees with the methodology used to evaluate the dissolved oxygen conditions in the Mattaponi and Pamunkey rivers. However, the service does not agree the methodology dictates a dissolved oxygen criteria of 4.0 mg/l (June 1 to September 30) for all four segments of the Mattaponi and Pamunkey rivers. Recommends that the Mattaponi and Pamunkey rivers have the same dissolved oxygen criteria as for the Open Water Fish and Shellfish Designated Use (5.5 mg/l and 5.0 mg/l, depending on salinity) from June 1 through January 30 for the following reasons:

1. Anthropogenic Sources. There is limited discussion in the Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2004 Addendum, (EPA 2004) as to whether point source discharges in the watersheds, such as the Smurfit-Stone Corporation pulp and paper mill (22 mgd), contribute measurable oxygen demands in one or both of the rivers. The Service recommends that a ground-truthed assessment of point source discharges be conducted, as the modeling assumptions used in the derivation may not apply to large heated discharges and biochemical oxygen demanding loads. The lower and less stringent numeric criteria would be used when assessing the summer month water quality on a routine basis and for modeling summer month impacts of a proposed Virginia Pollutant Discharge Elimination System permit discharges that might exert an oxygen demand. A lower dissolved oxygen criteria for the summer months may allow for an oxygen demanding discharge that previously may not have been accommodated in the river with higher criteria in place.

2. Mattaponi and Pamunkey used as reference sites. Summer month water quality monitoring station data for dissolved oxygen (1985 – 1994) from both the Tidal Fresh and Oligohaline areas of the Mattaponi and Pamunkey rivers were included as reference stations for derivation of the U.S. EPA recommended summer open water dissolved oxygen criteria (U.S. EPA 2003, Appendix H).

3. Monitoring Data Indicates Attainment. The 2000 - 2002 summer averaged dissolved oxygen concentrations, presented in Table VI - 2 (page 69) and Table VI - 3 of the 2004 Addendum, indicates dissolved oxygen concentrations at or above 5.0 mg/l. Table VI - 4b (page 80) presents the number (and percent of the total) of warm and cold month dissolved oxygen concentrations below 5 mg/l. For all segments, more than 66% of observations are above 5 mg/l in the warm months.

The Service believes that the 4.0 mg/l dissolved oxygen criteria for summer months is not supported by the data as presented. We recommend continuous monitoring station buoys be deployed throughout the summer (June through September) in all four segments, for a minimum of two seasons, to fully know the dissolved oxygen concentrations attained in these segments.

DEQ Response: *As documented by EPA in Table V-6 on page 155 in the 2003 Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability, even under the E3 (model simulation of 100 percent implementation of available technologies everywhere in the Bay watershed) and all forested watershed (elimination of all anthropogenic loads under simulation of a completely forested watershed) coupled Bay watershed and Bay water quality model simulation scenarios, EPA determined that the open-water fish and shellfish designated use 5 mg liter*$^{-1}$ *30-day mean criterion was not fully attainable in the tidal Mattaponi and Pamunkey rivers. These model scenarios fully accounted for all anthropogenic sources within the watersheds surrounding both tidal river systems. Also, under federal and state permit under antibacksliding regulations, a discharge permit limit cannot be relaxed due to new water quality criteria.*

Selected years of summer time dissolved oxygen concentration data from the tidal fresh and oligohaline segments of the Mattaponi and Pamunkey rivers were used in one of four possible approaches for developing reference curves for assessing dissolved oxygen criteria attainment using the recommended cumulative frequency distribution approach. Data from these two tidal river systems were <u>not</u> used to derive the actual open-water fish and shellfish designated use criteria.

While Tables VI2, VI-3 and VI-4b EPA's Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries–2004 Addendum show some dissolved oxygen means above 5.0 mg liter^{-1}*, there are many instances where this criterion is not met. Table VI-4b shows between 20 and 50% non-attainment. The data from the 1985-2002 multi-decadal Chesapeake Bay water quality monitoring program record summarized in Table VI-4b clearly indicate high percentages (13.2 to 31.3) of dissolved oxygen concentrations from 4.2 to 4.5 mg liter*$^{-1}$ *are observed during the summer months. In addition, Table VI-4b also documents dissolved oxygen concentrations less than 4 mg liter*$^{-1}$ *in both rivers down to mean concentrations of 3.5 to 3.3 mg liter*$^{-1}$ *during the summer months at percentages from less than 1 to 8 of total observations. Based on this data, EPA recommended a river specific criterion value of 4 mg liter*$^{-1}$ *as the 30-day mean criterion. Table VI-4b in EPA's Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries–2004 Addendum and Table V-6 in EPA's 2003 Technical Support Document for Identification of Chesapeake Bay Designated Uses and*

Attainability clearly indicate a 5 mg liter^{-1} 30-day mean criterion is not attainable in the tidal Mattaponi and Pamunkey rivers.

Tables VI-2 and VI-3 are not appropriate comparisons as they represent partial data sets. Also, as stated previously, model simulations of 100 percent implementation of available technologies everywhere in the Bay watershed and the all forested watershed model that eliminates all anthropogenic loads under simulation of a completely forested watershed, show that the open-water fish and shellfish designated use 5 mg liter^{-1} 30-day mean criterion was not fully attainable in the tidal Mattaponi and Pamunkey rivers.

As additional continuous buoy data are collected within the Mattaponi and Pamunkey rivers under the Chesapeake Bay Program partner's new shallow water monitoring program and as both river systems were simulated under the new Chesapeake Bay watershed and tidal water quality models now under development by the partners, new and directly applicable information may become available. If this new scientific information provides the basis for refining these river specific criteria, then Virginia expects EPA to publish such findings in a future addendum to the original 2003 Chesapeake Bay criteria document and propose such refined criteria during a future triennial water quality standards review.

3. Comment (VAMWA, Hanover)**:**
Support the recommended site specific criteria for the Pamunkey and Mattaponi Rivers. The work by the Department and EPA show that the naturally occurring oxygen depleting processes present in extensive tidal wetlands justify site-specific.

DEQ Response:
Site-specific criteria for dissolved oxygen in the Mattaponi and Pamunkey Rivers are needed because of the natural oxygen depleting processes present in the extensive surrounding tidal wetlands. This has been documented through modeling and observations of the natural water quality conditions in EPA's Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries–2004 Addendum.

Comments to 9 VAC 255-260-310 paragraph bb (Numerical Chlorophyll *a* Criteria for the Tidal James River)

1. Comment (Westvaco):
Dr. Marshall and others have provided information indication that the trends of concern in the James River algal community may be attributable to changes in the nitrogen to phosphorus ratio. If the change in the N:P ratio is the cause of the recent trends in the algal community, the impositions of the chlorophyll *a* criteria is not designed to correct the trends and may exacerbate them**.**

DEQ Response:
DEQ agrees the algal community can be affected by the N:P ratio. In order to assess this nutrient balance in the receiving waters of each tributary, several lines of evidence were investigated. Time-series of summer average TN:TP from the monitoring data indicated the nutrient balance remained relatively stable across the years (1985 to 2003). Further analysis of anticipated changes associated with nutrient reductions was studied using ten year summer averages of nutrient concentrations was simulated with the Water Quality Model. Long term TN:TP ratios remained unchanged in the York and Rapphannock and improved (increased) in the James tidal fresh region Also, under this and other load reduction scenarios (e.g. Virginia Tributary Strategy), chlorophyll a levels improve in all tidal fresh segments.

2. Comment (Honeywell):
Supports comments submitted by Hopewell Regional Wastewater Treatment Facility (HRWTF) on the proposed chlorophyll criteria. Wishes to have a meaningful opportunity to evaluate DEQ's proposed or revised chlorophyll criteria in the context of other regulatory developments such as the proposed nitrogen and phosphorus caps in the Water Quality Management Planning rulemaking.

DEQ Response:
The WQMP regulation and the proposed chlorophyll criteria are under executive order deadlines that only allow 150 days after the close of comment to get final regulations to the Department of Planning and Budget and Executive review and approval on a final regulation. Therefore, more evaluation (e.g. comment periods) on final regulations is problematic from a timing perspective. However, the WQMP regulation may allow for an additional comment period before it is published as final. This additional comment period is expected to be recommended to the State Water Control Board at their June 2005 quarterly meeting.

3. Comment (Dr. Land):
Chlorophyll *a* should not be used as a monitoring variable. Blooms are too variable in both time and space to characterize. It is impossible to relate chlorophyll *a* to "fishability." Use DO and water clarity.

DEQ Response: *DEQ agrees that DO and water clarity are good response variables to use to correct nutrient related problems in most waters. However, this approach will not lead to control of nutrient pollution in the James River. Due to hydrological features (e.g. proximity to the Atlantic Ocean, shallow depth, strong gravitational circulation, rapid advective transport or flow) the James does not experience acute or chronic dissolved oxygen yet the river does experience algal related impairments (e.g. blooms, high chlorophyll a and presence of nuisance algae at elevated levels). Water clarity improvements (via sediment reduction) are not expected to improve algal conditions and may make it* *worse absent nutrient reductions (Mann 2005). The best indicator for these types of impairments is chlorophyll a. DEQ recognizes blooms are highly variable in space and time but thinks the extensive (though admittedly not structured to capture algal blooms) 18 year record of monthly sampling at for chlorophyll and algal community composition at fixed sites clearly show algal related impairments in the James. Also, DEQ will be employing new chlorophyll "mapping" monitoring technologies which will provide very spatially intensive data for assessing chlorophyll conditions in the James.*

4. Comment (W. Lee Chamberlain)**:**
The City of Richmond is a chief nutrient contributor to the James River which adds to the death zone that is now occurring. Richmond has been a significant environmental polluter and has been coming up with a "plan of the plan" for the last five years while nothing is done, except for continued public hearings while the pollution continues and taxpayer moneys are lost. Virginia should lose its primacy and be monitored by the EPA as opposed to being allowed to aid in continued pollution because of politics.

DEQ Response: *All significant dischargers of nutrients, including Richmond, will need to reduce their nutrient dischargers as part of the Commonwealth's strategy to meet these new standards.*

5. Comment (JRA):
Supports the numerical chlorophyll *a* criteria in the James to ensure 'balance' is restored to the aquatic life. Has observed brown/ mahogany tides on the James.

6. Comment (EPA, USFWS):
EPA fully supports and expects Virginia's adoption of the proposed numeric chlorophyll *a* criteria for the tidal James River. The adoption of numerical chlorophyll *a* criteria for this tidal river is fully consistent with EPA published guidance strongly encouraging states to "develop and adopt site–specific numerical chlorophyll *a* criteria for tidal waters where algal- related impairments are expected to persist even after Chesapeake Bay dissolved oxygen and water clarity have been attained." EPA has reviewed the documented scientific basis for the proposed tidal James River seasonal and segment-specific numerical chlorophyll *a* criteria and found those numerical criteria are necessary to ensure the protection of the tidal river's designated uses and to provide the basis for guiding pollution reductions actions to restore the river's water quality and eventually delisting of the tidal river from Virginia's 303(d) list.

7. Comment (VCN, SELC):
Supports numeric chlorophyll *a* criteria for the James River. If meeting the nutrient reduction goals through dissolved oxygen and water clarity still results in an 'unbalanced' ecosystem (such as in the James River), then chlorophyll criteria are needed. High chlorophyll *a* levels can shift the algal population composition to less desirable species. These less desirable algae can affect the entire food chain. These algae can also produce harmful toxins to fish, bivalves and humans. High levels of chlorophyll *a* (=algae) can shade submerged aquatic vegetation and damage that valuable part of the ecosystem. EPA chose to use numeric criteria for dissolved oxygen and water clarity and a narrative criterion for chlorophyll. The conclusion was that in achieving the numeric criteria, the narrative chlorophyll criteria would also be met. EPA realized that this may not be the case in all situations and recommended site-specific numeric chlorophyll criteria in these other situations to address local algal-related impairments. DEQ's decision to move to numeric criteria for the James is well established

scientifically and comprehensively in the findings of the 2004 DEQ Technical Report (VA DEQ 2004) and long overdue.

8. Comment (CBF):
Supports numeric chlorophyll *a* criteria for the James River. The use of a numeric chlorophyll *a* criterion to drive revival of balanced ecosystems is, in fact, desirable in all waters in the state. Numeric standards and derivative effluent limitations provide clear and unambiguous expectations, thereby providing a discharger with predictability. In addition, accountability, compliance and enforcement are similarly more efficient and clear-cut. The narrative chlorophyll *a* standard in place for waters other than the James is simply less protective of water quality than a numeric standard as "undesirable water quality conditions … or aesthetically objectionable conditions" associated with chlorophyll *a* is a qualitative and interpretative condition. A scientifically sound numerical standard is clearly superior to a narrative standard and CBF advocates for use of a numeric standard for all waters subject to the revisions.

DEQ Response: *DEQ intends to ask the Board to adopt numerical chlorophyll criteria for the tidal James River.*

9. Comment (Honeywell)**:**
DEQ should share responses to these comments in a manner that gives interested stakeholders, a meaningful opportunity to evaluate the proposed or revised chlorophyll *a* criteria in the context of other regulatory developments (i.e., the nutrient caps in the WQMP regulation)

DEQ Response: *At this point in time, it is expected for this proposal as well as the other nutrient regulatory developments (i.e., the nutrient caps in the WQMP regulation) that are related to the adoption of these chlorophyll criteria, will have more stakeholder input via a second public comment period.*

10. Comment (Virginia Association of Municipal Wastewater Agencies or VAMWA, Augusta County Service Authority, BWXT Nuclear Products Division, Chesterfield County, Crater Planning District Commission, City of Fredericksburg, Georgia-Pacific Corporation, Greif, Hanover County, Henrico County, Honeywell Nylon, Inc., Hampton Roads Planning District Commission, Harrisonburg-Rockingham Regional Sewer Authority, Hampton Roads Sanitation District or HRSD, Hopewell Regional Wastewater Treatment Facility, J.H. Miles & Co., Inc. Seafood, Town of Leesburg, Philip Morris USA, Prince William County Service Authority , Rapidan Service Authority, City of Richmond, Rivanna Water & Sewer Authority, South Central Wastewater Authority, Upper Occoquan Sewage Authority , City of Virginia Beach, Virginia Manufacturers Association, MeadWestvaco Corporation):

There are 27 organizations listed above. Twenty-six of them specifically mentioned their support of all VAMWA comments and 23 specifically mentioned objections to numerical chlorophyll criteria for the James River.

Response: *The primary concerns of the organizations listed above and DEQ responses are listed in comments 11 – 19 below. Detailed responses to VAMWAs, HRSDs and Hopewell comments follow in* *comments 20 – end. Please note that complete citations for references provided in the comments are not included in this document. Complete citations used in DEQ responses are included.*

11. Comment (VAMWA): There is a high cost to meet these criteria with no apparent environmental benefit.

Response: *Cost estimates were provided to the Board at the June 2004 meeting for the proposal using the best information staff had at the time. This was done using the April 2004 Chesapeake Bay tributary strategy cost estimates. These cost estimates have been updated and have increased. They are published in the January 2005 Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy. The 2005 cost estimates have increased significantly, particularly for the nonpoint source sector.*

The tributary strategy recognizes that cost estimates for the York and James basins are considered interim until these waters quality standards are adopted by the Board and approved by the U.S. EPA. These estimates are the best information we have at this time and are as follows:

Basin	***Cost Point Source***	***Cost Non-Point Source***	***Total Costs***
James	*$501,000,000*	*$4,063,000,000*	*$4,564,000,000*
York	*31,000,000*	*$668,000,000*	*$699,000,000*

These costs increased from those presented in the April 2004 draft Tributary Strategies for several reasons. The costs now include operations and maintenance costs of the nonpoint source best management practices and include costs for the renewal of annual or short term best management practices (e.g. replanting cover crops is an annual practice). The largest cost increase is due to correcting the way urban stormwater best management practices cost is presented, using the installed costs rather than an annual cost. It should be noted that about 80% of the non-point costs are for urban best management practices. However, these practices, while expensive, provide the least amount of nutrient reductions. Therefore, they are not cost-effective and likely not the priority management actions to promote, especially in the near term.

Implementation of agricultural best management practices (BMPs) will achieve the most significant and cost effective reduction of nutrients and sediments from nonpoint sources. While farmers voluntarily implement some BMPs, financial incentive programs such as VA's Agricultural BMP Cost-Share Program and the federal USDA EQIP (Environmental Quality Incentive Program) are administered by the Department of Conservation and Recreation help fund these programs.

Funding sources for point source costs include the Virginia Revolving Loan Fund and the Water Quality Improvement fund. The state administers the Virginia Clean Water Revolving Load Fund which provides financial assistance in the form of low-interest loans to local governments for needed improvements at publicly-owned wastewater treatment facilities and/or collection systems. The U.S. Congress and the Virginia General Assembly determine the amount of monies *that go into this fund. The 2005 Virginia General Assembly has deposited approximately $65,700,000 into the Water Quality Improvement Fund to assist localities with cost-share grants. Another funding mechanism is through the USDA's Rural Utility Service which provides loans, grants and loan guarantees for drinking water, sanitary sewer, solid waste and storm drainage facilities in rural areas and cities and towns with populations of 10,000 or less.*

In addition, the 2005 Virginia General Assembly established a watershed general permit and point source nutrient trading program to assist in meeting the load allocations for the Chesapeake Bay. The resulting regulation from that legislation will provide a cost-effective means to achieve the nutrient reductions needed to meet the assigned nutrient allocations for point source dischargers.

The cost to meet these criteria is high. Costs to meet environmental programs often cannot be quantified against environmental benefits. However, benefits can be described as the return of a "balanced, indigenous population of aquatic life" and that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-10 and 20) as is required by the Virginia Water Quality Standards regulation. The James River was listed as impaired under the general standard and for nutrients (DEQ 2004 305(b) Report). It has been characterized as "nutrient saturated" (Butt 2004) and containing one of the worlds highest levels of chlorophyll a (Monbet 1992.)

The James River's aquatic life population is not balanced. Fisheries and zooplankton are in decline and not healthy (Garman, pers. comm., Stanley et. al. 2002, Dauer et al. 2003, Carpenter and Lane 2004). Macroinvertebrate populations are impaired (DEQ 2004 305(b) Report) and phytoplankton community composition favors undesirable food source cyanobacteria (DEQ Technical Report 2004). DEQ has demonstrated the reduction of nutrients will move the James River towards an 'unimpaired' status which is a benefit to aquatic life. Improvements in the algae community will provide a better foundation for healthier aquatic life higher in the food chain, reduce the risk of harmful algae blooms, and contribute to restoration of the Bay grasses.

12. Comment (VAMWA, HRSD): The proposed criteria are based on a highly subjective and poorly defined interpretation of the algal "balance" concept, without consideration of overall ecological impacts.

Response: *Much of the opposition to chlorophyll criteria was based on the belief that the term "aquatic life" refers only to higher trophic levels such as zooplankton, fish, crabs, and oysters and that impairments or linkages to these aquatic life must be demonstrated. DEQ believes that the phytoplankton community, which forms the critical base of the food web for aquatic life, is also protected under current State regulations which require protection for a "balanced, indigenous population of aquatic life" and that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-10 and 20). This phytoplankton community is the specific aquatic life form upon which the proposed chlorophyll criteria are based. Related to this comment is VAMWA's position that higher trophic levels in the James are currently in good condition. In fact, there are many indications that living resources which rely on a healthy algal community are currently degraded. It has been documented that both fisheries and zooplankton in the James River are in decline and not healthy (Garman, pers. Comm., Stanley et. al. 2002, Dauer et al. 2003, Carpenter and Lane 2004) and benthic macroinvertebrate* *[i.e., benthic] populations are impaired (DEQ 2004 305(b) Report). Improvements in the algae community will provide a better foundation for healthier aquatic life higher in the food chain, reduce the risk of harmful algae blooms, and contribute to restoration of the Bay grasses.*

13. Comment (VAMWA, HRSD): Analysis of monitoring data demonstrates that much higher – and less burdensome – chlorophyll a criteria would provide equivalent algal "balance".

Response: *DEQ did an analysis in the 2004 Technical Report which compared 'balance' via algae species composition between the tidal fresh York which is considered 'least unbalanced' to algae species composition in the James which is impaired and not 'balanced'. This analysis shows differences between the tidal fresh James and York - desirable algae (diatoms) comprise 45% of the York algae community vs. only 24% in the James. The undesirable algae (cyanophytes) comprise 30% of the York algae community vs. 60% in the James. These results indicate that in waters with least impaired conditions with more frequent low chlorophyll a levels the algae species composition will reflect healthier, more desirable and balanced conditions. The data for chlorophyll a in these rivers are consistent with this conclusion: in the least unbalanced tidal fresh York, the chlorophyll a levels are < 5 micrograms per liter (summer average for 2000-2004) versus the impaired and unbalanced lower tidal fresh James, the chlorophyll a levels are >25µg/L (summer average 2000-2004).*

The analysis of data that is mentioned in the comment compared the 'balance' of the phytoplankton community between low chlorophyll and high chlorophyll events in the James River. This analysis showed that the phytoplankton species composition (i.e.' balance') during low chlorophyll events was not different than during high chlorophyll events in the James River. However, this analysis was performed by comparing data within an already impaired system, which is not appropriate. That is why the phytoplankton species composition results during 'high' chlorophyll events and 'low' chlorophyll events are similar.

14. Comment (VAMWA, HRSD): The proposed chlorophyll *a* criteria could actually harm living resources such as oysters, striped bass, largemouth bass, and menhaden. These potential impacts have not been evaluated by regulators.

Response: *The harm that is discussed in this comment is that the chlorophyll levels proposed do not correspond to enough algal food for the living resources. In response to this comment DEQ conferred with scientists at the Virginia Institute of Marine Science (VIMS) and Virginia Commonwealth University (VCU). They all came to the same conclusion –the concentrations in the proposed criteria will provide more than enough algal food for the oysters, striped bass, largemouth bass and menhaden (the upper trophic level consumers). Dr. Paul Bukaveckas (VCU) did an analysis of existing data and concluded that suspended matter in the James River is rich in its algal carbon fraction and its phosphorus and nitrogen content. All three metrics exceeded values reported for consumer thresholds. This means that suspended food particles in the James River are so rich in carbon, phosphorus and nitrogen that it is unlikely that even a 50% reduction from current chlorophyll a levels would result in dietary limitations to upper level consumers (Bukaveckas 2005). In his May2005 letter to DEQ, Dr. Roger Mann of VIMS indicated that VIMS scientists have concluded that lowered algal levels should not mean poor food supply because species in the wild use food sources other than phytoplankton.*

However, these comments are based on chlorophyll only, with no consideration of algal community species composition. In the James River, the algal community is on occasion dominated by large cells or colonies that are inedible or even toxic to consumers. Under these conditions, the edible algal fraction is smaller than the total algal fraction. But this is one of the algal related impairments that will improve with nutrient reductions via chlorophyll a numerical criteria.

Modeling results provided to DEQ by the EPA Chesapeake Bay Program show that the numeric chlorophyll a criteria proposed for the tidal James River are at the same levels of chlorophyll expected in other parts of the Bay and its tidal rivers once the nutrient reductions are achieved to meet the dissolved oxygen and water clarity criteria in those waters. If the concern raised about food limitation was, in fact, real (staff believe the scientists referenced above clearly indicate it is not) then the entire Bay's resources would be in jeopardy from the entire watershed nutrient reduction program since the chlorophyll levels throughout a restored Bay are expected to be at the same levels as the proposed James river criteria. Staff is not aware of similar concerns regarding food limitation to existing Bay resources that have been raised by any of the many technical experts involved in the development of these regional criteria recommendations during the past five years.

15. Comment (VAMWA, HRSD): More scientifically-defensible methods that point to alternate chlorophyll-*a* criteria for the tidal fresh water region were not utilized. Linkages of chlorophyll-*a* to harmful algal blooms have promise but must be revised.

Response**:** *The municipal stakeholders proposed a monitoring approach for criteria derivation that they believed would provide a link between criteria and visually nuisance blooms. This study was deemed unnecessary by DEQ and untimely given that the Bay Program partners and stakeholders have direct access to two decades of algal species composition data collected at the same time as chlorophyll a concentrations and a host of other water quality parameters. In addition, the* EPA *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and its Tidal Tributaries, April 2003, already contained extensive technical data and scientific findings characterizing chlorophyll a concentrations at which blooms of nuisance algal species occurred. This data was utilized in the development of criteria along with other lines of evidence representative of a healthy algal community.*

These comments suggest that 35-40 μg/L (in tidal fresh areas) and 25 ug/l (in higher salinity waters) are threshold levels at which impairments exits. If these values were adopted as seasonal mean criteria (which are how the DEQ proposed criteria would be applied) they would basically be equal to or higher than the current chlorophyll levels and represent a "status quo" criterion. Unfortunately, as demonstrated in technical justifications for the criteria, the "status quo" of the James is an impaired system and it is already designated as such on the EPA list of impaired waters. Alternatively, if the suggested thresholds are considered maximum values, then the variability in the monitoring data indicates that even with attainment of the proposed seasonal mean criteria (15-20 ug/l in tidal fresh and 10 ug/l in higher salinity waters), there will likely still be some exceedences of the suggested impairment levels (though many less than currently observed). In short, DEQ believes the suggested VAMWA thresholds represent undesirable *conditions. The proposed seasonal mean criteria are designed so the occurrence of chlorophyll levels above these thresholds will be reduced from current conditions.*

16. Comment (VAMWA, HRSD): The agency should pursue an antidegradation or adaptive management approach to chlorophyll *a* standards development.

Response: *VIMS has stated that the proposed chlorophyll criteria for the lower James actually represent little change from current average seasonal conditions and therefore, represent an effective cap against degradation of the system as restoration activities are implemented. DEQ monitoring data supports this statement. However, the lower James has indications of algal related impairments (primarily degrading trends of undesirable algae). This may indicate the proposed criteria should be lowered. Due to numerous technical comments received on this issue, DEQ staff believe the best course of action is to pursue an antidegradation approach for the lower James to prevent further degradation.*

Furthermore, DEQ has, and will continue, to follow an adaptive management approach. For over 20 years, voluntary nutrient removal actions were taken to reduce the input of nutrients and sediments, yet the Chesapeake Bay and tidal tributaries are still listed for aquatic life and nutrient impairments. The next adaptive management step is to set the appropriate regulatory goals to achieve the necessary improvements in the Bay. The Chesapeake 2000 Agreement specifies that the jurisdictions with tidal waters will use their best efforts to adopt new or revised water quality standards consistent with the defined water quality conditions. After the goals are set, implementation of the criteria must be achieved. These management actions are outlined in the tributary strategies, the Water Quality Management Planning Regulation, the Nutrient Enriched Waters Regulation and the Chesapeake Bay Watershed Nutrient Credit Exchange Program established under the 2005 Virginia General Assembly (House Bill No. 2862 and Senate Bill No. 1275). Subsequent to adoption of criteria and implementing regulations, DEQ's monitoring program will evaluate results and future triennial reviews of Virginia's Water Quality Standards will afford opportunities in the future to adjust the goals.

Also, the comment suggests using an adaptive management approach of delaying adoption of chlorophyll criteria, along with the associated nutrient reductions, until suspended solids reductions necessary for water clarity achievement are implemented. The scientific community has clearly indicated that improvement in water clarity, with the resulting improvement in the critically important Bay grasses, depends on reducing both nutrients and sediments.

17. Comment (VAMWA, HRSD): The proposed chlorophyll *a* criteria were heavily influenced by pre-determined and politically-determined load allocations.

Response: *The chlorophyll a criteria were based on several lines of scientific evidence including the levels determined to restore balance to the phytoplankton community. The agency did not start with pre-determined loads and the resulting criteria. Attainment was considered as one of the lines of evidence to adjust the criteria within levels that still were believed to protect the James River. Attainment is not always considered in adoption of water quality standards but is certainly a prudent and reasonable approach to help in making environmental decisions. The* *resulting criteria (based on a reference community approach) were reasonably close to the attainment values.*

18. Comment (VAMWA): A use attainability analysis should be conducted and funding to obtain these standards has not been identified.

Response: *A use-attainability analysis to establish subcategories of aquatic life uses was conducted for the entire Bay watershed, including the James (USEPA 2003a, 2004). If the comment is referring to an economic use attainability analysis – the state is not obligated to do an economic use attainability analysis when adopting criteria. The state is obligated to consider economic impacts, which was done for this rulemaking (VADPB 2004). The state also agreed to conduct an alternative analysis to see which level of nutrient reduction would result in the most benefits to the James River.*

Furthermore, the Virginia General Assembly has deposited additional funds into the Water Quality Improvement Fund to assist localities with cost-share grants. Also, the 2005 Virginia General Assembly established a watershed general permit and point source nutrient trading program to assist in meeting the load allocations for the Chesapeake Bay through cost-effective means.

19. Comment (VAMWA): The state has failed to consider alternative, potentially much more beneficial approaches for nutrient management in the James River.

Response: *In response to public comment from the Virginia Association of Municipal Wastewater Agencies and inquiries from Senator Martin E. Williams during the 2005 General Assembly, DEQ in cooperation with EPA, committed to conduct an analysis that evaluated the benefits, detriments and costs of a range of nutrient loading scenarios and the corresponding predicted chlorophyll a levels. The results were to identify levels of nutrient reduction that might result in significant benefits and distinguish them from efforts that show diminishing returns or potential adverse effects. The expertise to do the modeling for this analysis resides at the EPA Chesapeake Bay Program Office. At the writing of this memo, the modeling work is underway and the results will be shared with the Board under a separate mailing before the June meeting.* ***The results of this analysis may necessitate further changes to the amendments.*** *The response to comments presented herein is also provided without the benefit of this alternatives analysis.*

20. Comment (VAMWA, HRSD, Hopewell): Many detailed technical comments were submitted by the Virginia Association of Municipal Wastewater Agencies, Hampton Roads Planning District Commission and Hopewell Regional Wastewater Treatment Facility.

Response: *Detailed responses follow.*

21. Comment (VAMWA):
VAMWA scientists have been involved with the efforts to derive chlorophyll-*a* standards since the criteria derivation process was initiated by the Chesapeake Bay Program in 2000. Over this time, VAMWA has put a great deal of effort into evaluating various methods for deriving and expressing chlorophyll-*a* standards, with a sincere desire to identify appropriate methods if

possible. Chlorophyll-*a* has been of special interest to VAMWA from the beginning of the process, due to the scientific challenges of quantitatively linking chlorophyll-*a* to designated uses in a manner that is not simply redundant of dissolved oxygen and water clarity standards.

Throughout this process VAMWA's major objective has been to ensure that—if and when chlorophyll-*a* standards were proposed—they represent scientifically-defensible regulations with tangible benefits to the environment and the public. Unfortunately, Virginia's proposed chlorophyll-*a* standards for the James River are deeply and fatally flawed on many levels, and have validated all of VAMWA's previously-expressed concerns about how a poorly-fashioned chlorophyll-*a* standard could lead to mismanagement of water quality and a waste of public resources. Major shortcomings of the regulation include the following:

- The proposed chlorophyll-*a* criteria are scientifically invalid, and are not based on demonstration of benefits to aquatic life or the public.
- Regulators have attempted to justify the proposed standard by numerous unsubstantiated and questionable claims regarding the impacts of chlorophyll-*a* on living resources of the James River.
- The proposed chlorophyll-*a* criteria could actually harm living resources such as oysters, striped bass, largemouth bass, and menhaden. These potential impacts have not been evaluated by regulators.
- The proposed criteria are based on a highly subjective and poorly defined interpretation of the algal "balance" concept, without consideration of overall ecological impacts.
- Analysis of monitoring data demonstrates that much higher—and less burdensome—chlorophyll-*a* criteria would provide equivalent algal "balance".
- The proposed numbers were heavily influenced by a pre-determined load allocation, the reverse of the process intended by the Clean Water Act.
- More scientifically-defensible methods that point to alternate chlorophyll-*a* criteria for the tidal fresh water region were not utilized.
- Regulators have not performed an analysis of alternatives to the proposed criteria, some of which are likely to represent superior environmental protection with much lower socioeconomic impacts.

The DEQ's technical support document on chlorophyll-*a* criteria (hereafter abbreviated as the TSD) failed to demonstrate aquatic life impairments in the lower James River that would justify the proposed standard. This segment generally does not experience nuisance or toxic blooms, and concerns in this segment are more related to potential trends in the (low) occurrence of potential bloom forming species, rather than any demonstration that the current algal composition is inherently unhealthy. VAMWA recommends that the lower James River be addressed by a phased adaptive management approach that includes consideration of food quantity requirements for oysters.

Of all the general and specific claims made by DEQ in the technical support document, the only category that VAMWA found to be partially substantiated were related to relatively high cyanophytes—including *Microcystis aeruginosa*—in the tidal freshwater segment of the James River. Monitoring data provide no evidence of adverse food quality impacts or toxicity. However, even if one accepted DEQ's description of this impairment, analysis of the monitoring data demonstrate that alternate chlorophyll-*a* criteria would provide equivalent protection against cyanophytes and *superior* protection of zooplankton and fish.

In summary, VAMWA believes that DEQ has largely ignored the data-based relationships between chlorophyll-*a* and designated uses in the criteria setting process. Instead, DEQ has compiled a range of low chlorophyll-*a* concentrations without connections to designated uses, and made a highly subjective selection of values, heavily influenced by a pre-determined load allocation, and without regard to potential harm to oysters and other fisheries. VAMWA encourages DEQ to instead base chlorophyll-*a* criteria on direct relations with designated uses where potential HABs commonly occur, and to take an anti-degradation or adaptive management approach to prevent the increases in potential HABs in segments where they are currently very rare. Such an approach could save Virginia hundreds of millions of dollars while providing comparable or superior ecological benefits.

VAMWA's opposition to the proposed chlorophyll-*a* standard should be considered in light of its general support of the dissolved oxygen and water clarity standards, which are also expected to require major expenditures by VAMWA members. Similarly, we recognize and appreciate the state's desire to address the James River in a progressive fashion. Protection of the water quality and living resources of Virginia tributaries, including the James River, is core to the VAMWA's mission. VAMWA sincerely desires to work with state agencies in a cooperative manner to put the James River on a positive path forward.

DEQ Response: *The wastewater discharging organization represented by VAMWA has made many comments disputing the need for chlorophyll criteria as well as the specific process used and numerical values DEQ is proposing. DEQ appreciates VAMWA's technical participation in the efforts to develop chlorophyll criteria and acknowledges their contributions to helping assure they are technically sound. By examining each criticism, concern, or suggestion in detail we have assured that the criteria will be an accurate gauge for the designated use of obtaining a "balanced and indigenous population of aquatic life" as well as the regulatory requirement to control "substances which nourish undesirable or nuisance aquatic plant life".*

A basic premise of the proposed criteria is that undesirable algal conditions (whether nuisance/harmful algal blooms or phytoplankton community imbalances) as currently found in the James are mediated by excess nutrients and climactic factors such as riverflow, temperature and other unknown triggers. While we have little control over natural climatic fluctuations in temperature and flows, excess nutrients are largely anthropogenic and James River remains very "nutrient saturated" even after the declining trends in nitrogen loads over the past decade. Under such conditions, the Virginia Water Quality Standards require that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-20)." As long as it is nutrient saturated, other natural factors (i.e. low flow years, warmer summers) will contribute to degrading algal conditions [with additional possible impacts to the higher trophic levels]. Holding the line on nutrients still exposes the biota to the risk of worsening conditions *beyond even the current impairments. In summary, with an enriched system such as the James, even further degradation can happen, which is why nutrients need to be reduced.*

The proposed chlorophyll criteria will help to set the nutrient reductions needed. It therefore, sets how much sediment reduction is also needed in order to achieve the clarity criteria. The more nutrient reduction achieved, the less sediment reduction is needed and sediments may be harder to achieve than the nutrient reduction.

The overall major shortcomings to the suggestions and criticisms in these comments are:

- *Many of the comments are based upon a mis-interpretation of the designated use of state waters of "propagation and growth of a balanced, indigenous population of aquatic life in all waters" (9 VAC 25-260-10). VAMWA bases much of it's opposition to chlorophyll criteria on the belief that the term "aquatic life" refers only to higher trophic levels such as zooplankton fish, crabs, oysters and that impairments or linkages to these aquatic life must be demonstrated. DEQ believes that the phytoplankton community which is at the base of the food web is clearly to be protected under current State regulations and it is this specific aquatic life that the proposed chlorophyll criteria are based on. Related to this is VAMWA's position that higher trophic levels in the James are currently in good condition. In fact there are many indications that living resources which rely on a healthy algal community are currently degraded.*

- *VAMWA suggests that much higher or alternative numerical criteria are appropriate based upon their analyses of data. Unfortunately, their analyses are based on faulty assumptions about algal community properties or analyses biased by selective exclusion of data. VAMWA has here and separately proposed that alternative chlorophyll criteria levels be examined between alternative nutrient reduction scenarios. A detailed analysis of chlorophyll conditions under these VAMWA alternative loading scenarios is presented in a separate document.*

- *VAMWA suggestions that lowering the current algal levels in the James will harm living resources such as oysters, striped bass, largemouth bass and menhaden were based on limited/biased data analyses or incorrect extrapolation of laboratory studies. DEQ has examined this issue extensively and found that the new chlorophyll criteria will not harm these higher trophic levels through food quality limitation and should in fact provide for a more desirable algal food quality base.*

- *The comments suggest that the criteria proposed be DEQ are scientifically invalid, subjective or poorly defined. In fact, DEQ has based the proposed criteria on an extensive monitoring data set, analyses based on widely scientifically and EPA accepted protocols, and published peer reviewed papers.*

- *While acknowledging some validity to concerns regarding the algal community, VAMWA suggest an "adaptive management" approach be taken at this time until further evidence of degradation occurs. In fact DEQ has been taking an adaptive management approach. The differences between the commenter and DEQ is the method of adaptive* *management. For the Commonwealth, environmental protection of the Chesapeake Bay has been implemented under an adaptive management scenario since the initialization of the Bay Program under the Clean Water Act. For over 20 years, voluntary nutrient removal was supported by the tributary strategies, yet the Chesapeake Bay and tidal tributaries are still listed for aquatic life and nutrient impairments. The next adaptive management step is to set the appropriate regulatory goals to achieve the necessary improvements in the Bay. The Chesapeake 2000 Agreement specifies that the jurisdictions with tidal waters will use their best efforts to adopt new or revised water quality standards consistent with the defined water quality conditions. These new water quality standards include the chlorophyll criteria being proposed. After the goals are set, implementation of the criteria must be achieved. This will be outlined in the tributary strategies, the Water Quality Management Planning Regulation, the Nutrient Enriched Waters Regulation and the Chesapeake Bay Watershed Nutrient Credit Exchange Program established under the 2005 Virginia General Assembly (House Bill No. 2862 and Senate Bill No. 1275). Subsequent to adoption of criteria and implementing regulations, our monitoring program will evaluate results and the triennial reviews of Virginia's Water Quality Standards will afford opportunities in the future to adjust the goals.*

22. Comment (VAMWA): **DEQ has mischaracterized the status of the James River and benefits to be expected from the proposed chlorophyll-a standards.**

In an effort to justify the proposed chlorophyll-*a* standards, the state has made numerous claims regarding the current status of the James River. The state's overall interpretation of the status of the river is highly negative, and in fact much more negative than any reports that preceded DEQ's push for chlorophyll-*a* standards (e.g., Virginia Secretary of Natural Resources, 2000; Dauer and others, 2003). DEQ's TSD makes frequent and liberal use of terms such as "undesirable", "nuisance", and "unhealthy", often without an objective basis for such claims. Positive aspects of the aquatic life status were largely ignored in the TSD. And the analyses presented in the TSD include almost no examination of the direct relations between chlorophyll-*a* and the claimed impairments, to demonstrate that the proposed criteria have any relation to the stated impairment.

The TSD ignores favorable biological indicators and mischaracterizes the likely effects of the proposed chlorophyll-a standards on aquatic life uses.

Much of the TSD is devoted to discussion of various algal indicators. At various junctions, DEQ makes the leap that these algal indicators have impaired various other biota such as SAV, clams, menhaden, and oysters. Most of these claims are unsupported by the data and the scientific literature. Contrary to suggestions of the TSD, there is no evidence that fish, crabs, oysters, clams, menhaden, or even zooplankton abundance are impaired by excess chlorophyll-*a* in the James River. If DEQ has actual data or evidence that this is occurring, we encourage them to make this information publicly known.

In fact, this river has many favorable biological indicators unmentioned by the TSD:

- The James River benthic macroinvertebrate community is the healthiest in the Chesapeake Bay Region (Virginia Secretary of Natural Resources, 2000).
- Fish data collected by the Virginia Department of Game and Inland Fisheries in 1998-99 demonstrated high abundance and diversity metrics, indicating a high quality fish community (Malcolm Pirnie, 2001)
- The river is a productive game fishery, hosting numerous tournaments including those for striped and largemouth bass.
- There is not a single study cited by DEQ or elsewhere that demonstrates that the algal community composition (or “balance”) is inadequate to support desired levels of living resources at higher trophic levels.

The abundance and diversity of fish and benthic macroinvertebrates in the James River is not surprising, given high dissolved oxygen conditions and a phytoplankton composition represented by favorable dominance and abundance levels of diatoms, chlorophytes, and cryptophytes (Dauer and others, 2003). The major challenges to living resources in the James River are:

- High levels of inorganic turbidity that hinder SAV growth (discussed further in comment 1-e)
- The diseases MSX and Dermo that affect oyster populations.
- Non-native species such as the blue catfish that compete with other species.

Chlorophyll-*a* driven nutrient load reductions are not expected to significantly affect any of these problems, and in fact may harm larval fish and oysters by imparting food quantity limitations (discussed further in comments 43-45).

DEQ Response: *DEQ did not mischaracterize the status of the James or the expected benefits of the proposed criteria. There may be some positive aspects of aquatic life in the James (as well as additional “challenges” as noted by the commenter) but the purpose of the Virginia Department of Environmental Quality Technical Report Chlorophyll a Numerical Criteria for the Tidal James River (henceforth referred to as the Technical Report (VA DEQ 2004) was not to characterize the overall status but rather to focuses on the degraded status of the algal community due to nutrient enrichment which the proposed Chlorophyll standards seek to correct. All references of “undesirable”, “nuisance”, and “unhealthy” used in the Technical Report (VA DEQ 2004) were based on appropriate and widely accepted usages in scientific ecological literature.*

The designated use addressed by the chlorophyll criteria is that of “propagation and growth of a balanced, indigenous population of aquatic life”. This designated use statement is currently part of Virginia’s water quality regulations that apply to all aquatic life including the algal community that is at the base of the food web.

Analyses presented in the Technical Report (VA DEQ 2004) show that these impairments exist in the current algal community of the tidal James River. There are excessive concentrations of algae compared to worldwide, nationwide and bay-wide measurements, widespread increases in algae levels and algae levels higher than reference levels. The frequency of algae blooms is *increasing. The James River's phytoplankton community is overly dominated by select, undesirable groups. Poor phytoplankton biotic integrity indices for the tidal James River also evidence a degraded aquatic plant community. There is low species diversity in the low salinity reach of the tidal James River along with elevated primary production. Undesirable, nuisance aquatic plant life is increasing over the past decade. This finding is evidenced by small cell sizes dominating throughout the tidal James along with increasing levels of undesirable and nuisance cyanobacteria in the upper tidal James during the summertime undesirable dinoflagellates observed in the lower tidal river.*

It is important to remedy these conditions because algae are an important component of river food webs providing a nutritional source for a wide variety of consumers (including commercially important fisheries such as shad and oysters). For example, cyanobacteria have been shown to be inedible for many consumers because of their size and the presence of toxic compounds.

The proposed numerical chlorophyll a criteria have direct relationship to fixing imbalances in the degraded status of the algal community. A major determinant and goal of the criteria development was to achieve algal communities similar to "reference communities" found in least impaired aquatic environments. As documented in the scientific literature, attaining the chlorophyll levels (and associated reference community structure) will lead to an algal community that is more "balanced" as characterized by lower chlorophyll levels, more stable community composition (i.e. less bloom frequency, stable proportions of taxonomic groups, and low biomasses of bloom forming species) and healthier cells with less phaeophytin and lower chlorophyll: carbon content (Buchannan et. al. 2005, Marshall et. al. submitted for publication). Achieving the reference community levels will also lead to less "undesirable or nuisance aquatic plant life" as evidenced by fewer cyanobacterium and less "red tide" dinoflagellate biomass (Marshall et. al. submitted for publication).

Contrary to the comment, there are many indications that fish, crabs, and benthic macroinvertebrates are impaired by the current degraded algal community. The existing Chesapeake Bay and tidal tributary monitoring data monitoring and analyses have not been designed to assess these direct linkages. But a vast body of ecological literature supports the concept that the base of the food web (i.e. the algal community) strongly and directly influences higher levels of the food web. Among these problems with higher trophic levels are:

1) *While the tidal James River is one of the relatively" healthiest" regions in the Bay in regards to benthic communities, this is equivalent to being the healthiest of the sick. In fact the mesohaline (JMSMH) and oligohaline (JMSOH) segments (i.e., from approximately the Chickahominy River to Hampton Roads) are listed as impaired for benthic macroinvertebrates in the 2004 303d list of impaired waters. Approximately 60% of the benthic degradation causing this regulatory impairment is related to eutrophication (either low D.O. or excessive organic productivity) with the remainder due to sediment contaminants (USEPA 2004b)*

2) *While the tidal James River hosts fishing tournaments (particularly the small tidal fresh tributaries such as Chickahominy), there are many indications of degraded fish communities in the river.*

- *In 2000, Virginia Department of Game and Inland Fisheries (VADGIF) started receiving angler complaints regarding largemouth bass fishing in the tidal Chickahominy River. Since that time VADIGF has focused extensively on the situation. Results of several years of research indicate the largemouth population in this river experienced year-class failures in 1999 and 2000, and several weak year-classes during the late 1990's. Almost no young-of-year (YOY) largemouth occurred in electrofishing samples collected during the fall of 2000, an indication that either adult largemouth were not spawning successfully or young bass were not surviving the summer during this period. These year-class failures resulted in a reduced catch of largemouth, particularly those bass smaller than 15 inches, during the 2000-2002 timeframe. (VADGIF 2004)*

- *The VA Department of Game and Inland fisheries (DGIF) says that the data they collected was not appropriately used by Malcolm Pirnie (2001) and they do not agree with the analyses performed in this report saying the James has a "high quality fish community". Specific comments provided by DGIF are:*

  "The study which MP references for their analyses was not designed for an upstream-downstream assessment. Rather the 1998-2000 DGIF study was a baseline survey of fish populations and communities occurring in the tidal James River basin. The criteria upon which the MP conclusions are based appear to be somewhat arbitrary, I am unaware of any peer reviewed and tested set of IBI metrics for assessing fish communities occurring in large tidal rivers of the mid-Atlantic region. In addition to the use of un-calibrated metrics, the analyses did not include comparison to a reference condition. What are the expected values for fish abundance and diversity for a high quality fish community in the tidal James River? Without a reference condition comparison, IBI-type analyses of fish communities in the tidal James are of questionable value. The MP upstream-downstream analysis is flawed in another respect in that the fish assemblage above Hopewell has been impacted by many other potential sources of impairment, including municipal and industrial waste discharges from Richmond.

  It should be noted that based on the pollution tolerance classification employed by the MP analyses, few pollution intolerant species were collected anywhere in the tidal James River. In addition, common carp, creek chubsucker, and blue catfish were designated as benthic species in the MP analyses. Occurrence of the above species should not be used as an indication of an ecologically high quality fish assemblage. Several species of insectivore which occur in the tidal James are fairly pollution tolerant, rendering use of insectivore abundance or species richness questionable for the purposes of IBI-type analyses in this system.

Any fish assemblage dominated by introduced species, can not be classified as an ecologically intact, or "high quality", fish community. Of the most abundant species occurring in the tidal James River, blue catfish, bluegill, common carp, channel catfish, and largemouth bass, are all non-indigenous to the watershed (Jenkins and Burkhead 1994)." (Letter submitted by the DGIF)

- *Shads and herrings have been in a long term decline in the James River as evidenced by this information:"The recreational fishery of the tidal James River is 'excellent' only if you fish for blue catfish- a large, long-lived, nonindigenous predator that was introduced by VADGIF in the mid-70's and has become invasive in the system. In many of these areas, nearly two-thirds of the fish biomass is blue catfish and there is an active recreational fishery … for the species in the lower James. Fisheries for many other species, especially the largemouth bass and migratory clupeid fishes have been in decline for some time. Bob Greenlee with VADGIF (Williamsburg office) might have some numbers for largemouth bass declines and we certainly do for the native shads and herrings in the system." (Dr. Garman, VCU, e-mail pers. comm.).*

- *In 1997, there were widespread occurrences of fish lesions in Maryland and Virginia tributaries to the Chesapeake Bay. This same year, lesions were found on 40-50% of live fish collected at 3 locations in the tidal fresh James River (Stanley et. al. 2002). This was as opposed to a "background" lesion rate of <2% found in other annual surveys of the James by the same authors since 1989. While the complex reasons for these widespread occurrences in tidal waters of Chesapeake Bay are in dispute, most scientists believe such lesions are definitely related to eutrophication through either direct causes of harmful algal blooms (HAB's) or other complex associations in the microbial community related to anthropogenic pollution.*

- *Menhaden populations in Chesapeake Bay are in decline and food quality for larvae and juveniles has been suggested as a possible factor per below excerpt (ASMFC 2004).*
    - *While there was not consensus by the committee as to the causes of low recruitment to age zero in Chesapeake Bay, the following are possible causes:*
        - *Insufficient spawning stock biomass*
        - *Eggs and larvae not being brought into Chesapeake Bay (transport)*
        - *Poor survival to at least several months old (unfavorable conditions of salinity, or temperature, **mismatch of food**, disease, and predation) (BOLD added for emphasis)*
        - *There is emerging evidence that climate forcing may play an important role*
    - *There is an ongoing concern of the decade-long decline in recruitment of menhaden in Chesapeake Bay.*
    - *Menhaden have diminished compared to its historical abundance in the Chesapeake Bay.*

- *Many Virginia BASS members would take issue with the use of the recreational largemouth bass fishery in the tidal James River as an example of "a productive game fishery". This fishery has suffered several years of reduced angler satisfaction, with the largemouth population experiencing multiple weak or failed year classes beginning in the late 1990's. While this was likely the result of reduced freshwater flows due to persistent drought, the exact cause is yet to be determined. (letter from DGIF)*

3) *Rotifer zooplankton abundance is increasing in tidal fresh and lower James (Dauer et al 2003). Rotifers are a small multicellular zooplankton animal of phylum Rotifera. These organisms are a major component of the microzooplankton and are major consumers of phytoplankton. High densities of rotifers are indicative of high densities of small phytoplankton such as cyanobacteria and as such are believed to be indicative of poor water quality.*

4) *Crab zoea abundance is declining in the polyhaline James near Hampton Roads (Dauer et al. 2003).*

5) *The Zooplankton Food Availability Index (FAI) for striped bass and white perch is "Below-Minimal" in Tidal Fresh James. The Index assesses total zooplankton food for larvae of migratory fish. During 1999-2002, the James had below-minimal FAI. Despite improving trends, zooplankton food levels for migratory fish larvae are currently inadequate in most major spawning/nursery areas of the Bay (USEPA 2004c).*

6) *Sharp declines in mesozooplankton abundance occurred at locations in the middle and lower James River. This indicates the overall zooplankton food base for important forage fish such as bay anchovy, menhaden, Atlantic silversides, and immature stages of other resident species is declining and shifting to smaller sizes. The zooplankton component of the Bay's food web is not healthy and its condition is worsening (USEPA 2004c).*

7) *Total Mesozooplankton diversity is worsening in Lower Polyhaline James near Hampton Roads (Dauer et al, 2003)*

8) *Mean Zooplankton "Index of Biotic Integrity" in lower James is "Bad" with some indication of declining trend (P<.064)). The Zooplankton Index of Biotic Integrity (IBI) changed from Fair in the late 1980's to Poor in 1999-2002. The IBI combines multiple indicators of zooplankton community health, such as total abundance and taxonomic composition, into a single index that can be scored. (Carpenter and Lane 2004)*

23. Comment (VAMWA, HRSD): ***The James River rarely experiences nuisance or toxic algal blooms.***

In presentations and their TSD, DEQ makes liberal use of the term "bloom" without adequate scientific definition. The document seems to refer to any increase in chlorophyll-*a* above some arbitrary level (not specified in the TSD) as an undesirable "bloom", regardless of whether the bloom has any harmful effects to other biota or would be even detectable by an observer. Most algal blooms are natural and not harmful, occurring in response to various environmental stimuli. In the context of designated use attainment, it is *harmful algal blooms* that are of concern, particularly nuisance or toxic blooms.

Nuisance blooms are exceedingly rare on the James River. Even in the tidal freshwater region, where chlorophyll-*a* levels are the highest, there is little to no visible expression of the algae. For example, aesthetic monitoring performed by the Hopewell Regional Wastewater Treatment Facility (HRWTF) and VIMS in 2004 showed no discernable change in the appearance of the water between March, when chlorophyll-*a* levels were very low, and late summer/early fall, when chlorophyll-*a* levels peak (Moore and others, elec. comm. 2004).

A review of the TSD reveals that DEQ was hard-pressed to identify examples of nuisance bloom conditions on the James River. The 1983 bloom that affected the Richmond water supply (cited on p. 12) actually originated in non-tidal waters that would not be covered by the proposed chlorophyll-*a* standard. The only other cited example was a reference to a photograph of a visible bloom in 2004, provided to DEQ by the Chesapeake Bay Foundation. While this photograph may in fact represent a "mahogany tide" as speculated—perhaps caused by the unusually high flow conditions of the summer 2004—the very fact that DEQ had no stronger evidence for nuisance conditions is a demonstration of how rare this condition is on the James River.

Table 1 lists the potentially harmful thresholds of several potentially toxic algal taxa, as cited by the USEPA Chesapeake Bay Program's *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries* (2003). Although previous reviews by VAMWA have shown that some of these thresholds are excessively conservative and not necessarily representative of aquatic life impairments, for the purposes of the present discussion these thresholds will be considered representative of "potential harmful algal blooms".

A review of Virginia CBP algal monitoring data reveals that potentially harmful dinoflagellate blooms are exceedingly rare in the James River. For example, in the 18-year record of algal monitoring in the James River, there has been only one incidence of the dinoflagellate *Prorocentrum minimum* exceeding the threshold, and none for *Cochlodinium heterolobatum* or *Karlodinium micrum*.

The absence of toxic blooms in the Bay is well-documented. For example:

- NOAA (1997) reported no "biological resource impacts due to nuisance or toxic algal blooms" in the lower James River.

- In a review of the occurrence of potentially phytoplankton blooms in the Chesapeake Bay, Marshall (1996) states that
    - "Blooms were not associated with toxin production, major fish kills, [or] shellfish poisoning."
    - "There is an apparent absence of toxin related events at this time in the Chesapeake Bay"

TABLE 1
Thresholds Representing Potential Harmful Algal Blooms
As Cited by USEPA (2003)

Species	Algal Group	Salinity Regime	Potentially harmful threshold cited by USEPA CBPO (2003) (count/mL)
Prorocentrum minimum	Dinoflagellate	Mesohaline-polyhaline	3,000
Cochlodinium heterolobatum	Dinoflagellate	Mesohaline-polyhaline	500
Karlodinium micrum	Dinoflagellate	Mesohaline-polyhaline	10,000
Microcystis aeruginosa	Cyanophyte	Freshwater-oligohaline	10,000

A concern has been expressed for the lower James River by Dr. Harry Marshall's (ODU) communications regarding an increasing trend in the number of dinoflagellate taxa identified, including the occurrence of some potentially toxic taxa—although generally at low, non-harmful levels. It must be emphasized that this trend does not represent an aquatic life impairment, but rather concern over a potential future impairment. VAMWA agrees that such a trend, if real, would provide reason for ensuring that it does not continue to the point that impairments actually occur, preferably using an adaptive management approach. However, there has been no demonstration that the proposed chlorophyll-*a* criteria have any relation to the occurrence of these taxa.

DEQ must examine the basis of the alleged increase in toxic dinoflagellate taxa, to ensure that is it not merely caused by statistical sampling effects and/or an increase in the ability of analysts to recognize such taxa over time. The probability of observing rare minority taxa increases as sample data increase. For example, when discussing the occurrence of minority estuarine algal taxa in the tidal freshwater James River, Marshall and Burchardt (1996) state that

> …the recording of estuarine taxa was probably enhanced by the extensive sampling base, which provided more opportunities to be recorded for this region;. e.g., during storm events and periods of low discharge. However, the majority of these taxa occurred in <2% of collections.

Hence, the total number of distinct taxa observed will almost always increase with time in a monitoring program.

Discussion of trends in the occurrence or abundance of potentially toxic taxa must be supported with statistical trend analysis.

In the tidal freshwater James River, DEQ's claims regarding harmful algal blooms center on *Microcystis aeruginosa*. This species does not occur in concentrations sufficient to cause visible or nuisance blooms in the James River. There is no evidence that it occurs in toxic strains or harms any other aquatic life. For example, *Microcystis aeruginosa* abundance actually correlates in a positive manner with mesozooplankton abundance in the Bay system (Figure 1). However, even if one accepted DEQ's definition of this impairment, analysis of the direct relations between *Microcystis aeruginosa* (and cyanophytes in general) and chlorophyll-*a* points to very different chlorophyll criteria than proposed by DEQ (see comment 41).

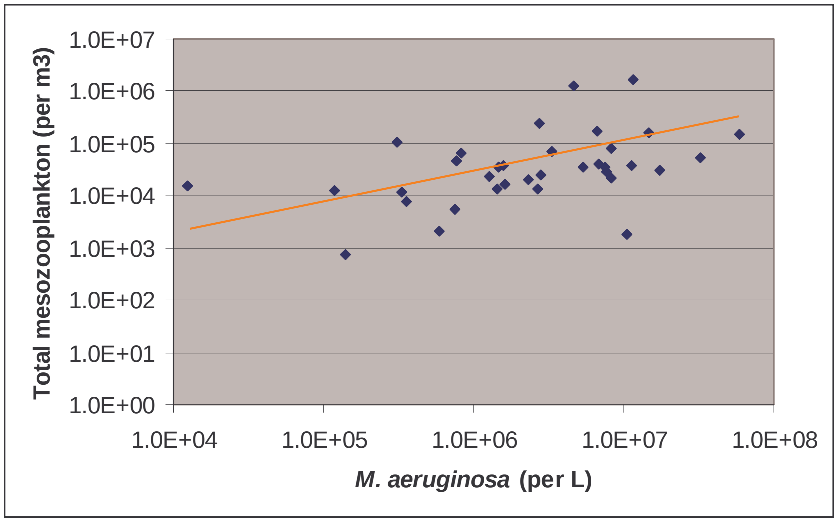

Figure 1. Total mesozooplankton v. *Microcystis aeruginosa* abundance in Chesapeake Bay and tributaries. From Plankton Goals Database (Buchanan and others, 2002).

In the TSD, DEQ makes the point that improvements in water clarity could be accompanied by an increase in undesirable blooms, given nutrient availability. The state has not proposed any plan to significantly reduce the resuspension-dominated turbidity of the James River. However, given the hope that turbidity could be reduced in the future, VAMWA finds this a valid point and agrees that an increase in undesirable blooms should be prevented. However, once again this does not lead to the proposed chlorophyll-*a* criteria. Prevention of an increase in blooms could be addressed by an anti-degradation approach, or a phased adaptive management approach. This would likely still lead to nutrient reductions if light conditions were actually expected to improve.

(HRSD): The frequency of algal blooms is increasing: *Inappropriate*. DEQ attempted to define "bloom" levels based on nutrient limited and light saturated conditions (so called "reference" conditions) rather than the chlorophyll concentration leading to biological impact. A bloom was defined when concentrations were greater than 3 ug/l in the polyhaline and 6 ug/l in the mesohaline during the spring season. This value is arbitrary and considerably less than the proposed standard. It is inappropriate to define a "bloom" based on chlorophyll at such low levels without biological relevance if this definition is to be used to justify a water quality standard. Further, this definition is based on a single published paper and does not necessarily represent a definition accepted and acknowledged by experts in the field. No linkage between the proposed criteria, increasing incidence of algal blooms and any biological end-point was provided in the report. Even if there were a relationship between the three, one would only conclude that concentrations should not be allowed to increase; reductions in concentrations would not be needed. Despite the uncertainties, we are in agreement with DEQ that general precautions should be taken to prevent the potential occurrence of algal blooms that might be caused by an increase in nutrient loadings in the future. Our recommendations for path forward in this area involve a full implementation of the 2000 James River strategy. This would serve to ensure that nutrient loads and chlorophyll levels in the James River are reduced through the implementation of non-point source sediment controls necessary for the water clarity standard.

DEQ Response: *The bloom criteria used in the Technical Report (VA DEQ 2004) was not arbitrary and was clearly specified as the 95th percentile of the reference community level. This means an unimpaired "reference" community only reaches these same levels 5% of the time (i.e. rarely). DEQ disagrees that only harmful algal blooms are in the context of designated use attainment. While true that some frequency of blooms are natural occurrences, in the context of the designated use of "propagation and growth of a balanced, indigenous population of aquatic life, the very high percentage of bloom conditions as shown in the Technical Report (VA DEQ 2004), this 95th percentile bloom criteria can be used as an indicator of designated use failure.*

The Chesapeake Bay Biological Monitoring Program was not designed to monitor blooms, with collections made on only 3% of the days over a 10 year period. The fact that any blooms have coincided with these collection dates would be unusual (Marshall pers. comm.). Therefore, the high percentage of blooms is indicative of an unbalanced algal population and evidence that these blooms are harmful is indicated by the degraded higher trophic level populations described previously.

Additional analyses of the unbalanced status of algal populations compared the bloom criterion used in the Technical Report (VA DEQ 2004) to other alternative bloom criterion. Table A shows chlorophyll a concentration greater than the 95th percentile of the values in the reference condition, values greater than peak concentrations seen world wide in mesotrophic conditions (USEPA 2003), and values greater than the proposed Virginia criteria concentration. With these criteria, the monitoring stations in the area of chlorophyll maximum (i.e., TF5.5, TF5.5A) still have greater than 65 percent of all chlorophyll a observations above the criterion and the frequency of blooms among the 3 phytoplankton community monitoring stations in the James was ~66% (TF5.5), ~24% (RET5.2), and ~44% (LE5.5). A "balanced" population would not show this extreme frequency of bloom levels.

Table A. Chlorophyll a criterion values (ug l^{-1}) used to define and examine frequency of spring and summer algal blooms in the tidal James River. An algal bloom is defined by a chlorophyll a concentration exceeding the threshold.

	Maximal (95th%) of Phyto Reference Community (Buchanan et al. 2005)	Peak Ranges for Mesotrophic Conditions [1]	VA proposed Concentration [2]
Spring			
Tidal Fresh	13.5	17	10/15
Oligohaline	24.6	24	15
Mesohaline	23.8	25	10
Polyhaline	6.4	7	10
Summer			
Tidal Fresh	15.9	17	15/20
Oligohaline	24.4	20	15
Mesohaline	13.5	14	10
Polyhaline	9.2	9	10

[1] Derived from Table V-8, pg. 130, USEPA 2003.
[2] VA DEQ Technical Report (VA DEQ 2004) 2004 (revised 2005)

Based on the three bloom metrics described above, the frequency in the three year period of 2000 through 200 4 is shown in figure A. The frequency of blooms also has been increasing since 1986 in some segments of the James River as noted in the Technical Report (VA DEQ 2004). Marshall and Burchardt (1998) also mention that there were in the upper reaches of the James River the presence of several bloom taxa and also potentially toxic species in these regions normally associated with higher saline conditions. Though present in low concentrations, their presence indicates a broad adaptability to conditions over the extent of this river. (Marshall per. comm.).

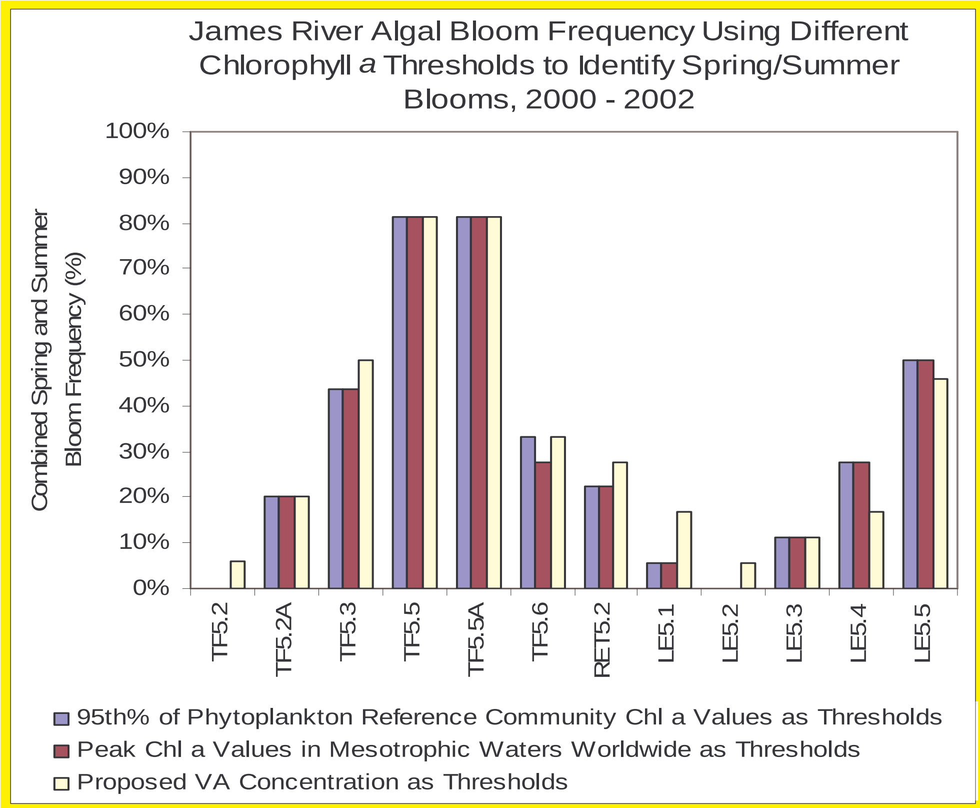

Figure A) Algal blooms using multiple thresholds 2000 - 2002

Review of Moore and others referred to in the comment indicates that the monitoring protocol attempted in 2004 for visually nuisance blooms proved unfruitful as a useful assessment protocol (Moore et al 2005). This and the short time frame of data collection (i.e. 1 year), negate it's usefulness as evidence of the lack of visual impacts. DEQ staff who performs water quality monitoring on the James have said this about aesthetic impacts of blooms in the James: "During more than 10 years of monthly monitoring for the Chesapeake Bay program on the James River in the Hopewell area, I have noted visibly green algae blooms in the summer and early fall months. Occasionally these gave off the characteristically fishy-musty odor of intense blue-green algae blooms. These occurred most intensely from the mouth of Bailey Creek downstream to Windmill Point. The mouth of Bailey Creek occasionally had low dissolved oxygen impacts from the die-off of the algae blooms" (Mark Alling pers. comm. E-mail).

The commenter "emphasizes" that an increasing in undesirable species does not represent an impairment "but rather concern over a potential future impairment." There is evidence that the Microcystis aeruginosa populations in the Potomac River are toxin (microcystin) producers. We confirmed its presence at several locations within Virginia inlets of the Potomac this past year. It would be expected and cannot be blatantly ignored that this same species within the James River would have this same capability. DEQ feels this is incorrect and that an increasing trend of undesirable species is a clear violation of the current water quality criteria of preventing "substances which promote the growth of undesirable or nuisance aquatic life."

In regards to the documented presence of harmful algal blooms, extensive impairments to higher trophic levels exist as noted in response to comment 22 but the commenter is somewhat correct about relatively few sampled events of toxic blooms or aesthetically objectionable conditions. However the main points about toxic algae in the James are:

- *To characterize the absence of toxic blooms as "well documented" is incorrect. It is more accurate to say it is well documented that we don't have a monitoring program designed to detect toxic blooms. The Chesapeake Bay Tidal Biological Monitoring Program was designed to provide only a general seasonal characterization of the biotic community within the tidal waters of the State. Based on the limited temporal (i.e. monthly) and spatial sampling regime (i.e. 15-20 miles distance between monitoring stations), the current monitoring program has a low percent probability of observing an algal bloom since they occur over just one or two tidal cycles and can be highly localized. Therefore, it is surprising and disturbing when the frequency and abundance of nuisance and potentially toxic algae were actually observed even under the current sparse sampling regime. Unfortunately, the DEQ also does not sample for algal toxin compounds.*

- *The comment fails to provide accurate or complete quotations from Marshall (1996). The actual sentence reads, "Although there is an apparent absence of toxin related events at this time in the Chesapeake Bay, the potential for these to occur exists from species already present in this ecosystem, in addition to new species that may be introduced". The next line states "There is also evidence that concentrations of potential toxin producers now living in the Bay are increasing". (Marshall 1996).*

  Another statement in the same paper regarding potentially toxic algae ignored by the commenter was "Since 1992 Cochlodinium heterolobatum has apparently expanded its regional range, and has become established as an annual bloom producer in several rivers of the lower Chesapeake Bay, where previously it had not been reported (James, Elizabeth, Pagan, and Lafayette Rivers)".

- *The NOAA (1997) report referenced as reporting "biological resource impacts due to nuisance or toxic algal blooms" in the comment was not based on any data analyses themselves but was a paper question/answer survey of limited state and federal agency personnel. At the time of the NOAA report, the planktonic (including chlorophyll conditions) were not as extensively analyzed as they have been during this criteria development process and therefore none of the issues presented in the Technical Report (VA DEQ 2004) were known at that time (e.g. the NOAA statement of "no resource impacts" is not applicable to the current discussion of criteria as there was no extensive analyses done). The NOAA study was only a broad brush attempt at evaluating the condition of the nation's estuaries. In any event, the NOAA report supports one of the basic premises of the Technical Report (VA DEQ 2004) by characterizing the James River as "In the James River, chlorophyll concentrations ranged from high to hypereutrophic".*

- *While specific sampling of toxic blooms has been limited, the James River has a decadal history of undesirable nuisance and potentially toxic algal blooms with numerous indications such blooms and opportunities for adverse human and aquatic health responses are increasing. There has been a significant trend over the past decade of increased abundance and biomass of cyanobacteria (commonly known as blue green algae) within all three reaches of the tidal James River, including Microcystis aeruginosa and several filamentous taxa. Noxious blooms of colonial cyanobacteria such as Microcystis are well known symptoms of eutrophication.*

- *The toxicity and large colonial size of Microcystis and other nuisance cyanobacteria can lower ingestion and assimilation rates of zooplankton (Lampert 1982; Nizan et al. 1986). Toxicity, lowered assimilation rates, and low nutritional quality of Microcystis can cause decreased survival and reproduction of zooplankton, thus leading to inefficient pelagic food webs." (Vanderploeg et al. 2001). The occurrence of cyanobacteria blooms has become a serious water quality problem for many coastal states and that nuisance algal blooms now are more frequent and more severe than before (Christian et al. 1986). Microcystis is associated with toxin production (microcystin) in estuarine systems. Microcystis sp. is the species of cyanobacteria that is most abundant in the tidal fresh James River, about 9 to 10 times higher than in the Rappahannock and York rivers' tidal fresh reaches, respectively. The levels of Microcystis in the James are the highest observed among all Chesapeake Bay plankton monitoring stations. In addition, there is clear evidence of increasing number of varieties of cyanobacteria present. For example, in 1994, the Old Dominion University scientists running Virginia's Chesapeake Bay phytoplankton monitoring program found 25 cyanobacteria taxa in the tidal fresh James River. That number increased to 110 taxa in the 2004 survey. As stated previously, chlorophyll levels at those set near the criteria level has been documented to result in lower levels of cyanobacteria. DEQ's acknowledges that not all cyanobacteria blooms are toxic. Even blooms caused by known toxin producers may not produce toxins or may produce toxins at undetectable levels. However, cyanobacteria in general and Microcystis in particular are known to produce a family of toxins called microcystins, named after this group of algae. These toxins can be lethal in relatively small amounts. Just a few years ago, it was believed that only about 10% of all cyanobacteria blooms produced toxins. However, recent studies have shown that the probability of an individual bloom containing Microcystis will be toxic is much higher 45-75% (M.A. Crayten, 1993). Unfortunately, sampling for the toxin is not part of the DEQ monitoring efforts.*

- *Studies show that Microcystis blooms are mediated by three factors: temperature, flow and nutrients. While we have little control over temperature and flows, nutrients are largely anthropogenic and James River has been characterized as "nutrient saturated" (Butt 2004). As correctly noted by the comment, Microcystis blooms are worst under low flow conditions due to the increased residence time for algal growth to occur. This same phenomenon has been noted in North Carolina (Christian et al. 1986). If nutrients and the current levels of cyanobacteria are not addressed through the proposed chlorophyll criteria, then the James will not only remain impaired as it already is but also be at high risk for much worse conditions if we see naturally occurring low riverflow years or* *warmer summers. This is a direct violation of the current Virginia Water Quality Standards which require that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-20).*

- *In addition to the cyanobacteria, there are other nuisance and potentially toxic algal forms called dinoflagellates. The commenter is correct that only one event of dinoflagellate blooms above a potentially toxic threshold has been sampled. The dinoflagellates, Prorocentrum minimum and Cochlodinium heterolobatum, which commonly bloom in spring and summer, respectively, in the lower James, have been shown to be harmful to various life stages of the Eastern oyster, Crassostrea virginica (Ho and Zubkoff, 1979; Luckenbach et al. 1993; Wickfors and Smolowitz 1995). The dinoflagellate Karlodinium micrum has been associated with numerous fish kills in the Chesapeake Bay (Goshorn et al. 2003). The status in the tidal James for these dinoflagellates is "poor" in the tidal fresh and oligohaline segments (VA DEQ 2004). Their representation in the Bay and tidal tributaries has also increased over the past decade. Many of the summer/fall blooms of dinoflagellates are becoming longer in duration and areal coverage. As an example, a large mahogany tide bloom assumed to be a dinoflagellate was noted in 2004 in the lower James River and reported by the Chesapeake Bay Foundation. Very high levels of dinoflagellate cysts have also been found in the James in comparison to other bay waters (VA DEQ 2004). Waiting for definitive evidence of oyster death or fish kills occur is a direct violation of the current Virginia Water Quality Standards which require that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-20).*

  In regards to these dinoflagellates, the comment states that "no demonstration that the proposed chlorophyll-a criteria have any relation to the occurrence of these taxa". In fact data analysis shows that if chlorophyll conditions attain those found in the reference conditions this will lead to lower mean biomass of the dominant bloom forming dinoflagellates of H. rotunda, Prorocentrum minimum, and Gymnodinium spp. (Marshall et. al., submitted for publication).

- *Since the literature states that zooplankton ingestion and assimilation rates are hindered by nuisance algae, the weak, but positive correlation shown in Figure 1 of the comment most likely indicates a predator-prey response. That is, as Microcystis abundance increases above a certain threshold, predation on zo9oplankton is reduced; thereby increasing zooplankton levels. At levels approaching a million cells per liter, the feeding behavior of meszooplankton predators would be hampered, making it difficult to find their zooplankton prey.*

The comments suggestion of alternative appropriate criteria derived specifically to control Microcystis is addressed in the response to comment 41.

This comment recommends that "adaptive management" be used at this time until further evidence of degradation occurs. DEQ believes we have been using an adaptive management approach for many years. The difference between the commenter and DEQ is the method of adaptive management. For over 20 years, voluntary nutrient removal actions were taken to *reduce the input of nutrients and sediments, yet the Chesapeake Bay and tidal tributaries are still listed for aquatic life and nutrient impairments. The next adaptive management step is to set the appropriate regulatory goals to achieve the necessary improvements in the Bay. The Chesapeake 2000 Agreement specifies that the jurisdictions with tidal waters will use their best efforts to adopt new or revised water quality standards consistent with the defined water quality conditions. After the goals are set, implementation of the criteria must be achieved. These management actions are outlined in the tributary strategies, the Water Quality Management Planning Regulation, the Nutrient Enriched Waters Regulation and the Chesapeake Bay Watershed Nutrient Credit Exchange Program established under the 2005 Virginia General Assembly (House Bill No. 2862 and Senate Bill No. 1275). Subsequent to adoption of criteria and implementing regulations, DEQ's monitoring program will evaluate results and the triennial reviews of Virginia's Water Quality Standards will afford opportunities in the future to adjust the goals.*

Also, the comment suggests an adaptive management approach of delaying adoption of chlorophyll criteria, along with the associated nutrient reductions, until suspended solids reductions necessary for water clarity achievement are implemented. The scientific community has clearly indicated that improvement in water clarity, with the resulting improvement in the critically important Bay grasses, depends on reducing both nutrients and sediments.

24. Comment (VAMWA): ***The "food quality" arguments are overstated and not substantiated.***

There is no evidence presented nor demonstration made that the food quality of the James River is of insufficient "quality" to support desired living resources. The numerous statements regarding "food quality" in the TSD are largely unsubstantiated, and seem based on several overgeneralizations and misconceptions that have been difficult to dispel

The concept of linking chlorophyll-*a* criteria to "food quality", while once promising, has not come to fruition. A draft version of the EPA criteria document attempted to derive chlorophyll-*a* criteria primarily based on food quality impacts to zooplankton, which would presumably then affect higher trophic levels. This approach—and the associated chlorophyll criteria—were severely criticized during independent scientific and stakeholder reviews, and were ultimately withdrawn. For example, a reviewer Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) labeled the idea that high chlorophyll-*a* levels can be associated with measurable food quality impacts as "overstated and not substantiated" (USEPA CBPO, 2002):

Similarly, the CBP's Chlorophyll-*a* Task Group was unable to derive any *a priori* definition of acceptable v. unacceptable phytoplankton composition relative to food quality requirements for upper trophic levels. While it was acknowledged that specific phytoplankton species could be harmful or non-nutritious, generalizations such as "dinoflagellates are poor food where as diatoms are good food" were not found to have a firm scientific basis.

With this background, VAMWA was dismayed to find that DEQ's TSD has perpetuated the shaky overgeneralizations about chlorophyll-*a* and food quality. Such statements are likely to mislead the public into believing that the proposed chlorophyll-*a* criteria would have a measurable positive impact on higher trophic levels, which has not been demonstrated in any fashion.

Because zooplankton feed directly on phytoplankton, a phytoplankton composition that represented unacceptable food quality would first be expected to manifest itself as a reduction in zooplankton. This in turn could affect higher trophic levels that feed on zooplankton. For example, a minimum of 20,000 m^{-3} total mesozooplankton has been cited as favorable for larval fish (Jacobs, 2003). If the proposed chlorophyll-*a* levels were representative of “poor food quality”, one would expect mesozooplankton abundance to decline when chlorophyll-*a* exceeded the criteria.

In fact, actual monitoring data indicate that this is not the case. Graphical and statistical analysis of data from the Plankton Goals Database (Buchanan and others, 2002) demonstrates no suppression of mesozooplankton when chlorophyll-*a* exceeded the criteria proposed by DEQ (Figures 2-7; Table 2). In fact, in the tidal freshwater regime, meozooplankton were significantly *lower* when chlorophyll-*a* was below the proposed criteria (i.e., in non-attainment), as was the probability to have sufficient mesozooplankton to support larval fish—despite higher cyanophyte abundance at higher chlorophyll-*a* concentrations.

VAMWA does not dispute that certain phytoplankton taxa can be less nutritious to consumers, nor that it may be possible in the future to establish stronger linkages between nutrient inputs, other environmental variables, and food web dynamics. However, VAMWA strongly challenges the concepts that the present algal composition has been demonstrated to be of insufficient quality to support desired living resources, or that the proposed chlorophyll-*a* criteria are based on documented food quality benefits to aquatic life uses.

TABLE 2
Results of Wilcoxon Rank-Sum Test of Mesozooplankton Abundance Above and Below Proposed Chlorophyll-a Criteria
[Analysis based on 1985-2002 data compiled in Plankton Goals Database (Buchanan and others, 2002)]

Salinity	Season	Proposed Chl-*a* Criterion (µg/L)	Median Total Mesozooplakton Below Criterion (per m^3)	Median Total Mesozooplakton Above Criterion (per m^3)	Significantly different at α=0.05?
Tidal Freshwater	Spring	15	5,500	44,200	Yes
	Summer	20	1,430	24,098	Yes
Oligohaline	Spring	15	11,300	13,900	No
	Summer	15	13,700	16,900	No
Mesohaline	Spring	10	10,700	12,300	No
	Summer	10	7,400	8,100	No

DEQ Response: *The food quality arguments were not overstated but rather based on generally accepted ecological principals found in most states water quality standards that a balanced algal community is beneficial to higher trophic levels and there is evidence that the current algal community in the James is less than desirable in regards to food quality. The designated use of all state waters is to support “a balanced, indigenous population of aquatic life in all waters”.*

This use designation includes all aquatic life from the base of the food chain (algae) to up to commercial and recreation fishes. DEQ (VA DEQ 2004) relied on multiple lines of evidence (the algal community composition was one of the considerations) that this designated use is not being met in the algal community and this is what is being addressed by chlorophyll criteria.

Analyses presented in the comment showing higher zooplankton levels under higher chlorophyll regimes in the summer tidal fresh regime (Table 2 in comment above and Figures 2 – 7 of VAMWA's comments which are not shown here) are misleading because they assume all low chlorophyll values represent equivalent food. When sufficient numbers of unimpaired water samples exist (mesohaline and polyhaline waters of the Chesapeake Bay), the food quality benefit to mesozooplankton under the lower chlorophyll level reference community conditions used in setting the criteria is readily apparent (Figure B below). Unfortunately there are relatively few data from unimpaired conditions in tidal fresh and oligohaline salinities where similar zooplankton responses to reference chlorophyll levels could not be empirically determined during the criteria development process.

Figure B) Mesozooplankton levels under reference conditions used to set criteria

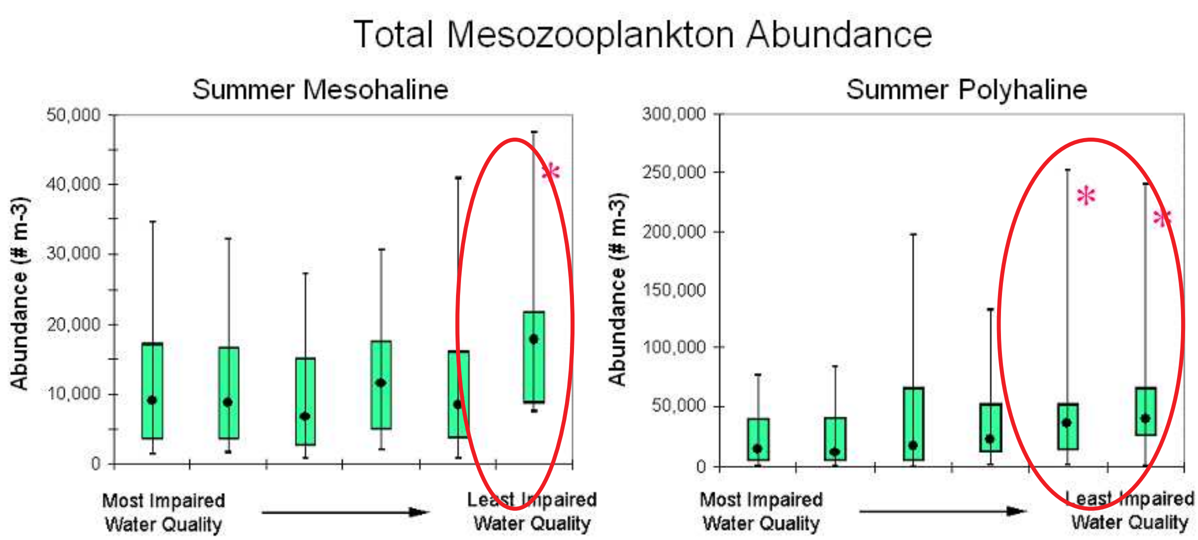

Table 2 in the comment presents results of data analysis from ALL tidal fresh monitoring stations in Chesapeake Bay (i.e. Mainstem Bay, Maryland waters etc.) and shows the expected relationship between high chlorophyll levels and higher zooplankton levels. One would expect that this would mean the tidal fresh James should have high Mesozooplankton levels associated with its high chlorophyll levels. However, as discussed previously, the food availability index developed by the Chesapeake Bay Program to evaluate zooplankton food resources for larvae of striped bass and white perch in spring indicates zooplankton food resources are "Poor" (<5,000 m^{-3}) or "Minimal" (5,000 – 10,000 m^{-3}) in most years. This is despite the high chlorophyll levels present and indicates a poor food quality of the algal populations in the James.

25. Comment (VAMWA): ***The phytoplankton reference community and phytoplankton IBI are more indicators of turbidity than absolute measures of the health of the algal community.*** The TSD references phytoplankton reference communities (Buchanan and others, submitted for publication) and the related phytoplankton IBI (Lacouture and others, in prep.) as basis for statements that the algal community in portions of the James River is "poor" or "degraded". The original phytoplankton reference community work had the reasonable purpose to examine the variability in certain plankton metrics with certain other environmental variables, such as light, salinity, and nutrient concentrations. It has long been VAMWA's concern that this work would then be misapplied in the context of water quality management and standards, and unfortunately it appears these concerns are being justified. Following is a summary of VAMWA's previous comments and concerns with the manner in which the phytoplankton reference community and associated IBIs are being applied:

As stated in the DEQ TSD, "the phytoplankton reference community approach does not demonstrate any direct relationship between chlorophyll-*a* concentrations and designated use impairments" (p. 16).

Similarly, the related IBI suffers from a similar lack of linkage with designated uses. There has not even been a demonstration that chlorophyll-*a* is a statistically meaningful predictor of phytoplankton composition for most season-salinity regimes.

It should be understood that the phytoplankton reference communities and associated IBIs do not represent *a priori* definition of "good" or "bad" algal compositions, based on observable ecological effects. Rather, they represent a *substitute* for such a definition, given the Chesapeake Bay Program's inability to define ecological impacts of different algal compositions. The use of these metrics for direct water quality management or standards development therefore represents circular logic: "This is the water quality we want to get the phytoplankton composition we want, which was itself derived from an *a priori* definition of the water quality we want."

As an example of this circular logic, note that the phytoplankton IBI is calculated using many highly correlated measures of biomass—including chlorophyll-*a* itself. By definition, the IBI will be worse when chlorophyll-*a* is high. Any attempt to justify chlorophyll standards on the basis of phytoplankton IBI scores therefore represents a tautology.

Results of the phytoplankton reference community approach make it clear that light, rather than nutrient concentrations, was the important controlling variable for phytoplankton communities. As stated by Buchanan and others (in press):

> The strong similarities between the better-best) [i.e., high light, low nutrient concentrations] and mixed-better-light [i.e., high light levels regardless of nutrient concentrations] in mesohaline and polyhaline waters…attests to the overall importance of water clarity for phytoplankton. As long as light levels are classified as "better", DIN and PO4 concentrations evidently do not need to be below…limitation thresholds before features characteristic of the better-best phytoplankton communities appear.

With this in mind, it can be concluded the <u>relatively high turbidity of the James River is the primary reason that the phytoplankton community would differ from other tributaries</u>. Non-algal suspended solids are the major cause of low light conditions throughout the James River, and nutrient reductions driven by chlorophyll-*a* criteria would not be expected to cause shifts from "worst/poor" light conditions to "better/best" light conditions. This suggests that attainment of the chlorophyll-*a* criteria would not cause the phytoplankton reference community to be significantly different, particularly in the mesohaline and polyhaline segments.

Low light conditions are also likely to be the primary cause of the asymmetric chlorophyll-*a* distribution in the water quality bins with lower light, either because low light conditions favor certain mixotrophic, bloom-forming taxa (Mullholland, 2004), or light-limited algae bloom when light become temporarily more available. Similarly, low light conditions favor blue-green algae in freshwater systems (Wilbur, 1983).

Conversely, improved light conditions would be expected to significantly affect the phytoplankton composition even if chlorophyll-*a* concentrations remained the same. Nutrient load reductions would likely be required to prevent an increase in chlorophyll-a if light conditions were expected to significantly improve. However, this would indicate the need for an anti-degradation or phased adaptive management approach to nutrient controls, rather than the concept that chlorophyll-*a* reductions are necessary or useful for achieving a particular phytoplankton composition.

Ironically, the major contribution of the phytoplankton reference community work in this context is to demonstrate that chlorophyll-driven nutrient controls would not be expected to achieve a particular phytoplankton composition in the James River. VAMWA encourages DEQ to re-evaluate the reference community and IBI work with a focus on the actual implications for nutrient and turbidity management. These or related metrics might have some utility as part of a phase adaptive management approach. However, they should not be used to justify chlorophyll-*a* standards.

***DEQ Response**: The comment refutes the use of reference communities in setting chlorophyll criteria by referencing the DEQ Technical Report (VA DEQ 2004) that "the phytoplankton reference community approach does not demonstrate any direct relationship between chlorophyll-a concentrations and designated use impairments". This statement in the Technical Report (VA DEQ 2004) originated during the EPA chlorophyll criteria process (see pg 116 of EPA 2003) in regards to the newly developed designated uses of "open water fish and shellfish…", "Deep water seasonal fish and shellfish…", "Shallow-water bay grass use" etc…, which are focused on support of higher trophic level communities. DEQ feels that the reference community information may not be useful in regards to those higher trophic level designated uses but is useful in regards to the current VA designated use supporting "a balanced, indigenous population of aquatic life", which clearly intends to maintain not only a balanced population of fish and shellfish, but all aquatic life from the base of the food chain (algae) to up to commercial and recreation fishes.*

The comment states a dissagreement with the approach of phytoplankton reference communities and associated index of biotic integrity (IBI) as published in the scientific peer reviewed literature (Buchannan et al. 2005) in defining a "balance, indigenous population" of algae and associated criteria chlorophyll levels. This reference community approach followed the procedure outlined/recommended by EPA for the development of regulatory biocriteria (Gibson et al. 2000). The approach is not circular- it is direct.

Desirable phytoplankton habitat conditions were first defined, and then the biological community associated with those conditions (reference community) was described. Before Chesapeake phytoplankton reference communities and IBIs were developed, least-impaired habitats were delineated with quantitative values of "good" or desirable water quality conditions. Least-impaired conditions were sampled with DIN and PO4 concentrations that had been experimentally shown to limit excess algal growth and Secchi depths that provided adequate light for phytoplankton and SAV growth. Impaired conditions were sampled with excess DIN, excess PO4 and inadequate light. Biological metrics were selected for inclusion in the IBI based on their ability to differentiate between impaired and least-impaired conditions. Scoring thresholds for the metrics were determined by comparing the data distributions in impaired and least-impaired conditions, and following scoring procedures recommended in Gibson et al. (2000) and elsewhere.

Chlorophyll was found to be a strong differentiator between impaired and least impaired aquatic habitat conditions. Buchanan et al. (2005) paper):

a) "In summary, unimpaired water quality conditions (BB) and marginally impaired water quality conditions with adequate light (MBL) support phytoplankton communities with consistently low chlorophyll a and phaeophytin concentrations and low chlorophyll cell content. Communities in nutrient rich, light-impoverished conditions (MPL, PW, W) exhibit wide ranges of these three photochemical indicators." The inference being more nutrients, more chlorophyll.

b) "Chlorophyll a concentrations in the 1984-2002 monitoring data show that today's Chesapeake Bay is mostly eutrophic, and even hyper-eutrophic at times according to benchmarks in the literature."

"One of the major contributors to reduced light intensity in the water column is associated with increased concentrations of phytoplankton abundance. High silt loads common during the spring rains, are reduced during the summer/fall months when blooms are most common by cyanobacteria and dinoflagellates, and chlorophyll peaks occur, thus a major factor reducing light comes from the developing algae, with reduced TSS contributions. As indicated by the reference to Wilbur (1983), cyanobacteria (blue green algae) are abundant during low light levels" (Marshall per. comm.).

Several metrics are used to assess chlorophyll a by salinity and season. One such metric is the discrimination efficiency (DE) of chlorophyll a. DE is the ability of an individual biological metric to correctly identify both impaired and least-impaired habitat conditions. Based on reference community conditions, DE ranged from 54.3% in spring tidal fresh, where its response is often masked by freshwater flow effects, to 78.4% in summer tidal fresh (see Table B).

Table B. Discrimination efficiency of chlorophyll

Chl a	*Tidal Fresh*	*Oligohaline*	*Mesohaline*	*Polyhaline*
Spring	*54.2%*	*65.5%*	*64.0%*	*74.1%*
Summer	*78.4%*	*70.0%*	*75.6%*	*63.0%*

Source; Buchanan et al. 2005

Similarly, classification efficiency is the ability of the overall IBI index to correctly identify both impaired and least-impaired habitat conditions. The overall phytoplankton IBI classification efficiencies (CE) range from 70.0% to 84.4% (see Table C). The DE and CE percentages of the phytoplankton IBI are generally robust and comparable to those for biological groups in other environments. They demonstrate that many phytoplankton metrics, either singly or composited in an index, can differentiate between water quality conditions that have been, a priori, identified as impaired and least-impaired.

Table C. Classification efficiency of phytoplankton IBI				
Season	*Tidal Fresh*	*Oligohaline*	*Mesohaline*	*Polyhaline*
Spring	*70.0%*	*70.5%*	*78.1%*	*84.4%*
Summer	*78.4%*	*75.5%*	*77.8%*	*71.8%*

Source: Buchanan et al. 2005

VAMWA is correct in claiming that nutrient reductions cannot be expected "to cause shifts from "worst/poor" light conditions to "better/best" light conditions because non-algal suspended solids are a major cause of low light conditions throughout the James River." Buchanan et al. (2005) state in their abstract "Improved water column transparency, or clarity, through the reduction of suspended sediments will be particularly important in attaining the reference communities. Significant nitrogen load reductions are also required." The comment acknowledges/accepts the first part (i.e. light is a major determinant and needs to be addressed), while ignoring the second part (i.e. nutrient loads are also important). If just sediment reductions are implemented in the James River watershed, and nutrients are left at its present high levels, an improvement in water clarity will inevitably result in increased algal blooms even above the already high levels.

The comment implies that DEQ will consider only nutrients as ultimately influencing management strategies to attain chlorophyll criteria. In fact, chlorophyll a criteria will effectively drive both nutrient and suspended sediment reductions, and will allow VA to empirically determine when concentrations of both have been reduced enough to provide acceptable habitat conditions for both SAV and phytoplankton. It is possible that the nutrient reductions needed to attain the reference community chlorophyll a concentrations will not be as severe as those proposed by models, assuming clarity improves (Buchanan et al. 2005). This will be part of the adaptive management approach DEQ continues to follow: adopted narrative standards, James River mainstem listed as "impaired" by EPA (1999 and 2004), development of numerical standards, implement management actions needed to meet the assigned nutrient and *sediment cap load allocations, measure results and adjust as needed through triennial review of Virginia's Water Quality Standards.*

Finally, the comment suggests that attainment of the chlorophyll criteria will not lead to a higher quality phytoplankton community. In fact, achieving the chlorophyll levels associated with reference phytoplankton community levels is expected to lead to the following changes in community composition in areas of the James River (from Marshall et al. submitted for publication).

- *Lower abundance and biomass of undesirable dominant seasonal bloom forming dinoflagellates;*
- *Larger cell size of desirable diatoms;*
- *Lower absolute abundance, percent of community abundance and biomass of undesirable cyanobacteria; and*
- *Lower overall abundance and biomass of summer phytoplankton.*

Also, the comment suggests an adaptive management approach of delaying adoption of chlorophyll criteria until suspended solids reductions necessary for water clarity achievement are implemented. Scientists have indicated to use that "absent constraints on phytoplankton community levels (implemented through the proposed chlorophyll a criteria) reducing suspended sediment levels will almost certainly result in significant increases in algal populations as those populations take advantage of increased light availability to utilize excess nutrients already in the system This response will offset many of the benefits from reduced suspended sediment loads, and may actually degrade habitat conditions for things other than SAV." (Mann 2005). It would be poor environmental management policy to allow this predicted degradation to occur. The lag time involved between finally deciding to implement nutrient reductions and when they were actually in effect sufficiently to reduce algal populations would allow for several years of impaired waters. This is not good public policy. Nutrient reductions are needed along with sediments so water quality problems do not arise in the future.

26. Comment (VAMWA, HRSD, Hopewell): ***Algae are not a significant impairment to SAV in the James River.***

In several places, the TSD attempts to justify the proposed chlorophyll-*a* criterion on the basis of water clarity and SAV. Virginia is in the process of adopting separate criteria for water clarity/SAV, and the EPA CBPO criteria document only calls for chlorophyll-*a* criteria where "algal related impairments are expected to persist even after the...dissolved oxygen and water clarity criteria have been attained." (USEPA CBPO, 2003). Therefore, it is clear that chlorophyll-*a* criterion are not necessary to protect or restore SAV in the James River. While this is sufficient justification for DEQ to remove the SAV-related justifications for chlorophyll-*a* criteria, VAMWA would also like to take this opportunity to address several other misconceptions regarding SAV included in the TSD.

The potential depth of SAV growth is not sensitive to chlorophyll-*a* reduction in the James River. For example, application of the Gallegos Diagnostic Tool (Gallegos, 1998) demonstrates that even a 50-percent reduction in chlorophyll-*a* from current levels would not expand the potential depth of SAV growth by as much as 0.1 m, due to the prevalence of inorganic suspended solids (Figure 8). Even complete removal of chlorophyll-*a* in the tidal freshwater segment was predicted to be insufficient for SAV growth to one meter or greater (Moore, 2000).

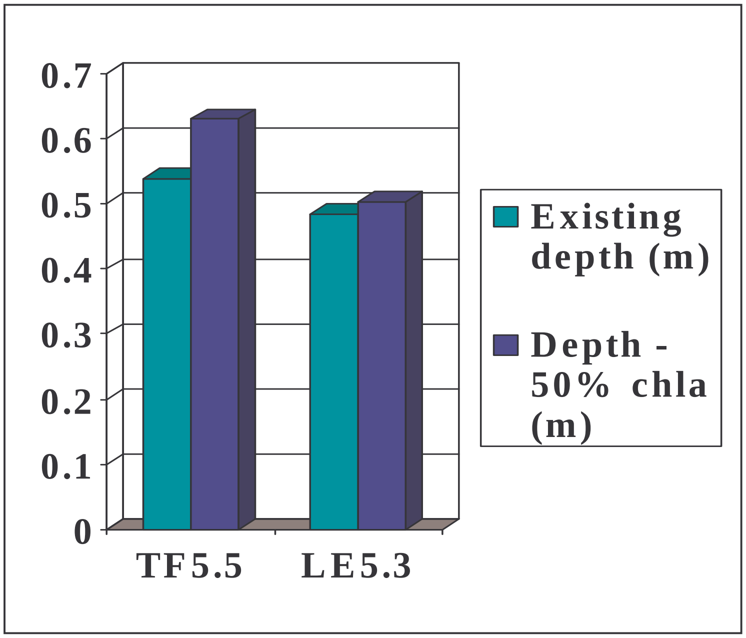

Figure 8: Application of the Gallegos Diagnostic Tool to predict the change in the potential depth of SAV growth from 50% reduction in chlorophyll-*a* at James River monitoring stations TF5.5 and LE5.3.

VAMWA is unaware of any model results that demonstrate a significant benefit of the proposed chlorophyll-*a* criteria to SAV in the James River, with or without sediment reduction.

HRWTF and VIMS have conducted SAV transplantation studies in the James River for several years (Moore, 2000; 2001; 2002, 2003; 2004). Results included:

- There is already sufficient light for SAV to grow in the shallows. Survival was limited not by chlorophyll-*a* or even water clarity, but by herbivory and salinity effects.
- Overall water clarity changed little between high chlorophyll-*a* and low chlorophyll-*a* seasons/years, nor between high flow and low years. Resuspension of sediment was cited as a major source of turbidity.
- There was no evidence of significant epiphytic growth on SAV.

Cerco and Moore (2001) address the issue of nutrient versus suspended sediment controls in relation to SAV recovery in the James River. They classified the lower James River as a region that “requires solids reduction”. Such regions will never support SAV without reductions in fixed solids since light attenuation from color and fixed solids exceed 1.5 m^{-1}. Further, much of the inorganic suspended sediment (i.e. fixed solids) are erived from re-suspension processes that cannot be addressed by land-based management practices. As stated by Cerco and others (2004), “resuspension may…counter or eliminate benefits gained from load reductions.”

If significant reductions in the inorganic turbidity of the James River were somehow achieved in the future, the potential depth of SAV growth might become more sensitive to the algal component of water column turbidity. Anti-degradation and phased adaptive management approaches would prevent the occurrence of light-blocking blooms. Regardless, SAV should be addressed by the SAV/water clarity criteria, not by chlorophyll-*a* criteria.

(HRSD): Excessive nutrient concentrations in combination with excess sediments create extremely poor water clarity conditions for underwater bay grasses. *Inappropriate*.
Taken alone, this statement is uncontroversial. However, taken in context with the chlorophyll a criteria proposal, it implies that control of chlorophyll a would be effective in addressing present water clarity problems and reduced SAV. Such statements mislead the public into thinking that chlorophyll reduction in the lower James River will restore SAV. DEQ knows that if all chlorophyll a were removed from the system through modeling (which is not ecologically desirable) the lower James River would still not attain the water clarity standard and meet proposed SAV goals, yet it makes the claim in question. A linkage exists between the biological end-point (SAV) and chlorophyll a, but the linkage is considered insignificant from a management perspective for the lower James River.

A Chesapeake Bay Program diagnostic tool exists to evaluate management options for inorganic suspended solids and chlorophyll reduction. Our analysis of lower James River data indicates that a 50% reduction in existing chlorophyll levels alone would provide a difference of only 0.02m of water clarity depth. This translates to less than ¾ of an inch difference in the restoration depth for grasses. Such small differences cannot be accurately and precisely measured given uncertainties in water quality and SAV measures and are insignificant.

(Hopewell): Numerical chlorophyll *a* standards are not necessary for SAV growth and to reduce epiphytic growth on SAV. After five years of SAV restoration efforts in the tidal freshwater James River near Hopewell, we have found that the only limiting factor to SAV growth is herbivory. The existing clarity conditions have not affected SAV (wild celery) growth in shallow depths of 0.5 meters. In addition, there is no evidence of epiphytic growth in light limiting amounts on the SAV leaves. In addition, our studies have demonstrated that light attenuation in the tidal freshwater James River is not affected by a reduction in chlorophyll *a*. In fact, removal of all chlorophyll will not improve light attenuation due to the re-suspension of inorganic sediment. Until re-suspension can be controlled, clarity will continue to be an issue in the tidal freshwater James River. However, as stated earlier, light attenuation is not the limiting factor in SAV restoration.

DEQ Response: *It is evident from historical records that today's James River supports a small remnant of a once diverse and extensive SAV habitat. The comment suggests that chlorophyll criteria should not consider impacts to SAV. DEQ feels we can not ignore these known interactions between nutrients, chlorophyll, light levels, and SAV growth (Orth and Moore 1983, 1984; Kemp et al. 1983; Dennison et al. 1993; USEPA 1992, 2000):*

- *Excessive nutrients have been implicated in the loss and slow recovery of wild celery in the tidal fresh Potomac and James Rivers (Carter et al. 1996; Moore et al. 2002, 2003). Not only are SAV beds absent, but most segments in James River fail to meet the minimum habitat requirements to support healthy SAV beds, much less meet conditions* *necessary for recolonization. The tidal James failed to meet three of the four SAV habitat requirements in four regions – JMSTF, APPTF, CHKOH & JMSOH (Dauer et al. 2003). Despite meeting the statistical assessment, DIN concentrations above the threshold of 0.15 mg liter-1, associated with SAV declines and lack of recovery, were consistently observed at both JMSMH (57%) and JMSPH (38%). JMSMH also failed two SAV habitat requirements, DIP and Secchi Depth (Dauer et al. 2003). It should be noted that DIN levels at VIMS SAV restoration sites were variable with many excursions above the threshold value (Moore et al. 2003, Fig. 3-14).*

- *Excessive phytoplankton growth can result in reduced water clarity, low dissolved oxygen levels and in some cases the development of blooms of harmful or toxic algae. The same nutrients that enhance phytoplankton growth also encourage excessive algal growth that attaches to the leaves of underwater grasses as epiphytes, or cover SAV beds in large algal mats. The combination of too many epiphytes, algae, and/or phytoplankton can result in severe shading or smothering of the SAV (Dennison et al. 1993). Such conditions result in the dieback of plants in established SAV beds and limit the regrowth or recolonization of young plants into many areas (Bartleson et al. 1997; Wetzel and Myers 1994; USEPA 2000). In shallow waters less than 0.5 m, there may be sufficient light for submerged aquatic grasses to grow. However, Baldizar and Rybicki (2004) show nutrient reduction and algal control strategies are needed to increase the chance of meeting SAV minimum light requirements in shallow water for low flow years. In addition, nutrient reduction should impede epiphytic growth also known to block light to underwater grasses. It has been shown that a very small amount of an epiphyte chlorophyll a biomass can reduce light availability by up to 60 percent (Stankelis 2000). While reductions of both nutrients and sediments should be sought, nutrient reductions are more important.*

- *The habitat conditions necessary to support the survival and growth of healthy beds can be controlled through nutrient and sediment reduction programs. However, studies show that without those critical habitat conditions, restoration efforts will be hampered. Nutrient levels in the tidal James far exceed algal needs - the system is nutrient "saturated" (Butt 2004). The upper tidal James is considered severely light limited to the point that even the algae often have difficulty growing (Haas and Webb 1998). Therefore, the aquatic plant community is currently being held "in check" by poor light conditions. Furthermore, these conditions – light limited and nutrient saturated – support the growth of undesirable, even toxic producing algae species like blue-green algae. These very opportunistic plants out-compete other more desirable forms. If sediments were reduced to the levels allowing for more light penetration, there are still plenty of nutrients to stimulate algal growth. Such excessive growth would create conditions favorable to blooms in the water column while algal growth on the leave surfaces could go unchecked. Such algae blooms would continue until nutrients were depleted or poor light conditions resumed (Butt 2005).*

- *More localized macrophyte management models for the Bay have shown that nutrient enrichment and sediment loading were instrumental in SAV declines, but go on to state that "nutrient enrichment of bay waters was estimated as the single most important* *factor contributing to the macrophyte decline." (Kemp et al. 1995) and that "reductions in nutrient loading to the estuary would be most effective in restoring SAV to levels of abundance similar to those extant in the early 1960s." (Kemp et al. 1995).*

The comment also suggests that chlorophyll is not a significant factor effecting SAV in the upper tidal James. This is contradicted by the following excerpts from studies funded by the Hopewell Regional Wastewater Treatment Facility:

- *"The parallel increases in TSS, VSS, Chlorophyll a, and turbidity over the growing season suggests that phytoplankton growth is a major source of TSS and light attenuation during middle and late part of the growing season"… "In summary, HERMA data demonstrates that both phytoplankton and non-phytoplankton related TSS are important sources of light attenuation in the Hopewell area" (Malcolm Pirnie, 1999).*

- *"Habitat conditions were characterized by high levels of suspended solids (>50 mg/l) during the spring at most sites and phytoplankton levels (>50 ug/l) during the summer, which typically exceeded 25% of the suspended loads during that time." (pg. v) … "Phytoplankton comprised a relatively large proportion of the total suspended particle concentrations (Fig 3-11) during August and again during several peaks in December and February" (pg. 10) (Restoration of Submerged Aquatic Vegetation (SAV) in the Tidal Freshwater James River: 1999 Pilot Study, June 2000,Dr. Kenneth Moore, Virginia Institute of Marine Science).*

- *"The distribution of turbidity demonstrates a general increase from downriver areas upriver to the Hopewell region and then a decrease continuing upriver to the fall line (Fig 3-21). Several of the highest regions of turbidity were also associated with the highest regions of chlorophyll indicating the significant contribution of phytoplankton to overall turbidity in these areas" (pg. 16) "The correlation observed between areas of phytoplankton blooms and elevated turbidities using spatially intensive monitoring (Dataflow) illustrates the additional light reductions that phytoplankton can add to the system above that of that provided by the suspended sediments. Thus implementation of strategies to reduce nutrient inputs to lower phytoplankton levels and reduce sediment inputs to decrease suspended sediment levels may be required to improve light conditions for SAV growth to greater depths than those transplanted here" (pg. 17) (Restoration of Submerged Aquatic Vegetation (SAV) in the Tidal Freshwater James River: 2002-2003, July 2003 (Dr. Kenneth Moore, Virginia Institute of Marine Science)*

Also, the comment suggests an adaptive management approach of delaying adoption of chlorophyll criteria until suspended solids reductions necessary for water clarity achievement are implemented. DEQ does not believe this is an appropriate approach because:

- *The algal community is already impaired as demonstrated in the Technical Report (VA DEQ 2004).*

- *Scientists have indicated to use that "absent constraints on phytoplankton community levels (implemented through the proposed chlorophyll a criteria) reducing suspended* *sediment levels will almost certainly result in significant increases in algal populations as those populations take advantage of increased light availability to utilize excess nutrients already in the system This response will offset many of the benefits from reduced suspended sediment loads, and may actually degrade habitat conditions for things other than SAV." (Mann 2005). It would be poor environmental management policy to allow this predicted degradation to occur. The lag time involved between finally deciding to implement nutrient reductions and when they were actually in effect sufficiently to reduce algal populations would allow for several years of impaired waters. This is not good public policy. Nutrient reductions are needed along with sediments so water quality problems do not arise in the future.*

- *The numerical chlorophyll a criteria for the tidal James River were derived to address existing Virginia Water Quality Standards Regulation requirements for supporting "a balanced, indigenous population of aquatic life in all waters" (VAC 25-260-10) and that "substances which nourish undesirable or nuisance aquatic plant life will be controlled"* (*VAC 25-260-20).*

27. Comment (VAMWA): **The lower James River has a balanced phytoplankton community composition and moderate chlorophyll-*a* concentrations.**

Throughout much of the TSD, DEQ makes highly general statements about the James River, (e.g., "The tidal James River has very high chlorophyll-*a* levels in comparison to 40 other estuaries", p. 7) and then provides an example from the upper tidal segment. However, many of these generalizations simply are not true for the lower James River. It is critical to distinguish the upper and lower James River segments for water quality management purposes. While concerns over cyanophytes and *Microcystis* in the tidal freshwater segment have some merit and should be addressed by other approaches, statements that the algal composition of the lower James River is "out-of-balance" do not withstand scrutiny of the monitoring data.

On p. 6 of the TSD, it is stated that "the York River maintains a population of flora considered 'least-impaired' or desirable with a balance phytoplankton composition for comparison." Even if one were to accept this definition of "desirable" (which VAMWA does not for reasons given previously), the data reveal that overall abundance and proportion of the major phytoplankton taxa in the lower James River is almost identical to that of the lower York River (Figure 9). Both communities are dominated by diatoms (~75%), with less than 5% dinoflagellates by abundance. In fact, the lower York River actually had a higher proportion of dinoflagellates than the lower James River.

Hypothesis testing (alpha = 0.05) of 1985-2003 CBP data (Table 3) indicates that:

- Chlorophyll-*a* concentrations in the polyhaline segments of the James and York Rivers were not significantly different in spring or summer.

- Chlorophyll-*a* concentrations in the mesohaline York River were significantly higher than in the mesohaline James River, both in spring and summer.

TABLE 3
Results of Wilcoxon Rank-Sum Test of Chlorophyll-a Concentrations in the Lower James and Lower York Rivers
[Based on 1995-2003 monitoring data of the Chesapeake Bay Program]

Salinity	Season	Median Chl-*a* (μg/L)		Significantly different at α=0.05?
		James	York	
Mesohaline	Spring	6.2	10.3	Yes
	Summer	4.7	13.7	Yes
Polyhaline	Spring	9.0	9.2	No
	Summer	8.5	8.0	No

It is unclear why DEQ is justifying chlorophyll-*a* reductions in the lower James River on the basis of algal "balance" considering that the chlorophyll-*a* concentrations here are actually lower than DEQ's example of a "balanced" system, and the phytoplankton community composition is basically the same.

***DEQ Response**: This comment basically states that the lower tidal James River has a similar (or slightly better) algal community than the lower York River and thus is unimpaired. This comment is based on the following misinterpretations of the Technical Report (VA DEQ 2004):*

- *The Technical Report (VA DEQ 2004) statement that the "York River maintains a population of flora considered "least-impaired" or desirable with a balanced phytoplankton community" refers to the tidal fresh segment of the York and not the lower York.*

- *No claim is made in the Technical Report (VA DEQ 2004) that the lower York is not impaired in relation to its algal community. Therefore saying the lower James has similar conditions to the lower York is not to say that the lower James is unimpaired.*

- *In fact, DEQ feels that the lower York (and other Bay tidal waters) may also have impaired algal communities but do not require the application of numeric criteria at this time because nutrient achievement of the dissolved oxygen and water clarity criteria in these waters may also improve the algal community sufficiently. This is part of an adaptive management approach for the York.*

Besides confusing the tidal fresh with the lower estuary, the comment also seems to be ignoring the earlier statements in Comment 25: "relatively high turbidity of the James River is the primary reason that the phytoplankton community would differ from other tributaries … nutrient load reductions would likely be required to prevent an increase in chlorophyll-a if light conditions were expected to significantly improve." The high turbidity levels in the lower tidal James River presently suppress phytoplankton growth through light limitation, and cause an unhealthy plankton community status as demonstrated by metabolic stress and higher death rates in phytoplankton - as evidenced by the high chlorophyll cell content (Chl:C ratio) and high pheophytin concentrations, respectively (Table D). These are not desirable phytoplankton community characteristics – rather the traits suggest blooms waiting to happen.

Table D. Comparison of Pheophytin and chlorophyll:carbon ratios between reference and impaired segments of tidal James River.				
	Polyhaline Reference	*LE5.5 JMSPH*	*Polyhaline Reference*	*LE5.5 JMSPH*
Pheophytin (chlorophyll degradation product)	*12.9%*	*73.8%*	*26.3%*	*56.1%*
Chl:C (chlorophyll cell content)	*29.0%*	*57.4%*	*19.3%*	*61.6%*

Source: Buchanan et al. 2005

Marshall et al. (submitted) found that "the same dominant taxa were generally found in both impaired and least-impaired water quality conditions, but their abundance varied considerably according to the extremes of water quality conditions." The authors also observe that "A gradual rehabilitation of Chesapeake Bay waters, or more specifically an improvement in light levels within the water column associated with lower suspended solids and a decrease in nutrient loadings, is not likely to cause major changes in the dominant species presently represented in the Bay. However, these improvements are likely to result in lower cyanobacteria to diatom biomass proportional relationships and spring diatom pulses of a more restricted diatom development, with diatom dominance continuing under both impaired and least-impaired conditions." In other words, water quality improvements are not be expected to substantially alter the types of phytoplankton species present. Rather, proportions of the dominant taxa to other taxa will change for the better, with fewer algal blooms.

28. Comment (VAMWA): **DEQ concerns regarding the phytoplankton composition of the upper tidal freshwater segment are overstated.**

In an evaluation of phytoplankton monitoring data from three Bay Program monitoring sites in the tidal freshwater James River, Marshall (2001) stated:

> [The] algae were dominated by diatoms, followed by chlorophytes, and cyanobacteria in both abundance and biomass, with diatoms the major contributor to the algal biomass at these sites…the phytoplankton species composition is considered common for the period of collection, and representative of what riverine algae may occur for this region…In conclusion, the results of analyzing monthly collections at the three river sites, indicate a diverse phytoplankton composition within these waters that was dominated by diatoms. (Marshall, 2001)

Notice the dissimilarity in tone of this description, which pre-dates DEQ's push for numeric chlorophyll-*a* criteria, to the dire portrayal of the DEQ TSD. The algal composition remains dominated by diatoms throughout most of the year. Even in the summer and fall, when cyanophytes can reach a significant proportion of the total abundance, ≥90% on average of the algal biomass was composed of diatoms and other taxa that DEQ labels as "favorable". There is no evidence that this particular composition is an inadequate food source or has harmful effects on other aquatic life.

It is reasonable for DEQ to raise points about the cyanophyte abundance and occurrence of *Microcystis aeruginosa* in the tidal freshwater segment. In fact, in all of DEQ's discussions related to a potential "imbalance" in the algal composition of the James River, the present proportion of cyanophytes and occurrence of *Microcystis aeruginosa* in the tidal freshwater segment were the only points deemed valid, considering that many cyanophytes including *Microcystis* have been shown to be capable of forming toxic blooms in other freshwater systems. However, we believe even this concern is overstated in terms of an existing designated use impairment, and does not justify the proposed chlorophyll-*a* criteria, for several reasons:

- Cyanophytes do not occur in sufficient concentration to form nuisance blooms. [By contrast, the 2004 blooms on the Potomac River were associated with chlorophyll-*a* concentrations in the hundreds or even thousands of μg/L (Maryland DNR, 2004)]

DEQ Response: *The respondent questions a quote from Marshall (2001) regarding the relative abundance of cyanobacteria in the upper tidal James River. There is no "dissimilarity in the tone of this description" as insinuated by VAMWA. Similar evaluations are presented in other papers by Marshall (Marshall per. comm.) The limited results of this 8 month study does not signify a position to invalidate concerns of future cyanobacteria development and bloom occurrences, especially with these potentially toxic species present in these waters taken from extensive multi-year data sets.*

Cyanophytes do occur in sufficient concentrations to form nuisance blooms. As shown in the Technical Report (VA DEQ 2004), 10,000,000 cells liter^{-1} of Microcystis aeruginosa was determined to be an appropriate threshold above which zooplankton communities can be adversely altered by large particle size of the colonies, increased density of particles in the water column, or directly by the toxin result in poor food quality to these primary consumers. This threshold was exceeded in 11 of the 17 years of the Chesapeake Bay phytoplankton monitoring program data record (65 percent) in the tidal fresh James River. In addition, the average summer Microcystis aeruginosa cell density in the upper James (station TF5.5) is above this threshold. Levels at this station are much higher than observed at any other Chesapeake Bay phytoplankton monitoring program station. There has also been a significant trend over the past decade of increased abundance and biomass of cyanobacteria within all three reaches of the tidal James River, including Microcystis aeruginosa and several filamentous taxa. Microcystis sp. is the species of cyanobacteria that is most abundant in the tidal fresh James River, about 9 to 10 times higher than in the Rappahannock and York rivers' tidal fresh reaches, respectively. In addition, there is clear evidence of increasing number of varieties of cyanobacteria present. For example, in 1994, the Old Dominion University scientists running Virginia's Chesapeake Bay phytoplankton monitoring program found 25 cyanobacteria taxa in the tidal fresh James River. That number increased to 110 taxa in the 2004 survey. As stated previously, chlorophyll levels at those set near the criteria level has been documented to result in lower levels of cyanobacteria.

29. Comment (VAMWA): Zooplankton and fish data do not indicate any food quality impairments associated with cyanophytes or *Microcystis* in this segment; mesozooplankton are abundant and peak at relatively high chlorophyll-*a* levels.

DEQ Response*: As discussed in the replies to comments 22-24, there is much evidence of impairments to zooplankton, fish and benthic population in this segment. The impaired fish* *"food availability" index is the most direct linkage given that is low in the tidal fresh James River in contrast to the high algal levels. There are direct laboratory studies which show the levels of cyanophytes found in the tidal fresh James impair zooplankton feeding as shown in the Technical Report (VA DEQ 2004).*

30. Comment (VAMWA):
Natural physical and chemical factors of the tidal freshwater James River—such as high turbidity from resuspension—probably favor a higher proportion of cyanophytes in the tidal freshwater James River relative to other segments and tributaries.

DEQ Response: *High turbidity may favor a higher proportion of cyanophytes in the tidal freshwater James. However it is the very high absolute level of cyanophytes (as well as the proportion) that is addressed by the proposed numeric chlorophyll a criteria.*

31. Comment (VAMWA):
Even if one accepted DEQ's definition of the impairment, a direct examination of the relations between chlorophyll-*a*, cyanophytes, and *Microcystis* shows that alternate chlorophyll-*a* criteria are warranted.

DEQ Response: *DEQ considered VAMWA's proposed alternative criteria which was presented to the DEQ Bay Criteria ad hoc technical advisory. The proposed alternative criteria were based on a single line of evidence to protect against harmful algal blooms. The numerical chlorophyll a criteria for the tidal James River were derived to address existing Virginia Water Quality Standards Regulation requirements: 1) for supporting "a balanced, indigenous population of aquatic life in all waters" (VAC 25-260-10) and 2) that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (VAC 25-260-20). DEQ feels that the other lines of evidence are strong enough to warrant the proposed criteria which are significantly lower than that proposed by VAMWA.*

32. Comment (VAMWA): DEQ correctly points out that *Microcystis aeruginosa* has been observed to exceed the 10,000/mL threshold that was cited by USEPA (2003) as potentially harmful to zooplankton. However deleterious effects on zooplankton are not actually observed in the James River. The explanation is probably a combination of several factors: (1) the strains of *Microcystis aeruginosa* in the tidal freshwater James River have not been demonstrated to be toxic; (2) even toxic forms do not necessarily produce high concentrations of toxins (Kristen, 1996; Oh *et al*., 2000; Whitton and Potts, 2000); and (3) the 10,000/mL threshold is highly uncertain and probably an extremely conservative indicator of aquatic life impacts. As stated by VAMWA (2003):

> The 10,000/mL *M. aeruginosa* threshold was selected as the geometric mean of two studies (Lampert, 1981; Fulton and Paerl, 1987) that differed by two orders of magnitude as to the threshold of effects. The paucity of studies that allow determination of a threshold and the large disagreement in the two available studies seriously undermine confidence in this value. In fact, the 1,000/mL threshold obtained from Lampert (1981) was from a study of effects on a single species (*Daphnia*) only. The Fulton and Paerl (1987) study examined effects on larger number of species and found a threshold of 100,000/mL. Even this value was not associated with an overall decline in zooplankton, but a shift in taxa from those inhibited by *M. aeruginosa* to those that gained a competitive advantage.

A potentially legitimate concern has been expressed in both the TSD regarding an increasing trend in cyanophytes over the last few years. We agree that is it not desirable that such a trend should continue. However, the proposed chlorophyll-*a* criteria are an inappropriate means to address such a trend. To highlight this point, consider that the increasing trend in cyanophytes was concurrent with major reductions in nutrient inputs to the tidal freshwater segment, due to voluntary nutrient control projects instituted by major point sources.

It is highly likely that the increase in cyanophytes is at least partially caused by a concurrent decrease in the nitrogen-to-phosphorus ratio (Figure 10), which tends to favor nitrogen-fixing cyanophytes. An examination of the input decks of the 2004 James River tributary strategy reveals that the strategy calls for similar levels of reduction in point source nitrogen and phosphorus loads from 2003 levels, suggesting that the overall summer N:P ratio would not necessarily change from current levels that (evidently) favor a relatively high proportion of cyanophytes. This provides an example of how blind application of the proposed chlorophyll-*a* criteria—disregarding the complex environmental controls on phytoplankton dynamics—could provide either no benefit or even a detriment.

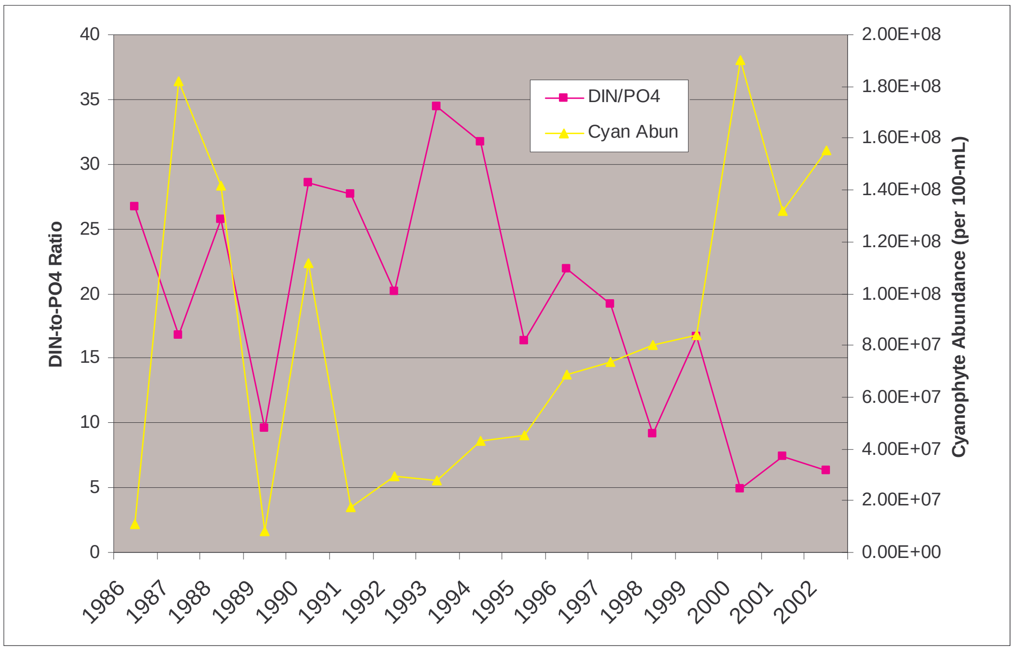

Figure 10: Trends in the DIN/PO4 ratio and cyanophyte abundance at station TF5.5

The TSD also refers to the 2004 nuisance blooms on the Potomac River, with the concern that James River could possibly develop similar conditions. As mentioned above, this condition would be prevented by an anti-degradation, phased adaptive management approach, or alternate numeric chlorophyll-*a* criteria for the tidal freshwater segment as discussed below (comment 46 of this document).

It should also be understood that the upper tidal James River and upper tidal Potomac River are very different systems and respond to nutrient loading in very different manners. For example, the extremely wet summer of 2004 was accompanied by nuisance bloom conditions on the Potomac River, while simultaneously the tidal freshwater James River actually had unusually low chlorophyll-*a* concentrations (Moore, in preparation), probably due to greater flushing rates. Analogies between the two systems should therefore be stated with caution.

(Hopewell): Numerical chlorophyll *a* standards are not necessary to limit the cyanobacteria and *Microcystis aeruginosa* algae that affect the abundance of mesozooplankton or fish food. In our 2001 phytoplankton study, we found that diatoms were the dominant taxa during the entire monitoring period. The cyanobacteria and chlorophytes did not comprise a significant proportion of the biomass until the fall season, when fish larval levels should be at their lowest. In addition, when the cyanobacteria and microcystis were higher, the median total mesozooplankton were significantly higher, as well, proving that the cyanobacteria and microcystis did not adversely impact the abundance of mesozooplankton.

DEQ Response: *The comments regarding no evidence of deleterious effects of cyanobacteria have been addressed previously by showing most directly the strong evidence of deleterious impacts on mesozooplankton (i.e. the striped bass/ white perch "Food Availability Index" is below minimal). Previous responses to prior comments also show that other higher trophic levels such as fish and benthos are unhealthy in the tidal James River.*

The issue of the N:P ratios was investigated by DEQ staff (Butt 2004). It was determined that N:P ratios in the tidal fresh favored Microcystis but that such ratios haven't changed significantly over the period of record. Further analysis was conducted to see if further nutrient reductions in the tidal James River would alter this ratio. Based on results from the Virginia Tributary Strategy Confirmation run, fall line load reductions tended to increase the balance of N to P in waters entering VA's the tidal fresh waters. In addition, summer averages employing results from the Chesapeake Bay Water Quality Model for the same simulation indicated that tidal fresh balance between N to P remained relatively unchanged with nutrient reductions. Unfortunately, the upper tidal river segment remained saturated with dissolved inorganic nutrients. Despite estimating significant improvements to chlorophyll levels based on this simulation, addition reductions of nutrients would be needed to prevent "nutrient saturation" and before improvement to the light environment were met.

Another assessment of the severity of cyanophyte levels recently performed by DEQ was to examine the data in relation to human health risk guidelines presented in Table E. Using these guidelines in examining the available phytoplankton data at station TF5.5, DEQ found that 75% of the summer samples were at concentrations with associated short term adverse health outcomes. This does not seem like an overstatement of undesirable conditions.

Table E Guidelines for safe practice in managing recreational waters according to three different levels of risk		
Level of risk[1]	*Health risks*	*Recommended actions*
20,000 cells cyanobacteria per ml or 10 µg l-1 chlorophyll a with a dominance of cyanobacteria	*Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness, probably at low frequency)*	*Post on-site risk advisory signs Inform relevant authorities*
105 cells cyanobacteria per ml or 50 µg l-1 chlorophyll a with a dominance of cyanobacteria	*Potential for long-term illness with some species Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness)*	*Watch for scums Restrict bathing and further investigate hazard Post on-site risk advisory signs Inform relevant authorities*
Cyanobacterial scum formation in bathing areas	*Potential for lethal acute poisoning Potential for long-term illness with some species Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness)*	*Immediate action to prevent contact with scums; possible prohibition of swimming and other water-contact activities Public health follow-up investigation Inform relevant authorities*

[1] Expressed in relation to cyanobacterial density and given in order of increasing risk
Source: Monitoring Bathing Waters - A Practical Guide to the Design and Implementation of Assessments and Monitoring Programmes © 2000 WHO.
http://www.who.int/docstore/water_sanitation_health/bathwater/begin.html

Regarding the comment that diatoms were the dominant tax during 2001 in the Hopewell region, it is true that on annual basis diatoms are the dominant taxa; however as demonstrated in the DEQ Technical Support Document, Cyanobacteria and Microcystis Aeruginosa dominate algal community abundance during the important summer season and frequently been above those levels which have been shown to be detrimental to higher trophic levels. The long term summer average is that cyanobacteria comprise 60% of the algal cells in the tidal fresh James near Hopewell (i.e. station TF5.5). Achievement of reference community chlorophyll levels and community composition used to set the criteria will lead to reduced cyanobacteria biomass. (Buchanan et. al. 2005).

33. Comment (VAMWA): **A more objective definition of "balanced aquatic life" is required that relates to overall ecological health.**

VAMWA is very concerned that DEQ is misapplying the concept of "balanced aquatic life" in the context of water quality standards. Without an objective definition of balance, DEQ is free to interpret almost any algal indicator as an "imbalance" and justify costly regulations on the basis, regardless of whether or not the indicator is a proven measure of ecological health. Like most biological communities, the algal community has a great deal of variability with season, location hydrology, salinity, and other environmental variables. Many of these differences in algal composition do not necessarily constitute an aquatic life impairment.

The TSD makes extensive use of ratings of both water quality and planktonic variables in the TSD, such as those utilized in ODU status/trend monitoring reports, phytoplankton reference communities, or phytoplankton IBIs. These ratings are not based on *a priori* definitions of what is healthy or unhealthy for the ecosystem, but are simply based on differences between other tributaries. Most of these indicators are unproven measures of ecological health, and higher trophic levels may be completely insensitive to them.

But a more fundamental point is that relative differences between very different tributaries do not necessarily constitute designated use impairments. Any number of chemical or hydraulic, or morphometric differences between tributaries might cause differences in algal composition. For example, the tidal freshwater segments of the York and James Rivers would not be expected to be highly similar even in the absence of anthropogenic influences. These two rivers have few similarities either in terms of their watershed characteristics, channel characteristics, or hydraulics. It is not reasonable to define differences in their algal communities as impairments.

As one example of an important difference between rivers, the upper tidal James River is likely to always be more turbid than the upper York due to a larger drainage area that includes higher slopes, a higher stream gradient, and a higher proportion of erodible Piedmont soils. Cyanophytes are favored by high turbidity conditions (Wilbur, 1983), and so the tidal freshwater James may naturally have a higher proportion of cyanophytes relative to the tidal freshwater York River. Marshall and Alden (1990) attributed many of the differences in phytoplankton composition between the tidal freshwater Rappahannock, York, and James Rivers to differences in the salinity gradient:

> The environmental conditions associated with the downstream oligohaline-mesohaline gradient appear to override the importance of relatively close geographic proximity and seasonal variability in the overall influence on these phytoplankton communities.

If DEQ liberally defines “out of balance” on the basis of differences in algal composition between tributaries, the James River is likely to always remain “out of balance” regardless of chlorophyll-*a* concentrations. Although relative differences between tributaries are of scientific interest, in the Clean Water Act framework, water quality criteria represent thresholds above which actual impairments to designated uses can be demonstrated to occur.

In making this comment, VAMWA is not completely dismissing the concept of “balance” in algal communities, but calling for a more rigorous, objective definition that goes beyond just relative differences and considers <u>actual impacts of the algal composition on overall ecological health or other designated uses</u>. According to this definition, an “imbalanced” algal composition is one which results in toxic, nuisance, food quality, or food quantity impacts. In other words, an “imbalanced” algal composition must be defined based on harm to aquatic life.
DEQ has taken a highly legalistic interpretation of the standard and interprets any difference in the algal community from some other condition as an imbalance indicative of an aquatic life impairment, regardless of whether fish, oysters, clams, or even zooplankton are harmed by the

difference. This is unfortunate not only for the regulation under discussion, but also sets a disturbing precedent for future water quality standards. This action would essentially provide the public no protection from DEQ imposing costly regulations that have no tangible environmental benefits.

DEQ Response: *DEQ feels that the indicators of imbalance, nuisance, and undesirable conditions used in the Technical Report (VA DEQ 2004) are all widely used and objective measures of the algal community. There are many ecology books and scientific journal articles discussing how high chlorophyll, high primary productivity, high frequencies of blooms, low species diversity, indications of eutrophic and "out of balance" algal communities. There is also much scientific basis for the undesirability of cyanobacteria and some dinoflagellates and particularly when they occur at the high levels in the tidal James. The use of reference communities and Indexes of Biotic Integrity are also well established as valid assessments of population health (Gibson et al 2000; Jorgensen et al. 2005).*

The comment suggests that a fundamental flaw in some of DEQ's demonstrations of algal impairments in the James is that they are shown through comparison to conditions in other Chesapeake Bay Rivers, stating that "any number of chemical or hydraulic, or morphometric differences between tributaries might cause differences in algal composition". This criticism would be valid if DEQ was performing direct comparisons of the James with widely geographically separated systems (i.e. estuarine systems outside the Chesapeake Bay). Except in cases where we show the James in relation to world-wide estuaries for general comparisons, we have focused comparisons to the York and Rappahannock Rivers which are geographically very close and all share common physical connections to the lower Chesapeake Bay. The scientific paper cited in the comment to support the contention that the James has naturally different phytoplankton community composition (vs. York or Rappahannock) is Marshall and Alden (1990) which specifically compared phytoplankton community characteristics of the James, York, and Rappahannock rivers during the first 16 months of CBP Phytoplankton monitoring program (i.e. 1986-1987). This paper actually says that the three rivers were generally quite similar in phytoplankton composition with the following quotes: 1) "although each river has a distinct drainage basin, they contain a similar estuarine phytoplankton flora..."; 2) "The tidal sections of these rivers were dominated by the same species..."; 3) "The phytoplankton assemblages at sites located relatively close to each other, within the same river, more closely resembled those at corresponding locations [i.e. locations with similar salinity] in <u>another river basin than each other</u>…". The quote provided in the comment is merely the authors observation that within each of the rivers, the salinity levels cause tidal fresh communities to be different that the meso-polyhaline communities. Marshall and Alden (1990) did not examine the types of algal impairment measures that DEQ has examined and was based on only 16 months of data, thus the authors did not point out the regulatory impairment as identified by DEQ. However, this paper and other papers show that all tidal rivers in the Chesapeake system have generally the same algal species present and that anthropogenically influenced conditions (e.g. nutrient levels, sediment loading levels) modify and cause the community balances to be different.

The comments reference to the James having naturally higher number of cyanophytes due to higher turbidity may have some validity but it is the extremely high levels of cyanophytes (esp. Microcystis spp. that are above levels which can effect higher trophic levels) which constitute the *algal impairment. It is also notable that if high turbidity is the main reason for higher cyanobacteria, one would expect that the Potomac (which has lower turbidity) would have lower cyanobacteria levels. In fact the Potomac has higher cyanobacteria levels than the James.*

The comment also again repeats the assertion that algal (i.e. chlorophyll) criteria should be only based on harm to higher trophic levels (e.g. fish, oysters, clams, and zooplankton) or the new suggestion of "overall ecological health". As stated previously, criteria and designated use impairments can be based on the algal community alone. There are many indications of degradation at higher levels (i.e. zooplankton, fish, and benthos) show that the overall ecological health of the tidal James River is impaired with the base of the food chain failing to meet Virginia's Designated Uses. Under such conditions, the Virginia Water Quality Standards require that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-20).

34. Comment (VAMWA): **The argument that chlorophyll-*a* criteria are necessary because segments of the James River are "eutrophic" amounts to empty reasoning.**

Part of DEQ's argument for the proposed chlorophyll-a standards is that chlorophyll-*a* in the tidal freshwater segment is high, relative to other locations (TSD, p. 6-7). This particular argument is equivalent to the empty reasoning that chlorophyll-*a* is too high because chlorophyll-*a* is high. The same can be said for the argument that chlorophyll-*a* is too high because chlorophyll-*a* is rated "poor", or because the upper James has chlorophyll-*a* concentrations categorized as "eutrophic".

The paradigm that eutrophic or high-chlorophyll systems are inherently unhealthy is derived from other settings where high chlorophyll-*a* concentrations are associated with low DO, nuisance blooms, or toxic blooms. The James River does not commonly experience any of these problems, notwithstanding *Microcystis* issues that can be addressed by the approach described in comment 41 of this document. Similarly, the paradigm that mesotrophic conditions are inherently desirable does not necessarily apply to the James River. In the absence of DO problems or toxic blooms, eutrophic conditions are actually preferred for most warmwater fisheries because of the greater food supply (for more on food quantity concerns, see comment 43) found with these conditions. DEQ must focus on demonstrable designated use impairments instead of relative chlorophyll-*a* levels, and abandon the unsubstantiated paradigm that mesotrophic is "desirable" whereas eutrophic is "undesirable".

DEQ Response: *Issues raised in this section are addressed under comments 22 above. As stated above, DEQ's Technical Report (VA DEQ 2004) was not to characterize the overall status but rather to focuses on the degraded status of the algal community due to nutrient enrichment which the proposed Chlorophyll standards seek to correct. All references of "undesirable", "nuisance", and "unhealthy" used in the Technical Report (VA DEQ 2004) were based on appropriate and widely accepted usages in ecological literature.*

The designated use addressed by the chlorophyll criteria is that of "propagation and growth of a balanced, indigenous population of aquatic life." and the absence of "substances which nourish undesirable or nuisance aquatic plant life". These designated use statements clearly are *not limited to higher trophic levels and apply to all aquatic life, including the algal community that is at the base of the food web. Analyses presented in the Technical Report (VA DEQ 2004) show that these impairments exist in the current algal community of the James. There are excessive concentrations of algae compared to worldwide, nationwide and bay-wide measurements, widespread increases in algae levels and algae levels higher than reference levels. The frequency of algae blooms is increasing.*

The James River's phytoplankton community is overly dominated by select, undesirable groups. Poor phytoplankton biotic integrity indices for the tidal James River also evidence a degraded aquatic plant community. There is low species diversity in the low salinity reach of the tidal James River along with elevated primary production. Undesirable, nuisance aquatic plant life is increasing over the past decade. This finding is evidenced by small cell sizes dominating throughout the tidal James along with increasing levels of undesirable and nuisance cyanobacteria in the upper tidal James during the summertime undesirable dinoflagellates observed in the lower tidal river.

Under such conditions, the Virginia Water Quality Standards require that "substances which nourish undesirable or nuisance aquatic plant life will be controlled" (9 VAC 25-260-20).

35. Comment (VAMWA): **Data analysis reveals that the proposed chlorophyll-*a* criteria are inappropriate for the stated purpose of achieving balanced algal composition.**

Even accepting (for the purposes of the present argument) DEQ's concept of algal-related impairments, DEQ has failed to demonstrate that chlorophyll-*a* is a useful management measure for the "balance" of the algal community or that the specific proposed chlorophyll-*a* criteria values correspond to attainment of "balance". Rather, the values are appear to be more rooted in the hazy belief that lower is better.

VAMWA performed independent analyses of the balance of the James River phytoplankton community under different chlorophyll-*a* conditions, using the 2004 Phytoplankton IBI database. Specifically, the relative abundance of the major phytoplankton taxa were examined when chlorophyll-*a* was (1) less than the proposed criteria; and (2) between the proposed criteria and twice the proposed criteria (Table 4). The exception was for the summer tidal freshwater segment, where 35 µg/L has been identified as a threshold above which cyanophytes and *Microcystis aeruginosa* become more abundant (see comment 43). For the season-salinity regime combination, the higher chlorophyll-*a* interval considered was between the proposed criteria (20 µg/L) and 35 µg/L. The non-parametric Wilcoxon rank sum test was applied to determine if lower chlorophyll-*a* concentrations were associated with significantly different proportions of selected taxa between the two intervals.

TABLE 4
Chlorophyll-*a* Intervals for Comparison of Algal Balance

Station	Season	Chla Interval in "Attainment" (µg/L)	Chla Interval in "Non-Attainment" (µg/L)

LE5.5	Spring	0-10	10-20
	Summer	0-10	10-20
RET5.2	Spring	0-15	15-30
	Summer	0-15	15-30
TF5.5	Spring	0-15	15-30
	Summer	0-20	20-35

Results of this analysis are presented in Figures 11-13 and in Table 5. The general conclusion is that the balance of the phytoplankton community under "non-attaining" conditions are *at least* as favorable as those under "attaining" conditions, even if one accepts the dubious overgeneralization that diatoms are "good" whereas dinoflagellates and cyanophytes are "bad". The spring diatom bloom in the mid-to-lower estuary caused the proportion of diatoms to increase with chlorophyll-*a*, such that the proportion of diatoms was actually higher in the non-attaining chlorophyll-*a* interval than the attaining chlorohypll-a interval. In other season-salinity combinations, there were no significant differences in the proportion of key taxa.

TABLE 4
Results of Wilcoxon Rank-Sum Tests Comparing Proportions of Phytoplankton Taxa in Lower and Higher Chlorophyll-*a* Intervals, 1985-2003
[see Table 3 for definitions of chlorophyll-*a* intervals]

Station	Season	Taxon	Result, α=0.05
TF5.5	Spring	%Diatoms	No significant difference between lower and higher chl-a intervals.
		%Cyanophytes	No significant difference between lower and higher chl-a intervals.
	Summer	%Diatoms	No significant difference between lower and higher chl-a intervals.
		%Cyanophytes	No significant difference between lower and higher chl-a intervals.
RET5.2	Spring	%Diatoms	Higher in 15-30 µg chl-*a*/L interval than 0-15 µg chl-*a*/L
		%Cyanophytes	No significant difference between lower and higher chl-a intervals.
	Summer	%Diatoms	No significant difference between lower and higher chl-a intervals.
		%Cyanophytes	No significant difference between lower and higher chl-a intervals.
LE5.5	Spring	%Diatoms	Higher in 10-20 µg chl-*a*/L interval than 0-10 µg chl-*a*/L
		%Dinoflag.	No significant difference between lower and higher chl-a.
	Summer	%Diatoms	No significant difference between lower and higher chl-a.
		%Dinoflag.	No significant difference between lower and higher chl-a.

These results provide clear evidence that (1) the proposed chlorophyll-*a* criteria cannot be expected or assumed to result in favorable changes in the balance of the phytoplankton community; (2) significantly higher chlorophyll-*a* criteria—with much different socioeconomic implications—would be environmentally equivalent.

As discussed in previous comments, the phytoplankton community composition is probably more a function of alternate environmental variables (including turbidity, salinity, temperature, nutrient ratios and other chemical/physical characteristics) than chlorophyll-*a*.

DEQ Response: *This analysis mistakenly assumes all low chlorophyll values represent equivalent food quality. These analyses would show different results if separating low chlorophyll values in impaired conditions from low chlorophyll values in least-impaired conditions. These two low-chlorophyll populations are not alike and have many physiological* *differences (e.g., Figure 3 in Buchanan et al. 2005) as well as subtle taxonomic composition differences (Buchanan et al. 2005, Marshall et al. submitted). The analyses presented in the comment is also skewed by limiting the "Chla Interval in non-attainment" to exclude data from high chlorophyll observations. In summary, the analysis as performed above uses James River data which is all 'impaired conditions" and is therefore invalid for assessing community composition under high and low chlorophyll levels. Also see DEQ's response to comment 23.*

36. Comment (VAMWA): **The proposed chlorophyll-*a* criteria values are technically erroneous, and are primarily based on concepts that have either failed previous technical reviews or not even undergone independent scientific reviews.**

In setting the actual criteria values, DEQ relied on a hodgepodge of tabulated values (Table 11 of the TSD) mainly derived from the USEPA CBPO Bay criteria document, communications from selected scientists involved in the unsuccessful efforts to derive numeric Chesapeake Bay Program chlorophyll-*a* criteria, preliminary estimations as to what concentrations were attainable, a table the USEPA CBPO brought to one of the Technical Advisory Group (TAC) meetings (primarily based on the Bay criteria document), and "professional judgment". The fact that so many sources were included in developing the criteria is testament to the fact that none of these sources were defensible in and of themselves. The concept that multiple lines of non-evidence add up to evidence is one that VAMWA has opposed throughout this process. <u>Neither DEQ's proposed criteria nor the sources from which they were derived have been shown to be founded in defensible science by independent reviews.</u> Most of the so-called lines of evidence are simply various means of quantifying the left side of the chlorophyll-*a* frequency distribution without any link to designated use impairments.

Specific comments on the validity of DEQ's justifications for the proposed criteria follow below.

USEPA CBPO's efforts to derive numeric chlorophyll-**a** ***criteria were unsuccessful.***

The DEQ TSD relies heavily on text and tabulated chlorophyll-*a* values from the USEPA CBPO criteria document. It should be understood that this document represents a well intended but ultimately failed attempt to derive numeric chlorophyll-*a* criteria. DEQ is well aware of this, having served on the Chlorophyll-*a* Task Group. The first draft of the CBPO criteria document (July 2001) emphasized the "Phytoplankton Reference Community Approach" along with other secondary sources of information such as historical values, literature values, and contributions to light attenuation and low dissolved oxygen. After the first review period it was recognized that this primary line of evidence (phytoplankton reference communities / water quality binning) lacked sufficient linkage between chlorophyll-*a* and designated uses.

In an attempt to correct this problem further analyses were conducted to link chlorophyll-*a* and mesozooplankton abundance. The resulting second draft of the criteria document (May 2002) emphasized these "food quality" connections as the next primary line of evidence. We supported that approach and provided data analysis to assist in the effort. Although this method seemed promising at first, a significant number of adverse review comments were received from a wide range of other reviewers including ourselves and STAC, demonstrating that chlorophyll-*a* was not a useful predictor of food quality impacts.

Ultimately, the CBPO Chlorophyll-*a* Task Group correctly concluded that they lacked a defensible technical basis for numeric chlorophyll-*a* criteria, and published a narrative criterion instead. The chlorophyll-*a* values that had been tabulated in previous drafts were repackaged and included in the EPA criteria document, in case they might provide some insight to states that might make additional attempts to link chlorophyll-*a* to designated uses. VAMWA expressed concerns about including these values in the criteria document, fearing that they could be misunderstood or misused by states. Unfortunately these fears are being realized.

One highly disturbing development is the new interpretation that regulators have since made of the failure of the USEPA CBPO to derive chlorophyll-*a* criteria, suggesting that the only reason that USEPA did not publish numeric criteria is that such numbers must be site-specific. Having served on the Task Group, VAMWA recognizes such statements as misleading.

<u>*EPA-recommended concentrations*</u>: With this background, the EPA-recommended concentrations of Table 11 in the TSD do not represent an independent line of evidence, but merely point back to the failed approaches compiled in the Bay criteria document; historical concentrations, reference communities, trophic-state classification, etc. VAMWA finds it completely unacceptable that USEPA CBPO would have insufficient technical basis to publish chlorophyll-a criteria for public review but then arrive at a DEQ TAC meeting with a table of "recommended criteria", completely circumventing the normal review process for 304(a) criteria.

It is revealing that DEQ's proposed criteria are as much as double the EPA-recommended concentrations for some season-salinity regimes, based primarily on attainability concerns. Just as revealing is the fact that EPA representatives then endorsed DEQ's proposed criteria in public hearings, despite some values being twice what EPA had recommended. While some groups might claim that this indicates that the proposed criteria are too high, it actually points to the extreme subjectiveness and lack of technical basis for the proposed criteria.

DEQ Response: *The EPA "failed" largely because it was committed to a consensus processes, and then couldn't build a consensus among the partners represented on the Chlorophyll Criteria Team. The current state of the science goes beyond a reasonable doubt in establishing the link between algal blooms (measured as chlorophyll a), water quality impairment, and trophic status. Eutrophic status is not desirable, and that is most definitely the current state of the James. DEQ's Technical Report (VA DEQ 2004) provides numerous citations of papers published in scientific peer reviewed journals as the basis for each line of scientific evidence to develop the salinity- and season-based numerical chlorophyll a criteria.*

The comment questions the basis of the proposed criteria noting EPA's publishing of only a narrative criterion. Unlike EPA, VA already had as a designated use "balanced indigenous population of aquatic life in all waters." DEQ's Technical Report (VA DEQ 2004) documents existing Virginia regulatory standard are violated because of high nutrient and chlorophyll a levels in the James. The tidal James River was listed as impaired by EPA in 1999 because existing water quality conditions. It was considered by EPA not supporting the "balanced" populations of aquatic life–fish, crabs, grasses– protected under Virginia's state water quality standards regulations. The principal water quality "impairments" continue to be too much *algae, blooms of potentially harmful algae species near Hopewell, degrading algal trends in the lower James and poor water clarity conditions. DEQ has followed a scientifically based approach in the development of all the proposed criteria, including chlorophyll a. According to EPA, the James River was the primary candidate and reason why this statement was included in their April 2003 criteria document. Scientists have noted an increasing frequency of algal blooms in recent years in the James, high and increasing levels of undesirable algal species, and undesirable algal community composition.*

37. Comment (VAMWA): ***Most of the chlorophyll-*a *values are not based on any threshold of impairment or direct link to designated uses, but on various reference condition methods that merely characterize the low end of the chlorophyll-*a *frequency distribution.***

As such, they are not appropriate for criteria derivation. These inappropriate lines of evidence include:

Historical concentrations: VAMWA's most fundamental concern with the historical data approach is that it does not define impairments of designated uses. Even perfect knowledge of what concentrations were at some point in the past does not allow us to identify the concentrations above which impairments occur, nor does it demonstrate a direct relation between chlorophyll-*a* and those impairments. Criteria derived by reference to some past condition could be highly overprotective or simply ineffective.

The second concern related to historical data is associated with the spotty / infrequent nature of the data collections and questions regarding their representative nature, which limit the usefulness of the dataset used the Harding and Perry (1997) to characterize historical chlorophyll-*a* concentrations in the lower Bay system. The role of historical levels of filter feeding grazers also should be taken into consideration when comparing chlorophyll-*a* values of the past with contemporary measurements. Two important filter-feeding species (the menhaden and the oyster) were in much greater abundance during the 1950s-1960s than during present times. Potentially lower chlorophyll-*a* values of the past (if genuine) probably reflected to some degree the greater ability of these species to consume algae, as opposed to a condition that justifies bottom-up controls.

***DEQ Response**: DEQ recognizes the limitations of the historical data and used it as only a general characterization of the lower chlorophyll levels most likely to have occurred under the less eutrophic conditions and likely more balanced algal conditions. These historical data were not used directly in derivation of the proposed tidal James chlorophyll a criteria. While an analysis of historical data is problematic as noted in the comment and EPA, it does serve as a benchmark for comparison. As noted above, taken in context with other factors/metrics, it provides a broader perspective for comparisons. This is a very relevant and important data set. Data across decades (1950-1990) show a steady increase in summer chlorophyll concentrations in the lower James. It should be noted that these historical numbers were not used directly in the derivation of the proposed numerical chlorophyll a criteria.*

38. Comment (VAMWA): *Phytoplankton reference community concentrations*: See comment 25 for discussion of why this line of evidence in inappropriate for deriving chlorophyll-*a* criteria.

It is unclear why this line of evidence would even be included in the tabulation of values used to derive chlorophyll-*a* criteria if DEQ admits that “the phytoplankton reference community approach does not demonstrate any direct relationship between chlorophyll-*a* concentrations and designated use impairments” (TSD, p. 16).

DEQ Response: *Once again, this comment questions the use of a reference community to chlorophyll a. This issue was discussed in detail under DEQ’s response to comment 25, above. As stated above, this comment in the Technical Report (VA DEQ 2004) originated during the EPA chlorophyll criteria process (see pg 116 of EPA 2003) in regards to the newly developed designated uses of “open water fish and shellfish…”, “Deep water seasonal fish and shellfish…”, “Shallow-water bay grass use” etc…, which are focused on support of higher trophic level communities. DEQ feels that the reference community information may not be useful in regards to those higher trophic level designated uses but is useful in regards to the existing VA designated use support of “a balanced, indigenous population of aquatic life”, which clearly intends to maintain not only a balanced population of fish and shellfish, but all aquatic life from the base of the food chain (algae) to up to commercial and recreation fishes.*

Chlorophyll was found to be a strong differentiator between impaired and least impaired aquatic habitat conditions. The discrimination efficiency of chlorophyll a, one of several metrics used in all seasons and salinity zones, ranged from 54.3% in spring tidal fresh, where its response is often masked by freshwater flow effects, to 78.4% in summer tidal fresh (see Tables A and B, above).

39. Comment (VAMWA): **The proposed chlorophyll-a criteria were heavily influenced by a pre-determined nutrient load allocation, the reverse of the process intended by the Clean Water Act**.

The line of evidence labeled <u>*attainable concentrations*</u> represented USEPA’s advice to DEQ regarding what chlorophyll-*a* concentrations are attainable in the James River. This advice was erroneous in that it was based on 10-year seasonal average chlorophyll-*a* concentrations, whereas actual attainment would be assessed by the cumulative frequency distribution approach (CFD) applied to 3-year increments of monitoring data. Conclusions based on 10-year data sets will provide erroneous attainment conclusions since 10-year data sets will likely mitigate the impacts of data variability that a 3-year data set cannot mitigate. The latest model runs from the Chesapeake Bay Program indicate that the James River would <u>not</u> be in attainment with the proposed chlorophyll-*a* criteria, even assuming full implementation of the 2004 James River tributary strategy. (Linker, L. 2004, handout materials from 6 Oct 2004 meeting of the CBP Modeling Subcommittee meeting).

But the more fundamental problem with the use of attainable concentrations to set criteria is that it represents “backing into” criteria based on a pre-ordained load allocation, instead of basing load allocations on criteria needed to protect designated uses. An examination of Table 11 of the TSD reveals that for most of the season-salinity combinations, Virginia’s recommended criteria were set at the supposed attainable concentration rounded up to the nearest integer that was a multiple of five.

One of VAMWA's chief concerns with the proposed chlorophyll-*a* criteria is that Virginia is using it to justify a pre-determined load allocation or level of effort for the James River, such as to attain a load allocation similar to the 2003 PSC agreement, or justify a level of nutrient control similar to tributaries that have more direct impact on the Chesapeake Bay. While VAMWA recognizes some of the political and legal pressures with which the state is dealing, DEQ must base water quality criteria only on sound science and defensible linkages to designated uses.

DEQ Response: *The nutrient cap loads allocated to the James River basin were not used as the basis for derivation of the James-specific chlorophyll a criteria. The proposed numerical chlorophyll a criteria, derived specifically for the tidal James River on a segment by segment basis for spring and summer seasons, were based on available scientific data and published findings as documented in the Technical Report (VA DEQ 2004). The numerical criteria were developed to ensure a 'balanced' phytoplankton community would be restored, that algal blooms would be reduced and that the criteria were attainable. Protecting for a 'balanced' aquatic life population and controlling substances that 'nourish undesirable or nuisance aquatic plant life' is required by the Virginia Water Quality Standards Regulation (9 VAC 25-260-10 and 20). Factoring in attainability is a prudent measure to take in order to ensure the criteria are reasonable. It is true; the original attainable concentrations were done using 10-year data sets as that was the only information available from EPA at the time of criteria development. Since then, we have received from EPA model runs using the prescribed 3-year data sets. It is true these data sets show non-attainment in the James, using the CFD (cumulative frequency distribution) method of analysis.*

Once the proposed Virginia water quality standards regulations are formally promulgated into state regulation and approved by EPA, there may be the need to adjust the James River basin nutrient and sediment cap load allocations to fully reflect the new standards regulation. This need was previously recognized by the watershed partners in Secretary Murphy's April 25, 2003 memorandum to the other members of the Principal's Staff Committee and headwater state representatives:

> *"While the allocations adopted at this time will provide the basis for tributary strategies, these allocations may need to be adjusted to reflect final state water quality standards". (Murphy 2003)*

Clearly, it has been the partners' collective intent since the signing of the Chesapeake 2000 agreement (Chesapeake Bay Commission 2000) that "water quality conditions necessary to support living resources" would drive derivation of Bay and river-specific water quality criteria and refinement of tidal water designated uses. (USEPA 2003 a,b,c 2004a) These criteria and designated uses, in turn, would drive the initial set of cap load allocations (USEPA 2003c) and form the basis for additions to and/or revisions to existing state water quality standards regulations. Those revised state water quality standards regulations would then be the basis for necessary refinements to the cap load allocations. The commitments within Chesapeake 2000 clearly lay out this sequence of events. Virginia, along with its other six jurisdictional partners and EPA, has closely adhered to this logical, stepwise and carefully sequenced approach.

40. Comment (VAMWA): **Water quality criteria must be based on thresholds above which designated use impairments are demonstrated to occur.**

The common fatal flaw of all the chlorophyll-*a* values derived from the approaches discussed above is that they do not represent thresholds above which designated use impairments have been demonstrated/predicted to occur. VAMWA finds it distressing that this fundamental requisite of water quality criteria is being ignored in favor of reference condition methods and unfounded concepts that lower chlorophyll-*a* levels are intrinsically better for the environment. Imagine if criteria for copper or dissolved oxygen were derived by similar reference condition methods instead of by cause-effect considerations. The copper criterion would be likely at the limit of detection, and the dissolved oxygen criterion would be near saturation. Both would be highly overprotective and essentially useless in the context of water quality management.

DEQ Response*:* Chlorophyll a criteria are a biocriteria which differs from criteria for dissolved oxygen or copper in fundamental ways which make the comparison to their development a impropert. The reference community approach as used by DEQ is recommended by EPA for development of biocriteria (Gibson et al, 2000).

41. Comment (VAMWA): **Linkages of chlorophyll-a to HABs have promise but must be revised**.

Linkages of chlorophyll-*a* to HABs represent the lone approach discussed in the TSD that has promise for deriving defensible criteria. VAMWA has made efforts in the past to assist DEQ in making these linkages. In Spring 2004, VAMWA proposed a monitoring approach that would allow the state to identify the chlorophyll-*a* concentration at which nuisance blooms occurred. DEQ staff rejected this approach upon the basis that they were required to produce recommendations to the State Water Control Board in June 2004, and therefore did not have time to implement the monitoring strategy.

Secondly, municipal groups used data from the Phytoplankton IBI database to identify the chlorophyll-*a* concentrations at which cyanophytes and *Microcystis aeruginosa* exceed specific thresholds in the tidal freshwater James River, and presented these results to the TAC. It was logical to believe that DEQ might favor such an approach, because it directly correlated the chlorophyll-*a* concentration to the cyanophyte and *Microcystis*-related impairments claimed by DEQ (notwithstanding VAMWA's concerns regarding whether a tangible impairment actually existed).

This analysis identified a threshold of about 35 μg/L for the tidal freshwater James River (Figures 14-16). *Microcystis aeruginosa* was not observed to exceed the 10,000/mL threshold below this chlorophyll threshold. Cyanophytes also have a very low incidence of exceeding values that had been identified by other researchers as potentially suppressing zooplankton at this chlorophyll threshold. As discussed in comment 35, the proportion of cyanophytes in the 20-35 μg/L chlorophyll-*a* range was not significantly different from the proportion in the 0-20 μg/L range. And as discussed previously, the mesozooplankton (i.e., larval fish food) abundance was much higher in the 20-35 μg/L interval than in the 0-20 μg/L range. Therefore, it appears that a criterion of 35 μg/L provides not just equivalent but superior protection of aquatic life in this segment, compared with 15-20 μg/L.

DEQ did include some of these results in the TSD as Figure 21. Similarly, the TSD clearly states that "at the phytoplankton monitoring station in this segment (TF5.5), [exceedance of cyanophyte thresholds] begin to occur in the 35-40 μg liter^{-1} chlorophyll *a* range." (p. 18). Unfortunately, it does not appear that these results were actually used to derive the criteria or even included in Table 11 of the TSD under the two columns devoted to HAB-related concentrations. The 35-40 μg/L threshold is quite clear and represents DEQ's only potential linkage of chlorophyll-*a* with designated uses for this segment. It is unclear why DEQ is ignoring this threshold in the James River criteria derivation process.

Given the lack of nuisance blooms or observable/predictable food quality impacts in the tidal freshwater segment, even a 35-40 μg/L criterion would be conservative. Nuisance blooms are typically associated with chlorophyll-*a* concentrations higher than the 35-40 μg/L range. For example, a report on the 1983 *Microcystis aeruginosa* bloom on the Potomac River (MWCOG, 1984) documents that surface scums of this taxon were observed only when chlorophyll *a* concentrations execed 50 μg/L to over 200 μg/L. Similarly, the 2004 blooms on the Potomac River were associated with chlorophyll-*a* concentrations in the hundreds or even thousands of μg/L (Maryland DNR, 2004).

Table 11 of the TSD includes two HAB-related columns of chlorophyll-*a* concentrations, but neither of these were based on the actual thresholds observed for the James River. The values cited for the TF1 and TF2 segments appear to be derived from the USEPA criteria document that did not consider James-specific data. As discussed in previous comments, the tidal freshwater James River is very different from many other segments, and cannot be assumed to have thresholds identical to those observed in a Bay system-wide analysis. James River-specific data show that a 35-40 μg/L chlorophyll a standard would be a protective range for the tidal freshwater summer, as discussed above. Cyanophytes including *Microcystis* are not abundant in the spring season in the segment, so a spring numeric criteria is not necessary unless it were based on anti-degradation.

For the high salinity segments of the James River, a threshold of 25 μg/L chlorophyll-*a* was cited in Table 11 of the TSD, based primarily on the prevention of *Prorocentrum minimum* blooms that could impair oysters. As discussed in comment 23, potentially harmful blooms of *Prorocentrum minimum* are exceedingly rare in the James River. Regardless, DEQ did not use this value when developing the criteria.

Given the rarity of actual toxic blooms in the lower James River, the best approach for this segment would be a phased adaptive management approach that monitors the response of the algal community to nutrient reductions elsewhere in Bay system, including the upper tidal James River. If numeric criteria are derived for the lower James River, they must be based either on anti-degradation or direct relations with harmful algal blooms.

DEQ Response: *The comment questions the linkage between chlorophyll a and Harmful Algal Blooms (HABs) and criticizes DEQ's failure to conduct additional studies in the upper James. The numerical chlorophyll a criteria for the tidal James River were derived to address existing Virginia Water Quality Standards Regulation requirements: 1) for supporting "a balanced, indigenous population of aquatic life in all waters" (VAC 25-260-10) and 2) that "substances* *which nourish undesirable or nuisance aquatic plant life will be controlled" (VAC 25-260-20). By deriving criteria to specifically address these two existing regulatory requirements, the criteria are directly linked to supporting Virginia's designated uses for the tidal James River.*

The municipal stakeholders did propose a monitoring approach for criteria derivation that they believed would provide a link between criteria and visually nuisance blooms. This study was deemed unnecessary and untimely given that the Bay Program partners and stakeholders have direct access to two decades of algal species composition data collected at the same time as chlorophyll a concentrations and a host of other water quality parameters. In addition, the EPA Chesapeake Bay criteria document, already contained extensive technical data and scientific findings characterizing chlorophyll a concentrations at which blooms of nuisance algal species occurred. (USEPA 2003).

The suggestion that a criterion of 35 ug/l would provide superior protection of aquatic life in the tidal fresh region is based somewhat upon invalid and skewed analyses presented previously (i.e. selective exclusion of high chlorophyll observations). Another reason for rejection of the suggested 35 ug/l criterion was that it is based upon analysis of an HAB (i.e. Microcystis) - chlorophyll relationship in James River data only. DEQ feels it is more appropriate to use the larger bay-wide data-set for defining the HAB (i.e. Microcystis) - chlorophyll relationship as used in EPA (2003), which points to a 15 ug/l threshold level.

The respondent goes on to state that harmful algal blooms of P. minimum are rarely exceeded and implied that a threshold of 25 ug/L chlorophyll a was not used in the numerical derivation in the higher salinity portions of the James. Blue-greens and dinoflagellates tend to dominate the nuisance and toxic algal forms of concern in this area of the James (Marshall 1996). Among these dinoflagellates are numerous bloom producers (and potentially toxic species) that are most common in this section of the tidal river. During bloom periods the cells are introduced into other estuaries by way of tidal flow. Over the past several years many of these blooms have increased in their range and bloom duration. Many of the summer/fall blooms of dinoflagellates are becoming longer in duration and larger spatially. What previously took 1-2 tidal cycles to dissipate a bloom may now involve 2-4 tidal cycles (Marshall per. comm. 2005).

The dinoflagellate, Prorocentrum minimum, is an undesirable species that commonly blooms in spring and summer in the lower tidal James. A concentration of 3,000 cells liter^{-1} of P. minimum is an impairment threshold. Despite programs not designed to monitor algal blooms, Virginia's Chesapeake Bay phytoplankton monitoring program station in the lower James River (LE5.2) observed levels exceeding 4,091 cells liter^{-1} in May 2003. In April of this year, visual reports by DEQ field staff again sighted algal blooms in the lower Bay.

Based on the limited temporal and spatial sampling regime, the current monitoring program has less than a 10 percent probability of observing an algal bloom since they occur over just one or two tidal cycles and can be highly localized. In fact, it would be rare that a bloom will actually be detected during its peak. The Tidal Tributary Phytoplankton Monitoring Program only samples monthly at fixed stations. Therefore, it was very surprising and disturbing to DEQ staff when algae known to be associated with harmful algal blooms were observed. As stated in response to 23 above, the risk of blooms in the lower James is also elevated. As stated in the

DEQ's Technical Report (VA DEQ 2004), the literature demonstrates that increases in the number of harmful algal species in the Bay have increased and been implicated with elevated nutrient levels (Marshall 1996; Mulholland 2004a,b). However, since this particular species constitutes a significant biomass to Virginia's water is additional reason for concern.

In addition to poor status and degrading trends for cyanobacteria as well as poor status with total phytoplankton, this region remains prone to sporadic and common summer and fall blooms of dinoflagellates in general (Dauer et al. 200). All this supports a comprehensive assessment of a system severely stressed.

42.Comment (VAMWA): **The proposed chlorophyll-*a* criteria are more stringent than any used by adjacent jurisdictions, and go beyond federal requirements**.

It is worth noting that the proposed chlorophyll-*a* criteria for the James River—in the 10-20 µg/L range—are significantly more stringent than those used by adjacent jurisdictions such as Washington DC (25 µg/L), North Carolina (40 µg/L), and Maryland (50 µg/L previously used for TMDLs, although they will not be adopting numeric chlorophyll-*a* criteria). This despite the fact that the James River has little impact on the Chesapeake Bay, has relatively high dissolved oxygen, and history of toxic or nuisance blooms, unlike many of the tributaries which less stringent goals have been applied.

The Virginia Regulatory Town Hall document states that the proposed standards are not more stringent than federal requirements. This is both technically and legally incorrect. Federal numeric 304(a) criteria for chlorophyll-*a* do not exist. Even under the presumption that USEPA would pressure Virginia to derive numeric standards, the specific criteria proposed in no way represent a federal requirement.

DEQ Response: *DEQ disagrees. North Carolina's chlorophyll a water quality standard is applied as a maximum concentration (as opposed to Virginia's criteria which are seasonal averages) addressing bloom concentrations in the Albemarle-Pamlico Sound. Furthermore, the concentration value for this estuarine system was derived from lake studies and is not applicable to the James River. When asked, staff at North Carolina's Department of Natural Resources could not provide any detailed documentation on exactly how their State's chlorophyll a water quality standard was derived.*

The Maryland Department of the Environment has used a 50 µg liter-1 chlorophyll a concentration as a numerical interpretation of its narrative water quality standards for establishing TMDLs in small tidal creek and river settings. When asked, MDE cites past work by Dr. Robert Thomann, formerly of Manhattan College in New York City, as the basis for the 50 µg liter-1 concentration but the state has no documentation supporting this value (Eskin and Summers pers. comm. 2002). The Virginia proposed values (with supporting documentation) cannot be compared to a non-regulatory value with no documentation.

The District of Columbia derived its tidal Anacostia River chlorophyll a criteria based on the scientific findings published in the EPA's Ambient Water Quality Criteria for Chesapeake Bay Dissolved Oxygen, Water Clarity and Chlorophyll a Criteria for Chesapeake Bay and Its Tidal

Tributaries, and through extensive model analysis of chlorophyll a concentrations that would meet the designated uses for the tidal river (e.g., restoration of SAV to shallow water habitats) (District of Columbia). The District of Columbia's chlorophyll a criteria and the designated uses it was derived to protect fully accounted for the extremely high water residence time, in part, leading to the concentration level higher then those proposed for similar tidal fresh habitats in the lower reach of the tidal fresh James River. Higher residence time was the central basis for proposing a summer seasonal chlorophyll a criteria concentration of 20 µg liter-1 for the lower tidal fresh James River segment(JMSTF2) compared with a criterion concentration of 15 µg liter-1 for the upper tidal James River (JMSTF1)(VA DEQ 2004).

EPA published a comprehensive inventory of all 50 states' chlorophyll a water quality standards as of 2002 in Appendix D of the Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries (USEPA 2003). As examples, Alabama has numeric chlorophyll a criteria of 16, 20 and 27 µg liter-1, Connecticut has numerical chlorophyll a criteria ranging from 2 to 30 µg liter- and Hawaii has adopted geometric mean of 2 µg liter-1 and a not to exceed 5 µg liter-1 for more than 10 percent of time and 10 µg liter-1 for more than 2 percent of time, with slightly higher values for Pearl Harbor estuary.

The tidal James River only has good dissolved oxygen conditions due to its physical proximity to the Atlantic Ocean, benefiting from the inflow of well-oxygenated ocean waters and the natural physical mixing of the water column. Located further away from the ocean, less physical mixing (leading to increased stratification) combined with the nutrient over enriched conditions and excess algal production would likely yield low dissolved oxygen conditions now observed in the tidal Rappahannock, Potomac and Patuxent rivers. DEQ's Technical Report (VA DEQ 2004) concurs that the James River has little impact on dissolved oxygen conditions in Chesapeake Bay (USEPA 2003). The lack of a James River impact on Bay dissolved oxygen conditions is not a reason to ignore needed protection within the tidal river.

The tidal James River does have a history of nuisance or toxic blooms with greater than 65% of chlorophyll a observations above bloom conditions (conditions are where chlorophyll is greater than least impaired reference sites, greater than the proposed criteria or greater than concentrations characterized world wide as mesotrophic conditions). Furthermore, bloom frequency has been increasing since 1986 according to the scientific literature (Marshall 1995, 1996). Finally, DEQ field staff has noted visibly green algae blooms in the summer and early fall months from the mouth of Bailey Creek downstream to Windmill Point. More recently, a mahogany tide was observed by a citizen on the river in the Burwell Bay area. The quantification of observed blooms is problematic in the Chesapeake Bay tidal monitoring program has less than a 10 percent probability of observing an algal bloom since they occur over one or two tidal cycles and are highly localized.

DEQ believes the Department was correct in stating that the amendments proposed were concurrent with federal requirements. The federal requirement (as opposed to guidance) is that the states must adopt criteria to protect designated uses. The proposal accurately provides that protection in accordance with EPA guidance published on this issue (USEPA 2003).

43. Comment (VAMWA): **The chlorophyll-*a* criteria could actually harm oysters and fish populations by imparting food quantity limitations**.

The concept that nutrient-related criteria can impart food quantity limitations on fisheries is well established. For example, the Virginia Academic Advisory Committee's (AAC) report to DEQ on freshwater nutrient criteria includes extensive discussion of the relations between nutrients and fisheries, including the statement that "to sustain quality fisheries, nutrient management is critical; excessive nutrients limit habitat, while low nutrient levels limit food supply" (Zipper and others, 2004). Unfortunately DEQ's TSD includes no analysis or discussion of potential food supply impacts, and seems to assume that none would exist. VAMWA is very concerned that DEQ has not considered potential food quantity effects on oysters, fish, or other consumers in the context of chlorophyll-*a* criteria. Several lines of evidence indicate that this could be a very real problem, as outlined below:

Oysters: Oyster modeling simulations recently sponsored by the Chesapeake Bay Program Modeling Subcommittee indicated that efforts to restore oysters to the James River could be limited by available food. The model algorithm suggested that the James River was currently supporting all the oysters it could based on the available food quantity. Light limitations on algal growth were assumed to be an important factor in preventing the algal biomass that would be necessary to support significantly higher oyster biomass (C. Cerco, presentation materials for the 6 Oct 2004 Modeling Subcommittee meeting).

It is reasonable to ask if this simulated food limitation is real, considering that the oyster biomass of the James River is thought to have been higher under lower historical nutrient loading levels. However, the paradox can potentially be explained by the fact that larger, older oysters grow more slowly and have lower food concentration requirements. Without harvesting and disease mortality, a mature oyster population would require lower food concentrations than a young oyster population of the same biomass (C. Cerco, pers. comm., 6 Oct 2004). Similarly, an abundant, established population of mature oysters could sustain itself with lower growth and larval recruitment rates than would be required to expand a small, young oyster population. Thus, in terms of *restoring* oysters to an area, the food limitation problem is likely real.

Dekshenieks and others (1993), drawing on oyster larval growth rate measurements of Rhodes and Landers (1973), demonstrated that maximum larval *Crassostrea virginica* growth rates occurred at a food concentration of about 3 mg C /L. Assuming that the majority of the food was comprised of algal biomass and a typical carbon:chlorophyll-*a* ratio of 80:1, this would correspond to a chlorophyll-*a* concentration of over 35 μg/L. Larval growth rates were reduced to about one-quarter of the maximum rate when food concentration fell below 1.0 mg C/L, corresponding to about 12 μg/L chlorophyll-*a*. Dekshenieks and others (1993) then used a model to demonstrate that variations in food supply could have significant implications for larval development time, with major consequences for adult populations, and conclude with following statement:

> …management strategies for an oyster fishery must be broad enough to include habitat effects on larval survivorship, which ultimately determine recruitment to the adult population.

Similarly, oyster modeler Eric Powell of Rutgers University has indicated that oyster larva generally require values of 20 μg/L chlorophyll-*a* for optimum growth during the summer months, and that suppressing values to less than 10 μg/L could do "serious harm" (E. Powell, elec. comm.. 10 Dec 2004). Eileen Hofman of ODU has stated that, based on her research, oyster larva are very sensitive to food concentration and that a maximum value of 10 μg/L is "not good for adult oysters and certainly not good for oyster larva" (E. Hofman, elec. comm., 14 Dec 2004).

Although the restoration of oysters to the James River is undoubtedly a complex problem with many facets, potential food quantity limitations must be considered by DEQ as part of an alternatives analysis in addition to other concerns regarding food quality and HABs that are discussed elsewhere.

***DEQ Response**: The respondents offer several lines of evidence to support their hypothesis of food limitation to oysters with lower chlorophyll a levels. Overall, the comments referring to "maximum growth rates" relate to oyster larval growth rates in models or experimental/hatchery conditions. The issue of food limitation was considered by DEQ staff during this process and concluded that meeting a reasonable chlorophyll a criterion was unlikely to limit food quality for oysters.*

For example, DEQ asked for guidance to respond to the comments provided by scientists on optimum growth levels for oysters. Scientists at VIMS disagree with food limitation argument and consider it more accurate that low nutrient levels lead to limitation of primary production, but not necessarily food supply. They state that the status of our understanding of food requirements for primary consumers such as larval finfish and shellfish is not complete. Knowledge of food requirements for larval marine and estuarine species is primarily based on trial-and-error laboratory culture using a limited suite of possible sources. The full range of food species utilized by larvae in natural systems remains unknown. Field studies that have quantified phytoplankton and larval populations often show healthy larval communities existing among phytoplankton concentrations that do not approach the requirements observed in the laboratory to support healthy larval development. There are other factors that may contribute to these discrepancies; however, this apparent lack of correlation between wild food levels and larval populations provide reason to believe that larvae exploit food sources other than phytoplankton. Because of this we (VIMS scientists) cannot place confidence in the argument that link nutrient limitations to sub-adequate food supply (Dr. Roger Mann, letter, pers. comm. May 2005).

VIMS continues on to say that chlorophyll a concentrations back-calculated from phytoplankton amounts known to produce optimal larval developmental rates in laboratory situations is a valid method that can provide guidance on wild stock food requirements. However these extrapolations are difficult and require the use of conversion factors to calculate the amount of useable carbon from measured chlorophyll a concentrations. There is not a single factor agreed upon in the scientific community and can range from approximately 100:1 to 25:1. These conversion factors can vary among phytoplankton species and mixtures of phytoplankton species. The conversion factor provided to DEQ through the public comment process used 80:1 and this should be viewed as a high-end guide (Dr. Roger Mann, letter, pers. comm. May 2005).

The respondents note that summer appears to be the most critical period for larvae feeding. Powell and Hofmann (per. comm.) also reported that 20 ug liter^{-1} was the optimum with 10 ug liter^{-1} the minimum for oyster growth. Based on these comments, the following response was directed toward summer conditions in the lower James River.

Two things are noted from their statements:

1) *summer chlorophyll a concentrations in the lower tidal James River are generally below those being proposed for chlorophyll a under this rule making (see Table F in response to comment 49); and*
2) *Based on published reference communities for Chesapeake Bay, food as measured by algae biomass would be the same or higher than current levels under the reference community levels used in setting the criteria.*

Therefore, it is unreasonable to assume that the chlorophyll levels sought would cause any adverse environmental affects to any living resources unless they were substantially lower than existing levels, which they aren't.

Continuing along with this idea of using a ratio of carbon vs. chlorophyll a to assess food quantity requirements, chlorophyll a can be multiplied by a ratio of carbon to chlorophyll (C:Chl) to approximate biomass (as carbon). Following this basic metric, C:Chl ratios can be used to assess "least-impaired" to "most-impaired" water bodies by season or habitat (salinity). For example, spring and summer C:Chl ratios averaged about 125 in the "least-impaired" polyhaline waters and about 65 in least-impaired mesohaline waters (see Table 4 in Buchanan et al. 2005).

*Using these observed ratios (125 and 65) and assuming that the majority of food is comprised of algal biomass (which is probably an erroneous assumption), the 3 mg C l^{-1} mentioned in the Dekshenieks and others (1993) paper, would convert to 24 ug chl l^{-1} in polyhaline and 46 ug Chl l^{-1} in mesohaline. It is important to note that these chlorophyll a concentrations (24 and 46 ug Chl l^{-1}, respectively) represented maximum larval growth rates under hatchery conditions. The respondents fail to note effects of food concentration on young larvae changes little between 1.5 and 6 mg C/L as monthly averages (Dekshenieks et al 1993, Figure 2). Also, it appears the commenter was using a 50:1 conversion factor rather than 80:1 above since 3 mg C liter^{-1} * (1 mg chl/80 mg C) = 37.5 ug chl l^{-1}. Dekshenieks (1993) show young larvae do the same across a range of chlorophyll (12 to 30 ug Chla /L). The same study concludes "…larval development and planktonic time are …primarily temperature controlled." All this tells us confirms that relating chlorophyll a concentrations to food quantity is variable and dependent on various factors.*

Other factors indicate that food quantity will not be altered by these proposed criteria:

- *Historically, chlorophyll a concentrations were lower than the chlorophyll a criteria proposed by VA (Harding and Perry 1997). These very low chlorophyll a concentrations were associated with high quality food levels that supported vast, abundant oyster reefs* *through the early/mid 20th century (http://www.chesapeakebay.net/baybio.htm.) While maximum larvae growth rates employing hatchery conditions do not exist in the wild, the chlorophyll concentrations being proposed are above historical concentrations during those critical periods (summer) and should provide sufficient biomass to sustain existing and new oyster populations.*

- *Oyster simulations in the Water Quality Model further demonstrate that the net change in oyster density under the Allocation loads was negligible (Cerco 2005).*

- *Water Quality Standard chlorophyll a concentrations being proposed for tidal James River will only bring concentrations closer to seasonal means observed in other parts of the Bay based on the nutrient allocations agreed to by the other states (Alternative Analysis 2005). No similar concerns of food limitation to existing Bay resources by Virginia or the other states were voiced by any of the many technical experts involved in that process (USEPA 2003a).*

- *Survival of oysters may be jeopardized by unfavorable eutrophic conditions and the occurrence of harmful algal blooms because of their ability to out-compete co-occurring algae under nutrient and dissolved organic enriched conditions (Mulholland 2005).*

44. Comment (VAMWA): Larval fish and zooplankton: Monitoring data indicate that the implementation of the proposed chlorophyll-*a* criteria would actually reduce total mesozooplankton abundance in the tidal freshwater segment of the James River (Figures 2-3; Table 2). This fraction of the zooplankton population is a critical food supply for many organisms including larval fish. For example, a review of the literature by Jacobs (2003) indicated that a minimum of 20,000 m^{-3} total mesozooplankton were required for optimum recruitment of larval fish (Jacobs, 2003). The probability of observing at least 20,000 m^{-3} total mesozooplankton was significantly less when the proposed criteria was attained than when it was exceeded. Hence, the proposed chlorophyll-*a* criteria could have adverse impacts on striped bass, largemouth bass, and other fish populations of the James River.

We refer DEQ to the generalized model of Ney (1996) as presented in the AAC's report (Zipper and others, 2004) on nutrient criteria to DEQ (Figure 17). According to this model, fish populations increase in response to nutrient loading until the positive effects of abundant food supply begin to be outweighed by negative impacts—most importantly habitat loss due to low dissolved oxygen in bottom waters. However, considering that the tidal freshwater James River has relatively high dissolved oxygen concentrations and no nuisance blooms, the most beneficial nutrient/chlorophyll-*a* levels for fisheries in this system would be higher than proposed. For comparison, freshwater ponds and reservoirs that are professionally managed for warmwater fisheries are often fertilized to achieve chlorophyll-*a* concentrations of 40-60 μg/L (M. Maceina, Auburn University, elec. comm., 27 Jan 2005).

It has already been demonstrated that chlorophyll-*a* criteria in the 35-40 μg/L range would prevent impacts from *Microcystis* or cyanophytes (if such actually occur in the James River), and would provide a more abundant food supply than criteria in the 15-20 μg/L range. In combination with present high dissolved oxygen levels, one cannot conclude that chlorophyll criteria in the 15-20 µg/L range are more defensible than in the 35-40 µg/L range.

Dr. Dennis Devries is a noted fisheries scientist at Auburn University with expertise in fish—zooplankton relations. Upon a review of information presented in this comment, Dr. Devries stated that an adaptive management approach would be preferred for the tidal freshwater James River, and that initial chlorophyll-*a* standards under this approach should not be set to suppress chlorophyll-a below 20 µg/L, given potential adverse impacts to the fishery of this segment (D. Devries, pers. comm., 21 Jan 2004).

In higher salinity segments, total mesozooplankton abundance generally has no statistical relation with chlorophyll-*a* concentration. However, considering that the tidal freshwater segment represents the spawning and nursery grounds for fish that populate the higher salinity segments as adults, the proposed chlorophyll-*a* criteria could have negative impacts on the fisheries of the lower James as well.

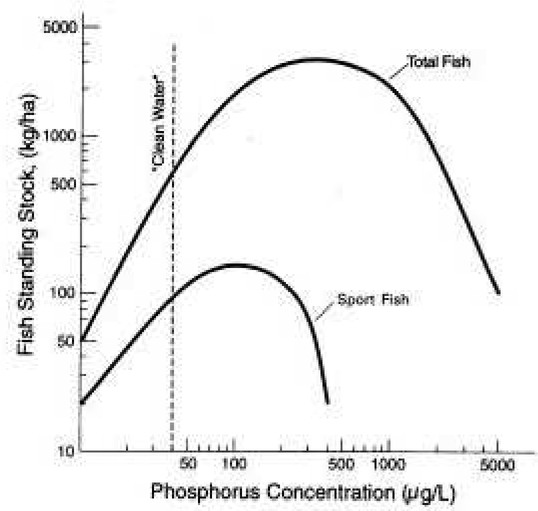

Figure 17. Generalized relation of total fish and sport fish standing stock with total phosphorous concentration in temperate latitude reservoirs, from Ney (1996) as reproduced in Zipper and others (2004).

***DEQ Response**: The suggestion that larval fish (and striped bass, largemouth bass and other fish populations) will be impacted by lower zooplankton levels resulting from lowered chlorophyll levels is based upon their previous analyses presented in comment 24. As discussed in response to comment 24, Table 2 in the comment presented results of data analysis from ALL tidal fresh monitoring stations in Chesapeake Bay (i.e. Mainstem bay, Maryland waters etc..) and shows the expected relationship between high chlorophyll levels and high zooplankton levels. This analysis result is not applicable to the tidal fresh James where one would expect that* *this would mean the tidal fresh James should currently have high Mesozooplankton levels. However, as discussed previously, the food availability index developed by the Chesapeake Bay Program to evaluate zooplankton food resources for larvae of striped bass and white perch in spring indicates zooplankton food resources are "Poor" (<5,000 m^{-3}) or "Minimal" (5,000 – 10,000 m^{-3}) in most years. This is despite the high chlorophyll levels present and indicates a poor food quality of the algal populations in the James. As discussed in Buchanan et al (2005) returning the tidal fresh James to a more balanced algal population (and lower chlorophyll levels) similar to the reference community conditions will not decrease the quantity of edible phytoplankton food available to zooplankton. In summary, achieving the proposed chlorophyll criteria levels should improve the quality of food that supports fisheries in the tidal fresh and provide at least the current level of quantity. As the comment notes, an improvement in the tidal fresh region should be reflected in improvements in the higher salinity region as well.*

The suggestion that higher nutrient/chlorophyll levels would be beneficial to fish based upon generalized models of fish stocks versus phosphorus concentration or chlorophyll levels in fertilized ponds/reservoirs ignores the extensive actual data in the James presented in the Technical Report (VA DEQ 2004 which shows current levels are too high and the proposed criteria would lead to a better algal community.

The comment that chlorophyll-a standards should not be set to suppress chlorophyll-a below 20 g/L, given potential adverse impacts to the fishery of this segment should be accommodated by the fact the proposed <u>mean</u> criteria of 15 ug/l will still allow many excursions of chlorophyll to levels above 20 ug/l.

Further confirmation that lower chlorophyll levels will not impair higher trophic levels has been provided by preliminary analysis performed by Dr. Paul Bukaveckas from Virginia Commonwealth University (Bukaveckas, 2005). Work has shown that algae constitute a small but nutritionally-important fraction of suspended particulate matter in riverine and estuarine environments. Specifically, algae are known to be rich in mineral nutrients (N, P) and essential biochemicals (fatty acids, sterols) that are important to consumer growth and reproduction. Therefore, a consideration of how changes in algal abundance will effect food-webs and efforts to restore fisheries (e.g., oysters) was examined using food resource metrics of N content (C:N), P content (C:P) and Algal-C fraction (as percent of PC). With respect to the algal-c fraction, his analysis indicates that even a 50% decline in the algal fraction would not be expected to impact consumer (i.e. zooplankton) growth rates. With respect to N content, his analysis suggests that the James River particulate matter is N-rich with respect to zooplankton nutrition and that N limitation is unlikely to occur even when a conservative threshold was applied. As with nitrogen, the phosphorus content of particulates in the James is very high. A four fold reduction in phosphorus would be required before the P content of suspended matter resulted in dietary insufficiencies for zooplankton.

45. Comment (VAMWA): <u>*Menhaden*</u>: The chlorophyll-*a* criteria could also have negative implications for menhaden, which can feed directly on phytoplankton. Menhaden actually seek out high algae densities for feeding, with the highest menhaden populations observed in conjunction with chlorophyll maxima of estuaries (Friedland and others, 1996). As stated by Gottlieb (1998):

> Menhaden schools, particularly postmetamorphic juveniles, tend to congregate in areas with the highest levels of phytoplankton biomass.

Although the filtering efficiency of menhaden varies with phytoplankton size, models of menhaden ecology indicate a direct relationship between primary production or biomass and menhaden growth (Durbin and Durbin, 1983; Gottlieb, 1998). It is unclear why DEQ would make the unreferenced assumption that chlorophyll-*a* reductions resulting from implementation of the criteria would benefit menhaden, when this fish actually seeks out high chlorophyll-*a*.

***DEQ Response**: Menhaden are known to have minimum and maximum size limits for filtration, and filtration efficiency varies as a function of particle size (Dekshenieks et al. 1993). It is most efficient between those extremes. Unfortunately, many undesirable bloom producers occur at these upper and lower limits. Either the cells are too small and abundant hampering feeding or bloom producers are large, filamentous forms, basically unavailable to menhaden as food. Unlike oysters, menhaden can and do migrate. Menhaden generally seek out areas with high chlorophyll, but can also turn away from certain types of algal blooms (Friedland, Ahrenholz and Ghthrie 1989). Studies funded by the NOAA Chesapeake Bay Program demonstrate this. Dr. Friedlander, Director of the University of Massachusetts NOAA Cooperative Marine Education and Research program (CMER), has shown that menhaden show preferences and avoidances of certain phytoplankton taxa and that menhaden can not digest cyanobacteria. In James River, menhaden are most frequently observed in the high salinity regions (polyhaline with occasional reports in the mesohaline) (Austin pers. Comm.). In fact, menhaden abundance appears to be mediated more by recruitment and mortality than food quantity.*

46. Comment (VAMWA): **The complexity and unpredictability of harmful algal blooms favors an adaptive management approach rather than blind nutrient controls.**

As noted in previous comments, DEQ has largely ignored the data-based relationships between chlorophyll-*a* and potentially harmful algal blooms in the criteria setting process. Instead, DEQ has compiled a range of low chlorophyll-*a* concentrations without connections to designated uses, and made a highly subjective selection of values, heavily influenced by a pre-determined load allocation. In previous comments, VAMWA has encouraged DEQ to instead base chlorophyll-*a* criteria on direct relations with designated uses where potential HABs occur, and to take an anti-degradation or adaptive management approach to prevent the increases in potential HABs in segments where they are currently very rare. Such an approach could save Virginia billions of dollars while providing comparable or superior ecological benefits.

One reason an adaptive management approach is preferred—as opposed to a simplistic nutrient reduction approach driven by chlorophyll criteria—is that the ability to control estuarine HABs by nutrient management is not well understood or even firmly established. Blooms occur in response to a complex set of physiological stimuli and are not necessarily predictable or manageable. In fact, it is unknown if the magnitude of anthropogenic nutrient loads is a major factor driving occurrences of potential HAB-forming species in the Chesapeake Bay. Anthropogenic nutrient enrichment is one among many factors that has been cited as a potential cause of increase in reporting of HABs worldwide. Others include:

- Increased monitoring and scientific awareness of toxic species
- Increased use of coastal waters for shell fisheries/fisheries
- Increased worldwide transport of cells, cysts, and shellfish stock
- Climatic/meteorological conditions

As stated by Donaghy and Osborn (1997:

> A growing body of laboratory, field, and theoretical work suggests that the dynamics of harmful algal blooms…are frequently controlled not only by physiological responses to local environmental conditions as modified by trophic interactions, but also by a series of interactions between biological and physical processes occurring over an extremely broad range of temporal scales. All too frequently, major gaps in our ability to identify, measure, and model the underlying biological and physical processes…have prevented the quantitative assessment of the importance of these factors in causing past blooms…

Similarly, Beltrami (1995) states that:

> Unusual bloom episodes appear to occur in an erratic manner and are seemingly unpredictable in duration and severity. The extent to which such blooms are actually due to deterministic mechanisms…is an open issue.

As discussed in comment 28, a shift in nutrient ratios caused by well-intended nutrient reductions may be a major factor in the increasing cyanophyte trend in the tidal freshwater James River (see Figure 10). Some authors (e.g., Hodgkiss and Ho, 1997) have also concluded that nutrient ratios are more important than absolute nutrient concentrations to regulating dinoflagellate blooms. For example, *Prorocentrum minimum* has a very low critical cell quota for nitrogen and has been shown to be able to out-compete other phytoplankton groups as nutrients become limiting (Roelke and Buyukates, 2001). During low frequencies of nitrate supply, uptake and growth rate of *P. minimum* become uncoupled, and *P. minimum* is able to form a large internal pool of nitrogen that constitutes a competitive advantage under low-nitrogen conditions (Sciandra, 2002).

Similarly, Mulholland (2004) has demonstrated that many potential bloom formers in Virginia waters have competitive advantages over other taxa under light-limiting conditions due to their mixotrophic nature; i.e., ability to utilize organic nitrogen and carbon. Given the high turbidity of the lower James River, major reductions in inorganic nutrient inputs from point sources might even increase the competitive ability of these taxa. This is a more complex management problem than simply attaining a particular chlorophyll-*a* concentration.

<u>These findings do not support the simplistic paradigm that lower nutrients result in fewer HABs</u>. HABs and the occurrence of potential HAB taxa must be tracked as part of an adaptive management strategy for the James River and other tributaries. Adaptive management is a systematic, iterative process of setting goals, taking actions, evaluating results, and adjusting goals. This approach is particularly appropriate for situations (as with chlorophyll-*a* management) in which a high degree of uncertainty exists between implementation and ecological responses. USEPA, Virginia DEQ, and other agencies have endorsed this as a common-sense approach to environmental management.

It must also be considered that by virtue of its position near the lower Bay, the lower James River will be affected by nutrient reduction driven by DO and clarity standards throughout the Bay system, as well as by nutrient control projects in the upper tidal James River. Implementation of DO and water clarity standards provides an excellent opportunity to monitor changes in chlorophyll *a*, HAB frequency/magnitude, aesthetics, etc. and further evaluate the benefits of numeric chlorophyll-*a* targets. Virginia's water quality standards must be reviewed and revised as necessary every 3 years as part of the Triennial Review process. This existing process provides sufficient opportunity to use adaptive management techniques along with ongoing research.

DEQ Response: *DEQ agrees that harmful algal blooms are unpredictable and complex and DEQ agrees with the concept of adaptive management. The difference between the commenter and DEQ is the method of adaptive management. For the Commonwealth, environmental protection of the Chesapeake Bay has been implemented under an adaptive management scenario since the initialization of the Bay Program under the Clean Water Act. For over 20 years, voluntary nutrient removal was supported by the tributary strategies, yet the Chesapeake Bay and tidal tributaries are still listed for aquatic life and nutrient impairments. The next adaptive management step is to set the appropriate regulatory goals to achieve the necessary improvements in the Bay. The Chesapeake 2000 Agreement specifies that the jurisdictions with tidal waters will use their best efforts to adopt new or revised water quality standards consistent with the defined water quality conditions. After the goals are set, implementation of the criteria must be achieved. This will be outlined in the tributary strategies, the Water Quality Management Planning Regulation, the Nutrient Enriched Waters Regulation and the Chesapeake Bay Watershed Nutrient Credit Exchange Program established under the 2005 Virginia General Assembly (House Bill No. 2862 and Senate Bill No. 1275). Subsequent to adoption of criteria and implementing regulations, our monitoring program will evaluate results and the triennial reviews of Virginia's Water Quality Standards will afford opportunities in the future to adjust the goals.*

47. Comment (VAMWA): **The state has failed to consider alternative, potentially much more beneficial approaches for nutrient management in the James River**.

The selection of numeric chlorophyll-*a* for the James River is wrought with uncertainty and subjectivity. This is evident in by the fact that DEQ felt free to as much as double EPA's recommended values. VAMWA's analysis (see comment 35) has demonstrated that even doubling DEQ's proposed criteria in most season-salinity regimes would provide equivalent "balance" of the algal community as determined by proportions of the major phytoplankton taxa.

<u>In light of this subjectivity and uncertainty, small changes in the proposed criteria—on the order of a few µg/L—could have enormous implications for the socioeconomic burden of compliance</u>. VAMWA believe is it critical that DEQ perform an analysis to determine what magnitudes of load reductions and associated costs would be required to attain different levels of chlorophyll-*a*. Instead, DEQ has selected values based on only one scenario—the 2004 tributary strategy.

VAMWA is aware of the CBPO-led efforts in 2003 to evaluate a range of loading options for the Bay as a whole. These analyses were oriented towards the determination of loads that would result in compliance of the mainstem Bay—and segment CB4 in particular—with proposed DO standards. This is in no way a substitute for a James River-specific analysis focused on chlorophyll-*a* standards.

The state should request modeling runs for a range of conditions between progress-to-date and the loading deck of the 2004 tributary strategy, including (1) nutrient controls associated of the 2000 tributary strategy; and (2) the effects of the implementation of DO and clarity standards—along with nutrient control projects in the tidal freshwater James River—on chlorophyll-*a* in the lower James River. This analysis would <u>not</u> be a substitute for defining direct relationships between chlorophyll-*a* and specific designated uses. But it would provide critical information that is necessary to help deal with the inevitable subjectivity and uncertainty associated with these standards.

In addition to examining the load-cost-chlorophyll curves, the results of each scenario should be interpreted with regard to the absolute and incremental benefits to aquatic life and other designated uses:

a. What is the magnitude and percentage reduction in chlorophyll-*a* values?

b. What is the total and incremental cost of the load reduction alternative?

c. Based on the observed variability of the James River plankton composition with chlorophyll-*a*, what is the expected shift in algal composition?

d. Is there sufficient scientific information to project that this shift in algal composition would have a measurable impact on fisheries?

e. How do the resulting chlorophyll-*a* values relate to thresholds for harmful algal blooms?

f. How do the resulting chlorophyll-*a* values relate to nuisance conditions that might impair recreation?

g. How do the resulting chlorophyll-*a* values relate to food requirements for adult and larval oysters (higher salinity segments)?

h. How do the resulting chlorophyll-*a* values relate to mesozooplankton abundance and, relatedly, food requirements for larval fish (lower salinity segments)?

VAMWA understands that these questions may be answered with varying degrees of precision and accuracy. While is obviously not practical to accurately predict numbers of fish or oysters under each scenario, the intent is to move beyond highly general or unsubstantiated statements about potential benefits to more rigorous statements based on the available scientific information. We encourage DEQ to consider the types of quantitative information discussed throughout this comment document, including HAB thresholds, mesozooplankton thresholds, larval food requirements, and direct, data-based relations between chlorophyll-*a*, plankton communities, and other environmental variables

DEQ Response: *DEQ in cooperation with EPA has conducted an extensive James Alternative Analysis on the proposed numerical chlorophyll a criteria, the results of which will be shared with the members of the Technical Advisory Committee convened to assist DEQ in developing the proposed Chesapeake Bay standards and with the State Water Control Board.*

48. Comment (HRSD): The lower James River is impaired for nutrients: *Inappropriate, Unsubstantiated*.
The EPA over-listing [305(b)/303(d)] did not provide a specific definition of environmental impairment, other than to state a general "aquatic life impairment". An evaluation of the efficacy of the proposed chlorophyll standards to address an undefined impairment is difficult. However, the information presented by DEQ (species diversity, occurrence of harmful algal blooms, chlorophyll levels, trends, etc.) does not point toward any discernable impairment of the aquatic life. Furthermore, the saline portion of the James River should not be listed for reasons provided on two separate occasions to DEQ regarding its 305(b)/303(d) Water Quality Assessment Integrated Report. The latest set of comments was submitted to the DEQ on April 22, 2004.

DEQ Response*: The tidal James River was listed as impaired by EPA in 1999 because existing water quality conditions were not supporting the "balanced" populations of aquatic life–fish, crabs, grasses– protected under Virginia's state water quality standards regulations. The principal water quality "impairments" continue to be too much algae, extensive blooms of potentially harmful algae species near Hopewell and down near the mouth of the river and extremely poor water clarity conditions due to too much sediment in the water and the excessive algal blooms.*

The comment that "the information presented by DEQ (species diversity, occurrence of harmful algal blooms, chlorophyll levels, trends, etc.) does not point toward any discernable impairment of the aquatic life" seems to be a misinterpretation of the designated use of state waters of "propagation and growth of a balanced, indigenous population of aquatic life in all waters" (9 VAC 25-260-10). The comment seems to be based on the belief that the term "aquatic life" refers only to higher trophic levels such as zooplankton fish, crabs, oysters and that impairments or linkages to these aquatic life must be demonstrated. DEQ believes that the phytoplankton community which is at the base of the food web is clearly to be protected and it is this specific aquatic life that the proposed chlorophyll criteria are based on.

Additional information regarding impairment of the phytoplanktonic life (i.e. beyond the extensive information in DEQ's Technical Document) is the Fisher-Gustafson (2003) nutrient limitation thresholds and the Olson (USEPA 2003a) relative status method which can be used to define nutrient and light impairment, respectively, for phytoplankton. This was done in Buchanan et al. (2005) for biomonitoring station data, and the results indicate that station LE5.5 in the lower James River is impaired as follows in spring and summer:

- *N exceeds the N-threshold of 0.07 mg/liter in ~33% of all samples*
- *P exceeds the P-threshold of 0.007 mg/liter in ~61% of all samples*
- *Secchi depth is below the light thresholds in ~93% of all samples*

Looking at the various combinations of these impairments, one finds the following:

* *In 18.7% of spring and summer samples, light is inadequate for phytoplankton and both DIN and PO_4 are excessive ("Poor/worst" category)*
* *In 74.6% of the spring and summer samples, light is inadequate for phytoplankton and there are undesirable levels of DIN (61.91%), PO_4 (87.37%), or both (76.19%) ("Mixed Poor Light" category)*
* *Only 6.7% of the spring and summer samples show light adequate and one or both of the nutrients desirably low, i.e. capable of limiting excess algal growth (Mixed Better Light and Better/Best categories).*

49. Comment (HRSD): Chlorophyll values are excessively high compared worldwide: *Unsubstantiated*. *Inappropriate*. The referenced study did not include data from the lower region of the James River. The study would have reported concentrations for this part of the James Rivers as low to moderate if data for the James were included in the study. Low to moderate chlorophyll concentrations do not support the need for chlorophyll criteria, and linkage between the proposed criteria and a biological end-point was not provided. It is also inappropriate to compare the James River to other estuaries anywhere in the world without first considering similarities/differences in hydrodynamics, salinity, temperature, etc. Supporting details: Monbet (1992) evaluated the relationship between dissolved inorganic nitrogen and chlorophyll based on data reported by Marshall and Alden (1990). A review of Marshall and Alden (1990) indicated that only stations TF5.5 and RET 5.2 between March 1986 and June 1987 were considered in their analysis for the James River. These stations are up-river of Williamsburg, VA. The authors did not consider data from monitoring stations LE5.1, LE5.2, LE5.3, LE5.4, or LE5.5 (covering the region from Williamsburg to the Hampton Roads Bridge Tunnel). Our analysis of Chesapeake Bay Program data indicates the average chlorophyll value to be 9 ug/l for monitoring stations LE5.1, LE5.2, LE5.3, LE5.4, and LE5.5 for the March 1986 to June 1987 time period. Relative to the world-wide scale shown by Monbet (1992) the value was considered low to moderate.

***DEQ Response**: The respondents claim that DEQ's statement "Chlorophyll values are excessively high compared worldwide" was "Unsubstantiated and Inappropriate" for reasons of not including information from the lower James River. The purpose of this section in DEQ's Technical Report (VA DEQ 2004) was to provide the reader with a comparison to worldwide and then narrow the focus to regional conditions.*

*DEQ concurs with the respondent's comments regarding data from the lower region of James River and are provided in Figures 1, 2 & 3 of the DEQ Technical Report (VA DEQ 2004). It should be noted that the respondents own analysis indicates that average chlorophyll concentrations in the lower James fell below those proposed and that the season averages (see **Table F** below) demonstrate that average chlorophyll concentrations in the lower James (JMSMH and JMSPH) generally fall below the proposed standard during the critical summer period.*

However, this does not imply that everything is balanced and unimpaired in the lower James. Spring chlorophyll a concentrations are excessive. In addition, water quality and phytoplankton communities in the lower James (LE5.5) are degraded when compared with other polyhaline waters of the Bay. For example, studies report poor status and degrading trends for *cyanobacteria (blue-greens) as well as poor status with total phytoplankton (as measured by biomass and biomass to cell abundance ratios). "This region remains prone to sporadic and common summer and fall blooms of dinoflagellates."(Dauer et al. 2003) There were also degrading trends among zooplankton, the major link between primary producers and many fishes.*

Table F. Mean chlorophyll a concentrations (ug/L) based on 3 year assessments by Chesapeake Bay Program segment from water quality monitoring data in tidal James River (red values indicate above the proposed level for that segment during that three year period).

Spring	Proposed Chl Criteria	1986 1988	1987 1989	1988 1990	1989 1991	1990 1992	1991 1993	1992 1994	1993 1995	1994 1996	1995 1997	1996 1998	1997 1999	1998 2000	1999 2001	2000 2002	2001 2003
JMSTFU	10	6.6	5.2	4	4.3	3.9	3.2	6.2	6	7.8	3.7	4.6	2.9	2.6	4.5	4.8	4.9
JMSTFL	15	22.9	21.6	23.1	15.6	15.2	12	11.6	12.1	15	18.2	16.2	18.1	15.1	19.7	21	18.5
JMSOH	15	12.4	16.5	23.5	21.5	20.3	11.3	8.3	5.2	10.3	13	15.9	13.7	15.2	18.6	16.6	12.9
JMSMH	10	11.5	13.5	17.4	18.9	21.7	16.3	9.8	6.2	8.2	12.9	11.4	13.8	10.1	10.3	6.5	11.2
JMSPH	10	17.2	15.5	12.2	12.5	13.6	13.1	12.4	10.1	12.7	12	12.7	8.4	7.3	7.5	7.1	11.2
Summer																	
JMSTFU	15	9.5	7.3	7.5	5.1	6.6	6.5	7.6	6.5	4	6	7.3	12	10.2	10.3	9.8	10.1
JMSTFL	20	40.1	39.3	40.3	31.5	34.1	40	40.4	34	19.3	32.6	39.7	45.1	32.4	32.1	35.4	27.6
JMSOH	15	9.7	12.7	13.2	14.7	15.9	17.1	15.6	10	7.7	9.2	10.6	13.2	11	10.7	8.1	
JMSMH	10	4.1	4.5	5.1	5.1	6.5	9.4	9	7.3	4.5	6.6	7.5	9.3	7.9	7.5	5.5	5.8
JMSPH	10	6.9	8.5	8.1	8.3	7.3	7.1	7.3	8	9.6	9.8	9.8	11.5	13.1	12.7	9.9	10.4

Source: http://www.chesapeakebay.net/

50. Comment (HRSD): Chlorophyll values are excessively high compared nation-wide: *Inappropriate*. It is true that the NOAA report classified the lower James River chlorophyll concentrations as "high". More importantly (in relation to “balance”), however, they indicated a "low expression" of nutrient enrichment. The authors of the NOAA report found *”no reported biological resource impacts due to nuisance or toxic algal blooms...the planktonic community is dominated by diatoms*.” Therefore NOAA did not correlate or assume a link between chlorophyll and “balance” and came to a conclusion regarding impairment that opposes that of DEQ. Supporting details: NOAA (1997) evaluated the conditions in the James River separately for the upper, middle, and lower regions. We concur that the authors classified chlorophyll in the “mixing region” (the lower region) of the James as “high”. Their classification was based on a finding that peak (i.e. maximum) chlorophyll values were greater than 20 ug/l and less than 60 ug/l. However, NOAA admitted that their approach was complicated by its nation-wide scope and lack of effects-based thresholds for chlorophyll. For this reason the authors evaluated the effects of “eutrophication” on more specific and causal end-points such as “nuisance algae”, “toxic algae”, “hypoxia”, and “anoxia”. Their assessments for the James River found “no resource impacts”. The narrative text of this report indicated that (for the James River) there are “*no reported biological resource impacts due to nuisance or toxic algal blooms*”, and “*the planktonic community is dominated by diatoms*.”

***DEQ Response**: As documented above, Marshall and Alden (1990) and Monbet (1992) provide strong evidence that the James River chlorophyll levels are excessive compared nationally and world wide. The NOAA report (1997) referenced above was a paper question/answer survey of state and federal agency personnel, but was not based on any analysis or any specific data from tidal James River. At the time of the NOAA report, the planktonic (including chlorophyll conditions) were not as extensively analyzed as they have been by Chesapeake Bay partners during 2001-2003 and more recently by DEQ staff during the chlorophyll a criteria development process. Therefore none of the issues presented in DEQ’s Technical Report (VA DEQ 2004) were known at that time (e.g. the NOAA statement of “no resource impacts” is not applicable to the current discussion of criteria as there was no extensive analyses done). The NOAA study was intended to be a broad brush attempt at evaluating the condition of the nation’s estuaries.*

51. Comment (HRSD): Chlorophyll values are excessively high compared bay-wide: *Unsubstantiated*.
Inappropriate. Recent VAMWA data analysis shows the lower James River chlorophyll values were significantly less than the mesohaline York River and were not significantly different from the polyhaline York River. Therefore DEQ’s claim that the lower James River has very high chlorophyll a levels compared to other rivers is not valid. The lower James River must also be considered in “balance” since DEQ equates balance with acceptable chlorophyll a levels. Finally, DEQ uses Buchanan et al. (2005) to define reference conditions for polyhaline waters. DEQ also states that the York River’s flora is “desirable” and “balanced”, yet York River’s mean summer chlorophyll concentration exceeds the reference condition that DEQ promotes in its Technical Report (VA DEQ 2004). The York River is ”balanced” and “desirable” yet is higher in chlorophyll than reference conditions. Since the chlorophyll levels of the lower saline James River are comparable to or less than those of the York River, it is also “balanced” and “desirable”.

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Supporting details: Statistical tests were conducted to evaluate whether significant differences existed between the chlorophyll values of the lower James River and lower York River. More specifically, Mann-Whitney tests (alpha=0.05) indicate the following relative to the 1985-2003 Chesapeake Bay Program data set: (1) chlorophyll-*a* concentrations in the polyhaline segments of the James and York Rivers were not significantly different in either spring or summer seasons. (2) chlorophyll-*a* concentrations in the mesohaline James River were significantly less than the mesohaline York River, both in spring and summer.

The results of long-term data analysis of chlorophyll a and nutrients for the lower James River reported by Dauer and others (2003) is also worthy of note. The authors indicate that the chlorophyll a values are "good" in all of the segments of the lower James River estuary.

DEQ Response*: The statement of James River chlorophyll being excessive compared Bay-wide is in specific reference to the upper James River and not the lower as indicated by the respondent. DEQ's Technical Report (VA DEQ 2004) also is referring to the tidal fresh York in saying it is "balanced" and "desirable" (not the polyhaline); however, what is considered "balanced and desirable" refers to a general classification based on an annual appraisal, or an average (based on means) evaluation, and does not include seasonal periods where maximum values occur and stress to biota and water quality is most evident and will vary monthly and annually. The above rationale also applies to Dauer's "good" terminology, which is a relative term, certainly does mean excellent or stable, and a status that may change over time, and within seasons. Most analyses are based on annual values, which exclude chlorophyll highs and lows, and various data on blooms, etc. Seasonal approaches help in this regard and are necessary as indicated by DEQ.*

There are concerns over HABs and degrading zooplankton communities as well in the lower James as discussed in Buchannan et al (2005). Therefore, to say that the lower James is comparable to the lower York and therefore "balanced" and 'desirable" is a mis-interpretation of the information provided in the Technical Report (VA DEQ 2004).

In addition, it is misleading to compare the polyhaline James to a polyhaline York "reference community." Water quality in the polyhaline York did not often qualify for reference status (i.e., 11.8% Mixed Better Light and Better/Best, versus 80.4% Mixed Poor Light, and 7.8% Poor/Worst). The lower James chlorophyll a concentrations in spring and summer are significantly different from those in the polyhaline reference community (described from qualifying samples in Buchanan et al. 2005), regardless of which statistical test is used.

Also, DEQ's Technical Report (VA DEQ 2004) and criteria document states that chlorophyll a criteria are going to be established for systems that may still show problems after water clarity and dissolved oxygen criteria are met. The lower James is one of those cases due to it's morphological characteristics. Despite shallow depths and strong mixing due to its close proximity to the Chesapeake Bay and the water, this region is nutrient "saturated" and remains prone to blooms from a variety of algae and fails to meet many of the habitat requirements of even SAV (Dauer et al. 2003).

52. Comment (HRSD): There are widespread increases in chlorophyll: *Inappropriate*. The mesohaline and polyhaline segments of the lower James River showed a lack of significant trends in increasing chlorophyll concentrations. DEQ correctly points out that isolated individual station and season combinations show increasing trends. However, these smaller spatial scales and season definitions were not consistent with those of the criteria proposal, nor shown to have any ecological relevance. Further, EPA (2003) cautions "*it should be noted that temporal trends alone do not demonstrate causal relations between chlorophyll a concentrations and specific ecological conditions*". Given that DEQ equates the lack of increasing trends in chlorophyll with balance, one must conclude that the lower James River is in "balance" despite DEQ claims. No linkage between the proposed criteria and any biological end-point was provided in the report.

***DEQ Response**: This section of the DEQ Technical Report (VA DEQ 2004) deals with the tidal fresh segment and was not intended to reflect issues raised by the respondent's concerns in the lower James. The primary concerns in the lower James related to ecological relevance are the long term trends of increasing cyanobacteria biomass. The direction of the trends should be considered as indicative of unfavorable conditions or status. In addition, spring chlorophyll a concentrations remain excessive in the tidal James, , the lower James is degraded for other reasons. This is based on poor status and degrading trends for cyanobacteria as well as poor status with total phytoplankton (as measured by biomass and biomass to cell abundance ratios). This region of the river "..remains prone to sporadic and common summer and fall blooms of dinoflagellates." (Dauer et al. 2003) There were also degrading trends among zooplankton as well as being listed on the Virginia 2004 303(d) list of impaired water bodies for benthic impairments (refer to Exec. Summary).*

53. Comment (HRSD):Algae levels are higher than trophic-based concentrations: *Inappropriate*. DEQ attempted to compare concentrations in Norwegian fjords and Swedish waters (marine) to those of the lower James River (estuarine). The comparison made by DEQ is technically indefensible because the nature of these waters is totally different. The EPA states, "*The polyhaline areas of the bay are in much closer proximity to land based freshwater and nutrient inputs. Therefore, they should be expected to have higher nutrient concentrations and associated chlorophyll a values than marine systems*." No linkage between the proposed criteria and any biological end-point was provided in the report.

***DEQ Response**: This section of the DEQ Technical Report (VA DEQ 2004) was attempting to synthesize data from many different aquatic systems and describe conditions that were judged to reflect the trophic status of different water bodies with chlorophyll a being the principal parameter quantified in these literature reviews. The information was drawn from a diversity of systems across the spectrum of healthy (oligotrophic) to severely stressed (eutrophic) water bodies. We agree that the use of these trophic classifications should only be used as a general guide since the majority of the scientific literature-based values were developed for lake, coastal or marine systems, not temperate, partially mixed estuaries such as the James River. The comparisons (including to fjords) were to provide some relative insight into the trophic status of the James River.*

54. Comment (HRSD): The phytoplankton community is dominated by select undesirable groups: *Inappropriate. Unsubstantiated*. VAMWA analysis of the lower saline James River shows the respective percentages of phytoplankton taxonomic groups are comparable to that of the lower York River region, an area cited as a "reference" condition in the DEQ report. No linkage between any biological end-point and chlorophyll was provided. In fact, HRSD's analysis shows that diatom representation (considered favorable by DEQ) increased at chlorophyll levels that are higher than those proposed as standards. If nutrients are linked to chlorophyll, and chlorophyll is linked to desired aquatic life, then nutrient and chlorophyll concentrations currently existing in the lower James River must be supporting desired aquatic life (in contrast to DEQ claims). Further, if the former statement is true, nutrient impairment does not exist throughout the tidal James River as alleged by DEQ and the 303(d) listing of this part of the James River is erroneous.

Supporting details: Additional data analysis of EPA Chesapeake Bay Program data was conducted to evaluate the abundance and relative proportions of specific phytoplankton taxonomic groups. The results indicate that phytoplankton assemblages of the lower James River are comparable to those of the lower York River; both lower estuaries being dominated by diatoms. DEQ considers diatoms "favorable" food sources for higher trophic levels such as oysters and menhaden, therefore the conditions in the lower James River must be favorable. DEQ also states in its Technical Report (VA DEQ 2004) that the York River's flora is "desirable" and "balanced" (although failing to define both). Therefore, the lower James River's flora must be "desirable" and "balanced" in contrast to DEQ's claims. Also compared were the phytoplankton assemblages in the lower James River at chlorophyll concentrations below the proposed standards with a level twice the proposed standard. The proportion of diatoms is higher (i.e. better) at chlorophyll concentrations exceeding the proposed standard during the spring and are unchanged in the summer, therefore the proposed criteria will not lead to more favorable conditions in the lower James River using DEQ's approach.

***DEQ Response**: The respondents are correct with respect to comparing phytoplankton assemblages of the lower James River to those of the lower York River. However, it was the tidal fresh area of the lower York River that was described in the Technical Report (VA DEQ 2004) as being "balanced", not the lower York. Table 2 and Figure 9 of DEQ's Technical Report (VA DEQ 2004) are presenting results from the tidal fresh, not the polyhaline. The station TF4.2 in the Pamunkey (York) has some of the better water quality and phytoplankton communities in Bay tidal fresh waters, and can be considered one of the closest sites we have for "reference" for that salinity zone. The high salinity potions of the York were not described as having desirable conditions. Comparing the lower York to the lower James may find them similar as they are both impaired for nutrients (VAWQA 305(b) Report 2004).*

Another part of the comment questions justification for the proposed criteria since "Virginia's status and trend reports indicate that the algal community composition in the lower James River is generally dominated by diatoms and has a favorable composition as a food source and oxygen provider to the river system". This has been a strategically excerpted portion of a complete statement in DEQ's Technical Report (VA DEQ 2004) which reads: "Although, the phytoplankton composition in the James River is represented by favorable dominance and abundance levels of diatoms, chlorophytes, and cryptophytes, there are still signs for concern. For instance, the status of the cyanobacteria is poor throughout the tidal river stations, and they possess degrading trends in both increasing biomass and abundance. DEQ considered the complete statement in determining that there are problems with the health of the phytoplankton *(i.e. algae) community in the James. When the "signs for concern" noted in DEQ's Technical Report (VA DEQ 2004) were examined in further detail with additional analyses, it was determined that there was need for the numerical chlorophyll criteria.*

55. Comment (HRSD): The phytoplankton index of biological integrity (P-IBI) is poor: *Inappropriate*.
Unsubstantiated. According to the data presented by DEQ the lower James River has a summer P-IBI score higher than the lower York River, an area considered "reference" by DEQ. DEQ also did not relate chlorophyll concentrations to the PIBI; precluding any conclusions as to whether the proposed criteria are defensible. One can only conclude that phytoplankton integrity is acceptable in the lower James River, which suggests that the phytoplankton community in this part of the river is balanced by DEQ's standards. If the population is balanced, either nutrients are not a problem in the lower James River or there is no relationship between nutrients and balance and the chlorophyll criteria are meaningless.

Additional details: HRSD reviewed a primary literature source for this subject "*A Phytoplankton Index of Biotic Integrity for Chesapeake Bay – Executive Summary – for review by the Monitoring and Modeling Workgroup and the Tidal Monitoring and Assessment Workgroup – no name, undated*". This summary indicates the P-IBI scores were developed using "several phytoplankton and phytoplankton related metrics". The "phytoplankton related" metrics cited were carbon to chlorophyll ratio, chlorophyll a, dissolved organic carbon, and pheophytin. We contend that these variables do not reflect "phytoplankton related metrics" but rather water quality variables. Given these circumstances the P-IBI scoring methodology is auto-correlated and artificially biased towards water quality conditions associated with low nutrients and chlorophyll. The authors should have evaluated P-IBI on the basis of biological attributes only (emphasis on "biotic" integrity).

***DEQ Response**: The respondents note that the phytoplankton Index of Biotic Integrity (P-IBI) in the lower James scored higher than the lower York and the lower York was considered 'reference' by DEQ. DEQ Technical Report (VA DEQ 2004) did not consider the lower York as a 'reference.' The report statement that the "York River maintains a population of flora considered "least-impaired" or desirable with a balanced phytoplankton community" refers to the tidal fresh segment of the York and not the lower York. The lower York is impaired for nutrients and the P-IBI scores between the lower York and the lower James are similar (2.49 and 2.57 respectively. Comparing the lower York to the lower James may find them similar as they are both impaired for nutrients (VAWQA 305(b) Report 2004).*

There are two <u>additional</u> points that need clarification. To state that the P-IBI does not include phytoplankton metrics, but water quality variables, is a misunderstanding and ignores the metrics directly associated with phytoplankton presence, e.g. most specifically chlorophyll a, a natural cellular component of the phytoplankton (Marshall pers. comm). The approach taken to develop the phytoplankton reference communities and IBIs follows the terrestrial, lake, and stream environment examples, and the procedure outlined/recommended in Gibson et al. (2000) for estuaries. Comparison to reference communities to measure aquatic life uses is well established and used widely, particularly using benthic macroinvertebrates. Furthermore, the phytoplankton reference communities and the underlying methods have been published in a *scientific peer reviewed journal (Buchanan et al. 2005). DEQ staff stand believe the use of the phytoplankton IBI is appropriate useful metric for characterizing a balanced community.*

56. Comment (HRSD): Food "quality" is insufficient to support desired living resources: *Inappropriate*.
There is no evidence presented nor demonstration made that the food quality of the James River is of insufficient "quality" to support desired living resources. Further, there has not been a demonstration made which links this concern to elevated chlorophyll a.

Supporting details: The concept of linking chlorophyll-*a* criteria to "food quality", while once a promising prospect, has not been established. A draft version of the EPA criteria document attempted to derive chlorophyll-*a* criteria primarily based on food quality impacts to zooplankton, which would presumably then affect higher trophic levels. This approach—and the associated chlorophyll criteria—were severely criticized during independent scientific and stakeholder reviews, and were ultimately withdrawn. A member of the Chesapeake Bay Program Scientific and Technical Advisory Committee (STAC) labeled the idea that high chlorophyll-*a* levels can be associated with measurable food quality impacts as "*overstated and not substantiated*" (USEPA CBPO, 2002). With this background, we were dismayed to find that DEQ has perpetuated the unproven notion of chlorophyll-*a* and food quality relationships in this rule making.

DEQ Response*: As stated above, several reviewers raised concerns about the fundamental basis underlying the food resource limitation models and EPA was unable to address their comments effectively in the time period available. Therefore, the specific food quality/resource limitation model was removed pending further research and evaluation. However, these same reviewers also made the following comments:*

> *"Although I could quibble with a few statements here and there, the overall approach adopted to explore the impact of chlorophyll on different aspects of the system was quite thorough. The approach considered impairments to the system due to exceeding feeding capacity of the mesozooplankton, food quality in terms of algal species composition, corroborating lines of evidence from the literature, and historic concentrations. I was especially impressed that useful relationships between mesozooplankton and chlorophyll levels could be obtained from what is understandably a rather noisy monitoring data set." [STAC Peer Review] EPA CBPO 2002.*

DEQ staff feel that available evidence does support the statement that food quality can be a factor, especially at high biomass levels when a single species dominates. This approach was never fully developed from the monitoring data for Chesapeake Bay, in part because of limitations with the zooplankton data.

The main food "quality" argument in support of derivation of the chlorophyll a criteria is associated with cyanobacteria and Microcystis aeruginosa. Noxious blooms of colonial cyanobacteria such as <u>Microcystis</u> are well known symptoms of eutrophication and are poor food quality for higher trophic levels. Published literature states that "Microcystis and other cyanobacterial blooms may have serious consequences to aquatic ecosystem function and health, *to aesthetics, and to wildlife, and human health… The toxicity and large colonial size of Microcystis and other nuisance cyanobacteria can lower ingestion and assimilation rates of zooplankton (Lampert 1982; Nizan et al. 1986). Toxicity, lowered assimilation rates, and low nutritional quality of Microcystis can cause decreased survival and reproduction of zooplankton, thus leading to inefficient pelagic food webs." (Vanderploeg et al. 2001) The occurrence of cyanobacteria blooms has become a serious water quality problem for many coastal states and that nuisance algal blooms now are more frequent and more severe than before (Christian et al. 1986).*

These concerns were demonstrated in Figure 16 of DEQ's Technical Report (VA DEQ 2004), where the infrequent and highly localized biological monitoring program detected the presence of nuisance species in concentrations far exceeding background or excessive levels compared to Virginia's other two major tidal rivers as documented in Table 4 of the DEQ's Technical Report (VA DEQ 2004). While the lower James does not exhibit the same excessive levels of cyanobacteria of the upper James, there are still degrading trends in the lower James._Studies report poor status and degrading trends for cyanobacteria (blue-greens) as well as poor status with total phytoplankton (as measured by biomass and biomass to cell abundance ratios). "This region remains prone to sporadic and common summer and fall blooms of dinoflagellates."(Dauer et al. 2003). The literature demonstrates that increases in the number of harmful algal species in the Bay, in general, and the upper and lower James, in particular, have increased (Marshall 1996; Mulholland 2004a,b). Elevated nutrient levels have been implicated as discussed in response to comment 58. There are also degrading trends among zooplankton, the major link between primary producers and many fishes

57. Comment (HRSD): Species diversity is reduced: *Not applicable*. The DEQ does not claim that species diversity is reduced in the lower James River. However, it is notable that phytoplankton species diversity reported in the DEQ report for the lower James River is higher than all other Virginia waters and was rated "good". DEQ equates diversity with community health and stability in the report, therefore the lower saline James River must be considered healthy, stable, and, therefore, "balanced" by DEQ standards. According to DEQ, whom cited Odum (1971), "species diversity is a classic and widely used way to measure the health and stability of biological communities."

***DEQ Response**: The respondents address the issue of species diversity in the lower tidal James. It should be noted that this section of the DEQ's Technical Report (VA DEQ 2004) deals with the low salinity (JMSOH) segment. However their reference to species diversity as good in the lower James does not mean the composition of the taxa present are all good, thus the assumption by HRSD that this reference means is healthy, stable, and balanced condition is incorrect. These populations are dynamic, diversity here is indicative of the number of taxa present, not their composition (Marshall per. comm.). But the comment is correct, the lower James was rated 'good' for species diversity. However, there are other degrading trends in the lower James.*

As presented above (see response to comments 23, 52, 54, &56), by comparisons documented in VADEQ & Dauer et al. (2003) the water quality and phytoplankton communities in the lower James (LE5.5) with those in other polyhaline waters confirm that the segment is degraded. This was based on poor status and degrading trends for cyanobacteria as well as poor status with *total phytoplankton (as measured by biomass and biomass to cell abundance ratios). As noted by Dauer et al. (2003), this region of the tidal James River remains prone to sporadic and common summer and fall blooms of dinoflagellates. They also report degrading trends among zooplankton.*

As described above, blue-greens and dinoflagellates tend to dominate the nuisance and toxic algal forms of concern in the lower tidal James (Marshall 1996). Among these dinoflagellates are numerous bloom producers (and potentially toxic species) that are most common in this section of the tidal river. During bloom periods the cells are introduced into other estuaries by way of tidal flow. Over the past several years many of these blooms have increased in their range and bloom duration. Many of the summer/fall blooms of dinoflagellates are becoming longer in duration and larger spatially. What previously took 1-2 tidal cycles to dissipate a bloom may now involve 2-4 tidal cycles (Marshall per. comm. 2005).

Many of these dinoflagellates form resting stages that settle in the sediment, allowing their development to continue the following year if favorable conditions are present. Data from Old Dominion University scientists shows that the tidal James River had much higher average numbers of dinoflagellate cysts than the tidal Rappahannock, York or Virginia Chesapeake Bay mainstem. Cysts of three potentially toxic forms were identified and the James also had much higher average numbers of these than the Rappahannock, York or Virginia Chesapeake Bay mainstem.

One specific undesirable dinoflagellate, Prorocentrum minimum, commonly blooms in spring and summer. A concentration of 3,000 cells liter^{-1} of Prorocentrum minimum is an impairment threshold (USEPA 2003a). This level was exceeded in May 2003 at the Virginia Chesapeake Bay phytoplankton monitoring program station in the lower James River (LE5.2) when 4,091 cells liter^{-1} was observed.

Another undesirable dinoflagellate found in higher salinity waters is Cochlodinium heterolobatum, which has been linked to deaths in fish culturing grounds and is listed as a toxin producer. This algae species was generally localized to the York River prior to 1992 but since that time has become an annual bloom producer in the James River system (Marshall 1996). It is clear from the evidence provided in the Technical Report (VA DEQ 2004) that James River's algal population is out of balance and is being nourished by eutrophic water quality conditions. The numerical chlorophyll a criteria for the tidal James River were derived to address these conditions with existing Virginia Water Quality Standards Regulation requirements supporting "..a balanced, indigenous population of aquatic life in all waters" and is required to control "..substances which nourish undesirable or nuisance aquatic plant life will be controlled" (VA STD 2004b).

58. Comment (HRSD): The biomass of undesirable dinoflagellates in the lower James River is unacceptable:
Inappropriate. *Unsubstantiated*. Dinoflagellate biomass was scored as "good" for the lower James region by DEQ. This scoring obviously does not indicate the need for chlorophyll criteria. If dinoflagellates are undesirable as alleged by DEQ, but their biomass is "good", either DEQ's statement that excessive nutrients are linked to undesirable algae must be incorrect or the lower

James region is not impacted by nutrients and is erroneously listed in the Virginia 303(d) report. Even if this taxonomic group were found to be problematic based on biomass a relationship between chlorophyll and this specific taxonomic group has not been demonstrated. DEQ concedes that the factors controlling harmful algal blooms (HABs) are poorly understood. HRSD's data analysis under claim # 8 (comment 54) also addresses this point by showing that the plankton community composition in the lower James River is comparable to that of the lower York River. No linkage between the proposed criteria and any biological end-point was provided in the report. Refer to our recommendations related to adaptive management.

***DEQ Response**: The respondents note that DEQ scored dinoflagellate biomass for the lower James as "good." However, more recent information shows the lower James as "fair" with degrading trends in dinoflagellate biomass (Dauer et. al. 2005). This information, should be used with other indicators to define the conditions of the lower James as this particular indicator (dinoflagellate biomass), is in reference to the statistical appraisal of dinoflagellate biomass, not the composition of the dinoflagellates (Dauer et al. 2003). Status was scored using the relative status method compare to other similar salinity regions of the bay – all of which are characterized by eutrophic conditions and degraded to some extent. "The dinoflagellate taxa present includes potential bloom and toxin producing species. Excessive nutrients have been documented in the literature to foster dinoflagellate growth, it is not incorrect that this growth can include these bloom producing species, as has been associated with Pfiesteria development in the Pokomoke River. As mentioned above, this River possesses bloom producing species capable of responding to increased nutrient levels." (Marshall per. comm.).*

*The IBI scoring criteria, which are derived from comparisons between the phytoplankton reference community and degraded communities, can be used to further examine the dinoflagellate status in the James. The status of phytoplankton community metrics from the IBI scoring is show below in **Table G.** It indicates that the dinoflagellate biomass at LE5.5, where dinoflagellates are significant members of the community, score about 3. This means the biomass concentrations resemble those in the reference community about half the time and those in the degraded community about half the time. The dinoflagellate scores are matched by chlorophyll a scores that indicate community degradation in 87% (spring) and 85% (summer) of the LE5.5 samples (Buchanan per. comm.).*

As a single measure, this may not indicate "unbalanced" conditions. However, taken in context with other factors/measures, it provides another indicator for ecological assessment. Based on the limited temporal and spatial sampling regime, the current monitoring program has less than a 10 percent probability of observing an algal bloom since they occur over just one or two tidal cycles and can be highly localized. The Tidal Tributary Phytoplankton Monitoring Program only samples monthly at fixed stations. Therefore, it was very surprising and disturbing to DEQ staff when algae known to be associated with harmful algal blooms were observed. As stated in response to comment 23, the risk of blooms in the lower James is also elevated. As stated in the DEQ's Technical Report (VA DEQ 2004), the literature demonstrates that increases in the number of harmful algal species in the Bay have increased and been implicated with elevated nutrient levels (Marshall 1996; Mulholland 2004a,b). The Virginia's existing Water Quality Standards Regulation require that substances which nourish undesirable or nuisance aquatic plant life be controlled (9 VAC 25-260-20).

***Table G**. Status of phytoplankton community metrics determined with IBI metric scoring protocols. The average score of each metric for 1986-2002 is given, as is the overall IBI score. Metrics are scored according to salinity-specific thresholds.[1] Average metric scores (**bold**) >3 indicate metrics resemble those in the phytoplankton reference community[2] more than half the time; average metric scores <3 (italics) indicate the metrics are significantly different from those in the reference community more than half the time, and degraded. Averages for some metrics are not reported because a) station n is too small, b) the data were not collected, or c) the scoring criteria were based on presence/absence and cannot be averaged. For the overall seasonal IBI score: Poor = 1-2, Fair-Poor = 2 - 2.67; Fair = 2.67 - 3.33; Fair-Good = 3.33 - 4; Good = 4 - 5.*

Metric	SPRING Upper TF5.5	SPRING Middle RET5.2	SPRING Lower LE5.5	SUMMER Upper TF5.5	SUMMER Middle RET5.2	SUMMER Lower LE5.5
Total nano-micro biomass	*2.31*	*2.61*		*1.14*		**3.24**
Diatom biomass			**3.7**	*1.06*	*1.48*	*2.77*
Dinoflagellate biomass			**3.07**			**3.16**
Cyanophyte biomass					*2.28*	*1.84*
DOC			*2.17*			*2.91*
%Cryptophyte biomass			*2.18*			
Surface chlorophyll *a*	*2.61*	*2.63*	*1.37*	*1.27*	*1.84*	*1.54*
Pheophytin	*1.45*	*1.19*	*1.7*	*1.4*	*1.06*	*2.44*
C:Chl ratio	**3.19**	*2.56*	*2.13*			*2.04*
Picoplankton abundance						**3.34**
Overall seasonal IBI score	2.19 Fair-Poor	2.17 Fair-Poor	2.40 Fair-Poor	1.44 Poor	1.75 Poor	2.57 Fair-Poor

[1] Lacouture et al. In prep.
[2] Buchanan et al. 2005.

59. Comment (HRSD): Dinoflagellate blooms are becoming larger in size and longer in duration:
Inappropriate. *Unverified*. This claim is based on personal communication with Dr. Harold Marshall cited by DEQ. The specifics of this claim (as it relates to a promulgated water quality standard) cannot be evaluated or validated without a review of the details (species and area involved, data analysis methods, etc.) behind the comments. No linkage between this claim and chlorophyll a concentrations was suggested. Regardless, a *trend* itself does not indicate an impaired *status*. Refer to our recommendations related to adaptive management on claim #7 (HRSD Comment 23) in relation to this issue.

***DEQ Response**: The respondents continue to express concerns about conclusions related to dinoflagellate blooms and comments made by Dr. Marshall. Dr. Marshall is a phytoplankton specialist with over 40 years experience (and extensive publications) on the flora in Chesapeake Bay and Virginia rivers. As an internationally recognized expert in the field of phytoplankton taxonomy, he participated in the ad hoc technical advisory committee during the development of the chlorophyll standards.*

As demonstrated in sections 57 and 12 (above), there is substantial evidence supporting Dr. Marshall's comments. By stating that "a trend itself does not indicate an impaired status", is ignoring the end point of trends that result in impaired status, and now represents a warning of impending conditions predicted as occurring under existing conditions. The fact that a bloom *producer has bloomed previously is important and means that future blooms will continue to occur unless water quality conditions improve. "Increased and eventual dominant concentrations (including toxic species) of cyanobacteria are not desirable conditions for the James River." (Marshall pers. comm.) and provides evidence of a degraded system.*

60. Comment (HRSD): Unacceptable potential for impacts due to *Prorocentrum minimum* blooms: *Suspect*.
This species is a natural inhabitant of the bay and laboratory studies have been inconclusive as to whether the effects of this species on oysters at bloom levels noted in the lab can be expected in the river. It may be that effects of this species on oysters will only occur under the same conditions tested in the lab, which consisted of a unialgal diet of *P. minimum* (i.e. this was the only species of algae available as food to oysters). Our previous analyses have shown that 100% dominance of the species has not been observed in the bay and never more than 20% of total biomass in Virginia waters. Therefore, the effects noted in lab studies would not occur instream under most conditions. It is notable that a correlation exists between *P. minimum* and chlorophyll values, but bloom levels for this species are suggested at 25 ug/l chlorophyll a but not at 10 ug/l (the proposed water quality standard). Only one incidence of a P. minimum bloom has been recorded in the lower James River since 1985 (during 2003 – a very wet year). Therefore DEQ's statement that there are "numerous observations of overabundances of undesirable plant life" does not apply to the lower James River. This represents one out of thousands of measurements taken in the past 20 years. DEQ claims that this species "can dominate the community at particular locations during specific times of the year"; this obviously is not true in the lower James River. This single occurrence does not indicate unacceptable potential *P. minimum* blooms in the lower James River. HRSD rated this claim as suspect given EPA (2003) recognition that the occurrence of HABs is "*a complex incompletely understood phenomenon, and that HABs cannotbe effectively predicted or modeled at this time*". It is illogical to propose a numerical standard to control HABs while accepting that HABs cannot be understood, modeled, or predicted. No defensible linkage was made between potential for impact due to *P. minimum* and the proposed criteria.

Supporting details: The following is taken from January 13, 2003 VAMWA comment package. A review of Wikfors and Smolowitz (1995) indicated a number of severe problems in the testing procedures that need to be taken into account before drawing conclusions about *Prorocentrum minimum* effects on oysters. In general, we are in agreement that when *P. minimum* was fed exclusively (i.e., alone with no other food sources) the impacts on the oysters appears reasonably consistent with starvation effects. However, we dispute the claims of impact on survival and growth in mixed diets (i.e. those diets that contained both *P. minimum* and the diatom species *Isochrysis*). The specific issues associated with these experiments are explained below:

The results associated with survival and growth were considered invalid given the very high losses in larvae reported by the authors due to sampling and handling alone. A review of Figure 1 (in this paper) shows that larval losses in the control (T-ISO) were very high and beyond acceptable limits for any toxicity tests used to develop water quality criteria. Therefore, it was not possible to differentiate experimental mortality from unexplained "losses" in this study.

It was considered inappropriate to arbitrarily select an interval of dates for statistical evaluation (i.e. between days 13 and 17) of growth while ignoring other time periods. The differences in growth observed over the entire exposure period should have been analyzed and reported instead of a selected sub-set of dates. Data review suggests that the conclusions of the paper would be different if other test durations were chosen and compared.

A review of Figure 2 (of the paper) indicates that shell lengths observed in EXUV (only EXUV) and unfed diets were considerably less than those of the T-ISO, 2/3 EXUV, and 1/3 EXUV diets. However, there appears to be little difference in mean shell length between T-ISO and either of the mixed diets (2/3 EXUV and 1/3 EXUV) over the course of the study and particularly at the end. This observation brings into doubt the results of Table III which report a significant difference in growth rate between the 2/3 EXUV and the 1/3 EXUV diets and the conclusion that impact increases as the percent EXUV increases.

Histological observation is not an accepted endpoint to establish impact in the context of water quality criteria and standards development. EPA only uses end points such as survival, growth and reproduction to develop such criteria. The relationship between this endpoint and the status or predictions of population condition is unknown. Because of these issues, the results (particularly those involving mixed diet treatments) should not be used to develop water quality criteria.. It is recommended that future studies of oyster larval tests follow accepted procedures to determine the survival and/or well-accepted sub-lethal end-points. The measurement of larval counts over time as opposed to at the beginning and end of the test in this study provided information not routinely available in toxicity tests. However, the experimental methods should be modified to prevent multiple samplings of single replicates to avoid the confounding effects of sampling losses and allow accurate estimates of mortality with each exposure. A review of Luckenbach et al. (1993) indicates results similar to Wikfors and Smolowitz (1995) in that effects on oysters were evident when *P minimum* was fed exclusively but not in the diets containing both *P. minimum* and diatoms. Figure 1 (of that study) shows that survival in unialgal *P. minimum* diets at 33% and 100% bloom levels were significantly less than other treatments. However, it is notable that survival in the 50% *P. minimum* and 50% diatom (*Thallassiosira*) were not significantly different than with *Thallassiosira* alone. Similar patterns were observed with growth where unialgal diets of P minimum at 33% and 100% bloom levels were significantly lower than the other treatments. Growth in the 50% *P. minimum* and 50% diatom were not significantly different than with 100% bloom levels of *Thallassiosira*.

A distinction of impacts between diets of exclusively *P. minimum* and mixed is critical to the derivation and application of the proposed chlorophyll a criteria. It is implicit in the criteria document that *P. minimum* effects on oysters are to be expected whenever the 3,000 cell/mL threshold is exceeded without regard to the availability of other food sources. We contend that *P. minimum* impacts on oysters can only be inferred where the threshold is exceeded AND *P. minimum* accounts for the great majority of the phytoplankton community assemblage biomass for an extended period.

An analysis was performed to assess the frequency of unialgal *P. minimum* occurrences, using CBP 1984-2000 monitoring data compiled by members of the chlorophyll team (Buchanan and others, 2002). For several different season and salinity combinations, samples were classified according to the proportion of the total phytoplankton biomass that was represented by *P.*

minimum. The total number of samples falling into each category was divided by the total number of samples collected in that season/salinity combination. The results (Table 1) demonstrate that this condition (i.e. >95% *P. minimum*) has not been observed in the Bay or its tributaries. Even when viewing >50% dominance instead of >95%, this condition still was never observed in the oligohaline and polyhaline environments and observed only rarely in the mesohaline spring (~1% of observed samples). *P. minimum* was never observed to exceed 20% of total biomass in Virginia waters.

In addition to these highly technical issues, recent reports of a resurgence of oyster harvests in the lower James River region are also worthy of note. A January 7, 2005 newspaper article of the Daily Press reported on a "new and thriving oyster harvest area on the James River between Deep Creek and the James River Bridge." The article further indicated "State officials opened the area in December for the first time since the 1980s after a fall survey found plentiful oysters there." Although a scientific linkage between *P. minimum* and oysters cannot be drawn from this source, it does provide practical level evidence that existing oyster populations are probably not being adversely impacted by *P. minimum* or other dinoflagellates in the lower saline James River.

***DEQ Response**: The respondent states DEQ overstated the impact of a particular species associated with blooms in the lower Bay. As discussed under response to comments 23, 57 & 58, an undesirable dinoflagellate, Prorocentrum minimum, commonly blooms in spring and summer. A concentration of 3,000 cells liter^{-1} of P. minimum is an impairment threshold. Despite programs not designed to monitor algal blooms, Virginia's Chesapeake Bay phytoplankton monitoring program station in the lower James River (LE5.2) observed levels exceeding 4,091 cells liter^{-1} in May 2003. In April of this year, visual reports by DEQ field staff again sighted algal blooms in the lower Bay.*

As outlined above (in comment 58), it is commonly accepted by scientists in the field that routine monitoring programs will only by chance coincide with algal blooms. In fact, it would be rare that a bloom will actually be detected during its peak. Therefore, it is poor logic to assume any or all blooms will be detected in these waters. When Buchanan stated that P. minimum was never observed to exceed 20% of total biomass in Virginia waters means the data base used in this study did not record values greater than this. However, since this particular species constitutes a significant biomass to Virginia's water is additional reason for concern.

A single species may not indicate problems in the River; however, taken in context with all the other indicators and blooms, it supports a comprehensive assessment of a stressed system. In addition to poor status and degrading trends for cyanobacteria as well as poor status with total phytoplankton, this region remains prone to sporadic and common summer and fall blooms of dinoflagellates in general. The Virginia's existing Water Quality Standards Regulation require that substances which nourish undesirable or nuisance aquatic plant life be controlled (9 VAC 25-260-20).

61. Comment (HRSD): *Cochlodinium heterobolatum* blooms are now occurring annually: *Suspect.* Similar to *P. minimum*, this species is a natural inhabitant of the bay, but effects to oysters have been documented only at bloom levels. There is no linkage between this claim and the proposed criteria because bloom levels for this species are suggested at 50 ug/l chlorophyll in contrast to the 10 ug/l level proposed as a criterion. There have been no reported blooms of this species at target thresholds in the lower James River. Refer to our recommendations related to adaptive management in relation to this issue.

DEQ Response*: The concerns expressed by the respondent refer to claims associated with another bloom producer, Cochlodinium heterobolatum. It should be noted that two of the most extensive and long lasting blooms recorded for Chesapeake Bay were produced by this species (Marshall 1995). The 1992 the bloom of Cochlodinium was so extensive in the Bay that concentrations reached 10^5 to 10^6 cells l^{-1} and at one time covered the western and central region of the Bay, passing out of the Bay southward to the North Carolina coastal waters (Marshall, 1994). More recently, Marshall (1996) reported Cochlodinium has expanded its range with annual blooms occurring in the James, Elizabeth, Pagan, and LaFayette Rivers.*

As presented in response to comments 23, 52,54, 56 & 57 (above), DEQ's Technical Report (VA DEQ 2004) and Dauer et al.(2003) characterize this section of the tidal James as degraded for several reasons, one being blooms of this algal species. In addition to poor status and degrading trends for cyanobacteria as well as poor status with total phytoplankton, this region remains prone to sporadic yet common summer and fall blooms of dinoflagellates.

62. Comment (HRSD): Comparisons with historical data suggest current problems: *Inappropriate*. The data set from the 1950s and 1960s is characterized by too few data points and QA/QC measures of reliability to establish historical annual averages and compare with contemporary data sets. Further, changes in the ecosystem since historical times have complicated the picture. On these points the EPA states "*The data limitations of the1950s and 1960s are particularly of concern in the lower portion of the Chesapeake Bay…The large reduction in filter-feeder (e.g. oysters, menhaden) populations has reduced the capacity of the Chesapeake Bay to maintain lower chlorophyll concentrations. Thus, changes in living resources may have affected chlorophyll a concentrations as much or more than the reverse*. No linkage between a biological end-point and the proposed chlorophyll a criteria was provided by DEQ.

DEQ Response*: An analysis of historical data is problematic as noted in the comment and by EPA. However it does serve as a benchmark for comparison. As noted above, taken in context with other factors/metrics, it provides a broader perspective for comparisons. This is a very relevant and important data set. Data across decades (1950-1990) show a steady increase in summer chlorophyll concentrations in the lower James.*

63. Comment (HRSD): Current chlorophyll concentrations are higher than reference conditions:
Inappropriate. This claim was already made in the document when DEQ addressed "greater incidence of blooms" and "P-IBI"; both of which employ "reference conditions". This approach was used in EPA's first attempt to establish chlorophyll criteria but failed due to a lack of linkage between the environmental condition and designated uses. The EPA stated "*the phytoplankton reference community approach does not demonstrate any direct relationship between chlorophyll a and designated uses*". Again, no linkage has been made by DEQ between any biological end-point and the proposed chlorophyll a criteria.

Supporting details: Concerns associated with the “reference conditions” approach to developing criteria were (1) reference plankton communities were not established *a priori* from other types of plankton communities, (2) the determination of “reference” was made with water quality measures rather than biological attributes, (3) the demonstration of specific relationships between biological attributes and chlorophyll are needed to establish a defensible chlorophyll a criteria but were not attempted by the referenced analysis, and (4) the reported differences in plankton communities between reference and nonreference could be due to inorganic suspended solids effects on water clarity rather than chlorophyll. The above comments expressed by VAMWA and others led to consensus for EPA’s Chlorophyll Criteria Workgroup that the “reference community” approach was not a defensible means to establish chlorophyll a criteria. Our review of Buchanon and others (in press) indicates that the above concerns in relation to chlorophyll a criteria have not been addressed. However, the authors clarified the following with regard to light effects: “Improved water column transparency, or clarity, through the reduction of suspended sediments will be particularly important in attaining the reference communities”.

DEQ Response*: The comment refutes the use of reference communities in setting chlorophyll criteria by referencing the DEQ Technical Report (VA DEQ 2004) that “the phytoplankton reference community approach does not demonstrate any direct relationship between chlorophyll-a concentrations and designated use impairments”. This statement in the Technical Report (VA DEQ 2004) originated during the EPA chlorophyll criteria process (see pg 116 of EPA 2003) in regards to the newly developed designated uses of “open water fish and shellfish…”, “Deep water seasonal fish and shellfish…”, “Shallow-water bay grass use” etc…, which are focused on support of higher trophic level communities. DEQ feels that the reference community information may not be useful in regards to those higher trophic level designated uses but is useful in regards to the current Virginia designated use supporting “a balanced, indigenous population of aquatic life”, which clearly intends to maintain not only a balanced population of fish and shellfish, but all aquatic life from the base of the food chain (algae) to up to commercial and recreation fishes.*

The comment states a disagreement with the approach of phytoplankton reference communities and associated index of biotic integrity (IBI) as published in the scientific peer reviewed literature (Buchanan et al. 2005) in defining a “balance, indigenous population” of algae and associated criteria chlorophyll levels. This reference community approach followed the procedure outlined/recommended by EPA for the development of regulatory biocriteria (Gibson et al. 2000). The approach is not circular- it is direct.

Desirable phytoplankton habitat conditions were first defined, and then the biological community associated with those conditions (reference community) was described. Before Chesapeake phytoplankton reference communities and IBIs were developed, least-impaired habitats were delineated with quantitative values of “good” or desirable water quality conditions. Least-impaired conditions were samples with DIN and PO4 concentrations that had been experimentally shown to limit excess algal growth and Secchi depths that provided adequate light for phytoplankton and SAV growth. Impaired conditions were sampled with excess DIN, excess PO4 and inadequate light. Biological metrics were selected for inclusion in the IBI based on their ability to differentiate between impaired and least-impaired conditions.

Scoring thresholds for the metrics were determined by comparing the data distributions in impaired and least-impaired conditions, and following scoring procedures recommended in Gibson et al. (2000) and elsewhere.

Chlorophyll was found to be a strong differentiator between impaired and least impaired aquatic habitat conditions. Buchanan et al. (2005) paper):

c) *"In summary, unimpaired water quality conditions (BB) and marginally impaired water quality conditions with adequate light (MBL) support phytoplankton communities with consistently low chlorophyll a and phaeophytin concentrations and low chlorophyll cell content. Communities in nutrient rich, light-impoverished conditions (MPL, PW, W) exhibit wide ranges of these three photochemical indicators." The inference being more nutrients, more chlorophyll.*

d) *"Chlorophyll a concentrations in the 1984-2002 monitoring data show that today's Chesapeake Bay is mostly eutrophic, and even hyper-eutrophic at times according to benchmarks in the literature."*

"One of the major contributors to reduced light intensity in the water column is associated with increased concentrations of phytoplankton abundance. High silt loads common during the spring rains, are reduced during the summer/fall months when blooms are most common by cyanobacteria and dinoflagellates, and chlorophyll peaks occur, thus a major factor reducing light comes from the developing algae, with reduced total suspended solids contributions. As indicated by the reference to Wilbur (1983), cyanobacteria (blue green algae) are abundant during low light levels" (Marshall per. comm.).

Several metrics are used to assess chlorophyll a by salinity and season. One such metric is the discrimination efficiency (DE) of chlorophyll a. DE is the ability of an individual biological metric to correctly identify both impaired and least-impaired habitat conditions. Based on reference community conditions, DE ranged from 54.3% in spring tidal fresh, where its response is often masked by freshwater flow effects, to 78.4% in summer tidal fresh (see Table H).

Table H. Discrimination efficiency of chlorophyll

Chl a	Tidal Fresh	Oligohaline	Mesohaline	Polyhaline
Spring	54.2%	65.5%	64.0%	74.1%
Summer	78.4%	70.0%	75.6%	63.0%

Source; Buchanan et al. 2005

Similarly, classification efficiency is the ability of the overall IBI index to correctly identify both impaired and least-impaired habitat conditions. The overall phytoplankton IBI classification efficiencies (CE) range from 70.0% to 84.4% (see Table I). The DE and CE percentages of the phytoplankton IBI are generally robust and comparable to those for biological groups in other *environments. They demonstrate that many phytoplankton metrics, either singly or composited in an index, can differentiate between water quality conditions that have been, a priori, identified as impaired and least-impaired.*

Table I. Classification efficiency of phytoplankton IBI				
Season	*Tidal Fresh*	*Oligohaline*	*Mesohaline*	*Polyhaline*
Spring	*70.0%*	*70.5%*	*78.1%*	*84.4%*
Summer	*78.4%*	*75.5%*	*77.8%*	*71.8%*

Source: Buchanan et al. 2005

VAMWA is correct in claiming that nutrient reductions cannot be expected "to cause shifts from "worst/poor" light conditions to "better/best" light conditions because non-algal suspended solids are a major cause of low light conditions throughout the James River." Buchanan et al. (2005) state in their abstract "Improved water column transparency, or clarity, through the reduction of suspended sediments will be particularly important in attaining the reference communities. Significant nitrogen load reductions are also required." The comment acknowledges/accepts the first part (i.e. light is a major determinant and needs to be addressed), while ignoring the second part (i.e. nutrient loads are also important). If just sediment reductions are implemented in the James River watershed, and nutrients are left at its present high levels, an improvement in water clarity will inevitably result in increased algal blooms even above the already high levels.

The comment implies that DEQ will consider only nutrients as ultimately influencing management strategies to attain chlorophyll criteria. In fact, chlorophyll a criteria will effectively drive both nutrient and suspended sediment reductions, and will allow Virginia to empirically determine when concentrations of both have been reduced enough to provide acceptable habitat conditions for both SAV and phytoplankton. It is possible that the nutrient reductions needed to attain the reference community chlorophyll a concentrations will not be as severe as those proposed by models, assuming clarity improves (Buchanan et al. 2005). This will be part of the adaptive management approach DEQ continues to follow: adopted narrative standards, James River mainstem listed as "impaired" by EPA (1999 and 2004), development of numerical standards, implement management actions needed to meet the assigned nutrient and sediment cap load allocations, measure results and adjust as needed through triennial review of Virginia's Water Quality Standards.

Finally, the comment suggests that attainment of the chlorophyll criteria will not lead to a higher quality phytoplankton community. In fact, achieving the chlorophyll levels associated with reference phytoplankton community levels is expected to lead to the following changes in community composition in areas of the James River (from Marshall et al. submitted for publication).

- *Lower abundance and biomass of undesirable dominant seasonal bloom forming dinoflagellates;*

- *Larger cell size of desirable diatoms;*
- *Lower absolute abundance, percent of community abundance and biomass of undesirable cyanobacteria; and*
- *Lower overall abundance and biomass of summer phytoplankton.*

64. Comment (HRSD): Proposed criteria are defensible based on EPA recommendations: *Inappropriate*.
The EPA failed to make a scientifically defensible connection between chlorophyll and designated uses employing, essentially, the same data used by DEQ in its Technical Report (VA DEQ 2004). For this reason EPA published only a narrative criterion. EPA (2003) states "Because of the regional and site-specific nature of algal related water quality impairments, bay-wide numerical criteria have not been published here. Therefore, the chlorophyll a concentrations tabulated in this document are not numerical criteria."

DEQ Response*: The EPA "failed" largely because it was committed to a consensus processes, and then couldn't build a consensus among the partners represented on the Chlorophyll Criteria Team. The current state of the science goes beyond a reasonable doubt in establishing the link between algal blooms (measured as chlorophyll a), water quality impairment, and trophic status. Eutrophic status is not desirable, and that is the current state of the James. DEQ's Technical Report (VA DEQ 2004) provides numerous citations of papers published in scientific peer reviewed journals as the basis for each line of scientific evidence to develop the salinity- and season-based numerical chlorophyll a criteria.*

This comment questions the basis of the proposed criteria noting EPA's publishing of only a narrative criterion. Unlike EPA, Virginia already had as a designated use "balanced indigenous population of aquatic life in all waters." DEQ's Technical Report (VA DEQ 2004) documents existing Virginia regulatory standard are violated because of high nutrient and chlorophyll a levels in the James. The tidal James River was listed as impaired by EPA in 1999 because of existing water quality conditions because of non-attainment of aquatic life uses due to nutrients. DEQ sees these "impairments" as too much algae and poor water clarity conditions due to too much sediment and algae in the water. DEQ has followed a scientifically based approach in the development of all the proposed criteria, including chlorophyll a. EPA recommended that states develop and adopt site-specific numerical chlorophyll a criteria for waters where algal-related impairments are expected to persist even after the Chesapeake Bay dissolved oxygen and water clarity criteria have been attained (USEPA 2003a). According to EPA, the James River was the primary candidate and reason why this statement was included in their April 2003 criteria document. Eutrophication is not evident in the James through dissolved oxygen (James is not impaired for dissolved oxygen) and water clarity improvements via sediment reduction are not expected to improve algal conditions (and may make it worse absent nutrient reductions (Mann 2005)); hence the need for site-specific chlorophyll a criteria.

65. Comment (HRSD): *Microcystis aeruginosa* blooms are currently problematic: *Not applicable*. DEQ states that these blooms are an issue only for the tidal fresh region. *M. aeruginosa* is a freshwater species and would not impact uses in the lower James River.

DEQ Response*: DEQ concurs in part with this comment about Microcystis in the tidal fresh* *region. Microcystis is a common alga in freshwaters, but it is also present in estuaries, and not limited to freshwaters. It is found in the various salinity regions of the James, and other Virginia tidal rivers, plus the Chesapeake Bay" (Marshall per. comm.). As noted in DEQ's Technical Report (VA DEQ 2004) trends show Cyanobacteria abundance and algal blooms increasing in the lower James.*

66. Comment (HRSD): Attainment of the chlorophyll a criteria will control Harmful Algal Blooms (HABs) and provide for a return of a balanced phytoplankton community. *Unverified*. Based on the above details, this claim reflects one of DEQ belief rather than verifiable fact. The EPA criteria document clearly states that the occurrence of HABs is *a complex incompletely understood phenomenon, and that HABs cannot be effectively predicted or modeled at this time*. DEQ does not have scientifically defensible information to demonstrate that the magnitude and frequency of HABs will be affected by the proposed criteria. No linkage between any biological end-point and chlorophyll a (with the exception of P. minimum) has been provided by DEQ. Refer to our recommendations related to adaptive management in relation to this issue.

***DEQ Response**: This comment questions the validity of controlling HABs through nutrient reductions in order to attain proposed chlorophyll a criteria. It is well documented that eutrophic waters have more algal blooms than occur in oligotrophic waters. A typical pattern is increased nutrients result in increased algal populations and the concentrations of chlorophyll they contain (Marshall per. comm.).*

Species that comprise the broad group referred to as HABs represent about 2 % of the total number of algal species reported in the Bay. That is twice the global rate (Marshall 1996). This increase in the number of harmful algal species in the Bay is attributed to elevated nutrient levels favorable to growth of opportunistic species (Marshall 1996; Mulholland et al. 2004a,b). Based on this premise, reducing chlorophyll concentrations through lower nutrients is the most direct approach to controlling blooms of any type, regardless of whether they are HABs or not.

67. Comment (HRSD): Higher dinoflagellate cyst concentrations in the James River sediment require the proposed chlorophyll criteria: *Inappropriate*. The DEQ claims that a greater number of dinoflagellate cysts (i.e. dinocysts) in the sediment create a higher risk of blooms if future water quality conditions are favorable. HRSD reviewed the primary literature associated with dinocysts (Seaborn, 1999) and Marshall (undated). We found that neither of these authors attempted to relate water column chlorophyll levels to the density of dinocysts. Further, Seaborn (1999) states "potential toxin producing dinoflagellates were identified in sediment samples. These were found in low concentrations and to date have not been associated with toxic events with the Chesapeake Bay system." This statement indicates the density of dinocysts in the James River (or elsewhere) have not been shown to represent an existing environmental problem for the region. The DEQ has failed to provide any evidence that a relationship between sediment cyst density and impacts on designated uses exist, which is crucial to water quality criteria development. Refer to our recommendations related to adaptive management.

***DEQ Response**: The comment questions the method(s) to control another bloom producer through numerical chlorophyll criteria and associated nutrient controls. The significance of Seaborn (1999) is that much higher levels of cysts from toxic dinoflagellates were identified from* *sediment in the lower tidal James than in other Virginia estuarine waters. These dinocysts reflect the high levels of dinoflagellates and also represent a seed population that has the potential to develop further under the right conditions. Favorable conditions have often been increased nutrient levels. Seaborn (1999) states in his study of the lower Chesapeake Bay and the 3 rivers (James, York, Rappahannock) that cyst density was highest in the James River with a mean number of 1086 cysts per cubic mm, the highest in any Virginia estuarine region. This fact alone is indicative that the tidal James is favorable to the development of future dinoflagellates, including those that are not cyst forming species.*

The high levels of dinocysts (some of which are potentially toxic) in the tidal James in comparison to other Virginia tidal waters is just one of the many indicators that chlorophyll levels are excessive and undesirable aquatic life is present. As stated in the DEQ's Technical Report (VA DEQ 2004), DEQ has the regulatory responsibilities to protect the designated use of a "balanced, indigenous population of aquatic life" and "control undesirable growths of aquatic plant life". Among these dinoflagellates are numerous bloom producers (and potentially toxic species) that are common in the lower James River. During bloom periods the cells are introduced into other estuaries by way of tidal flow. Over the past several years many of these blooms have increased in their range and bloom duration. Many of the summer/fall blooms of dinoflagellates are becoming longer in duration and spatial coverage and what previously took 1-2 tidal cycles to dissipate a bloom may now involve 2-4 tidal cycles (Marshall per. comm.). As an example, a large mahogany tide bloom assumed to be a dinoflagellate was noted in 2004 in the lower James River and reported by the Chesapeake Bay Foundation and by DEQ field staff in April of 2005.

68. Comment (HRSD): The proposed criteria values are attainable with "cap load" allocations: *Unverified*.
The analysis referenced by DEQ was based on long-term 10-year averages of chlorophyll and average hydrology. A presentation of the EPA's Chesapeake Bay Program Modeling Sub-committee (October 6, 2004) indicated persistent nonattainment of chlorophyll at "tributary strategy" level loads given DEQ's proposed CFD methodology for the lower James River. However, these also were based on a 10-year record. An evaluation of a 10 year record is considered "more optimistic" in terms of attainment rates, since the effects of more extreme years is buffered. DEQ's assessment approach for the proposed criteria only looks at 3-year intervals. One would expect higher degrees of variability over 3-year spans of time than 10-year spans, therefore DEQ's analysis is not representative of how the data will be analyzed once the criteria are promulgated. An analysis of chlorophyll attainment with running three-year assessment periods was requested and agreed to by DEQ during a meeting of the EPA Water Quality Standards Technical Advisory Committee. However, the results of this analysis have not been made available to the public. It is unknown whether the proposed criteria are attainable with "cap load" allocations and DEQ's proposed method of data assessment until the 3-year analysis is completed and reported. However, the prospects for attainment appear bleak considering the 10 year "optimistic" assessment done on a 10 year data set showed substantial noncompliance.

***DEQ Response**: DEQ did factor in attainability as one way to assess the impact of the regulations as well as a prudent measure to assure the regulations are reasonable. It is true this was done with the 10 year estimates of attainability which will be more "optimistic" showing* *more attainment of the criteria than using a 3-year estimate. DEQ is working with EPA Chesapeake Bay Program Office staff to investigate the issue of attainability based on 10 years vs. 3 year records the request of the respondent and others as part of an alternatives analysis. In response to public comment from the Virginia Association of Municipal Wastewater Agencies and inquiries from Senator Martin E. Williams during the 2005 General Assembly, DEQ in cooperation with EPA, committed to conduct an analysis that evaluated the benefits, detriments and costs of a range of nutrient loading scenarios and the corresponding predicted chlorophyll a levels. The results were to identify levels of nutrient reduction that might result in significant benefits and distinguish them from efforts that show diminishing returns or potential adverse effects. The expertise to do the modeling for this analysis resides at the EPA Chesapeake Bay Program Office. At the writing of this document, the modeling work is underway and the results will be shared with the Board before the June meeting. The results of this analysis may require further changes to the proposal.*

69. Comment (HRSD): The regulation must be updated to provide a quantitative basis for balanced phytoplankton populations: *Unsubstantiated*. The primary designated use identified by DEQ that is allegedly not being protected is a “balanced indigenous population of aquatic life in all waters”. Note that the use is not specific to phytoplankton and applies to all aquatic life. DEQ has never suggested that the regulation must be modified to support balanced populations of animal populations; primarily because the current regulation already provides for this in the form of numeric water quality standards. Review of the data and technical basis of the numeric criteria making up the standards finds that these criteria are designed to address the sensitivity of both animal and plant species. EPA’s “Guidelines For Deriving Numerical National Water Quality Criteria For The Protection Of Aquatic Organisms And Their Uses” states that when developing water quality criteria “data on toxicity to aquatic plants are examined to determine whether plants are likely to be unacceptably affected by concentrations that should not cause unacceptable effects on animals.” EPA defines “plants” in this guidance as algae or vascular plants and further states that “results of tests with plants usually indicate that criteria which adequately protect aquatic organisms and their uses will probably also protect aquatic plants and their uses.” The EPA guidance requires the results of at least one test with saltwater algae when developing acute criteria and chronic criteria usually capture the sensitivity of saltwater algae when the acute criterion is used to calculate the chronic criterion through an acute-to-chronic ratio. Therefore the criteria currently promoted by EPA and adopted by Virginia as standards are likely protective of algal populations. The current regulation does not require modification, therefore, if the current criteria provide for balanced populations and apply to phytoplankton.

***DEQ Response**: The primary designated use identified by DEQ is a “balanced indigenous population of aquatic life in all waters.” The commenter interprets this to mean the use is not specific to phytoplankton, rather applies holistically to the entire ecosystem. This statewide use designation includes all aquatic life from the base of the food chain (algae) to up to commercial and recreational fishes. There is nothing in this designated use statement that excludes any trophic level from the protection of “balance.” DEQ staff doesn’t believe this standard is being met in the algal community as documented in the DEQ Technical Report (VA DEQ 2004).*

The comment that “the criteria currently promoted by EPA and adopted by Virginia as standards are likely protective of algal populations” refers to EPA guidelines for developing *toxics criteria. DEQ agrees that the phytoplankton community in the James River is protected from toxic effects via the toxics criteria. However, nutrient pollution exerts itself in a different way to the ecosystem. Too many nutrients will not "kill" the phytoplankton, only cause the opportunistic species to replicate at greater rates, thus destroying the balance of the community (at all trophic levels) and create nuisance and undesirable aquatic plant conditions. Balance in the phytoplankton community (base of the food web) and its effect on higher trophic levels (zooplankton, crabs, fish, etc…) is an introductory level biological concept that must not be ignored.*

Developing nutrient criteria via chlorophyll a cannot be accomplished using EPA's 1985 Guidelines For Deriving Numerical National Water Quality Criteria For The Protection Of Aquatic Organisms And Their Uses. Chlorophyll a is an indicator of nutrient enrichment similar to bacteria criteria (i.e. fecal coliform) as indicators of illness. Fecal coliform bacteria themselves are not the pathogens, only indicators of the presence of pathogens. Chlorophyll is an indictor of nutrient impairment and DEQ has quantified this using the scientific literature, expert opinion and monitoring data.

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