COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER QUALITY PROGRAMS
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Subject: Guidance Memo No. 05-2017
2006 Water Quality Assessment Guidance Manual

To: Regional Directors

From: Ellen Gilinsky, Ph.D., Director Ellen Gilinsky

Date: December 12, 2005

Copies: Alan Pollock, Regional Water Quality Planning Managers and staff, Office of Water Quality Programs Managers, WQMA Staff and Cindy Berndt

Summary:

EPA's 2006 Integrated Report Guidance recommended that states submit an "Integrated Report" that will satisfy Clean Water Act (CWA) requirements for both Sections 305(b) water quality reports and 303(d) impaired waters lists. This Integrated Report will include the following information:

- delineation of water quality assessment units (AUs) based on National Hydrography Dataset (NHD);
- status of and progress toward achieving comprehensive assessments of all waters;
- Water Quality Standard attainment determination for every AU;
- additional monitoring that may be needed to determine Water Quality Standard attainment status and, if necessary, to support development of TMDLs for each pollutant/AU combination;
- schedules for additional monitoring planned for AUs;
- pollutant/AU combinations still requiring TMDLs;
- TMDL development schedules reflecting the priority ranking of each pollutant/AU Combination; and
- Water Quality "Effluent Limited" Waters.

DEQ has incorporated the Integrated Reporting guidance EPA developed for 2006 into the 2006 DEQ assessment guidance. It is essentially the same overall guidance used in 2004 and is designed to integrate or combine the 305(b) overall assessment of Virginia's waters and separate out those waters impaired and needing a TMDL as per 303(d). The EPA 2006 Integrated Report Guidance and Assessment Database (ADB V2.1) has 5 different categories, with 1 category having 3 subcategories, in which every segment or "assessment unit" (AU) will be placed. The US EPA Integrated Report Guidance allows the states to subdivide the federal Categories in order to address state programmatic needs. Virginia has subdivided the categories for enhanced tracking and data management purposes.

Below are the US EPA defined Categories followed by associated Virginia defined subcategories**:**

FULLY SUPPORTING - Waters are supporting one or more designated uses

- **EPA Category 1 -** Attaining all associated designated uses and no designated use is threatened

  Va Category 1A - waters are attaining all uses and a TMDL has been developed for one or more uses.

- **EPA Category 2 –** Available data and/or other information indicate that some, but not all of the designated uses are supported.

  Va. Category 2A - waters are supporting all of the uses for which they are monitored.

  Va. Category 2B - waters are of concern to the state but no Water Quality Standard exists for a specific pollutant, or the water exceeds a state screening value or toxicity test.

  Va. Category 2C - waters are now attaining the use(s) for which they were originally 303(d) listed and the TMDL is EPA approved but other applicable use(s) were not monitored and assessed.

INDETERMINATE - Waters needing additional information

- **EPA Category 3 -** Insufficient data and/or information to determine whether any designated uses are met

Va. Category 3A - no data are available within the data window of the current assessment to determine if any designated use is attained and the water was not previously listed as impaired.

Va. Category 3B - some data exists but are insufficient to determine support of any designated uses. Such waters will be a prioritized for follow up monitoring.

Va. Category 3C- data collected by a citizen monitoring or other organization indicating water quality problems may exist but the methodology and/or data quality has not been approved for a determination of support of designated use(s). These waters are considered as having insufficient data with observed effects. Such waters will be prioritized by DEQ for follow up monitoring.

Va. Category 3D - data collected by a citizen monitoring or other organization indicating designated use(s) are being attained but the methodology and/or data quality has not been approved for such a determination.

IMPAIRED - Waters are impaired or threatened but a TMDL is not required.

- **EPA Category 4A -** water is impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.

- **EPA Category 4B -** water is impaired or threatened for one or more designated uses but does not require the development of a TMDL because other pollution control requirements (such as VPDES limits under a compliance schedule) are reasonably expected to result in attainment of the Water Quality Standard by the next reporting period or permit cycle.

- **EPA Category 4C -** water is impaired or threatened for one or more designated uses but does not require a TMDL because the impairment is not caused by a pollutant and/or is determined to be caused by natural conditions.

IMPAIRED - Waters are impaired or threatened and require a TMDL

- **EPA Category 5 - Waters are impaired or threatened and a TMDL is needed.**

Va. Category 5A - a Water Quality Standard is not attained. The water is impaired or threatened for one or more designated uses by a pollutant(s) and requires a TMDL (303d list).

Va. Category 5B - the Water Quality Standard for shellfish use is not attained. One or more pollutants causing impairment require TMDL development.

Va. Category 5C - the Water Quality Standard is not attained due to "suspected" natural conditions. The water is impaired for one or more designated uses by a pollutant(s) and may require a TMDL (303d list). WQ Standards for these waters may be re-evaluated due to the presence of natural conditions.

Va. Category 5D - the Water Quality Standard is not attained where TMDLs for a pollutant(s) have been developed but one or more pollutants are still causing impairment requiring additional TMDL development.

Va. Category 5E - effluent limited facilities are not expected to meet compliance schedules by next permit cycle or reporting period.

Va. Category 5F - the WQ Standard is attained for a pollutant(s) with a TMDL and 303(d) delisting approved but the water remains impaired for additional pollutant(s) requiring TMDL development.

Electronic Copy:

An electronic copy of this guidance in PDF format is available for staff internally on DEQNET, and for the general public on DEQ's website at: http://www.deq.virginia.gov/water.

Contact information:

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Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER QUALITY ASSESSMENT GUIDANCE MANUAL for

Y2006

305(b)/303(d) Integrated Water Quality Report

December, 2005

Table of Contents

i **PREFACE** P. 4

ii **PURPOSE** P. 4

iii **BACKGROUND** P. 5

PART I **305(b)/303(d) ASSESSMENT PROCESS** P. 7

PART II **WATER QUALITY MONITORING, INFORMATION and RESTORATION ACT** P. 9

PART III **RULES FOR 2006 WATER QUALITY ASSESSMENT (WQA) PROCESS** P. 10

PART IV **DESIGNATED USES OF VIRGINIA'S WATERS** P. 13

PART V **CRITERIA TO DETERMINE DEGREE of USE SUPPORT** P. 15

PART VI **ASSESSMENT EVALUATION METHODOLOGY**

- Section 6.1 Conventional Parameter Evaluation Methodology P. 20
  - 6.1.1 Fixed Rate (Percent Method)
- Section 6.2 Monitoring Station Strategy P. 20
  - 6.2.1 Monitoring Station Delineation
- Section 6.3 Non DEQ Data Evaluation Methodology P. 21
  - 6.3.1 Citizen Monitoring
  - 6.3.2 Other State and Federal Water Quality Data
  - 6.3.3 Nonpoint Source Evaluation
- Section 6.4 Designated Use Evaluation Methodology P. 25
  - 6.4.1 Wildlife Use
  - 6.4.2 Aquatic Life Use
    - 6.4.2.1 Chesapeake Bay Subcategories of Aquatic Life Use
    - 6.4.2.2 Free-Flowing Waters
    - 6.4.2.3 Estuarine Waters
  - 6.4.3 Fish Consumption Use
  - 6.4.4 Shellfish Consumption Use
  - 6.4.5 Swimming Use
  - 6.4.6 Public Water Supply Use
- Section 6.5 Additional Parameter Evaluation Methodology P. 35
  - 6.5.1 Nutrient Evaluation
  - 6.5.2 Fish Tissue and Sediment Evaluation
  - 6.5.3 Additional Toxics Evaluation
  - 6.5.4 Natural Low DO and pH Evaluation for Swamp Waters
- Section 6.6 Lake and Reservoir Evaluation Methodology P. 48
  - 6.6.1 Interpretation/Assessment Issues Unique to Lakes
- Section 6.7 Coastal Assessment P. 52
- Section 6.8 Wetlands Assessment Methodology P. 52
- Section 6.9 Statewide Trend Analysis P. 55
  - 6.9.1 Data Preparation
  - 6.9.2 Data Processing
  - 6.9.3 WQ3 Analysis
  - 6.9.4 Individual Assessment Results
  - 6.9.5 Statewide Assessment Results

PART VII **303 (d) LISTING/DELISTING and TMDL PRIORITY RANKING EVALUATION**

- Section 7.1 Effluent Limited Waters (Category 4B/5E) P. 61
- Section 7.2 Impaired Waters (Category 5) P. 62

PART VIII **APPENDICES**

- APPENDIX A - Clean Water Act References P. 65
- APPENDIX B - Regional Biologist Assessment Checklist P. 67
- APPENDIX C - Classification of Virginia's Shellfish Growing Areas P. 68
- APPENDIX D - Incorporating the *Proactive Approach* for Impaired Waters Delisting P. 71
- APPENDIX E-1 - Fish Tissue Values (TV's) P. 74
- APPENDIX E-2 - Fish Tissue Screening Values (STV's) P. 76
- APPENDIX F - Consensus-Based and ER-M Sediment Screening Values P. 78
- APPENDIX G - Significant Lakes by DEQ Regional Offices P. 80

List of Tables

Table 1	Designated Use Matrix	P. 14
Table 2	Designated Use Assessment Criteria	P. 19
Table 3	Fixed Rate Assessment Guidelines	P. 20
Table 4	Technical Advisory Committee Recommended Nutrient Thresholds	P. 34
Table 5	Possible SQT Conclusions and Listing Decisions for Estuarine Toxics Evaluation	P. 38
Table 6	B-IBI Ranges and Benthic Community Condition	P. 39
Table 7	Trophic Index	P. 51

List of Figures

Figure 1	Bay Criteria Analytical Segmentation	P. 30
Figure 2	"Default" Cumulative Frequency Distribution Reference Curve	P. 31
Figure 3	Flow Diagram Used to Establish Weighting for Sediment Quality Triad Data	P. 42
Figure 4	EPA Shellfish Listing/Delisting Flowchart	P. 70

Preface

Each State must develop a program to monitor the quality of its surface and ground waters and prepare a report every 2 years describing the status of its water quality. DEQ will identify waters of concern as having observed effects and will schedule additional monitoring if appropriate, to determine if designated uses are being met. The EPA issues guidelines for States to use during the reporting cycle. States are encouraged to use these guidelines to prepare these reports for EPA. EPA compiles the data from the State reports, summarizes them, and transmits the summaries to Congress, including an analysis of the water quality nationwide. This new 305(b)/303(d) integrated process is the principal means by which the EPA, Congress, and the public evaluate current water quality, the progress made maintaining and restoring water quality and the extent of remaining work to be done. Many States, including Virginia, rely on the 305(b)/303(d) process for information needed to conduct water quality planning. The 305(b)/303(d) process is an integral part of Virginia's water quality management program, requirements for which are set forth in 40 CFR 130

Production of this guidance manual is to assist the public in its understanding and DEQ regional and central office staff in the development and reporting of the 2006 Integrated Report (305(b) Water Quality Assessment /303(d) Impaired Waters). The data window used in the development of the Integrated Report is January 1, 2000 through December 31, 2004. The manual uses excerpts from the "EPA 2006 Integrated Report Guidance", "EPA 1997 Guidelines for the Preparation of the 1998 State Water Quality Assessment 305(b) Reports", and "Assessment Data Base (ADB) Systems User's Manual" published by EPA, along with other State and Federal documents.

The Water Quality Monitoring, Information, and Restoration Act (WQMIRA) directs DEQ to develop and publish a procedure governing the process for defining and determining impaired waters. Additionally, DEQ shall provide for public comment on this procedure. Public comment was solicited through September 23, 2005 on a draft of this guidance. The processes for defining and determining impaired waters are contained in this guidance document and these will be public noticed in the Virginia Register. Additionally, this guidance document can be found on the DEQ website at ***http://www.deq.virginia.gov/wqa/***

The Water Quality Monitoring, Information, and Restoration Act (WQMIRA) requires the former 303(d) and 305(b) reports, now combined into the Integrated Report, be developed in consultation with scientists from State universities prior to the submission of these documents to the U.S. Environmental Protection Agency (EPA). In order to meet this directive, DEQ has updated this guidance containing procedures previously used to assist scientists in the review of the 2006 Integrated Report.

The guidance has been updated and public noticed prior to the Integrated Report submittal to EPA to incorporate input from the review processes and any pertinent public responses. This guidance manual will be used to guide the water quality assessment process for the 2006 305(b)/303(d) Integrated Report.

Purpose

Section 305(b) of the Clean Water Act requires each State to submit a biennial report to EPA describing the quality of its navigable waters. The 305(b) report provides DEQ's best overall assessment of water quality conditions and trends in the Commonwealth. The report is intended to be used as a tool in planning and management (40 CFR 130, page 4) of waters in Virginia. The report also directs continuous planning and implementation activities in coordination with the State Water Quality Management Plan and the Continuous Planning Process (CPP).

Primary objectives of the Integrated Report are:

1. To educate and inform citizens and public officials about Virginia's overall water quality.

2. To analyze water quality data in order to determine the extent to which Virginia's waters are supporting the designated uses for all state waters and to compare the results to WQ Standards and other appropriate criteria and guidelines.

3. To determine the causes for the "failure to support" the designated uses of the State's waters.

4. To determine the nature and recognizable extent of point and nonpoint source impacts in accordance with state and federal guidelines.

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's regulation 40 CFR Section 130.7 (d) promulgated in July 1992, require each state to submit a Total Maximum Daily Load (TMDL) Priority List to EPA on April 1 of even numbered years. Category (5) is a summary of those waters that are impaired and need a TMDL.

Category 4 includes waters that are "water quality effluent limited" and other waters not needing a TMDL. Water Quality Limited waters are those waters where WQ Standards are not expected to be met with the application of technology based effluent control technology of secondary treatment and best practicable treatment. Waters receiving effluent from facilities with water quality based effluent limits in their Virginia Pollution Discharge Elimination System (VPDES) permits with schedules of compliance to meet these limits within the next reporting cycle or within the current permit cycle (5 years) are considered Subcategory 4B (impaired but not needing a TMDL) due to the control requirements and compliance schedules associated with the VPDES permit. Waters, where compliance schedules extend past the current permit cycle or into the next assessment cycle, are considered part of the 303(d) impaired waters list (Subcategory 5E) that need additional compliance review and tracking until the compliance schedule falls within the next reporting or permitting cycle. See the Background section for additional Integrated Report Category descriptions.

Background

As in 2004, EPA's 2006 Integrated Report Guidance recommends that states submit an "Integrated Report" that will satisfy Clean Water Act (CWA) requirements for Sections 305(b) overall water quality report, 303(d) impaired waters list and Section 314 assessment of publicly owned lakes. This Integrated Report will show the following information:

- delineation of water quality assessment units (AUs) based on National Hydrography Dataset (NHD);
- status of and progress toward achieving comprehensive assessments of all waters;
- Water Quality Standard attainment status for every AU;
- additional monitoring that may be needed to determine Water Quality Standard attainment status and, if necessary, to support development of TMDLs for each pollutant/AU combination;
- schedules for additional monitoring planned for AUs;
- pollutant/AU combinations still requiring TMDLs; and
- TMDL development schedules reflecting the priority ranking of each pollutant/AU combination.
- Water Quality "Effluent Limited" Waters

DEQ has incorporated the Integrated Reporting guidance EPA developed in 2004 with supplemental guidance and clarification included in the 2006 assessment guidance. It is similar to the 2004 guidance in most areas and is designed to integrate or combine the 305(b) overall assessment of Virginia's waters and separate out those waters impaired and needing a TMDL as per 303(d). The 2006 EPA Integrated Report Guidance and Assessment Database (ADB V2.1) has five (5) federal categories with category 4 having 3 subcategories in which every "assessment unit" (AU) will be placed based on designated use attainment. Additionally, Virginia has incorporated several subcategories to supplement the federal categories and provide a more precise water quality tracking and reporting mechanism.

Below are the US EPA defined Categories followed by associated Virginia defined subcategories**:**

<u>FULLY SUPPORTING</u> - Waters are supporting one or more designated uses

- **EPA Category 1 -** Attaining all associated designated uses and no designated use is threatened

  Va Category 1A - waters are attaining all uses and a TMDL has been developed for one or more uses.

- **EPA Category 2 –** Available data and/or other information indicate that some, but not all of the designated uses are supported.

  Va. Category 2A - waters are supporting all of the uses for which they are monitored.

Va. Category 2B - waters are of concern to the state but no Water Quality Standard exists for a specific pollutant, or the water exceeds a state screening value or toxicity test.

Va. Category 2C - waters are now attaining the use(s) for which they were originally 303(d) listed and the TMDL is EPA approved but other applicable use(s) were not monitored and assessed.

<u>INDETERMINATE</u> - Waters needing additional information

- **EPA Category 3 -** Insufficient data and/or information to determine whether any designated uses are met

Va. Category 3A - no data are available within the data window of the current assessment to determine if any designated use is attained and the water was not previously listed as impaired.

Va. Category 3B - some data exists but are insufficient to determine support of any designated uses. Such waters will be a prioritized for follow up monitoring.

Va. Category 3C- data collected by a citizen monitoring or other organization indicating water quality problems may exist but the methodology and/or data quality has not been approved for a determination of support of designated use(s). These waters are considered as having insufficient data with observed effects. Such waters will be prioritized by DEQ for follow up monitoring.

Va. Category 3D - data collected by a citizen monitoring or other organization indicating designated use(s) are being attained but the methodology and/or data quality has not been approved for such a determination.

<u>IMPAIRED</u> - Waters are impaired or threatened but a TMDL is not required.

- **EPA Category 4A -** water is impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.

- **EPA Category 4B -** water is impaired or threatened for one or more designated uses but does not require the development of a TMDL because other pollution control requirements (such as VPDES limits under a compliance schedule) are reasonably expected to result in attainment of the Water Quality Standard by the next reporting period or permit cycle.

- **EPA Category 4C -** water is impaired or threatened for one or more designated uses but does not require a TMDL because the impairment is not caused by a pollutant and/or is determined to be caused by natural conditions.

<u>IMPAIRED</u> - Waters are impaired or threatened and require a TMDL

- **EPA Category 5 - Waters are impaired or threatened and a TMDL is needed.**

Va. Category 5A - a Water Quality Standard is not attained. The water is impaired or threatened for one or more designated uses by a pollutant(s) and requires a TMDL (303d list).

Va. Category 5B - the Water Quality Standard for shellfish use is not attained. One or more pollutants causing impairment require TMDL development.

Va. Category 5C - the Water Quality Standard is not attained due to "suspected" natural conditions. The water is impaired for one or more designated uses by a pollutant(s) and may require a TMDL (303d list). WQ Standards for these waters may be re-evaluated due to the presence of natural conditions.

Va. Category 5D - the Water Quality Standard is not attained where TMDLs for a pollutant(s) have been developed but one or more pollutants are still causing impairment requiring additional TMDL development.

Va. Category 5E - effluent limited facilities are not expected to meet compliance schedules by next permit cycle or reporting period.

Va. Category 5F - the WQ Standard is attained for a pollutant(s) with a TMDL and 303(d) delisting

approved but the water remains impaired for additional pollutant(s) requiring TMDL development.

For 2006, Virginia will declare waters impaired for aquatic life use and included in Category 5A if a 30-day semi-permeable membrane device (SPMD) sampled parameter exceeds a water quality criteria two or more times within a 3-year period. Additionally, any waters, where a trend analysis predicts temperature or pH will exceed a water quality criteria during the next reporting period, will be listed as threatened and included in Category 5A. Any waters where a trend analysis predicts that fecal coliform will exceed the out-going WQ Standard or total phosphorus will exceed the screening value during the next reporting period will be listed as having an observed effect. As in the past, DEQ will identify other waters of concern as having observed effects and will schedule additional monitoring, if appropriate, to determine if the designated uses are being met.

PART I 305(b)/303(d) ASSESSMENT PROCESS

Virginia's biennial water quality assessment is conducted by the Department of Environmental Quality (DEQ), with the assistance of the Department of Conservation and Recreation (DCR), to determine the water quality conditions in the Commonwealth. The results of this water quality analysis are reported to the EPA in the Integrated Report due on April 1 of even numbered years. The Integrated Report describes the aggregated water quality conditions of the State. The Integrated Report contains the individual listing of those waters identified as "impaired" for one or more designated uses and needing a Total Maximum Daily Load (TMDL). As per EPA 2001 guidance, the former 305(b) water quality assessment report and the 303(d) impaired waters list are now combined into a single Integrated Report. EPA compiles the data from all State reports into a national water quality status report that is presented to Congress.

Impaired waters needing a TMDL are those waters that do not meet WQ Standards due to a pollutant(s). *A pollutant, as defined in 40 CFR 122.2, means any dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.*

The assessment begins by analyzing all QA/QC approved data from DEQ ambient water quality, biological, sediment and fish tissue monitoring, other special studies and/or other non-DEQ water quality data for the 5-year assessment period. The results of these comprehensive data analyses are compared to both numeric and narrative criteria related to the designated uses contained in the WQ Standards. The WQ Standards are provisions of State and/or Federal regulations that contain numeric and/or narrative criteria for protecting the designated uses of all waters in the Commonwealth.

There are two basic types of water quality data used in the assessment process. The first type of data is QA/QC approved "monitored" data. This data comes from the collection and analysis of chemical, biological, and/or physical samples taken by DEQ and/or any other DEQ approved data submitted during the reporting period. These data are considered the highest quality data. Normally, the 303(d) Impaired Waters list is comprised of only QA/QC approved monitored data due to the assessment confidence associated with the QA/QC monitoring requirements. Monitored data is obtained using EPA accepted methods and DEQ approved protocols. All non-DEQ monitoring submittals, except USGS chemical data submittals, must provide a sampling and analysis protocol and all field data for review. If data discrepancies or other suspect information is generated, a field verification audit will be conducted by DEQ monitoring staff. Partially approved monitoring data can be used to signify waters as "insufficient but having observed effects" where DEQ assessment methodologies, had they been used, would show degradation (Category 3C). These waters should be prioritized for follow up monitoring. Partially approved monitoring data, where DEQ assessment methodologies would show fully supporting results, are considered insufficient data with low priority for follow up monitoring (Category 3D). These data could include results from water quality test kits or other alternate biological methodologies that do not provide the quality assured accuracy needed to confirm WQ Standards exceedences but can provide an accurate indication of good water quality or other observed effects.

The second type of data used in the assessment is considered "evaluated" data. These physical, chemical and/or biological data are primarily obtained from sources where there is not an EPA accepted sampling protocol and/or DEQ non-approved sampling and analysis protocols. An example of evaluated data would be data generated by water quality indicator test kits. These data are considered to be of lower quality with less confidence in their results and normally are not used directly for listing waters as fully supporting or impaired but on a case by case basis, as having observed effects. Assessment Units, where lower quality data indicate chronic and recurring water quality degradation, may be designated as insufficient but having observed effects for associated designated uses on a case by case basis. Additional DEQ monitoring shall be targeted for these waters as resources allow. Additionally, waters that were on previous 303(d) lists, with no additional monitoring data for the 2006 reporting period, will retain previous assessment results for associated designated uses. Additional information concerning assessment and use of Citizen Monitoring and other non-DEQ data can be found in Part VI, Sections 6.3.1 and 6.3.2.

<u>The following approval process will be used for non-DEQ "monitored" data protocol and QA/QC procedure review:</u>

All ancillary data that have been received and reviewed by DEQ and found acceptable shall be used for the Integrated Report. The data are from two categories, state/federal agencies (other than DEQ) and the Citizen Monitoring Program. The approval process for data from the Citizen Monitoring Program is addressed in Part VI, Section 6.3.1. The following addresses the approval process for data from state and federal agencies.

All "monitored" chemical and biological data must be supported by EPA accepted monitoring protocols. QA/QC procedures must also be reviewed and approved by DEQ. As regional assessment staff becomes aware of data sources, those parties generating data for DEQ 305b/303d assessment consideration should be requested by the regional assessment staff or Water Quality Data Liaison to submit QA/QC plans, standard operating procedures (SOPs), and monitoring procedures to the DEQ Water Quality Data Liaison. The Liaison will provide copies of supporting documentation for chemical data to QA/QC review staff in the Water Quality Monitoring and Assessment (WQMA) program and provide copies of all supporting documentation for biological monitoring of freshwater benthic macro-invertebrates to the WQ Standards biological monitoring Coordinator.

At this time, DEQ does not consider any non-agency free-flowing biological monitoring data other than benthic macro-invertebrate. Benthic information from non-DEQ sources may be independently assessed by regional biologists to determine their acceptability for assessment purposes on an individual basis. Copies of the supporting documentation for freshwater benthic data should be provided to the regional offices where the surveyed sites are located for review by the regional biologists. The regional biologists are most familiar with the various eco-regions in the state and are knowledgeable about location of appropriate reference sites, conditions or benthic metrics that are acceptable for assessing streams in these eco-regions. The regional biologists, in consultation with the biological coordinator, shall review the sampling and analysis methodology and if practical, the available data, to determine the acceptability of the benthic data. The regional biologists will provide any comments or requests for additional information directly to the data generators and will copy such communications to the DEQ Biological Coordinator. Copies of the review results shall be distributed to the regional assessment staff and the DEQ 305(b) Coordinator. If the protocols involve estuarine toxics data and/or biological assessments in tidal environments, supporting documents should be provided to and reviewed by the Chesapeake Bay Program staff.

All comments concerning toxics data, chemical (SOPs) and/or QA/QC plans will be coordinated through the Water Quality Monitoring and Assessment (WQMA) QA/QC Coordinator. WQMA QA/QC Coordinator is responsible for providing comments to data generators and DEQ 305(b) Coordinator concerning the acceptability of SOPs and QA/QC documentation for chemical data.

If a chemical, biological or tidal waters data package cannot be used in the assessment process, the appropriate DEQ staff will provide the data generator an explanation for the data not being useable. A list of all data providers and the status of the QA/QC review will be included in an Appendix of the 2006 Integrated Report.

PART II WATER QUALITY MONITORING, INFORMATION AND RESTORATION ACT (WQMIRA)

In 1997, the General Assembly enacted the Water Quality Monitoring, Information and Restoration Act (WQMIRA) §62.1- 44.19:4 through §62.1- 44.19:8. This legislation supplements the CWA 305(b)/303(d) federal requirements. The requirements of this legislation for State assessment procedures or processes are briefly outlined as follows:

1. The Act requires the 303(d) portion of the Integrated Report to identify geographically defined water segments as impaired if monitoring or other evidence shows:

    a. violations of ambient WQ Standards for aquatic life or human health;
    b. fishing restrictions or advisories;
    c. shellfish consumption restrictions due to contamination;
    d. nutrient over-enrichment;
    e. significant declines in aquatic life biodiversity or populations; and/or
    f. contamination of sediment at levels which violate WQ Standards or threaten aquatic life or human health.

2. Waters identified as "naturally impaired", "fully supporting but threatened" or "evaluated" (without monitoring) as impaired shall be set out in the 303(d) portion of the Integrated Report in the same format as those listed as "impaired".

3. The 303(d) portion of the Integrated Report shall include an assessment, conducted in conjunction with other appropriate state agencies, for the attribution of impairment to point and nonpoint sources. The absence of point source permit violations on or near the impaired water shall not conclusively support a determination that impairment is due to nonpoint sources. In determining the cause for impairment, the Board shall consider the cumulative impact of 1.) multiple point source discharges, 2.) individual discharges over time, and 3.) nonpoint sources.

4. The Board shall develop and publish a procedure governing its process for defining and determining impaired water segments and shall provide for public comment on the procedure.

5. The Integrated Report, inclusive of CWA sections 305(b) and 303(d) shall be produced in accordance with the schedule required by federal law and shall incorporate at least the preceding five years of data. Data older than five years shall be incorporated when scientifically appropriate for trend analysis.

6. The Integrated Report, inclusive of CWA sections 305(b) and 303(d), shall be developed in consultation with scientists from state universities prior to submission by the Board to EPA.

7. The Integrated Report, inclusive of CWA sections 305(b) and 303(d), shall indicate water quality trends for specific, easily identifiable, geographically defined water segments and provide summaries of the trends using available data and evaluations. This will allow the citizens of the Commonwealth to easily interpret and understand the conditions of the geographically defined water segments.

8. Based on the information in the Integrated Report, inclusive of CWA sections 303(d) and 305(b), the Board shall request the Department of Game and Inland Fisheries (DGIF) or the Virginia Marine Resources Commission (VMRC) to post notices at public access points for all "toxic" impaired waters. The notice, prepared by the Board, shall contain the basis for the impaired designation and a statement of potential health risks. The Board shall coordinate with the DGIF and VMRC to assure that adequate notice of posted waters is provided to those purchasing hunting and fishing licenses.

The following proposed water quality assessment procedures have been designed to meet the CWA 305(b), 303(d) and 314 federal requirements in addition to the State requirements contained in WQMIRA.

PART III RULES FOR THE 2006 WATER QUALITY ASSESSMENT

Rule 1

Impaired waters are defined as those with chronic or recurring WQ Standard exceedences using QA/QC approved ambient monitoring data, special study data and/or other programmatic in-stream data collections. Predictive data generally refers to computer generated modeling data and may be used for assessment purposes on a case by case basis. Impaired waters are generally based on exceedences of the numeric WQ Standards criteria using the guidelines described in Part V and VI of this guidance and/or exceeding the narrative WQ Standards.

Rule 1 applies to the conventional parameters dissolved oxygen, pH, bacteria, nutrients, and temperature (except temperature in tidal waters). Previous EPA guidance recommended States use a violation rate of > 10.5% of the total samples analyzed for classifying waters impaired. However, a single sample will not be assessed and will be placed in federal Category 3 (Insufficient Data). A single exceedence of the WQ Standards results in an assessment of insufficient data for small datasets (2-9 samples) of conventional parameters. At least two exceedences and > 10.5% of the total samples is required before a water is listed as impaired. This includes small datasets. Temperature in tidal waters up to the fall line will not be assessed due to the lack of a maximum WQ Standard for temperature.

Rule 2

Waters classified as impaired based on biological data or restrictions placed on the designated uses (shellfishing and fish consumption advisories, limiting consumption) by the Virginia Department of Health (VDH), are in violation of the narrative Designated Use Standard (9 VAC 25–260–10 A.) unless the designated use has been administratively removed due to the presence of a permitted discharge outfall or a consumption advisory that does not limit the designated use.

Rule 3

For swimming (primary contact) designated use, fecal coliform data will be assessed, along with E.coli (freshwater) and enterococci (saltwater and transition zone) data, independently where fewer than 12 E. coli/enterococci samples have been collected and monitoring data exists for both bacteria indicators. According to the new bacteria standard (9-VAC-25-260-170), where 12 or more E. coli/enterococci samples have been collected, the fecal coliform WQ criteria will no longer apply and only E.coli/enterococci data will be assessed. After June 30, 2008, the fecal coliform WQ criteria will no longer apply throughout the state no matter how many E. coli/enterococci samples have been collected.

During the transition between the fecal coliform and the new E coli/enterococci bacteria criteria, use the instantaneous maximum fecal criterion of 400 per 100 milliliters when the monitoring program is designed to provide fewer than 2 samples a calendar month. No more than 10.5% of the total single samples taken during the assessment period shall exceed the instantaneous maximum. The E coli/enterococci instantaneous standard of 235 per 100 ml (E. coli in fresh water) and 104 per 100 ml (enterococci in saltwater and transition zone) applies during designed, single sample per calendar month monitoring.

Apply the geometric mean criterion of 200 fecal coliform bacteria per 100 milliliters to monitoring data sets generated from special monitoring programs or projects that are designed to produce 2 or more samples during a calendar month. When appropriate, the geometric mean standard of 126 per 100 ml (E. coli) for freshwater and 35 per 100 ml (enterococci) for saltwater and transition zone applies where 2 or more samples are designed to be collected during any calendar month. See 9 VAC 25-260-140-C for fresh water and transition zone delineation.

Rule 4

Conventional parameter data, generated by probabilistic monitoring (Probmon) networks, will be used as a "general overview" of those waters and shall be used to direct additional targeted monitoring into those areas that

indicate potential water quality degradation. This is due to the fact that, for most stations, only one data point will be available from probabilistic monitoring and an assessment for the associated parameters will not be made on one data point unless that data point exceeds a human health standard. A single "grab sample" exceedence of human health or aquatic life criteria is assessed as fully supporting with an observed effect and follow-up monitoring should be conducted within a 3-year period to determine if the water is impaired. A single chronic or acute exceedence of a 30-day SPMD sample for a toxic parameter associated with aquatic life and wildlife use is considered fully supporting with an observed effect. A single fish tissue, 30 day SPMD sample and/or sediment sample with no exceedence is considered fully supporting the associated use because these types of samples are generally associated with longer-term water quality conditions. For probabilistic stations with 2 conventional data points, assessment will be the same as any station with 2 or more data points. This rule does not apply to free-flowing benthic data assessments. Benthic and habitat collections made within the free-flowing probabilistic monitoring program will not be assessed as reference stations or reference conditions do not exist at this time for probabilistic sites. Reference conditions, via the developing stream condition index (SCI), should be available for the 2008 reporting period.

Rule 5

When assessing multiple sample data, as with a hydrolab multi-probe, the daily average will be used as appropriate for the standard and the worst case data-point will be used to assess against instantaneous values. This rule does not apply to depth profile sampling where each depth sample should be assessed as an independent sample. Where information indicates a pycnocline (density gradient in estuarine waters) or thermocline (temperature gradient in reservoirs) exist, surface and bottom waters will be vertically segmented by the estimated pycnocline/thermocline or in the case of the Chesapeake Bay and its tidal tributaries, according to the associated Chesapeake Bay designated uses and corresponding criteria.

Rule 6

When data analysis reveals fully supporting or insufficient data but having observed effects, additional monitoring relating to the designated use associated with the observed effect should be considered. Observed effects are water quality observations where WQ Standards have not been exceeded due to the lack of a standard or criteria and/or lower quality and less reliable data indicates potential adverse water quality associated with a particular designated use. This rule applies to conventional and/or toxic parameters (water column, sediment, nutrient and/or fish tissue) as well as biological monitoring.

Rule 7

Waters that are assessed as impaired and suspected to be naturally occurring, non-anthropogenic (not human related) conditions (such as low DO and/or pH in slow-flowing swamp waters or high temperature from thermal springs) will be included in Category 5C (possibly needing a TMDL) of the Integrated Report. See Section 6.6 for assessment of lakes and reservoirs to determine if natural conditions exist. If natural conditions are shown to be responsible for the impairment, the water will be listed in Category 4C (impaired but not needing a TMDL). For waters in Category 5C or 4C, the WQ Standards will be reviewed and possibly be updated during next triennial review to reflect variations caused by natural conditions for these waters. Once appropriate WQ Standards are in place, data will be reviewed again to determine whether these waters should be delisted or a TMDL is needed. It may be necessary to conduct a TMDL study or Use Attainability Analysis (UAA) prior to WQ Standards modification in order to determine and/or verify the appropriate criteria based on natural pollutant loadings.

Rule 8

Waters that were on previous 303(d) lists, with no additional monitoring data for the reporting period will continue to be tracked in the Integrated Assessment Database (ADB). These waters will retain the results of the previous assessment for all designated uses. These waters will continue to be tracked until a TMDL is developed or additional monitoring data and assessment reveals the waters are fully supporting the designated uses for which it was originally listed and approved for delisting by EPA. Additionally, this rule applies to those waters

that were originally found to be fully supporting designated use(s) and no additional monitoring data has been collected to generate a new assessment.

Rule 9

For effluent limited waters, if the VPDES permit has been issued with a scheduled compliance date that extends beyond the next 303(d) listing or permit cycle, the water would be listed as Category 5E. If the compliance date falls within the next listing cycle or within the current permit cycle whichever is longer, the water would be listed in Category 4B. See Section 7.1 for additional information.

Rule 10

Duplicate and/or split samples collected for QA/QC purposes will not be used in the assessment. The primary sample (S1) will be assessed against the appropriate Standard and the duplicate/split sample (S2) will be used only to document lab analysis quality control.

Rule 11

In assessing water quality trends, a segment will be classified as threatened if the trend predicts a WQ Standard criteria exceedence by the next assessment reporting period. See Section 6.9 for additional information.

Rule 12

Sampling stations that happen to be located within a permitted mixing zone, primarily via probabilistic monitoring, will not be individually assessed for aquatic life use. They will be included with the overall probabilistic assessment. Any other stations that inadvertently were located in mixing zones will not be assessed individually for aquatic life use as the use is exempt in mixing zones.

Rule 13

A review of stockable and some natural trout waters currently listed as impaired has revealed that most if not all of these impairments are due to either erroneous segment boundaries or natural conditions. Both issues will be addressed as part of Virginia's next triennial review. For the 2006 assessment, these waters will be categorized as category 4C (impaired due to natural conditions and not needing a TMDL) as long as supporting documentation is provided by the Virginia Department of Game and Inland Fisheries (VDGIF). This will prevent and/or correct the misclassification of these segments, pending the triennial review process.

Rule 14

Multi-probe meters are accurate to single digits (tenths) and data associated with these monitoring devices should be rounded to single digits. Round down to the nearest tenths for hundredths that are 4 or less (e.g. 8.14 rounds down to 8.1). Round up to the next tenth for hundredths that are 6 or greater e.g. (8.16 rounds up to 8.2). Round hundredths that are 5 to the nearest even number (e.g. 8.15 will round up to 8.2 but 8.05 will round down to 8.0).

PART IV DESIGNATED USES of VIRGINIA'S WATERS

The 305(b) process assesses a total of six primary designated uses, as appropriate for a particular waterbody, based on the WQ Standards. Assessed designated uses may include wildlife use, aquatic life use, swimming use, fish consumption use, shellfish consumption use and drinking water use. Swimming use is assessed to represent the primary and secondary water contact recreational use. Drinking water use, where applicable, is based on attainment of public water supply criteria. The new Chesapeake Bay criteria, adopted in 2005, have sub-divided the aquatic life use into several distinct sub-uses. See Section 6.4.2.1 for additional information relative to the new Chesapeake Bay criteria. Following are details relating to the assessment of the six designated uses of Virginia's waters.

1. Wildlife Use:

Wildlife use includes the propagation, growth, and protection of a balanced, indigenous population of wildlife.

Support of wildlife use is determined by assessing Water Quality Toxic Standards for aquatic life found in 9 VAC-25-260-140 B. These criteria were developed to protect aquatic life as well as wildlife.

2. Aquatic Life Use:

Aquatic life use includes the propagation, growth, and protection of a balanced indigenous population of aquatic life (including game and marketable fish) which may be expected to inhabit the waters.

Support of aquatic life use can be determined by the assessment of conventional parameters (dissolved oxygen, pH and temperature, toxic pollutants in the water column (relative to the acute WQ Standards), toxic pollutant analysis of sediments, toxicity testing, nutrient analysis and/or the biological assessment of benthic communities. All available data, relative to aquatic life use, shall be considered to determine if the aquatic life use is being supported. This assessment includes the sub-categories of aquatic life use associated with the new Chesapeake Bay criteria. The maximum temperature will not be assessed for aquatic life in tidal waters as no maximum temperature standard is applicable.

3. Fish Consumption Use:

Fish consumption use includes the propagation, growth and protection of a balanced population of aquatic life including game and marketable fish. Human health is also a primary consideration with regard to fish consumption use.

Support of this use is determined using three separate criteria. First, support or lack thereof, is based on human health related advisories and/or restrictions issued by the Virginia Department of Health (VDH). Impairment for fish consumption results when the public is advised by VDH that fish consumption is prohibited for the general population or there is an advisory that certain fish species should not be consumed by the general population or sub-populations at greater risk, such as children and/or pregnant women.

Second, the assessment methodology used for fish consumption use is a comparison of fish tissue data to WQ Standards (WQ Standards) criterion based tissue values (TV's) and tissue screening values (TSVs) for toxic pollutants. Any single observation above the TV or TSV results in the water being assessed as fully supporting but having an observed effect. Two or more exceedences within or across species sampled of a particular TV listed in Appendix E-1 results in an impaired assessment of the water for the fish consumption designated use.

Third, support of the fish consumption use is determined by comparison to the human health criteria in public water supplies and other surface waters, as listed in the WQ Standards.

4. Shellfish Consumption Use:

Shellfish consumption use includes the propagation, growth and protection of a balanced population of aquatic life including marketable shellfish.

Support of this use is determined using the following criteria. The Division of Shellfish Sanitation (DSS) of the VDH bases support or lack thereof on a classification system designed for the harvesting and marketing of shellfish resources in accordance with Food and Drug Administration (FDA) guidelines. Four classifications are used to describe shellfish waters. They are approved, conditionally approved, restricted, and prohibited. ***Approved*** areas are waters from which shellfish may be taken for direct marketing at all times. ***Conditionally approved*** (seasonal condemnation) areas are

waters where the quality may be affected by a seasonal population increase or sporadic use of a dock or harbor facility. ***Restricted*** (condemnations) areas are waters where a sanitary survey indicates a limited degree of pollution which makes it unsafe to market shellfish for immediate consumption. Shellfish harvested in these areas must be moved to an approved area for a certain length of time to allow for depuration before marketing. ***Prohibited*** (condemnations) areas are waters where the DSS sanitary survey indicates dangerous numbers of pathogenic microorganisms or other contaminants that impact the area. Shellfish cannot be harvested or relayed for purification in prohibited areas.

Shellfish waters where restrictions or prohibitions are due solely to a discharge outfall and associated buffer zone but not due to water quality exceedences will not be included in the 303(d) list. In these cases, monitoring should not be conducted as the shellfish designated use has been administratively removed through the issuance of a discharge permit. Additional information relative to shellfish use assessment can be found in Appendix C of this guidance.

5. Recreation/Swimming Use:

Recreation use assessment includes swimming and other primary and secondary water contact recreation uses such as water skiing and pleasure boating.

Normally, support or lack thereof of this use is based on a comparison of fecal coliform and/or E. coli and enterococci bacteria data to the instantaneous standard using the > 10.5% percent assessment method. However, if a special study designed to collect multiple bacteria data points within a one-month period is conducted such as in the BEACH program, then these results should be compared to the geometric mean criterion described in 9 VAC-25-260-170. Also, any VDH beach closures/swimming advisories should be assessed according to Part V.

6. Public Water Supply Use:

Waters that are used for public drinking water supply are identified in the WQ Standards and are protected by additional health related standards that are applicable to these waters. Support or lack thereof of this use is based on VDH closures or advisories based on excessive pollutant(s) and/or a comparison of water column data to applicable public water supply criteria.

Table 1 is a summary of the designated uses and the criteria used to assess the individual uses.

Table 1 DESIGNATED USE MATRIX

NO.	DESIGNATED USE	SUPPORT OF USE ASSESSMENT CRITERIA
1.	Wildlife Use	Aquatic life toxics criteria in water column
2.	Aquatic Life Use	Conventional parameters (DO, pH, Temp.); Aquatic life toxics criteria in water column (relative to the acute WQ Standards); toxicity testing; biological evaluation. Waters exceeding nutrient and/or sediment screening values (SV's) are considered to have "observed effects"
3.	Fish Consumption Use	Advisories, limiting consumption, or restrictions issued by VDH; Comparison of fish tissue data to WQ Standards criterion based tissue values (TVs) for toxic pollutants found in Appendix E-1 and tissue screening values (TSVs) also found in Appendix E-2.
4.	Shellfish Consumption Use	Restrictive actions for harvesting and marketing of shellfish resources made by Div. of Shellfish Sanitation of VDH
5.	Swimming Use	Conventional Pollutant (Fecal Coliform and/or E. coli and enterococci bacteria) and/or VDH beach closures/advisories or other available bacteria data.
6.	Public Water Supply Use	Closures or advisories based on excessive pollutant(s) by VDH; comparison of data to applicable public water supply standards.

PART V CRITERIA TO DETERMINE DEGREE OF USE SUPPORT

Virginia bases its water quality assessment on the ability of the waters to support the associated designated uses. Support is based on the waters meeting the criteria for each use based on the numeric and/or narrative WQ Standards. The following is a description of the criteria used to determine the quality of the waters relating to each of the designated uses, and thereby the degree of use support that will be presented in the Integrated 305b/303d Report. Waters where no water quality data exist for any designated use(s) are categorized as insufficient data (Category 3).

1. Not Assessed

Waters with no data for any uses or a single sample (conventional data only) and no exceedence relative to aquatic life will not be assessed (Category 3A).

2. Insufficient Information

Waters that have a single exceedence in a small dataset (2-9 samples) are considered insufficient data (Category 3B). Waters, where the data are not QA/QC approved but the data review indicate potential degradation, are categorized insufficient but having observed effects (Category 3C). Waters where the data are not QA/QC approved but the assessment results indicate acceptable water quality will be considered insufficient data with no observed effects (Category 3D).

3. Fully Supporting

The following is a description of the types of data and the acceptable criteria used to assess waters as fully supporting designated uses. These waters would be placed in the Category 2A or 2C unless all designated uses are fully supporting, upon which the water would be placed in Category 1.

- *Conventional/Bacteria Parameters*:

Waters fully supporting designated uses can have up to 10.5% exceedences of WQ Standards for the parameters fecal coliform and/or E.coli or enterococci bacteria, (swimming use) and the conventional parameters dissolved oxygen, temperature, nutrients and pH (aquatic life use) without negatively affecting designated uses. This criterion is based on natural variables which DEQ acknowledges can cause exceedences of these criteria in the 0-10.5% range and still fully support both aquatic life and swimming designated uses. Additionally, a single exceedence of a geometric mean will be considered fully supporting with observed effects. All data assessed as fully supporting must be QA/QC approved.

The WQ Standards (9 VAC 25-260-50) criteria for D.O., pH and Temperature do **not** apply (7Q10).
7Q10 is the lowest flow averaged (arithmetic mean) over a period of seven consecutive days that can be statistically expected to occur once every 10 climatic years (a climatic year begins April 1 and ends March 31). Data for these parameters that are from flow conditions below 7Q10 will not be used in the Integrated Report.

- *Toxic Pollutants:*

For toxic pollutant assessment in free-flowing streams, waters where there are one or more samples and no exceedences of aquatic life criteria within a running 3-year period, using grab samples or SPMD data, are considered fully supporting for aquatic life and wildlife use. For public water supply and human health related criteria in other surface waters, one or more samples and no exceedences during the reporting period, using grab samples or SPMD data, are considered fully supporting for PWS and/or fish consumption use. Additional information on the details of using this approach can be found in Part VI, Section 6.5.3.

For toxic pollutant assessment in estuarine waters, where there are several types of toxic data available, a weight of evidence approach has been initiated. Additional information on the details of using this approach can be found in Part VI, Section 6.5.3

- *Fish Tissue/Sediment Contamination*

One or more samples recording no exceedences of a toxic fish tissue Water Quality Standard TV or TSV found in Appendix E-1 or E-2 or sediment screening values (SVs) found in Appendix F are considered fully supporting.

- *Biological Evaluation*:

For free-flowing stream biological community assessment, data for the overall assessment period is rated as not impaired where no biological assemblage (e.g. macro invertebrates) has been modified beyond the natural range of reference conditions based on EPA Rapid Bioassessment Protocol (RBP) II methodology.

A project to refine the estuarine biological assessment methodology has recently been completed and approved for use by EPA. See Section 6.4.2.2 for additional information.

- *Fish Advisories:*

Waters where the VDH has not issued any fish advisories or prohibitions.

- *Shellfish Advisories*:

Those growing areas where no restriction or prohibition (condemnation) on shellfish harvesting is imposed as indicated by the Department of Shellfish Sanitation (DSS) summary dated January, 2005. Additional information on shellfish assessment and consumption use is contained in Part VI, Section 6.4.4 as well as Appendix C.

- *Beach Closures/Advisories:*

No VDH beach closures and/or geometric mean exceedences, based on QA/QC approved sampling data, during the assessment period.

- *Public Water Supply Source Closures:*

No VDH public water supply source closures based on sampling data during the assessment period.

4. <u>Fully Supporting but Having an Observed Effect</u>

The following is a description of the types of data and the acceptable criteria used to assess waters as fully supporting but having an observed effect for a designated use(s). <u>It is the intent of the agency to focus additional monitoring resources on the waters that are identified as having an observed effect, based on initial monitoring data analysis.</u> These waters would be placed in the federal Category 2 and the Virginia Subcategory of 2B.

- *Conventional Screening Parameters*:

Waters that have > 10.5% and 2 or more screening value (SV) exceedences for nutrients (Chl a and/or total phosphorus) or 1 or more exceedences for sediment and/or toxicity test are considered fully supporting but having an observed effect for aquatic life use due to the lack of a Water Quality criterion for these parameters (Category 2B). Waters where trend analyses project a WQ Standards violation for total phosphorus or fecal coliform by 2008 will be considered fully supporting with observed effects of the Aquatic Life and Recreation Uses, respectively (Category 2B). This conclusion is due to the fact that a phosphorus Standard has not been adopted and the fecal coliform Standard will no longer apply after 2008.

- *Toxic Pollutants:*

For toxic pollutant assessment in free-flowing streams, a single exceedence of aquatic life criteria within a 3-year period, using grab samples or SPMD data, is considered fully supporting but having an observed effect for aquatic life and wildlife. For public water supply use or human health criteria in other surface waters, a single exceedence is considered fully supporting but having an observed effect for PWS and/or fish consumption use.

For toxic pollutant assessment in estuarine waters, where there are several types of toxic data available, a "weight of evidence" approach has been initiated. If no additional toxic data is available, the water would be assessed the same as the free-flowing waters. Additional information on the details of using this approach can be found in Part VI, Section 6.5.3.

- *Fish Tissue/Sediment Contamination:*

Waters with a single exceedence of a WQ Standards based TV or TSV found in Appendix E-1 or E-2 from one or more samples for fish tissue or SPMD, or an exceedence of a SV for sediment found in Appendix F, are fully supporting but having an observed effect for fish consumption and aquatic life, respectively.

- *Biological Evaluation*:

For free-flowing waters, biological community data for the assessment period with a single rating of moderately impaired using RBP-II methodology should be considered fully supporting but having an observed effect where professional judgment cannot confirm impairment. If the single moderate impairment was discovered from the last 2 samples, a documented justification for not assessing as impaired is required. For waters assessed as fully supporting but having an observed effect for aquatic life use, it is necessary for another biological assessment to be scheduled to make a final aquatic life use determination. Additional information can be found in Part VI Section 6.4.1.

A project to refine the estuarine (B-IBI) biological assessment methodology has recently been completed and accepted for use by EPA RIII and DEQ. See Section 6.4.2.2 for additional information.

- *Fish Advisories:*

A VDH fish consumption advisory, where a general advisory has been issued but fish consumption is not limited, are considered fully supporting but having an observed effect.

- *Shellfish Advisories:*

Those growing areas, as indicated by the DSS summary dated January, 2005, that have been classified as conditionally approved (seasonal condemnations) are considered fully supporting but having an observed effect. Additional information on shellfish assessment and consumption use is contained in Part VI, Section 6.4.4 and Appendix C.

- *Beach Closures/Advisories*:

A single geometric mean exceedence and/or one short term (less than one week in duration) beach closure and/or two short term (less than one week in duration) swimming advisories due to bacteria contamination, and based on QA/QC approved data within the 5 year assessment cycle with a low probability that the pollution will recur (based on best professional judgment). Best professional judgment decisions will be based on scientific data indicating the source of the pollution causing the closure/advisory is transient and there are no plans to implement pollution reduction measures or other controls, or documentation shows that mitigation has occurred and the two most recent years of water quality data, subsequent to the mitigation, show an improvement that fully supports the designated use.

- *Public Water Supply Source Closure:*

One, short term, VDH public water supply source closure during the 5 year assessment cycle with a low probability that the pollution will recur is considered fully supporting but having an observed effect. The source of the pollution is generally transient and there are no VDH plans to implement pollution reduction measures or other controls.

- *Other Criteria for Waters having Observed Effects*

Waters for which "evaluated" data, trend analysis for parameters with no WQ Standards but with screening criteria, or other water quality indicators appear to indicate an apparent effect on designated use(s) or a potential for water quality problems are considered to have "observed effects". Waters can be designated as having observed effects where there is a possible loss of a designated use documented by ancillary data such as fish kills with unknown causes and/or pollution potential documented by non QA/QC approved non-agency studies or reports. These waters are considered insufficient data with observed effects (Category 3C). For monitoring purposes, waters with observed effects should be considered in the next regional monitoring plan for continued monitoring during the next reporting period as resources allow.

5. Pollutant Caused Impaired Waters Not Needing a TMDL

Impaired or threatened waters not needing a TMDL are those waters that are listed in the federal Category 4. These are waters that are impaired but an EPA approved TMDL has been developed (Category 4A), other pollutant control requirements are reasonably expected to result in attainment of designated use(s) (Category 4B) and waters that are naturally impaired (Category 4C).

6. Pollutant Caused Impaired Waters Needing a TMDL

The following is a description of the types of QA/QC approved data and the acceptable criteria used to assess waters as impaired or threatened for the designated uses. Those waters impaired by pollutant(s) and needing a TMDL are included in the 303(d) list. These waters are placed in the federal Category 5 (needing a TMDL) and the Virginia sub-categories of 5A, 5B, 5D and possibly 5C and 5E.

- *Conventional Parameters*:

Waters with long term or chronic pollutant related problems based on the assessment of monitored data are considered impaired and needing a TMDL. For conventional parameters, at least two exceedences of WQ Standards and exceedences >10.5% are considered long term or chronic problems and are considered impaired and needing a TMDL. Additionally, waters with 2 or more exceedences of a geometric mean analysis are considered impaired. These geometric mean analysis are normally associated with the BEACH monitoring program conducted by VDH but also could be associated with a designed, multiple sample per month, bacteria special study. In addition, waters, where trend analysis projects a violation of the WQ Standards for temperature or pH by 2008, are considered threatened for aquatic life use and need a TMDL. See Section 6.9 for additional information.

- *Toxic Pollutants:*

For toxic pollutant assessment in free-flowing streams, waters where there are 2 or more exceedences of the same WQ Standards acute aquatic life toxic criteria in a running 3-year period using grab samples or SPMD data are considered impaired for aquatic life use and wildlife use. For public water supply or human health criteria in other surface waters, 2 or more exceedences of the same criteria within the reporting period using grab samples or SPMD data are considered impaired and needing a TMDL for PWS and/or fish consumption use.

For toxic pollutant assessment in estuarine waters, where there are several types of toxic data available, a "weight of evidence" approach has been initiated. Additional information on the details of using this approach can be found in Part VI, Section 6.5.3.

- *Fish Tissue Contamination:*

Waters exceeding the same toxic human health criteria based tissue value (TV) listed in Appendix E-1, 2 or more times are impaired for fish consumption. For example, the following situations would qualify as impaired under these guidelines. Two or more tissue samples from different fish species exceeding the same TV during one sampling event or two or more samples of the same or different species exceeding the same TV from different sampling events within the assessment period are considered impaired.

- *Biological Data*:

For free-flowing waters, the biological community survey data are confirmed to be moderately or severely impaired, are considered impaired and needing a TMDL. Based on professional judgment and/or other supplemental data, a second survey may be required to confirm moderate impairment and/or pollutant related causes. In this case, the initial assessment would be considered fully supporting but having an observed effect and follow-up monitoring scheduled.

A project to refine the estuarine biological assessment methodology has recently been completed and EPA accepted for assessment use. See Section 6.4.2.2 for additional information.

- *Fish Advisories:*

Virginia Department of Health (VDH) fish consumption prohibitions and/or advisories, where fish consumption is specifically limited, are considered non attainment of the designated use WQ Standard and therefore considered impaired and needing a TMDL.

- *Shellfish Advisories*:

Those growing areas, as indicated by the DSS summary dated January, 2005, that have been classified as prohibited and/or restricted (condemnations) based on bacteria data are considered impaired and needing a TMDL. Restricted areas that have been administratively condemned due solely to the presence of a VPDES permitted out-fall or administrative closure where no data is available will not be assessed. Additional information on shellfish assessment and consumption use is contained in Part VI, Section 6.4.4 and Appendix C.

- *Beach Closures/Advisories:*

Two or more geometric mean exceedences and/or one or more beach closures of one-week or more duration and/or two or more swimming advisories of one week or more duration due to bacteria contamination and based on QA/QC approved data within the assessment cycle with a medium to high probability that the closure/advisory will recur (based on best professional judgment). There are no plans to implement pollution reduction measures or controls nor have any plans been implemented.

- *Public Water Supply Source Closure*:

One or more VDH public water supply source closures within the assessment cycle with a medium to high probability that the pollution will recur are considered impaired and needing a TMDL. There are plans to implement pollution reduction measures or controls.

Table 2 summarizes the designated use assessment criteria.

Table 2 Designated Use Assessment Criteria

	Fully Supporting **Category 1, 1A, 2A, or 2C**	**Fully Supporting or Insufficient data but Having Observed Effects** **Category 2B or 3C**	**Impaired or Threatened Waters Needing a TMDL** **Category 5A,5B,5C, 5D or 5F** **(Impaired with TMDL Approved = Category 4A)**
Conventional Parameters Aquatic Life Use Support (ALUS) and Recreational Use (temperature will not be assessed in tidal waters)	2 or more samples and AR ≤10.5%	**Non QA/QC approved** with exceedences > 10.5% (2 or more exceedences in a small dataset (2-9 samples) **Nutrien**t SV exceeded > 10.5% (2 or more exceedences in a small dataset (2-9 samples)	AR > 1 exceedence and > 10.5% of total samples (includes small datasets with approved QA/QC)
Toxic Pollutants in Water Column and/or Sediment Aquatic Life Use Support (ALUS) and Wildlife Use	One or more samples and no exceedences	A single grab or SPMD sample exceedence of a acute aquatic life criteria or 1or more grab sample exceedences of same chronic aquatic life criteria in a 3 year period (water column only) (ALUS & Wildlife) One or more toxicity test or SV exceedence (sediment only) (ALUS)	2 or more grab sample or SPMD exceedences of the same acute aquatic life criteria in a 3-yr period (water column only) (ALUS & Wildlife) Failing the "weight of evidence" toxicity evaluation (Section 6.5.3)
Toxic Pollutants related to human health, (PWS, & Fish Consumption)	One or more samples and no exceedences	A single exceedence of a human health criteria using grab sample or SPMD data (PWS and/or fish consumption) A single exceedence of any toxic WQS TV or TSV, listed in Appendix E-1 or E-2 (fish consumption)	2 or more exceedences of the same human health criteria using grab samples or SPMD data (PWS and/or fish consumption) 2 or more exceedences of the same toxic WQS TV, listed in Appendix E-1 (fish consumption)
Biological Data	Freshwater: Not Impaired	Freshwater: Slightly Impaired or Unconfirmed, Moderately Impaired, Medium and/or lower quality benthic data show potential WQ problems. Estuarine: See Section 6.4.2.2 for additional information.	Freshwater: Confirmed or most recent Moderately or Severely Impaired Estuarine: See Section 6.4.2.2 for additional information.
Fish Consumption Advisories or Restrictions	No restrictions or prohibitions	A VDH advisory which does not limit consumption is in effect	A VDH advisory or restriction limiting or prohibiting consumption is in effect
Shellfish Advisories	No restrictions or prohibitions	Area classified as Conditionally Approved (seasonal condemnations)	Areas classified as Restricted or Prohibited: Excluding VPDES out-falls
Recreation Use (see Conventional Parameter criteria) and Beach Closures/Advisories	No geometric mean exceedences or beach closure	One geometric mean exceedence and/or one short term (< 1 week) closure/advisory due to QA/QC approved bacteria data with low probability of recurrence (pollution source transient)	2 or more exceedences of a geometric mean and/or 1 or more closure and/or 2 or more advisories > 1 week duration due to QA/QC approved bacteria data with medium or high probability of recurrence
Public Water Supply (PWS) Source Closures	No closures based on sampling data	One VDH closure based on QA/QC approved data with low probability of recurrence	One or more VDH closure based on QA/QC approved data with medium or high probability of recurrence

AR = arithmetic exceedence rate
SV = screening value
ALUS = Aquatic Life Use Support
PWS = Public Water Supply

PART VI ASSESSMENT METHODOLOGY

Section 6.1 CONVENTIONAL PARAMETER METHODOLOGY

State and federal law requires DEQ to produce a biennial report on the condition of its waters to Virginia's citizens and the EPA. The waters are evaluated in terms of whether the appropriate designated uses are met: These uses are: 1) wildlife, 2) aquatic life, 3) fish consumption, 4) shellfish harvest, 5) swimming (primary and secondary contact recreation) and 6) drinking water use. DEQ employs the "Percent Method" to assess conventional pollutant impacts in waters for two uses: aquatic life use and swimming use.

6.1.1 Description of the Fixed Rate (Percent) Method

Previous national guidance recommended that states use an assessment method for the 305(b) report based on assumptions about the kind and frequency of data needed to support such an assessment. The object is to indicate whether waters are fully supporting or impaired for the designated uses and ultimately for the assessment unit (AU). A 10.5% exceedence threshold is used for determining full support or impairment for conventional pollutants. A exceedence rate that is > 10.5% with at least 2 exceedences is considered impaired. It is the intent of the agency to clarify the Standards to specifically include the fixed rate percent. It is anticipated that this clarification will be in place prior to the next assessment.

In effect, the fixed rate assessment guidelines imply that an exceedence of a conventional numeric criterion in 10.5% of the samples taken does not impair the aquatic life designated use due to the ability to recover from short term exceedences of conventional parameters. This is due to many variables associated with sampling errors and/or weather factors that can cause periodic exceedences but not affect designated uses. The rule of thumb is described in Table 3

Table 3 Fixed Rate Assessment Guidelines

Violation Rate (AR) of Total Samples Analyzed	Assessment
AR ≤10.5%	Meets use (Category 2A, 2B or 2C)
AR > 10.5%	Fails to meet use (impaired) Categories 4A, 5A, 5B, 5C or 5D

In recent years, DEQ has been encouraged to spread its monitoring efforts over more of the State's waters. To achieve this goal with a fixed monitoring budget, the average collection frequency changed from monthly to bimonthly. This monitoring frequency has been applied to a rotating watershed scheme with 1/3 of the watersheds being monitored for a 2-year cycle with all watersheds being monitored within 6 years. The benefit from this change is that more streams and more stream miles can be assessed. The disadvantage is that the data collected from each station are fewer (12 samples/2 years). The data set has become wide geographically but shallow in frequency. This aspect somewhat concerns DEQ in that the fixed rate method assumptions are based on a monthly sampling frequency. Additional monitoring program review and possible update stems from the need for additional monitoring data for Total Maximum Daily Load (TMDL) development.

Section 6.2 MONITORING STATION DELINEATION AND SITING METHODOLOGY

6.2.1 Monitoring Station Delineation

DEQ has a vast network of active Ambient Water Quality Monitoring (AWQM) stations and a growing number of biological stations statewide. The AWQM stations are generally monitored bimonthly while the biological stations are monitored twice a year (usually in the spring and fall). Monitoring programs can be designed based on a "source targeted" (conventional) approach or a "probability based" approach or a combination of the two. Each monitoring program design has its advantages and disadvantages. Historically, most of DEQ's monitoring strategy has been based on the conventional approach. Many of the stations were located in proximity to (above and below) Virginia Pollutant Discharge Elimination System (VPDES) facility outfalls. During this reporting cycle, DEQ has continued to use a rotating watershed approach where stations are sited for 2 years of bimonthly sampling. The number of stations per watershed is based on the drainage area of the watershed and the Department of Conservation and recreation (DCR) nonpoint source potential rating of the watershed. In order to provide consistency between the regional planning staff and to get an accurate number of assessed stream miles in Virginia, the following stream delineation guidelines are the

primary considerations used in the assessment and listing process. However, in certain cases, best professional judgment of the regional staff may be used if the delineation results are contrary to these guidelines. Where appropriate, documentation of these best professional judgment decisions should be included in the segment narrative.

1. Typically, no more than 10 miles of free-flowing stream should be assessed by the conventional pollutant data from one ambient monitoring station. Miles assessed for a toxic pollutant or biological impairment may vary from the miles assessed for conventional parameters.

2. One monitoring station should not be used to assess an entire watershed unless land use, source, and habitat are relatively homogeneous.

3. When determining the miles assessed for a free-flowing monitoring station, the following items need to be considered:

   a) WQ Standards Use Designations (i.e. Classes and/or Special Standards)

   b) point and/or nonpoint source input to the stream or its tributaries,

   c) changes in watershed characteristics such as land use,

   d) changes in riparian vegetation, stream banks, substrate, slope, or channel morphology,

   e) entry of a large tributary or diversion, or

   f) hydrologic change such as channelization or a dam.

4. For tidal and estuarine stations, EPA guidance suggests using a 4-mile radius for open water stations; a 2-mile radius for bay stations and a 0.5 mile radius for sheltered bay stations. The new Chesapeake Bay WQ Standards criteria adopted the Chesapeake Bay Program segmentation scheme.

5. Segment delineation will be performed using the EPA National Hydrography Dataset (NHD) coverage.

6. Spatial coverage for estuarine probabilistic monitoring stations should be identified in conjunction with the development of the monitoring plan and coordinated by regional monitoring and assessment staff and/or the Chesapeake Bay Program monitoring coordinator and Bay monitoring staff. Estuarine B-IBI data will be assessed according to methodology recently developed.

7. When assessing an impaired segment, it is understood via WQ Standards that the existence of a VPDES permitted mixing zone lies within the impaired segment for a specific pollutant. If a mixing zone exists, the parameter specific mixing zone length is specifically understood as not part of the impaired segment even though map delineation and/or assessment unit description may show the impairment as continuous.

8. Single physical or chemical sample free-flowing probabilistic stations will not be delineated into 303(d) segments. Probabilistic physical/chemical stations meeting Part III Rules 1 and 4 will be delineated and assessed. Free-flowing probabilistic benthic and habitat samples will not be delineated or assessed.

Section 6.3 NON DEQ EVALUATION METHODOLOGY

6.3.1 Citizen Monitoring

For the purposes of this guidance document, a citizen water quality monitoring program, or "citizen monitoring", is defined as water quality monitoring which uses volunteers to collect the data. Some of these programs are run by local governments, soil and water conservation districts, citizen organizations, community organizations or colleges. Generally, K-12 school monitoring is conducted for educational purposes and does not fall under citizen monitoring unless working in cooperation with existing citizen monitoring efforts. Citizen monitoring is not defined as monitoring

conducted by all entities external to DEQ, such as colleges and local governments, unless volunteers are used in their efforts.

In 1997, Water Quality Monitoring, Information and Restoration Act (WQMIRA) was passed by the Virginia General Assembly. This bill charged DEQ with monitoring and assessing all the waters within the Commonwealth. During this same General Assembly session, the position of Citizen Monitoring Coordinator (CMC) was added into the operating budget of DEQ. The primary duties of the CMC were providing guidance and support to citizen water quality monitoring groups in the development of monitoring programs and quality assurance project plans, facilitating communication among citizen groups and other State agencies, sponsoring citizen monitoring seminars, promoting the use of citizen water quality data in a manner consistent with the data use goals of the organization and encouraging additional citizen monitoring efforts. In 2002, the Virginia General Assembly passed legislation that established the Virginia Citizen Water Quality Monitoring Program in the Code of Virginia (§62.1-44.19:11).

In 2004, the CMC position was replaced with the new position of Water Quality Data Liaison (WQDL). The replacement was due to DEQ centralizing the task of requesting any and all available data collected outside of DEQ activities for inclusion into water quality assessment reports and follow up monitoring by DEQ staff. The duties and responsibilities of the former CMC position regarding citizen monitoring data submissions, and working with the citizen monitoring community are maintained and expanded to include all other non-DEQ potential sources of water quality data, in the Employee Work Plan (EWP) of the WQDL position.

Assessment Process:

1. All citizen water quality data should be sent to the WQDL at DEQ. The WQDL and QA/QC staff in the Water Quality Monitoring and Assessment (WQMA) program will review all standard operating procedures (SOPs), QA/QC plans or Quality Assurance Project Plans (QAPPs), QA/QC plans, training manuals, and current monitoring procedures for each citizen monitoring group submitting chemical data. All supporting documentation for biological freshwater benthic macroinvertebrate citizen monitoring programs will be reviewed by the WQDL and the biological program coordinator. Based upon the review of all procedures, the appropriate use of the data will be determined. Any changes in QA/QC and/or SOP methods and/or any additions or deletions of current monitoring sites should be brought to the attention of the WQDL.

2. All data collected under documented and DEQ approved SOPs, protocols, and QA/QC procedures should be included in the 305(b) assessment as follows:

    a) All approved conventional parameter data should be summarized by major watershed and characterized according to the procedures and considerations in Part V of this manual.

    b) Until biological programs are fully evaluated by the DEQ biological program coordinator, the biological monitoring sites characterized by citizen monitors as “excellent,” “good” or “acceptable” should be designated as “Area of low probability for adverse conditions” (Category 3D). Biological sites periodically characterized as “fair,” “poor,” “unacceptable” or “moderate” should be designated as “Area of medium probability for adverse conditions” and listed as insufficient data with observed effects and prioritized for follow-up monitoring (Category 3C). Likewise, biological sites that are consistently “poor” or “unacceptable” should be characterized as “Area of high probability for adverse conditions” and listed as insufficient data with observed effects with DEQ follow up monitoring to be prioritized (Category 3C).

    c) The summaries of the citizen data will be placed under a separate Citizen Monitoring section of the 305(b)/303(d) Integrated Report.

    d) Segment lengths represented by a monitoring site should be determined using the mileage delineation guidance found in Section 6.2.1. Specific monitoring site location, including latitude, longitude and a physical description of the site (i.e. Route 646 bridge crossing, 3 mile north of route 647) should be provided for each monitoring site. Each monitoring site should be identified with a unique station id

using a system similar to the DEQ station id system. The WQDL assigns this station id to each citizen monitoring site.

e) Data collected at sites that complement and are comparable (i.e. chemical to chemical comparisons and biological to biological comparisons) to DEQ monitoring sites, should be included in the major basin report. However, the final assessment of that river segment will be made using the DEQ monitoring data (found in the appropriate section of the Integrated Report). In this case, the data collected by the citizen monitoring organization would be used as supplemental data.

f) The WQDL should coordinate with each regional office regarding the final assessment of the citizen monitoring data. In coordination with the WQDL and the 305(b) coordinator, each regional office should provide any appropriate final editing of the citizen monitoring assessment to be included in the Integrated Report.

3. The WQDL will provide all data approved by DEQ for use in the Integrated Report in basic data tables. The tables will be posted on the DEQ website along with the final Integrated Report. These data tables should include each individual sample period as well as statistical results (number of observations, maximum and minimum).

4. The WQDL will review data collected without SOPs and QAPPs plans. This data will be acknowledged in the appropriate river basin evaluation as appropriate.

5. Once the data is summarized into the data tables, they will be sent to each region for their review and comparison to similar DEQ data points.

6. If, during the regional review, a discrepancy between data from DEQ monitoring stations and data from similarly sited citizen monitoring station and/or a citizen monitoring technique is believed to be suspect, the WQDL should be notified and an attempt to rectify the discrepancy initiated. The WQDL should collaborate with the WQMA (QA/QC) program coordinator to evaluate the potential causes for the data disparity and/or review the QAPP and the monitoring techniques of the citizen group. After this evaluation is complete and a problem is confirmed, the WQDL and QA/QC coordinator will recommend appropriate corrective actions to the citizen monitoring group for inclusion in the citizen monitoring organization's WQMA QAPP and/or SOPs. Until the discrepancies with the data and/or methods are fully evaluated by the WQDL and the WQMA QA/QC coordinator, the data (for either the specific parameter or for the group) should not be used in agency assessments. If corrective action is not initiated by the citizen monitoring group, the QAPP for that parameter and/or for the group as a whole may no longer be considered valid by DEQ and the data will not be considered for state-wide water quality assessments.

7. Regional DEQ planning and monitoring staff will be given a list of all stations classified as "Area of medium probability for adverse conditions" and "Area of high probability for adverse conditions". The regional monitoring staff should review the station list results and consider including appropriate sites to their regional monitoring plan for future monitoring activities.

6.3.2 Other State and Federal Water Quality Data

After review and approval of monitoring and QA/QC protocols, DEQ will consider, for use in the Integrated Report, data generated by other State and Federal monitoring programs. DEQ has established a water quality data sharing agreement with the U.S. Forest Service (USFS) for the George Washington and Jefferson National Forests using the USFS Fisheries and Aquatic Ecology Program.

The USFS program collected macroinvertebrate data from numerous monitoring stations within the two National Forests. Sampling for macroinvertebrates is conducted utilizing the same collection methodology (Plafkin et al 1989) that DEQ biologists use in the ambient biomonitoring program. Therefore, the raw data collected by the USFS should be highly comparable with DEQ data. The USFS has used the Macroinvertebrate Aggregated Index for Streams (MAIS) to assess this raw data and make an initial water quality interpretation.

The DEQ regional biologist and planners may use the data, provided to DEQ by the USFS, in the Integrated Report if they find it acceptable for assessment purposes. If the regional biologist or planners have information which conflicts with the initial USFS assessment or for any other reason, question the final USFS stream assessment, they may elect to disregard the USFS assessment results until further verification can be obtained. If the initial assessment is not used, documentation relating to this decision will need to be provided. The regional Biologist may elect to reevaluate the raw data using the EPA RBP-II metrics to confirm consistent assessment methodology and conclusions. If differences become apparent, the regional biologists may decide not to use the assessment data in the Integrated Report until an on-site stream visit can be performed and conditions verified. Final assessment results of the USFS data should be consistent with the ambient biological assessment criteria described in Section 6.4.2 of this guidance. Any non- approved data will not be used directly in the assessment.

6.3.3 Nonpoint Source (NPS) Assessment

A nonpoint source pollution assessment of hydrologic units will be performed by the Virginia Department of Conservation and Recreation (DCR). As performed since the 2002 NPS assessments, the 2006 process will calculate net loadings of nitrogen, phosphorous, and sediment per hydrologic unit. Gross load calculations are done via modeling in a manner that closely approximates the results of the Chesapeake Bay Program water quality model in regards to loadings in the Bay watersheds, thereby diminishing if not removing the uncertainty of having conflicting assessment results for this portion of the state. This model is then employed to calculate similar values for non-Bay watersheds to develop consistent statewide loadings. Inputs to this modeling process include:

- A DCR modified land use / land cover layer
- A DCR developed confined animal data set
- Census of Agriculture animal numbers by jurisdiction
- VDOF forest harvesting data
- The USDA's Natural Resources Inventory
- Chesapeake Bay Program Watershed Model output
- USDA statewide soil surveys
- A DCR developed table of dominant crop types by modeled hydrologic unit
- National Weather Service weather records for a multi state area
- USGS stream flows from gage stations
- Census of Population and Housing indicators of septic system use by block
- Slopes developed by USGS DEMs
- A DCR developed indicator of stream density by modeled hydrologic unit
- A DCR developed manure application schedule by manure type and by region

Net loadings are formed by subtracting from calculated gross loads the reductions in nitrogen, phosphorous, and sediment that are realized from both best management practice (BMP) installations and relevant grant projects. This includes BMPs funded and installed through DCR, VDOF, and the USDA. Results will produce NPS pollution rankings per pollutant by land use of the modeled hydrologic units.

In contrast to modeled potential nutrient loadings, the NPS related portions of the most current list of water quality limited waters (from the 303(d) list) will be assessed by modeled hydrologic unit. This will produce an impaired waters ranking by water regime of the modeled hydrologic units.

Aside from the NPS loadings described above, two variables used in the past NPS assessments for prioritizing watershed protection efforts for biological health will also be recalculated by modeled hydrologic unit in 2006. An aquatic IBI score will be used to indicate modeled hydrologic units in need of aquatic species health protection and a source water population variable will highlight modeled hydrologic units in need of human health protection. Rankings of modeled hydrologic units for both indicators will be produced.

DCR rates modeled hydrologic units as high, medium, or low for potential NPS problems as indicated by the NPS assessment. This categorization is performed so that approximately the highest 20% of the net loadings by unit are assigned the high rank. The next highest 30% of the net loading values are assigned the medium rank. All other units are assigned a low NPS rank. Rather then make a hard and true category split at these percentages, the category breaks are made where net loading differences occur nearest to the stated percentages.

Impaired riverine waters follow a 10, 20, and 70 percent split for high, medium, and low ranking. Impaired waters of other regimes, and the biological indicators, are ranked based more on the clustering and spread of values.

Like the 2004 NPS assessment, no single NPS ranking will be produced. Each program's total ranking needs can be met by deciding which of the ranked categories are pertinent to the program's cause and creating customized rankings from only those categories.

Section 6.4 DESIGNATED USE EVALUATION METHODOLOGY

6.4.1 Wildlife Use Support

Determination of the degree of use support for wildlife is based on the aquatic life toxic criteria found in 9 VAC 25-260-140 B. Two or more exceedences of the same acute criteria within a 3-year period will result in the water being impaired for wildlife use.

6.4.2 Aquatic Life Use Support

Determination of the degree of use support for aquatic life is based on conventional physical parameters (DO, pH, temperature) and aquatic life toxic criteria along with biological monitoring data and best professional judgment, relying primarily on recent data collected during the current reporting period. Up to 5 additional years of data may be used if they reflect current conditions. Additional potential chemical pollutants with no Water Quality Standard criteria are examined as well. These include sediment and nutrients. These pollutants are assessed according to Section 6.5 of this guidance.

- Conventional parameters (Dissolved Oxygen (DO), pH, temperature)

Conventional pollutant data will continue to make up the bulk of free-flowing, estuarine and lake water quality assessments. The Percent Method will be used to determine the degree of use support. The assessment determination is based only on available data except where professional judgment indicates that natural causes are responsible for the exceedences or where there is reason to believe the quality of the data are suspect. Waters not meeting WQ Standards due to natural conditions will be assessed as impaired and the source of impairment listed as "natural conditions". For DO, the instantaneous minimum standard for the specific WQ Standards designated Class of water is used to assess exceedences. For estuarine and lake waters, all DO data will be assessed including depth profile data. See Section 6.6 for more information relative to DO assessment in lakes and reservoirs. Each DO measurement associated with the depth profile will be assessed as an independent data point. At least 2 sampling events must show exceedences > 10.5% of the independent data points before the water is listed as impaired. Additionally, Chesapeake Bay and tidal tributary estuarine waters will be assessed according to Section 6.4.2.1.

6.4.2.1 Chesapeake Bay Sub-categories of Aquatic Life Designated Use

Assessment of aquatic life use in Chesapeake Bay and it's tidal tributaries will be assessed though 1) Assessment of newly adopted subcategories of aquatic life use specific to the Chesapeake Bay estuarine system, 2) Assessment of the general narrative standard for aquatic life use through examination of benthic invertebrate community condition, and 3) protocols discussed in other parts of this document (e.g. see conventional parameters and toxics). Items 1 and 2 are discussed in detail here.

The Chesapeake 2000 agreement committed its signatories (the states of Pennsylvania, Maryland and Virginia; the District of Columbia; the Chesapeake Bay Commission and the EPA) to, "define the water quality conditions necessary to protect aquatic living resources." (see http://www.chesapeakebay.net/agreement.htm). Accordingly, the EPA with the participation of State partners has defined protective water quality conditions through Chesapeake Bay-specific water quality criteria for dissolved oxygen, water clarity and chlorophyll (USEPA, Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries, EPA 903-R-03-002, April 2003,. available at http://www.chesapeakebay.net/baycriteria.htm). This document identified and described five habitats (or designated uses) and associated water quality criteria for dissolved oxygen, water clarity and chlorophyll that are adequately protective of the Chesapeake Bay. Collectively, these three water quality criteria provide the best and most direct measures of the effects of too much nutrient and sediment pollution on the Bay's aquatic living resources– fish, crabs, oysters, their prey species and underwater bay grasses.

These standards were developed as part of the larger effort to restore Chesapeake Bay water quality and living resources, including consideration of achievable nutrient and sediment loading reductions. As such, these standards are not expected to change CBP pollution reduction strategies or commitments. The revised dissolved oxygen standards may reduce the square mileage of estuarine waters considered impaired due to dissolved oxygen because they will more realistically reflect the fact that dissolved oxygen impairments are generally limited to bottom waters and/or summer temperatures. Alternatively, the new submerged aquatic vegetation (and associated water clarity) standards will likely lead to large areas of aquatic life designated use impairment because this is the first rigorous use of this important aquatic community status using actual water quality standards designed to protect and restore SAV.

This is a new and complex assessment procedure as described in detail in "Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries (USEPA, April 2003)". An integral first step in the process involves spatial interpolation and extrapolation of data collected at individual fixed locations to project water quality conditions in areas distant from where data has been actually collected. All appropriate and readily available data will be used for this step. A subsequent step involves development of cumulative frequency distribution (CFD) of criteria exceedences combining both spatial and temporal domains over large spatial areas. A final step is to compare this CFD of criteria exceedences against a "reference" CFD of allowable exceedences to determine if the use is being met. The spatial scale (i.e. a single assessment result for large CBP segments containing both main channel waters and smaller tidal tributaries and embayments) is one aspect of assessment which is quite different from previous assessments and may affect the prior impairment status of many small tributaries. A first generation of spatial and computer analysis tools has been developed for performing these new assessment procedures. DEQ believes the current tools are sufficient to perform assessment analyses but expects future refinement and enhancements.

Subcategories of the propagation and growth of a balanced indigenous population of aquatic life, including game fish designated use for waters in the Chesapeake Bay and its tidal tributaries are listed below.

- **Migratory Fish Spawning and Nursery Designated Use**: waters in the Chesapeake Bay and its tidal tributaries that protect the survival, growth and propagation of the early life stages of a balanced, indigenous population of anadromous, semi-anadromous, catadromous and tidal-fresh resident fish species inhabiting spawning and nursery grounds. This designated use extends from the end of tidal waters to the downriver end of spawning and nursery habitats that have been determined through a composite of all targeted anadromous and semi-anadromous fish species' spawning and nursery habitats (see boundaries in U.S. Environmental Protection Agency. 2004. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland). This designated use extends horizontally from the shoreline of the body of water to the adjacent shoreline, and extends down through the water column to the bottom water-sediment interface. This use applies February 1 through May 31 and applies in addition to the open-water use described in this subsection.

- **Shallow-Water Submerged Aquatic Vegetation Designated Use**: waters in the Chesapeake Bay and its tidal tributaries that support the survival, growth and propagation of submerged aquatic vegetation (rooted, underwater bay grasses). This use applies April 1 through October 31 in tidal-fresh, oligohaline and mesohaline Chesapeake Bay Program segments, and March 1 through November 30 in polyhaline Chesapeake Bay Program segments and applies in addition to the open-water use described in this subsection.

- **Open-Water Aquatic Life Designated Use:** waters in the Chesapeake Bay and its tidal tributaries that protect the survival, growth and propagation of a balanced, indigenous population of aquatic life inhabiting open-water habitats. This designated use applies year-round but the vertical boundaries change seasonally. October 1 - May 31, the open water aquatic life use extends horizontally from the shoreline at mean low water, to the adjacent shoreline, and extending through the water column to the bottom water-sediment interface. June 1 - September 30, if a pycnocline is present and, in combination with bottom bathymetry and water column circulation patterns, presents a barrier to oxygen replenishment of deeper waters, this designated use extends down into the water column only as far as the upper boundary of the pycnocline. June 1- September 30, if a pycnocline is present but other physical circulation patterns (such as influx of oxygen rich oceanic bottom waters) provide for oxygen replenishment of deeper waters, the open-water aquatic life designated use extends down into the bottom water-sediment interface (see boundaries in U.S. Environmental Protection Agency. 2004. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland). This designated use includes the migratory fish spawning and nursery and shallow-water submerged aquatic vegetation uses.

- **Deep-Water Aquatic Life Designated Use**: waters in the Chesapeake Bay and its tidal tributaries that protect the survival, growth and propagation of a balanced, indigenous population of aquatic life inhabiting deep-water habitats. This designated use extends to the tidally influenced waters located between the upper and lower boundaries of the pycnocline where, in combination with bottom bathymetry (depth, contour & shape) and water circulation patterns, a pycnocline is present and presents a barrier to oxygen replenishment of deeper waters. In some areas, the deep-water designated use extends from the upper boundary of the pycnocline down to the bottom water-sediment interface (see boundaries in U.S. Environmental Protection Agency. 2004. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland). This use applies June 1 - September 30.
- **Deep-Channel Seasonal Refuge Designated Use**: waters in the Chesapeake Bay and its tidal tributaries that protect the survival of a balanced, indigenous population of aquatic life inhabiting deep-channel habitats. This designated use extends to the tidally influenced waters at depths greater than the lower boundary of the pycnocline in areas where, in combination with bottom bathymetry and water circulation patterns, the pycnocline presents a barrier to oxygen replenishment of deeper waters (see boundaries in U.S. Environmental Protection Agency. 2004. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland). This use applies June 1 through September 30.

Criteria to protect Aquatic Life from the impacts of nutrients and suspended sediment in the Chesapeake Bay and its tidal tributaries.

1. Dissolved Oxygen Assessment

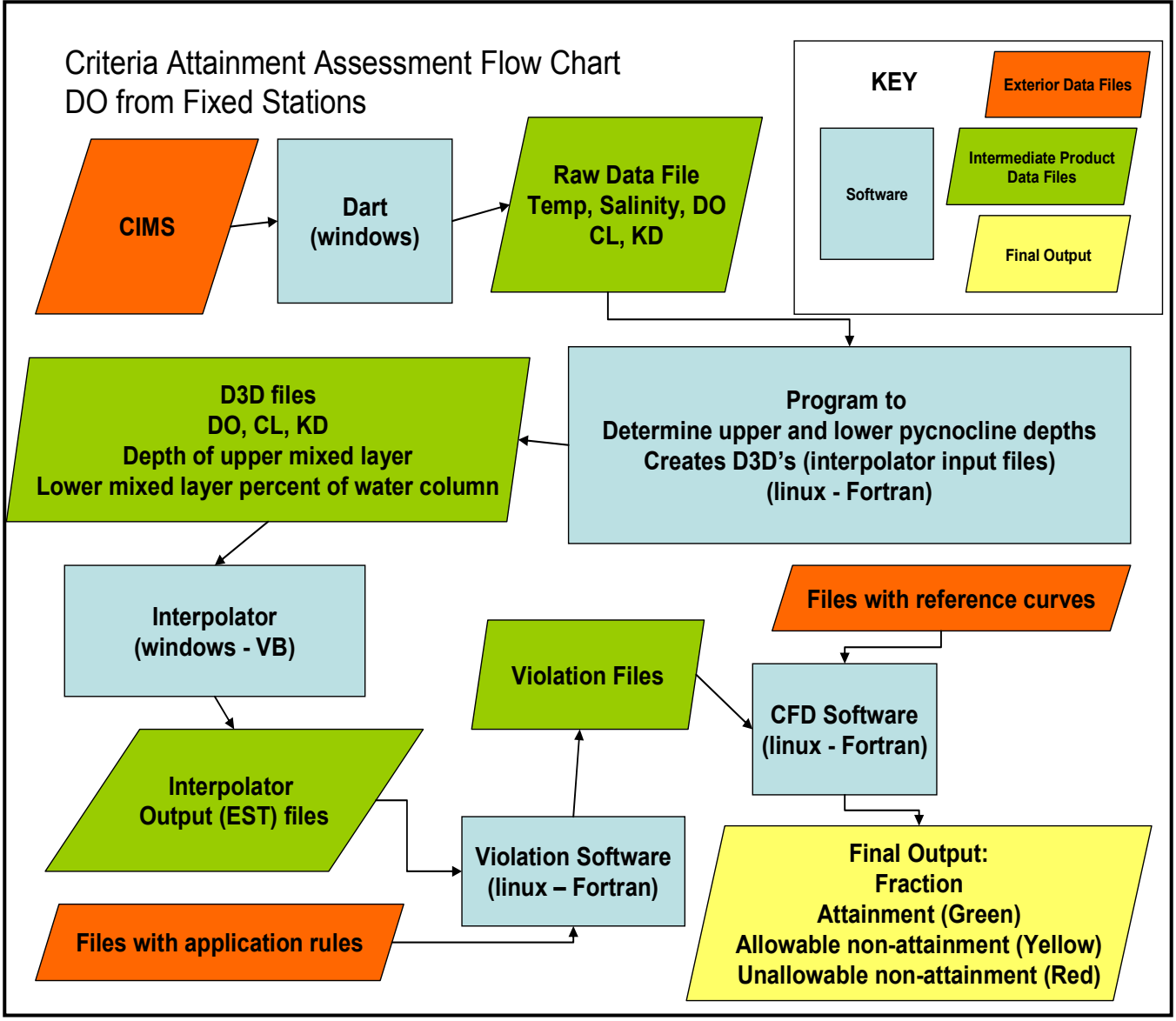
Designated Use	Criteria Concentration/ Duration	Temporal Application
Migratory fish spawning and nursery	7-day mean > 6 mg/l (tidal habitats with 0-0.5 ppt salinity)	February 1 - May 31
	Instantaneous minimum > 5 mg/l	
Open-water[1]	30 day mean > 5.5 mg/l (tidal habitats with 0-0.5 ppt salinity)	year-round
	30 day mean > 5 mg/l (tidal habitats with >0.5 ppt salinity)	
	7 day mean > 4 mg/l[2]	
	Instantaneous minimum > 3.2 mg/l at temperatures <29°C Instantaneous minimum > 4.3 mg/l at temperatures > 29°C	
Deep-water	30 day mean > 3 mg/l	June 1 - September 30
	1 day mean > 2.3 mg/l	
	Instantaneous minimum > 1.7 mg/l	
Deep-channel	Instantaneous minimum > 1 mg/l	June 1 - September 30

1= In applying this open-water instantaneous criterion to the Chesapeake Bay and its tidal tributaries where the existing water quality for dissolved oxygen exceeds an instantaneous minimum of 3.2 mg/l, that higher water quality for dissolved oxygen shall be provided antidegradation protection in accordance with 9 VAC 25-260-30 subsection A.2.

2= Special criteria have been proposed for the Mattaponi and Pamunkey due to natural effects of adjoining wetlands. These special criteria are in the process of final adoption and will be used in future criteria assessments. These criteria are 30 day mean > 4 mg/l.

Documentation for Dissolved Oxygen Criteria Assessment, August-October, 2005

General information about the Chesapeake Bay and tributaries criteria assessment process can be found in EPA 903-R-03-002 "Ambient water quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll *a* for the Chesapeake Bay and Its Tidal Tributaries" and the 2004 Addendum to the same document. This documentation gives specifics on actual procedures followed and data used. The figure below describes the process of assessing criteria from observed data. All data, fortran code, application rules files, reference curve files, and the particular version of the interpolator are available at ftp://ftp.chesapeakebay.net/modeling/2006_WQ_criteria_assessment/.



Data

Data used for this assessment came from two sources, CBP's CIMS water quality database and Virginia-specific data. The Virginia specific data were received by email at the CBP on 8/19/2005 from Rick Hoffman of the Virginia DEQ. They were combined with data pulled from the CBP's CIMS water quality database using the DART tool. The CIMS data had the following specifications: Dissolved oxygen, salinity, and temperature were retrieved for all data specified as MD mainstem, VA mainstem, MD Tidal Tributaries, or VA Tidal Tributaries. The start date was 1/1/1985 and the end date was 12/31/2004. One replicate was retrieved for all depths 0 to 50.

Processing before the interpolator

Using the 'raw_to_d3d' program, interpolator input (d3d) files for each cruise were generated as follows:

Assign a cruise to any data point where cruise is not given, such as with the additional Virginia data. If there is more than one observation at the same monitoring station within a single cruise, average the values.

For each column of temperature and salinity data, determine if the upper and/or pycnocline boundaries exists by looking for a robust vertical change in density of 0.1 kg/m^4 for the upper boundary and 0.2 kg/m^4 for the lower boundary. Write (d3d) files of the depth to the upper pycnocline boundary and the percent of water column below the lower boundary. The upper pycnocline boundary is fairly stable across horizontal space so these interpolate well. Interpolating the depth to the lower boundary would cause wide variation in the size of the lower layer while interpolating the depth of the lower layer would cause interpolations that were above the water surface. The lower layer is interpolated as a percent of the water column, which gives stable and reasonable results.

Dissolved oxygen and salinity d3d files will be interpolated in three dimensions. The current interpolator interpolates a stacked two dimensional domain, so the columns of data are linearly interpolated in the vertical direction to one meter apart,

starting with 0.5 (0.5, 1.5, 2.5, etc). These vertical interpolations are put in to the d3d files. A script is generated to run the DO, salinity, and pycnocline interpolations in batch mode.

The 'raw_to_d3d' program also generated data files and scripts which, when called by matlab, generate vertical profile plots of DO and density, and indicate the upper and lower pycnocline depth, if applicable, for each station and date.

Interpolation
The DO, salinity, and pycnocline d3d files are interpolated using the following specifications:

The vertical search range is narrowed to 0.1 meters since the data are vertically interpolated to match the interpolator depths already. A special modified version of the interpolator is used for this purpose. The method of interpolation is 3-D inverse distance squared.

Data regions (the interpolator search region in two dimensions for each CBP monitoring segment) were modified to allow for inclusion of the Virginia data and the exclusion of data from smaller tribs in the calculation of main bay segments. These data regions are available on the above ftp site.

The Tangier segment TANMH is separated by Smith and Tangier islands into two regions for interpolation purposes, so that data are not interpolated across the islands. The two regions are aggregated to calculate violations.
Segments and designated uses crossing state lines are interpolated separately, although the same data regions are used. TANMH, CB5MH, POCMH, and POCOH are separated into Maryland and Virginia portions. POTTF is separated into Maryland and Washington, DC portions.

Calculate spatial violations
Standards are specific to particular averaging periods. The deep channel instantaneous standard is evaluated using the individual cruise interpolations. The deep water, open water summer, and open water rest-of-year standards are monthly averages. To calculate the monthly averages, each interpolated cruise within a month is averaged on a point-by-point basis. Generally, there are 2 cruises per month in the warmer months and 1 cruise per month in the cooler months. The program 'make_monthly_est' generated the averages.

Spatial violation rates were calculated using the program 'vio', which performs as follows: The user inputs the particular designated use and averaging period. The program checks for which months constitute the designated use, which segments to evaluate, and the criterion for each segment. Each interpolator output (est) file is evaluated for violations for each segment. The spatial violation rate for each est file and segment is stored as output. The 'vio' program uses the pycnocline to determine boundaries between open water summer, deep water, and deep channel where applicable and uses salinity to determine the appropriate criterion for open water summer.

The criteria evaluated for dissolved oxygen are as follows:
Deep channel instantaneous < 1 mg/l – June-Sept
Deep water monthly < 3 mg/l – June-Sept
Open water monthly summer < 5 mg/l (5.5 mg/l for water < 0.5 ppt salinity)
Open water rest-of-year < 5 mg/l (5.5 mg/l for water < 0.5 ppt salinity)

9. Evaluate the CFDs as follows using the Weibull plotting position
10. Assess the CFDs versus the reference CFDs
10.1. For instantaneous, do not use a reference curve
10.2. For Clarity and DO, use biological reference curves
10.3. For Chlorophyll, use the 10 percent curve, evaluated at the same points in time as the assessment curve

Create and Evaluated CFDs
The output of the 'vio' program above is analyzed by use of the 'ref_plot' and 'tbl_dis_plot' programs. Both of these programs use the Weibull plotting position to generate CFDs and generate scripts to plot reference and assessment CFDs using matlab. The text output of these programs is the areas of 'non-exceedence' (above the assessment curve), 'allowable exceedence' (below both curves), and 'unallowable exceedence' (below the assessment curve and above the reference curve). 'Unallowable exceedence' is generally the metric used in most cases.

For deep water and open water summer, the appropriate biological reference curves published in EPA 903-R-03-002 are used, using the 'ref_plot' program. Since both the assessment and reference curve are piecewise linear, repeated applications of the

trapezoidal rule can be used to calculate the areas. Deep channel is assessed using this program, but no reference curve is used so the assessment space is divided into non-exceedence and unallowable exceedence.

The 'tbl_dis_plot' works the same way except that the reference curve used is the standard 10% curve, which is specified as follows:

$$(x+b)*(y+b)=a$$

Where: b = 0.0429945

a = b^2 + b

This curve has the properties that it is hyperbolic, symmetric about the 1:1 line, passes through (1,0) and (0,1), and has a total area below the curve of 10%. Since the hyperbolic curve is continuous and the assessment curve is piecewise linear, it would be possible for the reference curve to have area below the assessment curve even if none of the points of articulation on the assessment curve were below the reference curve. For this reason, values of the hyperbolic function are calculated at the same points on the temporal axis as the assessment curve, and the evaluation is performed using the trapezoidal rule, as above.

2. <u>Submerged Aquatic Vegetation and Water Clarity Assessment</u>

If the submerged aquatic vegetation (SAV) acres are met in any individual Chesapeake Bay Program segment as described below, then the shallow-water submerged aquatic vegetation use is met in that segment. If the SAV acres are not met in any individual Chesapeake Bay Program segment, then the water clarity criteria shall apply to the water clarity acres in that segment. If these water clarity criteria are met to the bottom water-sediment interface for the number of water clarity acres in that segment, then the shallow-water submerged aquatic vegetation use is met; regardless of the number of acres of SAV in that segment. If sufficient data are not available to assess "water clarity acres", and the SAV criteria acres is not met, then the water shall be considered impaired for this designated use. If sufficient data is available to assess water clarity acres, and these water clarity criteria are met to the bottom water-sediment interface for the number of water clarity acres in that segment, then the shallow-water submerged aquatic vegetation use is met; regardless of the number of acres of SAV in that segment. For those segments that have 0 acres expected, they will be treated as though the SAV and water clarity designated use does not apply.

Designated Use	Chesapeake Bay Program Segment	SAV Acres[1]	Water Clarity Criteria (percent light-through-water)[2]	Water Clarity Acres[1]	Temporal Application
Shallow-Water Submerged Aquatic Vegetation Use	CB5MH	7,633	22%	14,514	April 1 - October 31
	CB6PH	1,267	22%	3,168	March 1 - November 30
	CB7PH	15,107	22%	34,085	March 1 - November 30
	CB8PH	11	22%	28	March 1 - November 30
	POTTF	2,093	13%	5,233	April 1 - October 31
	POTOH	1,503	13%	3,758	April 1 - October 31
	POTMH	4,250	22%	10,625	April 1 - October 31
	RPPTF	66	13%	165	April 1 - October 31
	RPPOH	0	-	0	-
	RPPMH	1700	22%	5000	April 1 - October 31
	CRRMH	768	22%	1,920	April 1 - October 31
	PIAMH	3,479	22%	8,014	April 1 - October 31
	MPNTF	85	13%	213	April 1 - October 31
	MPNOH	0	-	0	-
	PMKTF	187	13%	468	April 1 - October 31
	PMKOH	0	-	0	-
	YRKMH	239	22%	598	April 1 - October 31
	YRKPH	2,793	22%	6,982	March 1 - November 30
	MOBPH	15,901	22%	33,990	March 1 - November 30
	JMSTF2	200	13%	500	April 1 - October 31
	JMSTF1	1000	13%	2500	April 1 - October 31
	APPTF	379	13%	948	April 1 - October 31
	JMSOH	15	13%	38	April 1 - October 31
	CHKOH	535	13%	1,338	April 1 - October 31
	JMSMH	200	22%	500	April 1 - October 31
	JMSPH	300	22%	750	March 1 - November 30
	WBEMH	0	-	0	-
	SBEMH	0	-	0	-
	EBEMH	0	-	0	-
	LAFMH	0	-	0	-
	ELIPH	0	-	0	-
	LYNPH	107	22%	268	March 1 - November 30
	POCOH	0	-	0	-
	POCMH	4,066	22%	9,368	April 1 - October 31
	TANMH	13,579	22%	22,064	April 1 - October 31

1 = The assessment period for SAV and water clarity acres shall be the single best year in the most recent three consecutive years. When three consecutive years of data are not available, a minimum of three years within the most recent five years shall be used.

2 = Percent Light through Water = $100e^{(-KdZ)}$ where K_d is water column light attenuation coefficient and can be measured directly or converted from a measured secchi depth where K_d = 1.45/secchi depth. Z = depth at location of measurement of K_d.

3. Chlorophyll *a* Assessment

Designated Use	Chlorophyll *a* Narrative Criterion	Temporal Application
Open Water	Concentrations of chlorophyll *a* in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in undesirable or nuisance aquatic plant life, or render tidal waters unsuitable for the propagation and growth of a balanced, indigenous population of aquatic life or otherwise result in ecologically undesirable water quality conditions such as reduced water clarity, low dissolved oxygen, food supply imbalances, proliferation of species deemed potentially harmful to aquatic life or humans or aesthetically objectionable conditions.	**March 1 - September 30**

A river specific approach to translating this narrative criterion into numerical criteria for assessment is currently under development for the James River (Virginia Department of Environmental Quality. 2004. Virginia Department of Environmental Quality Technical Report: Chlorophyll a Numerical Criteria for the tidal James River. November 30, 2004 (revised January 12, 2005). This approach has not been approved by the State Water Control Board in time to be used in the 2006 assessment. Future assessment reports may use similar approaches dependant upon the outcome of the James River process, as well as ongoing efforts of the Federal-Interstate Chesapeake Bay program, to determine appropriate numerical criteria for other waters.

Chesapeake Bay Criteria Segmentation, Assessment and Assessment Database (ADB) Reporting Units
Chesapeake Bay program segmentation scheme as described in Chesapeake Bay Program. 2004. Chesapeake Bay Program Analytical Segmentation Scheme-Revisions, Decisions and Rationales: 1983 -2003, CBP/TRS 268/04. Chesapeake Bay Program, Annapolis, Maryland is listed below and shall be used as the spatial assessment unit to determine attainment of the criteria in this section for each designated use.

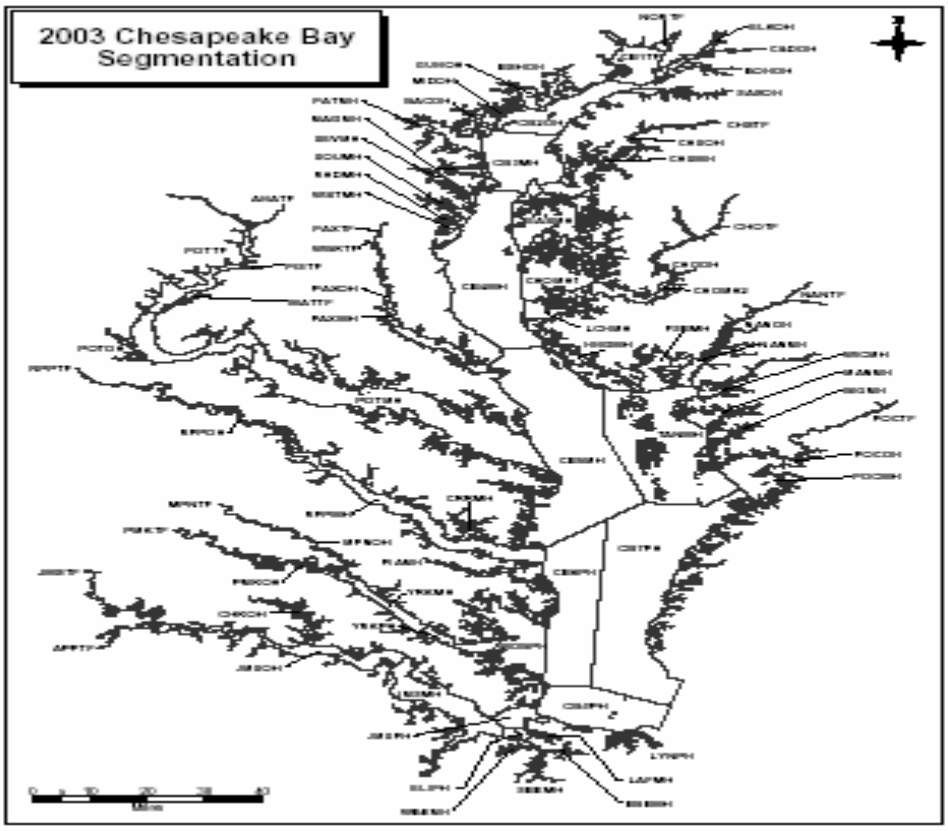
Chesapeake Bay Segment Description	Segment Name[1]	Chesapeake Bay Segment Description	Segment Name[1]
Lower Central Chesapeake Bay	CB5MH	Mobjack Bay	MOBPH
Western Lower Chesapeake Bay	CB6PH	Upper Tidal Fresh James River	JMSTF2
Eastern Lower Chesapeake Bay	CB7PH	Lower Tidal Fresh James River	JMSTF1
Mouth of the Chesapeake Bay	CB8PH	Appomattox River	APPTF
Upper Potomac River	POTTF	Middle James River	JMSOH
Middle Potomac River	POTOH	Chickahominy River	CHKOH
Lower Potomac River	POTMH	Lower James River	JMSMH
Upper Rappahannock River	RPPTF	Mouth of the James River	JMSPH
Middle Rapphannock River	RPPOH	Western Branch Elizabeth River	WBEMH
Lower Rapphannock River	RPPMH	Southern Branch Elizabeth River	SBEMH
Corrotoman River	CRRMH	Eastern Branch Elizabeth River	EBEMH
Piankatank River	PIAMH	Lafayette River	LAFMH
Upper Mattaponi River	MPNTF	Mouth of the Elizabeth River	ELIPH
Lower Mattaponi River	MPNOH	Lynnhaven River	LYNPH
Upper Pamunkey River	PMKTF	Middle Pocomoke River	POCOH
Lower Pamunkey River	PMKOH	Lower Pocomoke River	POCMH
Middle York River	YRKMH	Tangier Sound	TANMH
Lower York River	YRKPH		
1= First three letters of segment name represent Chesapeake Bay segment description, letters four and five represent the salinity regime of that segment (TF = Tidal Fresh, OH = Oligohaline, MH = Mesohaline and PH = Polyhaline) and a sixth space is reserved for subdivisions of that segment.			

During the development of the new Chesapeake Bay water-quality criteria, the Chesapeake Bay Program Water Quality Steering Committee (WQSC) specified that criteria assessment units would be defined by CBP monitoring segments and designated use areas. The applicable language reads ”Attainment of all three Chesapeake Bay criteria should be assessed by Chesapeake Bay segment separately for each designated use habitat. Therefore, each designated use habitat in an individual Chesapeake Bay Program segment is considered a spatial assessment unit. This is consistent with the scale of

data aggregation and reporting for Chesapeake Bay tidal water quality monitoring and the physical scale of the designated use areas. (Water-Quality Criteria document, page 150, par. 3; page 154, par. 3)".

The Chesapeake Bay program segmentation scheme (*Chesapeake Bay Program Analytical Segmentation Scheme-Revisions, Decisions and Rationales: 1983 -2003,* CBP/TRS 268/04. Chesapeake Bay Program, Annapolis, Maryland) is listed below and shall be used as the assessment unit to determine attainment of the criteria in this section for each designated use (Figure 1). The spatial boundaries of each aquatic life use subcategory within each of these CBP segment are described in the *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland.

Figure 1. Bay Criteria Analytical Segmentation



The Assessment Database (ADB) is used to track assessment data for all designated uses across the state. ADB assessment unit spatial boundaries are defined by many factors including the availability of data to assess for any/all designated uses. There are many ADB assessment units included in each Chesapeake Bay program segment assessment unit.

In ADB, attainment status can only accept estuarine assessment units defined by surface areas (i.e. square miles). The complete water column within that assessment unit is assigned to a single aquatic life use attainment status. In applying the Chesapeake Bay Aquatic Life Criteria, each individual Bay segment assessment unit may have deep channel, deep water, and open water aquatic life designated use areas (that may only account for a portion of the total volume/area of the assessment unit) which each will have its own aquatic life use attainment status. In order to accurately report the results of the Chesapeake Bay Aquatic Life Criteria assessment, the assessments from the two segmentations schemes will have to be joined to prepare the final assessment

To address the issues between the two segmentation schemes for the 2006 reporting cycle, the following procedures will apply:

1) The existing system of ADB assessment units will remain essentially the same as used in 2004. Adjustments will be made to ensure that ADB assessment units are divided at the same spatial locations as Bay segment assessment units.

2) Each ADB assessment reporting unit will be designated as having the overall aquatic life use attainment status of the appropriate CBP segment/designated use assessment areas which it is geographically coincident with. For example

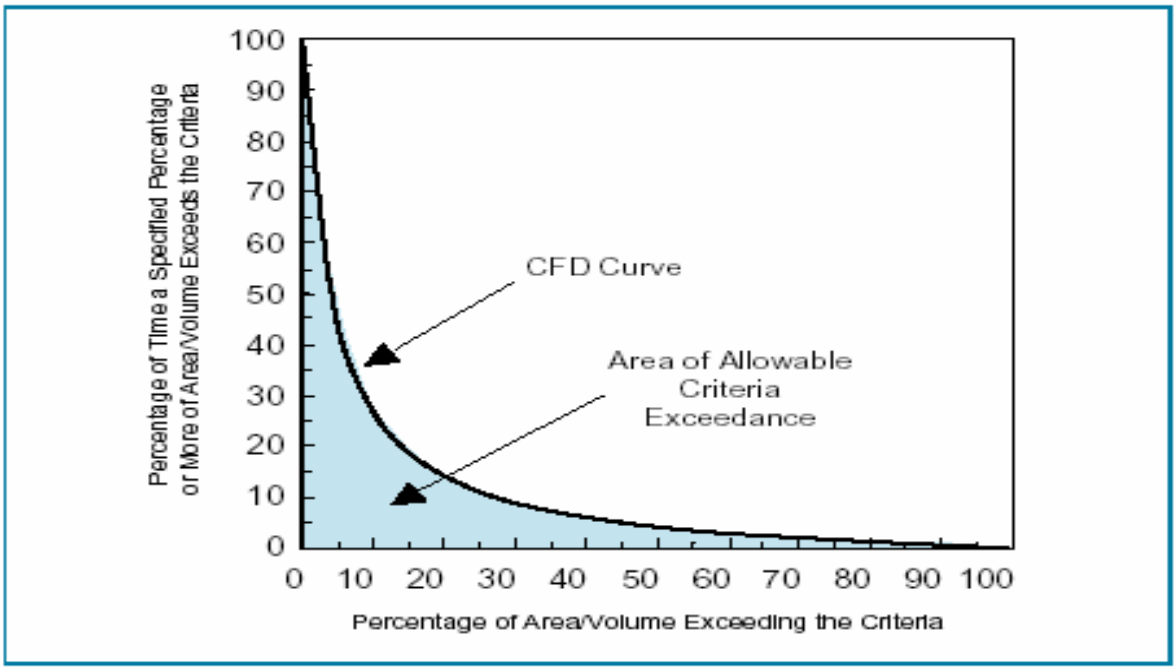
a) Open water designated extends from "shoreline to shoreline" within each CBP segment and thus all ADB reporting units located within the boundaries of each CBP segment is reported as having "open water" aquatic life use attainment consistent with the CBP segment attainment of open water criteria.
b) Deep water designated use spatial boundaries within each CBP segment are spatially constrained as smaller areas within the larger CBP segments (see *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum.* Chesapeake Bay Program Office, Annapolis, Maryland). Thus the "deep water" designated use status for each CBP segment will apply only to ADB reporting units which contain a "deep water" designated use area.
c) The overall aquatic life use status of any single ADB assessment unit will be assigned to the "worst case" status of aquatic life use within that ADB assessment unit (e.g. an ADB reporting unit containing an open water use which meets it's associated criteria and a deep water use which fails it's associated criteria will be overall categorized as failing aquatic life use). It may be noted here that any other aquatic life criteria assessments applicable to ADB assessment unit (e.g. for benthic communities or Toxics "weight of evidence etc…) also determine the overall aquatic life use attainment, based on a 'worst case" determination.

3) New 303(d) listings will be based on the above described methods. ADB assessment units that have been previously listed as non-supporting of Aquatic Life Use due to D.O. impairments, benthic aquatic impairments due to D.O. causes, or previously being "overlisted" will continue to remain on the 303d list until all applicable dissolved oxygen criteria are assessed and attained (i.e. any 7-day mean or instantaneous criteria must be assessed as well as the 30-day criteria).

4) Overall results of the Chesapeake Bay Aquatic Life Criteria assessment will be tracked in ADB using the new probabilistic survey module currently being developed by USEPA. This module will allow for the reporting of overall summary statistics for the Chesapeake Bay Aquatic Life Criteria assessment.

The assessment period for these D.O., water clarity and chlorophyll criteria shall be the most recent three consecutive years. When three consecutive years of data are not available, a minimum of three years within the most recent five years shall be used. Attainment of these criteria shall be assessed through comparison of the EPA Bay Program generated cumulative frequency distribution of the monitoring data to the applicable criteria reference curve for each designated use. If the monitoring data cumulative frequency curve is completely contained inside the reference curve, then the designated use for the criteria is attained. The reference curves and procedures to be followed are published in the USEPA, *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries*, EPA 903-R-03-002, April 2003. If no reference curve has been published by EPA, the "default" cumulative frequency distribution reference curve in Figure 2, which represents 10% allowable exceedences equally distributed between time and space, shall be the applicable reference curve. An exception to this requirement is in measuring attainment of the SAV acres, which are compared directly to the criteria.

Figure 2 . "Default" Cumulative Frequency Distribution Reference Curve



6.4.2.2 Free-Flowing Biological Assessment

DEQ is currently working with the U.S. Environmental Protection Agency and their contractor Tetra Tech to develop a Stream Condition Index for use in evaluating the integrity of benthic macroinvertebrate data in Virginia's freshwater non-coastal streams. This effort uses data from reference streams in Virginia to develop a numerical index to use for assessing the biological condition of these streams. The work to develop the new SCI for Virginia will not be finalized in time to allow the use of the new SCI in the 2006 assessment review. The 2006 Integrated Report will be assessing the biological data using the same methods and metrics as have been used by DEQ in previous 305(b) reports. DEQ intends to finalize this Stream Condition Index and use this new index to review the benthic biological data and make assessments of the biological data for the 2008 Integrated Report.

Evaluations of biological monitoring data from the DEQ biological monitoring program are used to assess support of the aquatic life use. Where ratings have changed during the 5-year reporting period and possibly between fall and spring, the regional biologist should determine the most appropriate rating for the assessment period. The following are considerations to be used when preparing bio-assessment results.

Consideration 1: Is a single biological survey sufficient data to make a water quality assessment?

The DEQ uses the Rapid Bioassessment Protocol II (RBP II) developed by the USEPA for non-coastal streams for biological assessment as well as the Mid-Atlantic Coastal Streams (MACS) Workgroup protocols for coastal plain streams. The RBP-II and MACS surveys follow a highly structured protocol that reaches an objective and repeatable ranking based on the raw data collected. Rankings, based on a single RBP-II or MACS survey, are the result of the data evaluation and reduction of numerous measurements and observations conducted during the sampling survey. The survey measures the response of the biological community to all perturbations it has experienced, integrated over time. A single, properly conducted, RBP-II or MACS survey is not a "single data-point" analogous to a single D.O. measurement or fecal coliform sample. It is proper to place a large degree of confidence in the results of a single well-conducted RBP-II survey, which shows no impairment or severe impairment. Slightly impaired or moderately impaired rankings are less certain and should be verified with further surveys or other ancillary data before complete confidence can be placed in the results. Slight impairment is considered fully supporting aquatic life due to the natural variability of the methodology. For the purpose of the 2006 305(b)/303(d) Integrated Report, a single moderately impaired RBP-II or MACS ranked water within the reporting period, will be listed as "fully supporting but having observed effects for aquatic life use" until further analysis can be conducted. If the single moderate impairment has been detected in the most recent two surveys, a justification for not listing the water as impaired must be provided. Otherwise, it should be listed as impaired. Further analysis should be given a high priority and an additional survey conducted as soon as possible. If additional surveys continue to show moderate or severe impairment, then the water will be listed as "impaired".

If the Biologist has observed natural conditions, such as high or low flow conditions at time of sampling or recent extreme drought or flooding, etc, or believe that unusual natural conditions are responsible for a questionable ranking, they should note the lack of confidence in the survey and it should not be used for assessment purpose nor should it be reported.

<u>Consideration 2</u>: Should Biological survey data be assessed like chemical data i.e. need more than 10% of the rankings to show impairment before it is listed as impaired?

The frequency approach is not appropriate for interpretation of multiple biological survey results over time. Biological data reflect the impacts of water quality conditions over a period of time. These data are different from chemical/physical data, which represent only the water quality at that single point in time. The reason it is acceptable to have 10% exceedences of a conventional standard and still say the waters are not impaired is that a judgment has been made that the system can sustain that many exceedences without being damaged. It is based on the assumption that water quality can slip below the standard occasionally for short periods of time without damaging water quality and/or aquatic life. The RBP-II or MACS data however, are a direct measurement of the condition of the biological integrity of the system. If impairment is noted, it means that damage to the community already has occurred. If you have less than 10% exceedences of a standard, damage to the aquatic system may or may not occur, however, a single biological survey can indicate that you currently have or have had a problem.

<u>Consideration 3</u>: How should five years of RBP-II surveys be interpreted for the 305(b) reporting period ?

The regional biologists should review the biological assessments for the five-year period and they should make a final biological assessment ranking based on these data. If you have spring/fall surveys each year for a 5-year period, this record can be used to describe any trend, which has occurred. Since RBP-II surveys are dependable records of the condition of the community at the time of the survey, the most recent survey should be the most accurate indicator of stream biological health at the time of report preparation. The older data indicate what conditions were at the time the surveys were completed, but if conditions have changed, they should be reflected in the more recent data. An attempt to average the data over a five year time period would weaken your ability to accurately predict current conditions. Aside from trend characterizations, the most recent ranking should be given the most consideration for the overall assessment of current conditions. Place the greatest validity in the last survey completed. If the last survey showed severely degraded conditions (and the biologist has confidence in their survey) but the previous samples showed only slightly impaired conditions, the stream should be considered severely impaired. If the last survey shows stream improvement, this should be given primary consideration.

A standardized fact sheet, as found in Appendix C of this manual, has been developed to help the regional biologists review and assess the data for the five-year period. The fact sheet includes a summary of the biological assessments for the five-year period and will be used to summarize and review all the information available for a site. The fact sheet allows for consideration of supplemental information about the watershed that is important in making the final assessment decision. In a case where the most recent biological assessment shows a significant change from previous rankings, special note should be made of any known recent changes to the watershed that may explain any changes in the more recent biological assessments

If a stream survey shows impairment based on old data (> 5 years), it should be monitored again to verify if conditions have improved, stayed the same or degraded. It should not be assumed that conditions have changed unless data are collected to validate that assumption.

<u>6.4.2.3 Estuarine Biological Assessment</u>

In cooperation with EPA RIII and the State of Maryland, DEQ has developed a new assessment methodology for estuarine benthic community biological (B-IBI) data to be used for the 2006 assessment. This new methodology will assure Bay wide consistency in determinations of estuarine benthic impairments and addresses some of the shortfalls of the previously used methodology based on the Stratified Wilcoxon Rank Sum test.

In the previously used Wilcoxon approach, a test was conducted to determine whether the percentage of sites with low B-IBI scores (< 3.0) significantly exceeds the percentage of sites with low scores in the reference distribution. In the case of multiple habitats, a mixture distribution was estimated using area-based weights for each habitat type. A

limitation of the approach was that it does not allow estimation of the magnitude of shift from reference conditions and also the method was too sensitive to small shifts in distributions of scores across the different habitats. The method thus was thought to possibly indicate impairment when in fact there is no ecologically significant difference from the reference condition and this was accounted for through the use of best professional judgment to 'override" some of the statistically based findings. DEQ has researched alternative methods that take into account the magnitude of departure from the reference condition, and whether this magnitude is above specific thresholds of protection that the States may wish to implement. The new method also generally removes the need for "best professional judgment"

New Methodology for 2006 Assessment

The new methodology incorporates uncertainty in the reference condition and is based on the confident limit and bootstrap simulation concept described in Alden et al. (2002). Bootstrap simulation (Efron and Tibshirani 1998) will be applied to incorporate uncertainty in reference conditions as well as sampling variability in the assessment data. For each habitat, a threshold based on percentiles in an unimpaired reference data set will be applied (i.e. 5th percentile). This threshold is not intended to serve as criteria for classifying individual B-IBI scores, rather it will be used to categorize the segment as impaired or not based on the proportion of samples below the threshold and the variance associated with this estimate.

The impairment assessment for each segment will be based on the proportion of samples below the threshold with the variance in this proportion estimated by simulation. In each simulation run, a subset of the reference "unimpaired" data for each habitat will be selected at random, and the threshold will be determined (i.e., the B-IBI score at the 5th percentile of the un-impaired dataset). A random subset of the assessment data will be compared to the threshold value to estimate the proportion of sites below the threshold. By repeating this process over and over again (2000 runs) we will estimate the variance in the proportion of sites below the threshold from the bootstrap estimates. For this analysis, we assume that each reference 'un-impaired" data set (by habitat) is a representative sample from a "super population" of reference sites.

The assessment result for each benthic segment (i.e. % of area with IBI score below 5th percentile threshold) is then statistically compared ($p<.05$) with the percentage that would be expected even if the segment is unimpaired. This percentage under "un-impaired" conditions is assumed to be 5%.

In addition to an assessment of impairment, a new discriminant analysis tool (benthic diagnostic tool) has been developed that can be used to identify sources of stress affecting benthic community condition in the Chesapeake Bay (Dauer et al. 2002). The results can distinguish stress due to contaminants versus stress due to other factors (e.g., low dissolved oxygen, or unknown). This tool will be used to identify which impaired segments have high probability of sediment contamination. Separately from the discriminant tool, the B-IBI metric scoring will also be used to identify (1) insufficient abundance patterns consistent with a low dissolved oxygen effect and (2) excessive abundance patterns consistent with eutrophication effects in the absence of low dissolved oxygen events. The combined use of these causal analyses will be used to assign causes for benthic impairments to either 1) Sediment chemical contaminants 2) Low dissolved oxygen 3) Eutrophication or 4) Unknown.

The spatial assessment unit for determining attainment of the general standard for aquatic life use using benthic community data will be the same as used in the 2004 assessment report. These criteria assessment units are described in "*Chesapeake Bay Program Analytical Segmentation Scheme-Revisions, Decisions and Rationales: 1983 -2003,* CBP/TRS 268/04. Chesapeake Bay Program, Annapolis, Maryland" with the additional caveat that minor tidal tributaries are considered separate benthic assessment segments.

Assignment of aquatic life use status, as determined by benthic assessments to ADB reporting waterbodies, will be the same as described previously for the new Bay criteria assessments found in Section 6.4.2.1. Each ADB reporting unit will be assigned the aquatic life use status of the benthic assessment segment in which it is geographically located.

References:

Alden, R.W. III. 1992. Uncertainty and sediment quality assessments: Confidence limits for the Triad. Environmental Toxicology and Chemistry 11:645-651.

Alden, R.W. III, D.M. Dauer, J.A. Ranasinghe, L.C. Scott, and R.J. Llansó. 2002. Statistical verification of the Chesapeake Bay Benthic Index of Biotic Integrity. Environmetrics 13:473 498.

Dauer, D.M., M.F. Lane, and R.J. Llansó. 2002. Development of diagnostic approaches to determine sources of anthropogenic stress affecting benthic community condition in the Chesapeake Bay. Report submitted to the USEPA Chesapeake Bay Program Office, Annapolis, Maryland, by Old Dominion University Department of Biological Sciences, Norfolk, Virginia. 65 pp.

Efron, B. and R. Tibshirani. 1998. An Introduction to the Bootstrap. Chapman & Hall/CRC.

Llansó, R.J., J.H. Vølstad, and D.M. Dauer. 2003. Decision Process for Identification of Estuarine Benthic Impairments. Final Report submitted to Maryland Department of Natural Resources, Tidewater Ecosystem Assessments, Annapolis, Maryland, by Versar, Inc., Columbia, Maryland.

6.4.3 Fish Consumption Use

The support of the fish consumption use can be based on two types of information. The first type include consumption advisories (limiting consumption) or restrictions (no consumption) issued by the VDH as per the Memorandum of Understanding (MOU) with DEQ. The second type includes the comparison of fish tissue data to WQ Standards criterion based tissue values (TVs) and tissue screening values (TSVs). Waters exceeding the same toxic WQ Standards derived value (TV) listed in Appendix E-1, for fish tissue two or more times are impaired for fish consumption. For example, both of the following situations would qualify as impaired under these criteria. Two fish samples from different species exceeding the same TV during one sampling event or two or more samples of the same or different species exceeding the same TV from different sampling events within the assessment period are considered impaired. See Section 6.5.2 for additional information on fish tissue analysis. Waters are assessed as impaired for fish consumption use if an advisory, specifically limiting consumption, or a restriction has been enacted. For additional information, fish consumption use support will be determined according to criteria found in Part V.

6.4.4 Shellfish Consumption Use

Shellfish consumption use support is based on the determination of restrictions or condemnations on the harvesting and marketability of shellfish resources made by the VDH-Division of Shellfish Sanitation (DSS) as of the most recent condemnation list (January 2005) associated with the reporting period. The DSS is the State agency with the statutory authority to determine shellfish harvesting and marketability status. The DSS uses four classifications for describing the status of shellfish waters. They are approved, conditionally approved, restricted, and prohibited and these are assessed according to the considerations found in Part V. A description of these terms follows:

Approved area:	Growing areas from which shellfish may be taken for direct marketing at all times.
Conditionally Approved:	Growing areas where the water quality may be affected by seasonal or sporadic use of boat docks or harbor facilities are considered conditionally approved. Normally, this would occur during the boating season (April 30 through October 31).
Restricted Area:	Growing areas where a sanitary survey indicates a limited degree of pollution which makes it unsafe to market shellfish for direct marketing. Shellfish from such areas may be marketed after purifying or relaying activities in accordance with certain VDH-DSS requirements.
Prohibited Area:	Growing areas where the sanitary survey indicates dangerous numbers pathogenic microorganisms or other contaminants that might reach that area. The harvesting of shellfish from these areas for direct marketing, relaying, or depuration is prohibited.

Specific information regarding DSS assessment methodology and the listing/delisting flowchart for shellfish waters can be found in Appendix C of this guidance document. For the 305(b)/303(d) Integrated Report, listing and delisting will be based on data assessed for the reporting period. However, as the TMDL begins development, if new or more recent data shows the shellfish water is no longer impaired, a petition for delisting will be crafted and submitted to EPA for their approval by the Watershed Program (TMDL) staff.

6.4.5 Recreation Use

Based on the requirements of Section 305(b), support of the swimming and secondary contact recreation uses are assessed together using the similar procedures used in past reports. However, for the 2006 report, E.coli (freshwater) and enterococci (transition zone and saltwater) data will also be assessed along with fecal coliform data unless 12 or more E. coli/enterococci samples have been collected, fecal coliform will not be assessed in this case. Waters should be assessed as impaired for the swimming use if fecal coliform, E. coli and/or enterococci bacteria data or bathing area closure indicates less than full support. See Part V for additional recreation use assessment information.

6.4.6 Public Water Supply Use

Toxics in drinking water are assessed according to the WQ Standards criteria (9 VAC 25-260-140.B) for public water supply and support of this use will be based on methodology described in Part V.

Section 6.5 ADDITIONAL PARAMETER ASSESSMENT

6.5.1 Nutrient Screening Values

The 1985 Virginia General Assembly established a joint subcommittee to examine nutrient enrichment problems in Virginia's portion of the Chesapeake Bay. One of the recommendations of their report was to direct the SWCB to develop standards to protect the Chesapeake Bay and tributaries from nutrient enrichment.

In 1986, the SWCB appointed a Technical Advisory Committee (TAC) to assist in the development of nutrient standards. The TAC recommended the following thresholds found in Table 4 for identifying nutrient impairment.

Table 4 TAC Recommended Nutrient Thresholds

Parameter	Freshwater Lakes	Flowing Waters	Estuarine	Tidal Freshwater
Chl (a)	25 ug/l monthly avg 50 ug/l MAXIMUM	Narrative Standard	120% of Background	120% of Background
Dissolved Oxygen	Narrative Std	24 hr fluctuation > 1/3 oxygen saturation	Standard related to background Chl (a)	Standard related to background Chl (a)
Total Phosphorus	50 ug/l	100-200 ug/l	No Standard Monitor only	No Standard Monitor only
Total Nitrogen	No Std	No Std	No Std	No Std

Ug/l = micrograms per liter

However, **the SWCB did not adopt the recommendations of the TAC** and these values will **not** be used unless specified below. The agency adopted two regulations to protect Virginia's waters from the effects of nutrient enrichment. The first regulation allows the Board to designate "nutrient enriched waters" where there has been degradation due to the presence of excessive nutrients. The second regulation allows the control of nutrient discharges from point sources into the designated "nutrient enriched waters".

In the absence of approved numerical WQ Standards nutrient criteria for chlorophyll a and total phosphorus or universally accepted nutrient criteria, the assessment process will not designate a segment impaired, based on nutrient data alone. However, these waters will be listed as fully supporting but having observed effects for aquatic life, where monitored nutrient screening values have been exceeded. It is recognized that other designated uses could be affected but the aquatic life use is considered the primary use affected by nutrient enrichment.

- Procedure for Assessing Nutrient Monitoring Data

For "free flowing" streams, total phosphorus will be assessed for the five-year period. The screening value (SV) is 200 ug/l. For assessment of lakes, the total phosphorus SV is 50 ug/l. In the absence of other monitored data related to aquatic life use, if at least two samples exceed the SV and these exceedences are >10.5% of the total samples, the water will be listed as fully supporting but having observed effects for aquatic life use. Single samples meeting or exceeding

the SV will not be assessed. And a single exceedence from a small dataset (2-9 samples) is considered fully supporting. For phosphorus and chlorophyll (a) evaluation, the primary concern is the impact on dissolved oxygen concentrations as it relates to aquatic life.

For fresh and tidal fresh waters, estuaries and lakes, chlorophyll (a) will be assessed for the five-year period. The SV is 50 ug/l. In the absence of other monitored data related to aquatic life use, if at least two samples are available and exceedences are >10.5% of the total samples, the water will be listed as fully supporting but having observed effects for aquatic life use. A single sample will not be assessed and a single exceedence from a small dataset (2-9 samples) is considered fully supporting. Once again, it is recognized that other designated uses could be affected. However, for chlorophyll (a) evaluation, the primary concern is increased algae production and the corresponding impact on dissolved oxygen concentrations.

DEQ is in the process of creating and adopting nutrient related WQ Standards for all waters. Nutrient criteria associated with aquatic life designated use for the Bay and tidal tributaries have been developed first as part of the new Chesapeake Bay Standards, with lake criteria and free-flowing stream criteria being developed thereafter. See section 6.4.2.1 for additional information on the new Bay criteria.

6.5.2 Fish Tissue and Sediment Toxics Assessment

- **Fish Tissue (Consumption) Use**

The WQ Standards and Biological Monitoring Programs known as WQSBP, collects fish tissue samples from designated monitoring stations for contaminant analysis. WQSBP staff identifies the results of any analysis that exceeds the WQ Standards criterion based tissue value (TV) or tissue screening value (TSV) found in Appendix E-1 and E-2 respectively, for the toxic contaminants and provides this data to water quality assessment (WQA) staff. Older fish tissue data may be included where deemed appropriate.

Fish tissue data collected at stations during routine monitoring throughout Virginia represent Tier 1 monitoring data. These Tier 1 monitoring data are meant to identify sites where concentrations of contaminants in the edible portions of commonly consumed fish indicate a potential health risk to humans. Usually, three fish tissue composite samples are analyzed for chemical contaminants at each Tier 1 station. Each is a composite of edible fillets for one species of fish from a top-level predator, a mid-level predator, and a bottom feeder. If Tier 1 results reveal potential problems, a more intensive Tier 2 study is initiated by the WQSBP staff to determine the magnitude, geographical extent, and potential sources of contamination in the fish. The need for a more intensive Tier 2 study takes into consideration the severity of the potential concern and is initiated as soon after the discovery of a potential problem as resources allow. Generally, if additional information is requested by the Virginia Department of Health for determining the need for fish consumption advisories, a follow-up monitoring effort is initiated the year after the discovery of the potential problem. If limited resources prevent this, the waterbody will be sampled more intensely as soon as resources allow and at least during the next rotation of monitoring in the river basin which is conducted on a rotational basis every three to five years.

Analytical results for fish tissue are expressed in wet-weight and are compared to WQ Standards TVs and TSVs for the toxic pollutants using EPA risk assessment techniques for noncarcinogen and carcinogen effects. WQ Standards human health calculations use the 10^{-5} risk level adopted by the State Water Control Board in 1992, an average human body weight of 70 kg and a lifetime average fish consumption rate of 6.5 grams per day (general U.S. population). These same values are used to calculate the human health water quality criteria found in 9 VAC 25-260-140.B. Also included in the calculation, are toxicological data pertinent to human health effects. A reference dose (RfD) is used for non-carcinogen toxic effects and a cancer oral slope factor is used for carcinogen effects. TV's are based on the same toxicological data (and body weight, fish consumption, and cancer risk level) that form the basis for the water quality criteria listed in 9 VAC-25-260-140.B, under the column labeled "Human Health, All Other Surface Waters". These water quality criteria are water column concentrations that are based on a specific fish tissue concentration, which were calculated to represent a safe or acceptable minimal human health risk level. The water quality criteria are designed to prevent the fish from bioconcentrating the toxic contaminants to levels greater than these fish tissue concentrations. The TV concentrations listed in Appendix E-1 represent the same fish tissue concentrations that are the basis for the water quality criteria listed in 9 VAC-25-260-140.B and may be considered the fish tissue concentration

equivalent of those water quality criteria. Appendix E-1 contains TV's for all chemicals for which Virginia has adopted water quality criteria. However, many of the TV's listed in Appendix E-1 do not bioaccumulate and are not often found in fish tissue and have been included for completeness. All TVs are rounded to two significant digits.

Appendix E-2 also lists TSV's for additional toxic chemicals for which Virginia has not adopted water quality criteria that are based on fish tissue concentrations (those criteria listed under "All Other Waters" in 9 VAC-25-260-140.B). It includes chemicals recommended for monitoring by EPA or of special interest to DEQ as well as some chemicals that are based on recent changes to toxicological data and /or exposure assumptions that are different from those used to calculate the water quality criteria found in 9 VAC-25-260-140.B. The TSV's are updated using available data from the EPA IRIS database and/or recommendations from EPA or the VDH before each assessment effort.

If a fish tissue composite sample exceeds a single WQ Standards TV or TSV, the water body should be delineated as fully supporting but having an observed effect for the fish consumption use. If the TV for the same toxic pollutant is exceeded in two or more samples from the same site, the water is considered impaired. For example, both of the following situations would qualify as impaired under this criterion: two different fish samples from different species during one sampling event or two or more different samples of the same or different species from different sampling events. Data from all Tier 1 and Tier 2 monitoring studies are evaluated by DEQ as well as provided to the VDH for their consideration of the need for establishing fish advisories. DEQ and VDH have signed a Memorandum of Agreement (MOA) that describes how the agencies exchange information regarding the results of all Tier 1 and Tier 2 fish tissue monitoring. If VDH issues a fishing ban or advisory, limiting consumption, the segment should be designated impaired for fish consumption use based on the advisory. The results of the Tier 2 study should be clearly communicated in the Integrated Report narrative.

- **Sediment (aquatic life use)**

Similar to the sediment monitoring and analysis conducted by WQSBP, the regional offices will assess the AWQM sediment data. For freshwater sediments above the fall-line, the Consensus Based Probable Effects Concentrations (PEC; MacDonald et al. 2000) should be applied. If a PEC is unavailable for a particular contaminant, the VA 99th percentiles should be used where available (see Appendix F). Estuarine sediment contaminant data collected during scheduled AWQM monitoring should be compared to National Oceanic and Atmospheric Administration (NOAA 1995) effects-range-medium (ER-M) SVs for sediment. Once again, if the ER-M is not available, use the VA 99th percentiles where available (see Appendix F). <u>One or more exceedences of an ER-M/PEC value results in a fully supporting but having observed effects status for aquatic life use support. In these cases, additional biological monitoring should be scheduled to assess actual aquatic life use support.</u> For National Coastal Assessment, a "weight of evidence" approach using sediment toxicity and sediment chemistry will be used to determine aquatic life designated use. See Section 6.5.3 for additional information. All metals contaminant screening values found in Appendix F have been converted to parts per million (ppm) for consistency.

6.5.3 <u>Additional Toxics Evaluation</u>

- **Freshwater Toxics Evaluation**

For overall freshwater toxics evaluation, DEQ uses the Virginia WQ Standards for human health in surface waters, other than public water supplies (9 VAC 25-260-140.B). These same values are used to assess the fish consumption use in public water supplies as well as all other surface waters. (Please note the criteria for human health in public water supplies will be used to assess the drinking water use in PWSs only). For metals assessment, only dissolved metals data will be used. In conformance with water quality management plans and VPDES permitting procedures, water column toxicant data collected up to 5 years prior to the current 305(b) period should be assessed along with current data <u>if they reflect current conditions</u>. When assessing the aquatic life and wildlife use support for toxic contaminants, compliance should be based on meeting the aquatic life WQ Standards found in 9 VAC 25-260-140 B. See Part V for additional information.

- **Estuarine Toxics Evaluation**

The intent of ambient toxics monitoring is to perform a quick screen of the medium of interest to determine whether a potential exists for the presence of toxic pollutants that negatively impact aquatic life. Measurable effects applicable to the biota include survival, growth and reproduction, which are derived from toxicity tests, and/or the status of the resident benthic community. While ambient water can be the focus of these efforts if there is a nearby source, more often the medium of interest is sediment because chemical contaminants have a greater affinity for suspended particles that ultimately settle to the bottom of all water bodies. Historically, ambient toxics monitoring of sediment focused solely on bulk chemicals, or on a less frequent basis, simultaneous collection of both chemicals and the benthic community. The interpretation and subsequent assessment of data based on one or two evaluation methods are often filled with uncertainty and frequently lead to a recommendation for additional sampling if the community is stressed. To reduce uncertainty in ambient toxics-related studies, Virginia, the Federal EPA Chesapeake Bay Program, and other Federal efforts (NOAA, and the National Coastal Assessment Program) have adopted a more holistic approach. Ambient sediment toxicity studies performed in the Chesapeake Bay Estuary (Hall et al., 1997) have employed a three-tiered method that focuses on toxic pollutants found in the sediment and their potential affects on the biological communities. These studies were designed to follow the Sediment Quality Triad (SQT) concept originally developed by Chapman et al. (1986, 1987) and which continues to be the preferred approach (Chapman, 1992; Chapman et al., 1997; McGee et al., 2001; Roberts et al., 2002; Roberts et al., 2003).

Table 5. Possible SQT Conclusions and Listing Decisions for Estuarine Toxics Evaluation. Adopted from Chapman (1992).

Scenario	Chemistry	Toxicity	Benthic Community Alteration	Possible Conclusions	Listing Decision (Weight dependent)
1	1-3 "+"	1-3 "+"	1-3 "+"	If "+++" in all three categories, strong evidence for chemical contaminant-induced degradation.	**VA Category 5A** (Cause = Toxics)
2	0 "+"	0 "+"	0 "+"	Strong evidence for absence of chemical contaminant-induced degradation.	**VA Category 2A**
3	1-3 "+"	0 "+"	0 "+"	Chemical contaminants are not bioavailable.	**VA Category 2A (or 2B)**
4	0 "+"	1-3 "+"	0 "+"	Unmeasured chemical contaminants or conditions may exist that have the potential to cause degradation.	**VA Category 2A**
5	0 "+"	0 "+"	1-3 "+"	Alteration is probably not due to chemical contaminants.	**VA Category 3B or 5A** (Cause = Water Quality)
6	1-3 "+"	1-3 "+"	0 "+"	Chemical contaminants are likely stressing the system.	**VA Category 3B (or 2B)**
7	0 "+"	1-3 "+"	1-3 "+"	Unmeasured chemical contaminants are causing degradation.	**VA Category 3B (or 2B)**
8	1-3 "+"	0 "+"	1-3 "+"	Chemical contaminants are not bioavailable or benthic alteration is not due to chemical contaminants.	**VA Category 3B**

"+" Indicates measured difference between test and control, reference conditions, or bulk chemistry and applicable SQG.
"–" Indicates no measurable difference between test and control, reference conditions, or bulk chemistry and applicable SQG.

Scenario 1. With many possible variations, all three triad attributes must be evident at a high level. Best professional judgment will be necessary in cases where "+ + +" are not attained in all three categories.

Scenario 2. There are no other variations as all three data types overwhelmingly demonstrate the aquatic life designated use is being met in stream.

Scenario 3. With a lack of biological effects, it is rather unlikely the chemical contaminant(s) are in a form that is bioavailable. It is possible, although unlikely that a toxicant could exceed its SQG $\geq$ 2x but fail to yield toxic affects (ancillary data such as AVS or TOC would be supportive). It can be concluded there is attainment of the aquatic life designated use.

Scenario 4. Unmeasured chemical contaminants may be contributing to the observed toxicity. Without benthic degradation, there are several other possibilities. The unmeasured toxicants are not bioavailable in-stream, or toxicity test conditions are highly favorable for expressing the toxicant effects from the unkown(s), or perhaps the associated toxicity is an artifact of the test itself (i.e. ammonia or salinity adjustment). If more than one species is affected, best professional judgment shall be applied.

Scenario 5. Some possibilities for benthic alteration could be a result of nutrient enrichment, habitat condition, habitat type, or a high energy environment. However, toxic contaminants are an unlikely cause of the stressed community.

Scenario 6. Best professional judgment should be applied by assessing the magnitude of both the chemical stressors and their toxicological effects. On the other hand, significant weight must be given to the B-IBI as an indicator capable of integrating all in-situ stressors over time.

Scenario 7. Chemical contaminants cannot be ruled out as targeted analytes are not very extensive and observed biological effects could be a result of unknown contaminant(s). Additive or synergistic effects from chemical contaminants could also be occurring. Again, best professional judgment should be applied.

Scenario 8. The benthic community could be impacted for reasons highlighted in Scenario 5 above. However, the magnitude of the chemical contaminant component must be considered. Lack of sediment toxicity suggests the chemical contaminants may not be bioavailable or perhaps the toxicity test organism(s) are not sensitive to the toxicants. Best professional judgment is warranted.

Note: The symbols used in the matrix contained in the Excel Workbook differ somewhat from those used in the original "Sediment Quality Triad / Weight-of-Evidence" matrix described above. Rather than using dashes ("-") in the workbook matrix the same element is indicated with a zero ("0"). Furthermore, a numerical score is presented for each element and is equivalent to the number of pluses ("+") as originally described by Chapman. Finally, the sum (Total Score) is used as a 'qualitative' evaluation of the total effects observed during the SQT Weight-of-Evidence Assessment.

The SQT is an effects-based approach that describes the condition of the sediment relative to toxic pollutants. The three main components that are integrated into a “weight of evidence” analysis include: (1) bulk chemical data, (2) toxicity test

data, and (3) an evaluation of benthic community condition. Rather than considering each data type individually, the complementary methods integrate biological responses with chemical data (Chapman, 1992) for a more scientifically defensible assessment process. Chapman (1992) provides eight possible scenarios from which conclusions can be drawn with the SQT approach. It is this concept that serves as the foundation required for implementing the "weight of evidence" assessment from triad data (Table 5).

The objective of this guidance is to provide an explanation for interpreting data generated by the traditional SQT approach, but with added insight on how to consider "weighting" of each triad component. This is not to suggest sound scientific interpretation and best professional judgment are unnecessary, but does provide some degree of process simplification. Conceptually, this is a similar approach to that used by the Chesapeake Bay Program and its partners for the Toxics Characterization of the Bay (EPA 903-R-00-010, June 1999). The use of this guidance will provide assistance in "applying "weight" to the different triad components, which are then inserted into the classic SQT matrix. The bulk chemistry results, for example, can receive additional weighting based on the magnitude of exceedence of the applicable Sediment Quality Guideline (SQG). For toxicity tests, greater weight is applied with two or more statistically significant sediment toxicity tests than what is applied to a single significant test, for the affected endpoint. The type of toxicity test endpoints that exhibit statistical significance must also be given consideration, since the ecological consequence of not surviving is greater to a population of a species than the growth of individuals. Therefore, survival would receive a greater weight.

Benthic community alteration is often evaluated by establishing metric scores relative to thresholds (e.g., Weisberg et al., 1997) and then comparing the overall site B-IBI score with the defined ranges (e.g., Llansó et al., 2003) for the Chesapeake Bay. Weighting the overall benthic community condition with this B-IBI is straight-forward, as there are four categories ranging from good to severely degraded (see Table 6). An alternate benthic IBI, developed for estuaries of the Middle Atlantic Region (Llansó et al., 2002), will be used for assessment in non-Bay estuarine waters. Index values < 3.0 for this B-IBI are considered to indicate stressed benthic assemblages indicative of degraded conditions. When one or more measurements essential for the calculation of either of these B-IBIs is lacking, a third alternative is available. A modified benthic IBI, based on the 1990-1993 results of EPA's Middle Atlantic Integrated Assessment (MAIA) Program, was developed for the Virginian Biogeographic Province (Cape Cod to the mouth of Chesapeake Bay) by Paul et al. (2001). For this B-IBI, final values greater than zero (> 0.000) indicate non-degraded conditions and values less than zero (< 0.000) indicate degraded sites. Although no systematic salinity-induced bias has been demonstrated for any of these B-IBIs, it should be noted that all three are notably less reliable in low-salinity habitats, *i.e.*, oligohaline and tidal fresh waters (salinity < 5 ppt). Approximately 28% of Virginia's estuarine probabilistic sites sampled between 2001 and 2004 were within this salinity range!

Table 6. Chesapeake Bay B-IBI Ranges and Benthic Community Condition.

B_IBI	Benthic Community Condition
≥ 3.0	Meets Goal
2.7-2.9	Marginal
2.1-2.6	Degraded
≤ 2.0	Severely Degraded

Data Assessment

Bulk Chemistry data are compared with the appropriate Sediment Quality Guideline (SQG). It is recognized that extra caution must be applied for SQGs where weaker relationships existed between the threshold and an effect (e.g., ER-M – Nickel; PEC – Mercury, Nickel, Total PCBs, Total DDT, and DDE). If the study sites are located in a Tidal Fresh or Oligohaline (Transition Zone) area, the lower value of either the ER-M or PEC is applicable, whereas the ER-M has greater applicability within the more saline habitats. Based on the uncertainty associated with SQGs, the magnitude of exceedence is considered in the weighting process. For example, a contaminant that exceeds its guideline by a factor of four is more likely to be contributing to or may be the cause of observed toxicity, although a Toxicity Identification Evaluation (TIE) would be necessary for confirmation. If available, ancillary data such as Acid Volatile Sulfide (AVS) and/or total organic carbon (TOC) can be considered within the weighting, as these are important relative to the bioavailability of some metals (AVS) and organic compounds (TOC). Other factors worthy of consideration include: (1) length of the chemical target analyte list (many toxicants could be excluded so their presence/absence is unknown), and (2) sediment quality guidelines have not been developed for the majority of chemicals, so a basis for comparative

analysis for potential toxicity does not exist. Average and summed quotient values are also calculated from the SQGs although little, if any weight is presently applied.

The magnitude of observed effects can be considered for sediment toxicity. The survival of test organisms, expressed by the survival endpoint, is generally associated with higher levels of toxicants (although chemical additivity, antagonism and synergism can also play a role). Sub-lethal test endpoints that provide a measure of exposure effects at an increased level of sensitivity, with lower toxicant concentrations, include organism growth (expressed in weight), reburial (amphipods), etc. In relative terms, the ecological significance of these endpoints is not likely as critical as the measure of survival. Therefore, less weight is applied in cases where these endpoints show effects. In situations where the survival endpoint yields statistically significant effects by one or more species, greater weight would be applied accordingly. It is important to factor into the weighting the number, type and associated sensitivities of the test species. Attention must also be applied to artificial toxicity such as in the case of naturally occurring sediment ammonia. Another is salinity adjustment, which can geochemically alter the sediment, thus leading to changes in chemical bioavailability and ultimately affecting sediment toxicity (Roberts et al., 2002). Indigenous predators can also significantly alter the test outcome.

Benthic community alteration and application of an associated "weight" is easily obtained (refer to Table 5, see Figure 3). Best professional judgment may be necessary in cases where a degraded community could be a consequence of the habitat type. Alden et al, (2002) statistically determined there is greater uncertainty associated with scores derived from tidal fresh, oligohaline, and mesohaline habitats and labeled these as either degraded, non-degraded or of intermediate/ indeterminate quality. These scores were a result of habitat uncertainty rather than sediment quality.

While potential scenarios are too numerous to list, for many sites the conclusion should be obvious. For example, chemical contaminants are commonly detected but at concentrations below their respective SQGs. The biological results from the same samples indicate a lack of effects, as demonstrated by no sediment toxicity and a healthy benthic community. The resultant listing would be VA Category 2A (fully supporting designated use). On the opposite end of the spectrum, three components of the triad may show extreme effects and sediment would consequently be listed in the 5A category (impaired for toxics - needing a TMDL). For those instances where the conclusions are not obvious, it will be necessary to obtain consensual agreement between Central Office and the Regional Office associated with that water. If agreement cannot be attained, advice from the Academic Advisory Committee should be sought.

Figure 3 contains a flow chart and Table 5 includes Chapman's (1992) SQT matrix that was adapted for this process. When assessing each data type at a particular site, the resultant weighting can be incorporated into the triad matrix from which scenario comparisons can be made and a proper conclusion drawn. Included are eight possible scenarios with descriptions for toxics-related problems and the associated relationship to Virginia's impaired waterbody list. It is preferred that this approach only be applied when all three sediment data components are available from a particular site. It is still possible, however, to implement this process if only two elements are available, as long as data on the condition of the resident benthic community is included (e.g., sediment chemistry and benthic IBI or sediment toxicity and benthic IBI) and they are both in agreement as to the condition of the site (e.g., degraded or severely degraded). In those instances, a corresponding assessment may be attained (i.e., Category 5A with toxics as the cause). If only sediment chemistry and sediment toxicity data are available, follow-up monitoring should be scheduled (Virginia Assessment Category 3B), even if both chemical and toxicological results are in agreement on the potential existence of a toxic condition.

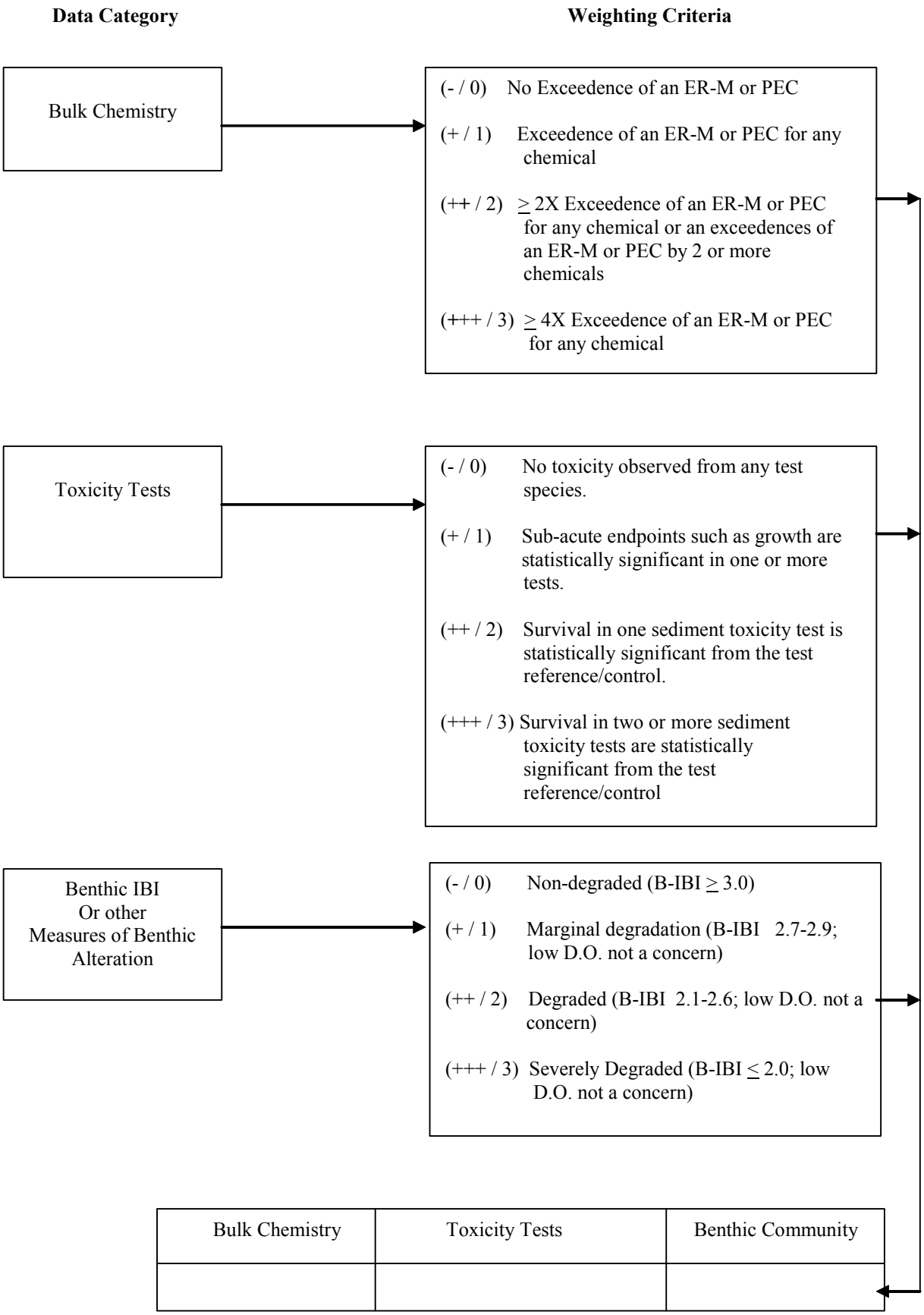
An Excel Workbook has been developed to help implement this process in a standardized, systematic manner. An example of this Excel workbook is electronically linked to this Assessment Guidance Manual:

Weight-of-Evidence Assessment Workbook - Ver 3.0 Template.xls

An example of a completed workbook is also included for the additional information to help with the Weight-of-Evidence assessment process:

Example - Weight-of-Evidence Assessment (2-ELI002.64)

Figure 3 - Flow diagram used to establish weighting for Sediment Quality Triad data generated by ambient toxics monitoring.



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6.5.5 Natural Low DO and pH Evaluation in Swamp Waters

Virginia's list of impaired waters currently identifies many waters as not supporting the aquatic life use due to exceedences of pH and/or DO criteria that are designed to protect aquatic life in Class III waters. However, there is reason to believe that most of these streams or stream segments have been misclassified and should more appropriately be classified as Class VII, Swamp Waters. A procedure for assessing if natural conditions are the cause of the low pH and/or low DO levels in a given stream or stream segment.

The level of dissolved oxygen (DO) in a water body is determined by a balance between oxygen-depleting processes (*e.g.*, decomposition and respiration) and oxygen-restoring processes (*e.g.*, aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen- depleting processes. The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity.

Conditions in a stream that would typically be associated with naturally low DO and/or naturally low pH include slow-moving, ripple-less waters. In such waters, the decay of organic matter depletes DO at a faster rate than it can be replenished and produces organic acids (tannins, humic and fulvic substances). These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems.

The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below. DEQ is using this approach to implement State Water Control Law 9 VAC 25-260-55, Implementation Procedure for Dissolved Oxygen Criteria in Waters Naturally Low in Dissolved Oxygen.

Waters that are shown to have naturally low DO and pH levels will be re-classified as Class VII, Swamp Waters, with the associated pH criterion of 4.3 to 9.0 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for these waters. An assessment category of 4C will be assigned until the waterbody has been re-classified.

LOW DISSOLVED OXYGEN (DO) AND pH NATURAL CONDITIONS ASSESSMENT

Following a description of the watershed (including geology, soils, climate, and land use), a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions), and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated in four steps.

Step 1. Determine appearance and flow/slope.

Streams or stream segments that have naturally low DO (< 4 mg/L) and low pH (< 6 SU) are characterized by very low slopes and low velocity flows (flat water with low reaeration rates). Decaying vegetation in such swampy waters provides large inputs of plant material that consumes oxygen as it decays. The decaying vegetation in swamp water also produces acids and decreases pH. Plant materials contain polyphenols such as tannin and lignin. Polyphenols and partially degraded polyphenols build up in the form of tannic acids, humic acids, and fulvic acids that are highly colored. The trees of swamps have higher polyphenolic content than the soft-stemmed vegetation of marshes. Swamp streams (blackwater) are therefore more highly colored and more acidic than marsh streams.

Appearance and flow velocity (or slope if flow velocity is not available) must be identified for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. This can be done through maps, photos, field measurements or other appropriate means.

Step 2. Determine nutrient levels.

Excessive nutrients can cause a decrease in DO in relatively slow moving systems, where aeration is low. High nutrient levels are an indication of anthropogenic inputs of nitrogen, phosphorus, and possibly organic matter. Nutrient input can stimulate plant growth, and the resulting die-off and decay of excessive plankton or macrophytes can decrease DO levels.

USGS (1999) estimated national background nutrient concentrations in streams and groundwater from undeveloped areas. Average nitrate background concentrations are less than 0.6 mg/L for streams, average total nitrogen (TN) background concentrations are less than 1.0 mg/L, and average background concentrations of total phosphorus (TP) are less than 0.1 mg/L.

Nutrient levels must be documented for each stream or stream segment to be assessed for natural conditions and potential re-classification as Class VII swamp water. Streams with average concentrations of nutrients greater than the national background concentrations should be further evaluated for potential impacts from anthropogenic sources.

Step 3. Determine degree of seasonal fluctuation (for DO only).
Anthropogenic impacts on DO will likely disrupt the typical seasonal fluctuation seen in the DO concentrations of wetland streams. Seasonal analyses should be conducted for each potential Class VII stream or stream segment to verify that DO is depressed in the summer months and recovers during the winter, as would be expected in natural systems. A weak seasonal pattern could indicate that human inputs from point or nonpoint sources are impacting the seasonal cycle.

Step 4. Determine anthropogenic impacts.
Every effort should be made to identify human impacts that could exacerbate the naturally low DO and/or pH. For example, point sources should be identified and DMR data analyzed to determine if there is any impact on the stream DO or pH concentrations. Land use analysis can also be a valuable tool for identifying potential human impacts. Lastly, a discussion of acid rain impacts should be included for low pH waters.

7Q10 Data Screen

If the data warrant it, a data screen should be performed to ensure that the impairment was identified based on valid data. All DO or pH data that violate WQ Standards should be screened for flows less than the 7Q10. Data collected on days when flow was < 7Q10 should be eliminated from the data set and the violation rate recalculated accordingly. Only those waters with violation rates determined days with flows > or = 7Q10 flows should be classified as impaired.

In some cases, data were collected when flow was 0 cfs. If the 7Q10 is identified as 0 cfs as well, all data collected under 0 cfs flow would need to be considered in the water quality assessment. In those cases, the impairment should be classified as 4C, "impaired due to natural conditions", no TMDL needed. However, a reclassification to Class VII may not always be appropriate.

NATURAL CONDITION CONCLUSION MATRIX

The following decision process should be applied for determining whether low pH and/or low DO values are due to natural conditions and justify a reclassification of a stream or stream segment as Class VII, Swamp Water.

If velocity is low or if slope is low (<0.50%) AND
If wetlands are present along stream reach AND
If no point sources or only point sources with minimal impact on DO and pH AND
If nutrients are < typical background
- average (= assessment period mean) nitrate less than 0.6 mg/L
- average total nitrogen (TN) less than 1.0 mg/L, and
- average total phosphorus (TP) are less than 0.1 mg/L AND

For DO: If seasonal fluctuation is normal AND
For pH: If nearby streams without wetlands meet pH criteria OR if no correlation between in-stream pH and rain pH,

THEN determine as impaired due to natural condition
→ assess as category 4C in next assessment
→ initiate WQ Standards reclassification to Class VII Swamp Water
→ get credit under consent decree

The analysis must state the extent of the natural condition based on the criteria outlined above. A map showing land use, point sources, water quality stations and, if necessary, the delineated segment to be classified as swamp water should be included.

In cases where not all of these criteria apply, a case by case argument must be made based on the specific conditions in the watershed.

EXAMPLE ANALYSIS – pH

Following a description of the watershed (including geology, soils, climate, and land use); a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions); and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated as follows:

- Step 1: Are there low velocities or low slope? Are there large inputs of decaying vegetation in a wetland that produce acids and lower pH as they decay?
- Step 2: Are there excessive nutrients instream that can indicate human activity?
- Step 3: N/A
- Step 4: Does evidence of human impact though discharges or land use warrant a TMDL?

<u>Example Stream: White Oak Swamp</u>

<u>APPEARANCE/FLOW or SLOPE:</u>
Visual inspection upstream and downstream of bridges at Rt. 156 and Poplar Springs Rd, revealed very swampy conditions usually with standing water in woods on either side of the channel (provide photos and map of area).

The hydrologic slope from the 110 ft topo contour at rivermile 6.60 downstream to the 50 ft contour at rivermile 1.12 is estimated at 0.21%, considered low slope.

<u>NUTRIENTS</u>:
- Total Phosphorus Av. 0.047 mg/l (n=78)
- Orthophosphorus Av. 0.024 mg/l (n=70)
- Total Kjeldahl Nitrogen Av. 0.61 mg/l (n=78)
- Ammonia as N Av. 0.03 mg/l (n=78)
- Nitrite + Nitrate as N Av. 0.10 mg/l (n=6)

→ Below USGS Average Backgrounds

<u>HUMAN IMPACTS</u>:
- Capital Regional Airport Commission (VA090301) reported pH twice per year for 2000 - 2003 at pH 7.19, 5.10, 6.56, 6.89, 6.44, and 8.44. One pH 4.20 in Aug 2001 during no flow period. Max flow 1357 cfs at Beulah Rd. stormwater outfall during Nov. 2001 to Apr 2002.
- Henrico MS4, 3 General Ind. Minors and 5 Ind. Stormwaters have no pH reporting requirements.
- High Intensity Commercial / Industrial land use comprised 9.0 % of watershed (1586 ac), however only 6.7% pH violations at Beulah Rd, with highest pH values.
- Watershed predominately forested (57.3 percent), with 9.2 percent wetlands and open water.
- Human E. coli impairment at 22% of annual load, therefore it is possible that human activities impact watershed in headwaters.
- Acid rain impact analysis
  - White Oak Swamp is located east of the fall line and an acid rain impact analysis developed for the nearby Mechumps Creek can be applied
  - 10 stations within 17 miles of Mechumps Creek have 2 to 15 years of pH data.
  - If acid rain is an impact, all stations should have low pH impairment, however:
  - 5 stations within 13 miles to the west above the Fall line have higher pH and no impairment (mean pH 6.63 - 7.01); Little, Newfound, and South Anna Rivers, Falling Creek, Stony Run.
  - 5 stations within 17 miles to the east below the Fall line have low pH and natural

impairment (mean pH 5.89 - 6.44); Hornquarter, Herring, Totopotomoy, Monquin, and Matadequin Creeks.

CONCLUSIONS:
- Low slope, with predominantly wetlands, not indicative of human impact.
- Low nutrients, not indicative of human impact.
- Human activity above Beulah Rd. can affect pH in headwaters, but there was no observed pH impact downstream at Rt. 156 attributed to the headwaters commercial / industrial land use.
- Low pH is more related to swamp water from low slope swamps below the Fall Line than to acid rain.

→ White Oak Swamp and its tributaries exhibit low pH due to natural conditions and should be re-classified as Class VII, Swamp Water, with the associated pH criterion range of 4.3 to 9 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for these waterbodies. An assessment category of 4C will be assigned until the waterbody has been re-classified.

EXAMPLE ANALYSES - DO

Following a description of the watershed (including geology, soils, climate, and land use); a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions); and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated as follows:
- Step 1: Are there low velocities or low slope? Are there large inputs of decaying vegetation in a wetland that produce acids and lower DO as they decay?
- Step 2: Are there excessive nutrients in-stream that can indicate human activity?
- Step 3: Do seasonal changes lower DO in summer and raise it in winter?
- Step 4: Does evidence of human impact though discharges or land use warrant a TMDL?

Example Stream: Tuckahoe Creek

APPEARANCE/FLOW or SLOPE:
Visual inspection at bridges on Rt. 6 and Rt.650 revealed very swampy conditions. A large wetland named Big Swamp exists for 4 miles above Rt. 6. There are wetlands noted on the land use map along Tuckahoe Creek and Little Tuckahoe Creek from just below Rt. 250 downstream approximately 8 miles to below Rt. 650. Wetlands promote input of decaying vegetation throughout this 8 mile segment, which causes low DO from bacterial decomposition (provide photos and map of area).

The hydrologic slope from the 150 ft topo contour at river mile 10.55 below Rt. 50 downstream to the 120 ft contour at river mile 2.59 above the old railroad grade below Rt. 650 is estimated at 0.07%, considered very low slope.

NUTRIENTS:
- Total Phosphorus Av. 0.074 mg/l (n=226)
- Orthophosphorus Av. 0.043 mg/l (n=218)
- Total Kjeldahl Nitrogen Av. 0.64 mg/l (n=224)
- Ammonia as N Av. 0.067 mg/l (n=226)
- Nitrite + Nitrate as N Av. 0.31 mg/l (n=23)

→Below USGS average backgrounds, and below background levels in a permitted livestock study by DEQ.

SEASONAL FLUCTUATIONS:
Seasonal fluctuations of DO values where within normal ranges.

HUMAN IMPACTS:
- Henrico Water Treatment Plant (VA0091197) is not required to report DO or CBOD.
- Henrico County MS4 (VA0088617) is not required to report DO or CBOD.
- Two general stormwater permittees, Henrico WTP and Short Pump Town Center, are not required to report DO or CBOD.

- High Intensity Residential, Commercial / Industrial land use comprise 21 % of watershed (8647 ac), located in the eastern portion of the watershed.
- Watershed is predominately forested (52 percent), with 5 percent wetlands / open water.
- Human E. coli impairment is at 12% of annual load, the lowest among three watersheds in Henrico County receiving bacterial TMDLs. However it is still possible that human activities impact watershed.

CONCLUSIONS:
- Low slope, predominantly wetland in impaired segment, not indicative of human impact.
- Low nutrients, not indicative of human impact.
- Normal seasonal DO fluctuation.
- Unknown if DO impact observed at Rt. 6 can be attributed to human activity. Henrico WTP has little impact on DO. The Henrico MS4 has an unknown impact on DO, but discharges following rain events with high velocity, promoting elevated DO from reaeration, and unknown BOD loads. Residential, Commercial / Industrial land use (21%) has suspected effect on watershed.

The impaired segment of Tuckahoe Creek exhibits low DO due to natural conditions and should be re-classified as Class VII, Swamp Water, with the associated pH criterion range of 4.3 to 9 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for this waterbody. An assessment category of 4C will be assigned until the waterbody has been re-classified.

Low DO values in the two tributaries appear to be at least partially due to anthropogenic inputs. However, 7Q10 analysis resulted in changed violation rates for two tributaries from 12.1% to 8.9% (Little Tuckahoe Creek) and from 15.9% to 9.6% (Deep Run).

Section 6.6 LAKE and RESERVOIR ASSESSMENT

DEQ has completed the process of reviewing and revising the Lakes Monitoring and Assessment Program. A program to prioritize the many lakes and reservoirs has been developed. This prioritization allows the Department to focus on the most important lakes as they relate to designated uses. Limited resources will then be able to be utilized for these significant lakes and an intensive monitoring schedule can be conducted that will allow a thorough assessment of those priority lakes.

Meanwhile, for the 2006 assessment, the lakes and/or reservoirs, which meet the following definition of a "significant lake", will be reviewed as available data allow. A list of current significant lakes is included in Appendix G of this document.

1. All publicly accessible public water-supply lakes and/or;
2. All publicly accessible lakes 100 acres or more in size.

This definition includes the federally owned lakes, which meet these criteria, but all other federally owned lakes would be excluded from the agency lakes monitoring program.

At least one of these two criteria must be met for the lake assessment consideration:

1. lakes and reservoirs should have exceedences of numerical WQ Standards, with actual data observations in DEQ files, as well as confirmation made by more than a single data point, or
2. for any parameters for which DEQ does not have a Water Quality Standard, a loss of designated use (fishable, swimmable, public water supply) documented by ancillary data (such as records of conditions preventing swimming and/or boating, recurrent fish kills, other QA/QC approved non-agency studies or reports, etc.)

6.6.1 Interpretation/Assessment Issues Unique to Lakes and Reservoirs

The assessor should provide a complete narrative documenting assessment decisions. If uses are impacted, document those uses impacted and how they are impacted. Name causes and sources where possible, (e.g. nuisance algal blooms preventing swimming during summer months, numerous complaints on file or aquatic weed growth preventing free

navigation of lake and/or expensive mechanical or chemical clearing, etc). Assessment should be performed and documented by the regional biologist or other designated regional staff. The regional 305(b) coordinator will be responsible for entering the data into the ADB (Assessment Data Base).

Background*:*
It is a natural condition for lakes to stratify in the summer due to the thermal gradient that forms because of surface heating and then acts to separate the warmer less dense upper layer (epilimnion) from the cooler denser lower layer (hypolimnion). If the lake is sufficiently deep for stratification to occur, the hypolimnion may become anoxic because there is no oxygen restoring processes taking place, while natural detritus settling from the epilimnion and sediment oxygen demand (SOD) continue to deplete the available oxygen. Excessive nutrients delivered to lakes can aggravate the problem by stimulating production, which feeds additional organic matter to the hypolimnion and can reduce the transmission of sunlight to the lower layers of the epilimnion. In the absence of sunlight, algae and phytoplankton in the bottom of the epilimnion begin to respire, removing oxygen from the epilimnion.

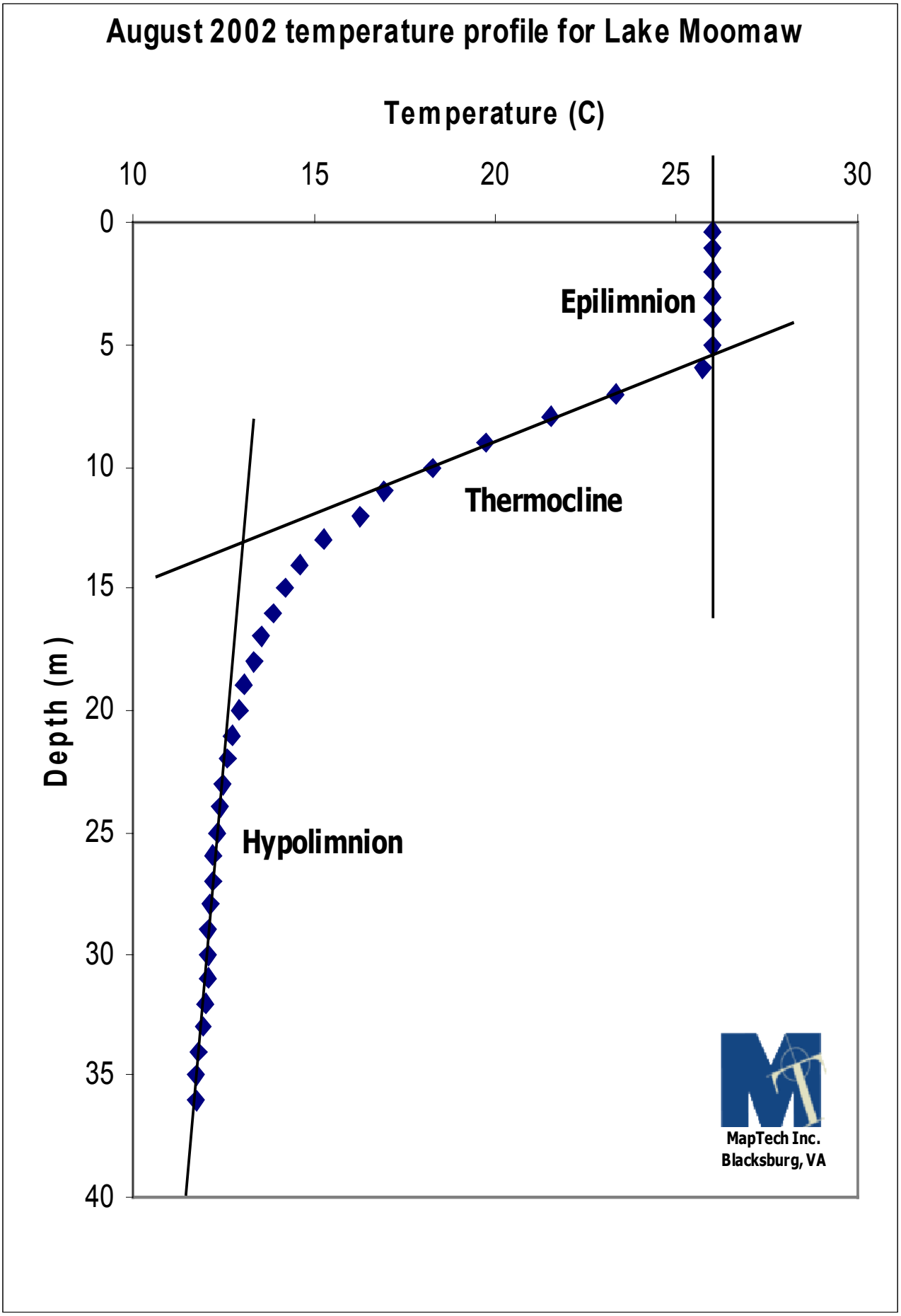
The natural dissolved oxygen (DO) depletion process of lakes can be compounded by anthropogenic activities that contribute significant amounts of nutrients or organic matter to the system. This guidance outlines the general approach for determining lake DO impairments and a logical process to determine if anthropogenic pollutants are exacerbating the natural DO depletion process. The general approach is to assess the water quality data from the lakes and evaluate antidotal information in the watershed. First, the temperature data will be evaluated to determine if the lake is stratified and determine the configuration or thermal zones of the lake. The, DO measurements will be assessed using Virginia's DO standard. Next, the Trophic State Index (TSI) will be calculated to determine if excessive nutrients are contributing to low DO concentrations in the hypolimnion. Finally, antidotal information such as fish kill data and land use information will be evaluated to determine if the natural conditions of the lake are possibly exacerbated by anthropogenic activity. Also, the guidance provides justification for proceeding with TMDL development or an alternate path such as revision of the water quality criteria for DO.

Monitoring Station Data:
If a lake monitoring station has more than one year of data, the data will be aggregated for the entire assessment period for the analysis. The 10.5% violation factor will not be applied to the TSI analysis since it is being used only as an indicator of anthropogenic pollutants. For large lakes having more than one monitoring station, each monitoring station will be assessed individually.

TMDL Development and Assessment Process*:*
The process for TMDL development and assessing lakes and reservoirs is described in the following 4 steps. This methodology applies to all lakes/reservoirs previously assessed as well as lakes/reservoirs being assessed for the 2006 assessment.

<u>Step 1: Determine if Lake/Reservoir is Stratified</u>
Temperature data collected in the summer months (June through September) is used to develop a temperature profile of the lake. A lake or reservoir is considered stratified if there is a difference of ≥ 4ºC between the surface-to-bottom temperature (June through September). If the differential between T_t and T_b is < 4ºC the lake is not considered stratified and the entire water column will be treated as a homogenous unit

Stratified Lakes - 2 Methods to Delineate the Epilimnion and Hypolimnion
First, if a thermally stratified lake is sufficiently deep to develop a well-defined thermocline, the epilimnion and hypolimnion can be determined from a plot of the temperature profile. The thermocline (metalimnion) or transition zone separates the overlying epilimnion and the underlying hypolimnion. A temperature profile from Lake Moomaw is shown below to illustrate the delineation of the thermal layers.


August 2002 temperature profile for Lake Moomaw
Temperature (C)
10
15
20
25
30
0
5
10
15
20
25
30
35
40
Depth (m)
Epilimnion
Thermocline
Hypolimnion
MapTech Inc.
Blacksburg, VA

Second, there are conditions in thermally stratified waters where the temperature profiles do not allow the thermocline and thermal layers to be clearly delineated due to shallow depths, unusual circulation patterns, or other problems. In cases where the layers cannot be clearly defined, assume the epilimnion is the upper 1/3 of the water column and the hypolimnion is the lower 2/3 of the water column.

Non-stratified Lakes
If the lake's temperature differential (T_t and T_b) for the summer months (June through September) is < 4ºC, the lake is not thermally stratified and the entire water column will be treated as a homogenous unit.

Step 2: Apply DO criteria

Epilimnion:
For each monitoring station, all DO data collected in the epilimnion (delineated using temperature profile or assumed to be the upper 1/3 of the water column) will be aggregated and assessed. If the violation rate exceeds 10.5%, the assessment unit or entire lake/reservoir will be assessed as impaired partially due to one or more pollutants from anthropogenic sources and will be placed in category 5A for TMDL development. If the violation rate is less than 10.5%, assess the hypolimnion.

Hypolimnion:
For each monitoring station, all data collected in the hypolimnion (delineated using temperature profile or assumed to be the lower 2/3 of the water column) will be aggregated and assessed. If the violation rate exceeds 10.5%, the lake/reservoir will be assessed as impaired partially due to one or more pollutants. Go to Step 3 and calculate the Tropic State Indices to determine whether the violations are due to pollutants from anthropogenic sources or natural sources. If the violation rate is less than 10.5%, the assessment unit or lake will be assessed as fully supporting.

Non-stratified Lakes - Water Column Treated as Homogenous Unit:
If the lake is not stratified (T_t and T_b differential <4ºC) all DO data in the water column will be aggregated and assessed~~)~~. If the violation rate exceeds 10.5%, the assessment unit or entire lake/reservoir will be assessed as impaired partially due to one or more pollutants from anthropogenic sources and will be placed in category 5A for TMDL development. If the violation rate is less than 10.5%, the assessment unit or lake will be assessed as fully supporting.

Step 3: Apply Trophic State Indices (TSI)

Secchi Depths (SD), Chlorophyll *a* (CA), and Total Phosphorus (TP) will be calculated only on stratified lakes (T_t and T_b differential ≥ 4ºC) using aggregated station data in the epilimnion from mid-June through mid-September (at 0.3 m for TP and CA).

A tropic state index value of 60 or greater for any one of the 3 indices will indicate that nutrient enrichment from anthropogenic sources are adversely interfering, directly or indirectly, with the designated uses. A TSI value of 60 corresponds to a CA concentration of 20 ug/l, a SD of 1 meter, and a TP concentration of 48 ug/l.

Following are the TSI equations:

$$TSI(SD) = 10(6 - (\ln SD / \ln 2))$$
$$TSI(CA) = 10(6 - ((2.04 - 0.68 \ln CA) / (\ln 2)))$$
$$TSI(TP) = 10(6 - ((\ln (48 / TP)) / (\ln 2)))$$

SD = meters
CA = ug/l
TP = ug/l

The following rules apply:

1. Do not calculate a chlorophyll a TSI in lakes that are treated with algaecides.
2. The Chlorophyll a TSI will normally be the preferred indicator in un-treated lakes.
3. Assume that typical Virginia freshwater lakes and reservoirs are phosphorus limited.
4. Do not use the secchi depth index in the assessment if it is much larger than the CA and TP indices in the same assessment unit (prevalence of inorganic matter).

5. The appropriate TSIs should be calculated based on all summer sample data collected in the segment using the spreadsheet that has been developed for easier data processing.

For each monitoring station, if one or more of the TSIs ≥ 60*, the lake/reservoir will be assessed as impaired partially due to one or more pollutants from anthropogenic sources. The assessment unit or entire lake/reservoir will be placed in category 5A for TMDL development.

For each monitoring station, if each of the TSIs < 60, the lake/reservoir will be assessed as impaired due to pollution from natural sources and placed in category 4C. A TMDL is not needed for the assessment unit represented by the monitoring station(s) and appropriate DO criteria will be developed for the hypolimnion.

Based on the results of calculating TSI indices, the reservoir trophic status will be assigned in the Assessment Database (ADB) according to Table 7.

Table 7 Trophic Index

Trophic State	Carlson Trophic State Index	ADB Category
Hypereutrophic	80 – 100	5A
Eutrophic	60 – Less than 80	5A
Mesotrophic	40 – Less than 60	4C
Oligotrophic	0 – Less than 40	4C
Unknown	Insufficient Data	3A

Step 4: Evaluate Anecdotal Information

Fish Kill Data
If there are documented chronic (more than 1) fish kills in the lake caused by low DO , the assessment unit or entire lake/reservoir will be assessed as impaired partially due to one or more pollutants from anthropogenic sources and will be placed in category 5A for TMDL development.

Lakes with Algaecide Applications
When the algae are killed from chemical applications they settle to the bottom taking phosphorous and particulate matter out of the epilimnion. Therefore, a lake subject to algaecide applications having a TSI for TP greater than 60 should be listed in category 5A for TMDL development if the land use or other information shows the probable presence of potential anthropogenic sources.

- A TSI value of 60 was chosen based on review of approved lake TMDLs for DO impairments.

Section 6.7 COASTAL ASSESSMENT

Virginia has 120 miles of Atlantic Ocean coastline and approximately 2,500 square miles of estuary. This resource has a prominent place in Virginia's history and culture. It is valued for its commercial fishing, wildlife, sporting, and recreational opportunities, as well as its commercial values in shipping and industry. In the 1970's adverse trends in water quality and living resources were noted and prompted creation of the Federal-Interstate Chesapeake Bay Program (CBP). The coastal assessment is conducted in the same manner as the estuarine assessments previously described in Sections 6.4.1.2 and 6.5.3.2. Additionally, the recently enacted federal BEACH program, which is being implemented by the VDH, has begun collecting recreational use data during the swimming season and assessment of this data is being incorporated into the 2006 Integrated Report.

Section 6.8 WETLANDS ASSESSMENT METHODOLOGY

Background:
Impacts to tidal wetlands, including vegetated tidal wetlands and non-vegetated shoreline between mean low and mean high water, are regulated under the Virginia Tidal Wetlands Act (Title 28.2, Chapter 13 of the Code of Virginia) enacted in 1972 and revised in 1982. The Virginia Marine Resources Commission (VMRC) is the regulating authority for the tidal wetlands laws while localities in Tidewater Virginia have the option to regulate their own tidal wetlands through

citizen Wetlands Boards with oversight from VMRC. The Virginia Department of Environmental Quality (DEQ) is responsible for providing Section 401 Certification of Clean Water Act for Section 404 federal permits for tidal and nontidal wetlands and water withdrawals, through the Virginia Water Protection Permit (VWPP) Program, first developed in 1992. In 2000, Virginia passed a Nontidal Wetlands Act that amended Section 62.1-44.15:5 of the Code of Virginia relating to wetlands. The Nontidal Wetlands Act mandates that the Commonwealth implement a nontidal wetlands regulatory program to achieve no net loss of existing wetland acreage and function, and to develop voluntary and incentive based programs to achieve a net resource gain in wetlands. Amendments to the VWPP program, fully implemented in October 2001, provide additional state jurisdiction and require a state permit for the following activities in a wetland: excavation, filling or dumping, activities in a wetland that cause drainage or otherwise significantly alter or degrade existing wetland acreage or function, and permanent flooding or impounding. The VWPP can serve as the Section 401 certification of a federal permit or as a state permit when no federal permit is required. The permit process for both tidal and nontidal wetlands relies on a Joint Permit Application (JPA) which receives independent and concurrent review by local wetlands boards, VMRC, DEQ and the U.S. Army Corps of Engineers (Corps), as appropriate.

By statute and by regulation, Virginia adopted the same definition of wetlands as the federal definition, and requires that wetlands be defined in the field using the Corps' 1987 Manual. Specifically, wetlands are defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Wetlands are part of state waters, which are defined as "all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction, including wetlands."

Tidal wetlands are defined to include tidally influenced areas within Tidewater Virginia contiguous to mean low water extending landward to an elevation 1 1/2 times the mean tide range at a site and upon which is growing certain listed plant species. They also include "nonvegetated wetlands" which include unvegetated lands between mean low water and mean high water tides.

Section 62.1-44.15:5 of the Code of Virginia specifies that the state utilize the Corps' Wetlands Delineation Manual (Technical Report Y-87-1, January 1987, Final Report) as the approved method for delineating wetlands, and that the state shall adopt appropriate guidance and regulations to ensure consistency with the Corps' implementation of delineation practices.

Purpose:
The overall wetland monitoring strategy is to establish baseline conditions in various broad contexts, including land use, watershed, and wetland type. This information can then be used to guide management decisions regarding wetland restoration efforts, programmatic compensatory mitigation, and integration with overall WQ Standards. This strategy provides the ultimate framework for an ongoing assessment of the status of the Commonwealth's wetland resources and the success of both wetland regulatory and voluntary programs. The wetlands monitoring strategy will be coordinated with Virginia's comprehensive water quality monitoring program strategy. The monitoring objectives are designed to support regulatory decision-making, allow reporting of wetland conditions, and provide information for policy development.

The wetland monitoring program will also meet the Clean Water Act objectives for water monitoring programs by addressing the quality of the Commonwealth's wetlands and their condition as part of the overall condition assessment of state waters.

By July 2006, DEQ will prepare and have in place a strategic plan for integrating existing and new programs into wetland monitoring. The plan will include tasks to accomplish, timelines for their completion, budget needs, and plans for funding these initiatives. This strategy will provide the ultimate framework for an ongoing assessment of the status of the Commonwealth's wetland resources and the success of both our wetland regulatory and voluntary programs. The end result will be the incorporation of on-going wetland monitoring and assessment into the Commonwealth's water monitoring programs.

Wetlands Assessment:

Virginia has begun application of a hierarchical suite of assessments that constitute a three level approach to wetlands sampling and analysis. Comprehensive coverage of all mapped wetlands is achieved with a GIS based analysis of remotely sensed information (Level 1 analysis). These data are summarized on the basis of small watersheds or hydrologic units. It provides a first order evaluation of the condition and functional capacity of wetlands based on their landscape position.

The second level assessment is intended for use in a statistically selected sub-sample of the watershed wetland population and involves a more sophisticated analysis of remotely sensed information and a site visit for verification and additional data collection. The third level assessment involves very detailed analysis of wetland performance of specific functions (i.e., habitat and water quality). This involves extensive sampling of a limited number of sites, specifically chosen to allow validation of the conceptual model of wetland function that underlies the Level 1 and Level 2 assessments.

Monitoring Program Development:
The DEQ wetlands program, in coordination with the overall DEQ water quality monitoring program, is working to develop a ten-year plan for wetland monitoring and assessment in Virginia. This work is being accomplished as a work product under EPA State Wetland Development Grant CD 983815-01 to the Department of Environmental Quality. The development of this strategy will follow the EPA October 2002 draft document "Elements of a Wetland Monitoring and Assessment Program Checklist" and will include a discussion of the following 'Ten Essential Elements of a State Water Monitoring and Assessment Program' (USEPA, March 2003):

1. Monitoring Program Strategy
2. Monitoring Objectives
   Information derived from monitoring will be used to:
   - Report ambient wetland conditions in Virginia's Clean Water Act (CWA) Section 305(b) reports;
   - Assist in the evaluation of environmental impacts of proposed impacts to wetlands during permit review as part of Virginia's regulatory program;
   - Evaluate the performance of wetland restoration and compensatory wetland mitigation in replacing wetland acreage and function; and
   - Evaluate the cumulative impacts of wetland loss and restoration in watersheds relative to ambient ecological conditions.
3. Monitoring Design
4. Core and Supplemental Water Quality Indicators
5. Quality Assurance
6. Data Management
7. Data Analysis/Assessment
   Examples of different wetland quality data analyses may include:
   - Comparison of wetland quality within a watershed and between watersheds
   - Comparison of wetland quality within a locality and between different localities
   - Comparison of wetland quality within a watershed or locality over time
   - Comparison of wetland quality between wetland types
   - Correlation of wetland type and specific stressor
   - Comparison of wetland quality within and between hydrogeomorphic (HGM) classes
   - Comparison of wetland quality within a specific wetland over time
8. Reporting
9. Programmatic Evaluation
10. General Support and Infrastructure Planning

As part of the overall development of a wetland monitoring and assessment strategy, an interagency committee of other state agencies involved in wetland issues, including the Chesapeake Bay Local Assistance Department, the Virginia Marine Resources Commission, the Department of Game and Inland Fisheries, and various programs within the Department of Conservation and Recreation will be established. The goal is to have this interagency committee available to review and comment on the monitoring and assessment strategy as implementation begins and to provide periodic updates on what other agencies are doing with regard to wetland resources.

Section 6.9 STATEWIDE TREND ANALYSIS

The Water Quality Monitoring, Restoration, and Information Act (WQMIRA Code of Virginia § 62.1-44.19:5) requires DEQ to include water quality trend analysis for the biennial 305(b) Water Quality Assessment report and 303(d) Total Maximum Daily Load Priority List.

> "Water quality monitoring and reporting.
>
> A. The Board shall develop the reports required by § 1313(d) (hereafter the 303(d) report) and § 1315(b) (hereafter the 305(b) report) of the Clean Water Act in a manner such that the reports will:…(ii) identify trends in water quality for specific and easily identifiable geographically defined water segments;… Data older than five years shall be incorporated when scientifically appropriate for trend analysis."

To meet the WQMIRA requirement, DEQ has previously incorporated the Chesapeake Bay Program trend results as well as the Virginia Water Resources Research Center (VWRRC) results from the document "Long-term Water Quality Trends in Virginia's Waterways" (1998) into recent 305(b)/303(d) reports. This original VWRCC trend analysis and subsequent report was sponsored by DEQ as a multi-phase project. During the first phase, the VWRRC developed the software program WQ1, performed the trend analysis, and generated the report. In the second phase, the VWRRC developed the WQ2 software program so that DEQ staff could do trend analyses in-house. Since the original report is now 6 years old, DEQ is generating its own trend analysis to be incorporated into the 2006 305(b)/303(d) report. DEQ is currently planning to update the trend analysis every 6 years (every 3rd 305(b)/303(d) assessment cycle).

The central question of trend analysis is: Are the waters of the Commonwealth improving over time? More specifically, in order to scientifically measure trends the question becomes: Is there an increasing, decreasing or no trend at a specific location for an individual variable?

The detection of trends in water quality variables implies that a change over a period of time is occurring. Key variables that exhibit significant changes over time may indicate improvements or declines in water quality at a specific location for a period of record. Trend detection is an important water quality assessment component in that restorative efforts can be measured to determine improvements as well as degradation of water quality.

The Water Quality Monitoring and Assessment (WQMA) Program of DEQ operates a trend monitoring network of approximately 260 stations distributed statewide. These stations are selected to represent stream conditions from a variety of waterbodies. Trend stations are typically located at the mouths of major rivers, along the fall line, collocated with flow monitoring stations, in major estuaries, on reservoirs, and at other points of interest where long term trend detection is a priority. Many of these stations have a long history of monitoring, in excess of 20 years with some in excess of 30 years, however there are a few stations with relatively short monitoring periods that will require an additional ten years of monitoring before being considered for formal trend analysis. The Chesapeake Bay Program (CBP) of DEQ operates a network of approximately 63 stations in the Bay and major tributaries which will be assessed for trends on CBP segments.

The analysis of water quality data for trend detection requires several basic assumptions. First, continuous monthly or bimonthly monitoring for a period of at least 10 years is generally necessary to determine with any statistical confidence a change in conditions. Second, the water quality variables collected over the period of record must be consistent. Third, monitoring frequency should remain fairly constant, with minimal periods of interruption. Fourth, stations should be sited to be most representative of watershed conditions.

The WQMA parameters being analyzed during the 2006 assessment are: Fecal Coliform Bacteria, Dissolved Oxygen % Saturation (DOSAT), Total Nitrogen, Oxidized Nitrogen, Total Phosphorus, pH, Temperature, Total Kjeldahl Nitrogen,

and Total Suspended Solids. The CBP parameters being analyzed during the 2006 assessment are: Total Nitrogen, Total Phosphorus, and Total Suspended Solids. During the 2006 cycle, the trend analysis will include monitoring data from 1985 through 2004, indicating the most recent 20 years of data as well as corresponding with the start of significant Chesapeake Bay Program initiatives.

As with the VWRRC report, the current analysis will be performed using a modified seasonal Kendall tau rank correlation analysis. The seasonal Kendall tau analysis reviews whether each observation has increased or decreased from the observation in the same month or season of the previous year. It is a measure of the consistency of the relationship and does not consider the magnitude of the change year to year (non-parametric), therefore it is considered robust against outliers. The CBP trend test is also a seasonal Kendall tau test as described in Dauer et al. 2005.

For the 2006 analysis, Drs. Golde Holtzman and Carl Zipper from Virginia Tech were retained to update the WQ2 software. This new program, WQ3, allows multiple parameters to be "batch-run", an improvement over WQ2 which had to run parameter by parameter. This greatly increases the ease of use and reduces the time needed for large reporting efforts.

6.9.1 Data Preparation

The data preparation and statistical analysis for the WQMA stations in the 2006 report will be handled by Roger Stewart and Don Smith in WQMA. The trend analysis will be run on all trend stations identified in the DEQ database. Once queried, data cleanup is necessary to review and address erroneous values and to prepare the data for analysis.

- For those rivers with depth profiles, only the surface value should be used. To do that, restrict the retrieval to depths of 1 m or less, but also include the old STORET legacy depths of 304.5m. (These represent surface samples collected before STORET could store a depth variable.) Then, compare the data from the same location/date/time and eliminate duplicates less than 1 meter and stratify the 304.5 m data by temperature (warmest at surface) and DO (highest at surface) to further eliminate duplicates. This should obtain the surface values with reasonable accuracy.

- Of the trend stations, each parameter must have at least 100 data points with no more than a 5 year data gap. Stations with less than 100 collection dates or less than100 pH values are queried out.

- Dissolved oxygen levels previously were measured by Winkler and are now measured by a probe. These results are combined to create one consistent parameter. When both Winkler and probe were reported at the same sampling event and time, the Winkler value is used. Once the dissolved oxygen data set is compiled, the values are converted to percent saturation (DOSAT) using temperature and salinity as described in Standard Methods for the Examination of Water and Wastewater, 20th Edition. Salinity values were calculated by converting from the specific conductance measurement when salinity was not reported.

- pH values 11 and above are generally deleted. Values above 10 should be deleted if they are isolated observations and appear to be significant outliers from the remainder of that station's pH values.

- For temperatures that appear to be erroneously high, the decimal point can be migrated if the new temperature seems appropriate and the result deleted if it does not. For temperatures that are negative, if the temperatures appear to simply have an incorrect sign, the value can be converted to positive; for those where the correct values cannot be determined (including those with values of -999.00), the results should be deleted

- The parameter codes 00665 and 70505, Total Phosphorus and Total Phosphate colorimetric method, respectively, should be combined.

- For all parameters, the comment code "K" is converted to code "U". The comment codes are defined in Appendix B.

- For fecal coliform values, for many years measurements were made using 31615 (MPN) and then later a combination of 31615 (MPN) and 31616 (MF) were used. All 31615 and 31616 values were copied into a new variable named BACT and treated as equal. If values exist for the same station and time, then the MPN method

results should be used. The fecal coliform comment codes ">" and "P" are converted to "L". The comment code "M" is converted to "U" and the comment codes "O", "R", "Q", "B", and "H" should be ignored.

Once the data set is finalized, it should be exported as text files into Statistica for manipulation. WQ3 is a SAS-based program and requires a strict table format; the instructions for creating that format are described in the WQ3 user's manual.

6.9.2 Trend Data Processing

After data cleanup, the data is imported into the pre-WQ preprocessing program. Pre-WQ has four separate macros that prepare the data for analysis in WQ3. The purposes of these macros in pre-WQ are described below;

- The user will choose which of the water-quality variables will be analyzed for trend. Typically more water quality variables are retrieved from the database in addition to those for which trends will be reported. These other variables are useful in determining the validity of outliers, possibly erroneous data and validity of detected trends.

- Uniform Detection Limits - When multiple detection limits are used through time, the Uniform Lower Detection Limits (ULDLs) and Uniform Upper Detection Limits (UUDLs) must be defined in pre-WQ. The ULDL should be the minimum detection limit that has the highest value. Conversely, in the case of multiple upper detection limits, the lowest value should be chosen. For example, with the MPN and MF methods of fecal coliform analysis, the LDLs are typically 18 and 100, respectively. When these values are combined, the ULDL should be defined as 100. Explanation: If two seasons were compared; the first with a quantified value of 60 and the second with a value of 100 (U), the trend analysis would be skewed to indicate a trend although we have no way to know how the second count truly compares to the first. To prevent this, all values less than 100 (the higher LDL) would have to be considered a tie.

  In the output, the maximum value will be listed as the highest "L" value, even if a particular analysis had a max UDL of less than that. To calculate the values as ties, the program changes all tied values to the highest UDL. So, for instance, if there are two upper detection limits, 8000 and 16000, the user should pick the UUDL to be 8000 and all values above 8000 are considered ties. To accomplish this, WQ3 sets all values >8000 to 16000. You will need to note that the listed maximum values may be well above the actual upper detection limit for any given result.

  Please note that for Total Suspended Solids, there were several detection limits: 1 mg/L prior to December 1990, 5 mg/L from January 1991 through March 1991, and 3 mg/L from March 1991 through present. Due to the very short period of time where the detection limit was 5 mg/L, 3 mg/L was used as the ULDL.

- Outliers – Significant work has been done to find and correct obviously incorrect values. The underlying data is being changed in CEDS when correct values can be determined. Where the source of the extreme value cannot be determined, the value should be left as is and will be used in the analysis. The pre_WQ preprocessing program enables allowable bounds to be defined; however, we will not use this option and will leave all values that cannot be confirmed to be in error. Because the seasonal Kendall's tau is robust against outliers, little effect from an outlier is expected – the magnitude of the values is not considered in the analysis, only whether it is higher or lower than a previous value. Due to the large number of comparisons between data points, one potentially incorrect determination of an increase/decrease should not have significant effect on the results. However, when reviewing the output, if any additional outliers are identified and can be explained, the reviewer will send the information (station, date, and parameter) to the CEDS Data Coordinator at CO. He will correct the value in the trend data set and rerun the analysis. In addition, the erroneous data point will be corrected in CEDS and identified in the Historic Field Data Screen Valid Value field as changed.

  - Total Nitrogen - The Total Nitrogen variable is calculated automatically by summing the results for Nitrate, Nitrite, (or in some cases, the variable Nitrate + Nitrite), and Total Kjeldahl Nitrogen.

Flow adjustment – WQ3 has the capability to perform flow adjustment on the trend analyses. Unfortunately, because a large number of DEQ monitoring stations are either tidally influenced or are free-flowing but cannot be correlated to gages, the non-flow adjusted method will be used for data reporting during the 2006 trend analysis. However, flow will be analyzed as a separate variable in the trend analysis to determine if there are any significant trends in flow over the

trend period of record. If statistically significant trends in flows are detected then the trend analysis for the other water quality variables must be rerun for the corresponding station. The daily average flow values were provided to DEQ from a special USGS custom retrieval that supplied monthly median flow in a separate text file format for each station. Each of these individual data files were combined into one data set that was imported into SAS and then analyzed using WQ3.

6.9.3 WQ3 Analysis

The modified seasonal Kendall's tau is a rank-order statistic that can be defined as the number of increasing values divided by the number of decreasing values. Tau is always between 1 and –1 where a 1 means all observations increase over the previous season's value and a –1 means all observations decrease from the previous value. The analysis is appropriate for use in truncated data sets that have upper and lower boundaries, as occurs with analytical detection limits.

Kendall's tau is a measure of the magnitude of the trend. The stronger the tau value, the more consistent the trend is. However, please note that it does not indicate the severity of the trend. For instance, DO values of 9.9, 9.8, 9.7, 9.6, and 9.5 would have a trend of –1 since all values are less than the one before; however, so would a trend of 9, 7, 6, 4, 1, which of course is a much more concerning trend. The tau indicates the consistency with which the step changes are in the same direction, not the size of the changes themselves. Another weakness of the method is that changes in trend direction (e.g. increasing trend for 10 years, then decreasing trend for 10 years) may cancel out and cannot be determined.

As stated, the analysis is the modified seasonal Kendall's tau. The "seasons" are blocks in time during the year and can be chosen to best fit the analysis and data set. If there is more than one observation in a season, then the median of the observations is calculated. For our use, historical sampling has occurred monthly through most of the time period, therefore for the 2006 analysis we will use 12 monthly "seasons". However, in future years it may be necessary to reduce to 6 seasons to match the current bimonthly monitoring schedule.

The p-value is the probability of observing a tau of equal or greater magnitude than that calculated from the data collected, if no real trend was present. The smaller the P-value, the more contradictory are the data to the H_0 hypothesis that no real trend is present (tau = 0). We will use p-value <0.05 (5%) to indicate statistical significance. In other words, we will have a 95% confidence that a real trend is present.

Two p-values are reported in WQ3 – independent and dependent; for our use dependent p should be used (pvalcovs). Dependent p assumes that the water quality observations for individual months or blocks are linked and accounts for the correlation. For example, the water quality in January is assumed to be similar to the water quality in February, etc.

WQ3 includes a slope estimator to assist with determining the severity of the trend, as discussed above. The seasonal Kendall slope estimate is defined as the "average" rate of change per year of the water quality parameter. Again, the dependent value should be used. Note that with this method, a situation can occur where a significant tau indicates a trend is present, but the slope is zero. This usually occurs in data sets where the majority of data is "tied" at the lower detection limit, but there are occasional values that are higher. If there is a distinctive shift through time in the number of quantified values, then a trend can be determined, but since the vast majority is tied values, the slope does not change.

The WQ3 output will be incorporated as a table in the EPA Assessment Database (ADB) to ensure that the data are kept together. The goal is to eventually create a field in the AU screen to allow linkage of the AU with a trend station.

Note that in data output, all results are reported as Seasons, not data points. For instance, the observations column in printout is number of Seasons, not number of original data points. This includes the listed minimum and maximums as well, which may actually be calculated medians. On the output graphs, original data are shown as black dots; calculated medians in cases where more than one observation per month were collected are represented as letters with A for season 1 (January), B for season 2 (February), etc.

The following labels are used for each of the trend parameters:

BACT – fecal coliform bacteria
DOSAT – Dissolved Oxygen % saturation
Nitrogen – total nitrogen

NOx – Nitrate (NO3) + Nitrite (NO2)
P1 – phosphorus
pH
Temp - temperature
TKN – Total Kjeldahl Nitrogen
TSS – total suspended solids

6.9.4 Individual Assessment Results

For the first time, data from trend stations will be used not only for the regular 5-year water quality assessment, but also to determine threatened waters based on long-term trends. To accomplish that, the trend analysis results will be entered into ADB and incorporated into the 305(b) assessment in addition to the standard assessment performed on the data collected at each trend station. For the trend assessment, segmentation should be performed using the same methodology as for ambient watershed stations, CBP stations or for previous assessments using the trend station. In ADB, in the AU comment field, list the trend monitoring station, put (T) for trend as per the ADB data entry guidance, and identify specific significant results (e.g. any statistically significant trend(s) and if assessed as an observed effect or if threatened as outlined below.) For each segment, please indicate in the assessment methodology that trend analysis was performed (Assessment Type # in the Assessment Documentation screen).

A column has been added to the data output that calculates the projected value in 2008. This is calculated using the equation for the slope line; "Intercept" is the value at year 0 and "Thielsen" indicates the estimated slope, i.e. the change in the observation or median year, of the trend line.

Assessment categories for conditions projected for 2008 based on the trend line analysis will be assigned as described in the following paragraphs.

For temperature and pH, if the Thielsen slope is projected to violate the instantaneous WQ Standards within the 2008 listing cycle and the p-value is less than 0.05, indicating statistical significance, then in collaboration with the TMDL coordinator assess the water as threatened for the applicable use (Assessment Category 5A, marked as threatened water in ADB).

If, in the following assessment cycle, water quality conditions for the regular assessment window indicate full support of the applicable use, the segment will no longer be considered threatened, and will receive the appropriate assessment category in accordance with standard assessment guidance.
New source codes for projected impairments by next assessment cycle–

Increasing trend in temperature #
Increasing/decreasing trend in pH #

For phosphorus, if the projected value in 2008 violates the DEQ screening value and the p-value is less than 0.05, (indicating statistical significance) assess the water as fully supporting with observed effects - Category 2B. If, in the following assessment cycle, water quality conditions for the assessment window indicate full support of the applicable use, the segment will receive the appropriate assessment category in accordance with standard assessment guidance. As nutrient standards are approved and adopted, trend analysis to determine threatened status will be conducted and the results will be reported as described above for temperature and pH.

For fecal coliform, the WQ Standards is being phased out and being replaced by standards for E. coli and enterococci. Currently, the fecal coliform standard does not apply at stations that have been sampled 12 or more times for E. coli/enterococci and the fecal coliform WQ Standard will no longer apply anywhere after 2008. Due to the short length of time that DEQ has been monitoring for E. coli and enterococci, we are unable to apply trend analysis to these parameters. However, we are still interested in determining whether any long term bacteria trends can be detected. Therefore, if the trend result projects a statistically significant violation of the current fecal coliform trend assess the segment as having an observed effect – Category 2B. If, in the following assessment cycle, water quality conditions for the assessment window indicate full support of the applicable use, the segment will receive the appropriate assessment category in accordance with standard assessment guidance. In future trend assessments, DEQ will begin performing trend analysis on E. coli and enterococci as the monitoring period allows. At that time, if the results indicate a projected

violation, the segment would be classified as threatened (Assessment Category 5A) and would be treated as described for pH and temperature above.

New observed effect code –

Increasing trend in total phosphorus #
Increasing trend in fecal coliform #

In addition, if WQ Standards or screening values are developed for other parameters in the future, the parameter should be added to the threatened or observed effects categories as applicable and as described above.

6.9.5 Statewide Assessment Results

The trend results will be compiled into a stand-alone chapter of the 2006 305(b) Integrated Report. This chapter will be written by the 2006 Trend Committee.

An overall map showing the location of all trend stations that were analyzed will be included. In addition, we will include maps by parameter showing improving trends with white circles and deteriorating trends with dark squares. This will help determine any geographic tendency in the results. Stations where no significant trend was determined will be left off to help with visual display.

Narrative results will 1) summarize major results by basin, 2) summarize the results by parameter, and 3) discuss any regional or other significant results. A basin summary table will identify the increasing and decreasing trends by basin and subtotals the trends by parameter and number of degrading/improving sites by basin for all parameters. Any decisions for listing in categories other than 1A or 2A will be tabulated.

A section will be written that discusses blocking of the WQMA station trends by time period. As mentioned above, the seasonal Kendall method only determines monotonic changes and a change in trend direction may not be detected. To address this, the data will be blocked into two 10-year blocks and analyzed to determine recent more recent trends versus 20 year trends. Any significant results will be discussed in a subchapter of the report.

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PART VII 303 (d) LISTING/DELISTING and TMDL PRIORITY RANKING

Section 7.1 "EFFLUENT LIMITED" WATERS (Category 4B/5E)

Rule 1

When reviewing waters receiving effluent from facilities with water quality based effluent limits in VPDES permits, the following should be considered in developing the 303(d) list;

1. If the permit has been issued with no compliance schedule and the limits are to be met upon permit issuance, then listing is not necessary.

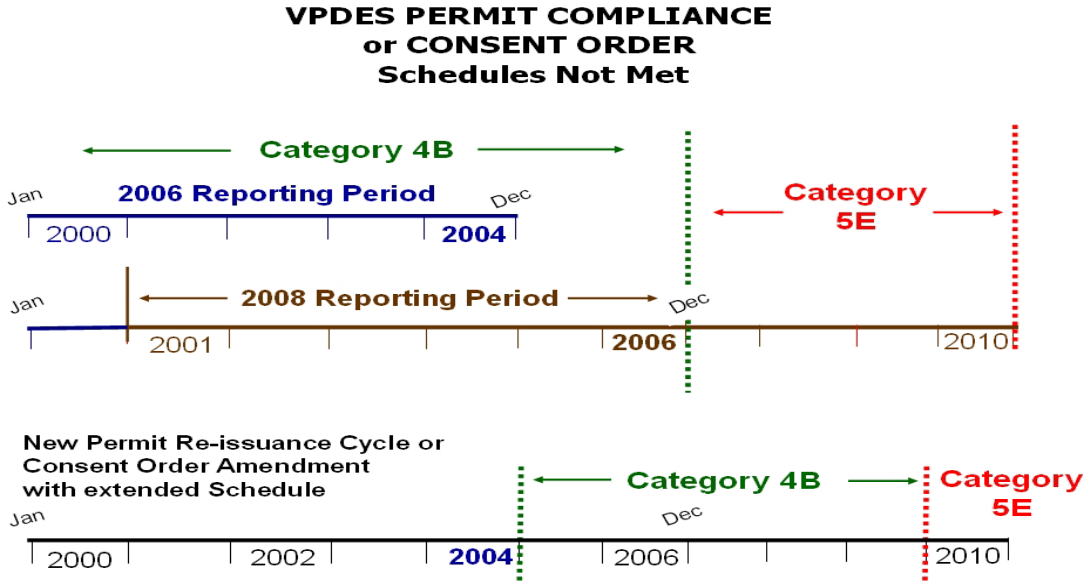
2. If the permit for a previously listed water has since been issued with no compliance schedule and the limits are required to be met upon permit issuance, then delist the facility. EPA must be provided a verification package for delisting waters (see Section 7.1 Rule 2).

3. If achievement with the existing permit compliance schedule or consent order has not occurred by the end of the 2006 reporting period (12/31/04) and the permit is still in effect but is anticipated to meet the schedule by the end of the 2008 reporting period (12/31/06) it is Category 4B.

4. If the existing permit expiration date does not extend past the 2006 ending date (12/31/04) and the compliance schedule or consent order compliance date extends beyond the 2008 reporting period ending (12/31/06) it is Category 5E.

5. If a permit re-issuance occurs with a compliance or consent order schedule after the 2006 ending date (12/31/04) but prior to the 2008 ending date (12/31/06):

    a. And compliance with the previous permit compliance or consent order schedule was not achieved.
    b. And a new compliance schedule or consent order date extends beyond the 2008 reporting ending date (12/31/06) up to 12/31/09. Then the water is Category 4B based on the five year permitting cycle.
    c. If a staged or phased permit compliance schedule (greater than the permit five year cycle) or consent order extends beyond 12/31/09 then the water is Category 5E.



Rule 2

The verification process for removing or delisting effluent limited waters must consider the following;

- The removal or delisting process applies only to waters impacted by a single point source discharge. TMDLs will have to be developed and approved by EPA prior to delisting waters impacted by multiple discharges or a single point source with a significant nonpoint source "load allocation" component. A water listed in Part II for NH3-N discharging into a segment listed for nonpoint source fecal coliform bacteria could be removed since the bacteria problem is unrelated to the NH3-N.

- If compliance with the Water Quality (WQ) based effluent limits is not met by the compliance date, the waters should not be removed from the list or should be relisted in Category 4B if previously removed and a new compliance schedule requiring compliance by the end of the next reporting period is in place. If a new compliance schedule has not been negotiated or extends past the next reporting period, the water should be listed as Category 5E. If post operational water quality data shows that WQ Standards are not being met, the water should remain on the list or be relisted in Category 5A.

If the above conditions are met, the following information should be submitted to EPA for delisting those waters identified in Category 4B of the 2004 303(d) Report. Waters that do not meet the above conditions should be listed or remain in Category 4B of the 2006 303(d) Report.

Verification Packet for VPDES Permits:
Hydrologic Unit Code (HUC), Watershed Identity Number, Stream Name, Parameter, and VPDES Permit Number, Owner/Facility Name and recent DMRs showing compliance.

- A statement identifying the basis for delisting the water. The statement should confirm that water quality based effluent limits were in place by the compliance date, and these effluent controls are sufficient to attain or maintain WQ Standards. If the facility will meet the water quality based effluent limits within the listing cycle required by federal law and WQ Standards are expected to be attained or maintained, the verification should describe the facility's progress in meeting the effluent requirements and the expectation that the compliance date in the permit will be met.

- Copy of water quality analysis modeling conducted as part of permit development that shows the level of controls necessary to implement WQ Standards.

- Copy of permit page (and/or any State compliance order and associated interim limits and schedule to achieve the final limit) that contains the required control levels.

- Copy of permit page that provides the compliance date for water quality based controls.

Section 7.2 IMPAIRED WATERS (Category 5)

Rule 1

Waters listed as impaired and needing a TMDL in the Integrated Report will remain on the list and tracked in subsequent Integrated Reports until:

- An EPA approved TMDL is developed for all pollutants causing impairment

OR

A subsequent assessment of new monitoring data or in special cases, modeling results show that the water is no longer impaired and EPA approves the delisting of the water. (see Section 7.2 Rule 2 for necessary delisting documentation)

Rule 2

Documentation required by EPA for delisting previously listed impaired waters:

Scenario # 1: when new data demonstrates a previously impaired waterbody is currently attaining WQ Standards, DEQ should submit the following documents to justify the delisting of this segment from the next 303(d) list.

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- Hydrologic Unit Code (HUC), Federal TMDL ID (if available), State TMDL ID, Watershed Identity Number, Stream Name and Listed Parameter
- Rationale for the decision to remove the previously impaired segment from the next 303(d) list
- Copies of the data that are being used to justify the removal of the segment
- Copies of the previous data which were used to list the segment
- Any differences between the sampling techniques should be documented and submitted
- A description of the water including but not limited to: stream name, impaired miles (acres or sq. mi.), beginning and ending river miles, impairment, watershed identification code and hydrologic unit code (HUC)

Scenario # 2: when new water quality modeling determines the stream is now attaining WQ Standards, DEQ should submit the following documents to justify the removal of this segment from the next 303(d) list.

- Hydrologic Unit Code (HUC), Federal TMDL ID (if available), State TMDL ID, Watershed Identity Number, Stream Name and Listed Parameter.
- Rationale for the decision to remove the previously impaired segment from the next 303(d) list
- Submission of any new data that were used in the modeling
- A copy of the EPA approved model that was used. A summary of the differences between the new and the old models. The reasons why the stream attains WQ Standards under the new model opposed to the former model (data, modeling assumptions, modeling applications, etc)

A description of the water including but not limited to: stream name, impaired miles (acres or sq. mi.), beginning and ending river miles, impairment, watershed identification code and hydrologic unit code (HUC)

Scenario # 3: when new management practices from point and/or nonpoint sources lead to the attainment of WQ Standards, DEQ should submit the following documents to justify the removal of this segment from the next 303(d) list.

- Hydrologic Unit Code (HUC), Federal TMDL ID (if available), State TMDL ID, Watershed Identity Number, Stream Name and Listed Parameter.
- Rationale for the decision to remove the previously impaired segment from the next 303(d) list.
- Submission of the most recent 2 years of water quality data that indicate the water is a candidate for delisting and
- A description of the new management practices and other changes that have occurred in the watershed to explain the change in water quality.
- A description of the water including but not limited to: stream name, impaired miles (acres or sq. mi.), beginning and ending river miles, impairment, watershed identification code and hydrologic unit code (HUC).

The TMDL staff should apply the Proactive Approach, as appropriate, any time a TMDL is scheduled for development. Appendix D contains additional procedural information on this approach.

Scenario # 4: when errors are detected in the rationale for the initial listing of the segment or WQ Standards have been modified and the segment is attaining WQ Standards, DEQ should submit the following documents to justify the removal of this segment from the next 303(d) list.

- Hydrologic Unit Code (HUC), Federal TMDL ID (if available), State TMDL ID, Watershed Identity Number, Stream Name and Listed Parameter.
- Rationale for the decision to remove the previously impaired segment from the next 303(d) list
- Documentation of the errors in the initial listing
- A copy of the data and/or modeling that demonstrates the segment attains WQ Standards at least 90% of the time
- A description of the water including but not limited to, stream name, impaired miles (acres or sq. mi.), beginning and ending river miles, impairment, watershed identification code and hydrologic unit code (HUC).

In certain cases EPA may request additional documentation to justify the removal of the segment from the 303(d) list.

Rule 3

Impaired bacteria waters falling geographically within an EPA approved TMDL bacteria study area should be identified, incorporating the Federal TMDL ID (if available) and State TMDL ID into ADB and the TMDL database for the assessment unit and subsequently listed as Category 4A (impaired and TMDL has been completed and EPA approved). For benthic impairments within an EPA approved benthic TMDL, professional justification and documentation is necessary indicating the new impairment is covered by the approved TMDL allocations.

Rule 4

Section 303(d) requires States to "establish a priority ranking" for the waters it identifies on the impaired waters list, taking into account the severity of the pollution and the uses to be made of such waters, and to establish TMDLs "in accordance with the priority ranking." Federal regulations provide that "schedules for submissions of TMDLs shall be determined by the Regional Administrator and the State" (40 CFR 130.7(d)(1)). Other reasonable factors such as the State's use of a rotating basin approach or commitments specified in court orders or consent decrees may also be considered when States develop priorities and schedules.

For the waters covered by the June 1999 Consent Decree pertaining to Virginia's TMDL program, DEQ has developed a TMDL development schedule ending on May 1, 2010. A specific TMDL development schedule for the period ending on May 1, 2008 was noticed for public comment and is available on the DEQ web site. For waters listed as impaired subsequent to the Consent Decree, TMDLs are expected to be completed within 12 years of the first listing date. Outside of the specific TMDL development schedule, TMDL due dates assigned to each water body reflect the date when a TMDL must be established. However, if subsequently listed waters are within a Consent Decree watershed, every effort will be made to address the impairments at the same time. This may result in TMDL development much sooner than the 12 years generally anticipated. Also, in response to concerns raised by the United States Fish and Wildlife Service during the development of the 2002 303(d) List, certain impaired waters of concern to them have accelerated TMDL development dates.

In preparing the TMDL development schedule, Virginia does not specifically identify each TMDL as high, medium or low priority. Instead, DEQ uses the TMDL schedule itself to reflect Virginia's priority ranking. The CWA does not prescribe a particular method of expressing a priority ranking, and DEQ believes a TMDL schedule is a reasonable, efficient way to demonstrate priority ranking.

In scheduling TMDLs for development, every effort should be made to address all related impairments in a watershed at the same time. If endangered species are affected by an impairment listing, TMDL development should be scheduled as expeditiously as possible. If a public water supply is affected by an impairment listing, TMDL development should be scheduled as expeditiously as possible. In the absence of impacts to public water supplies or endangered species, a watershed approach should be used for TMDL development scheduling. Other factors that may impact TMDL scheduling include public interest and support, locally available funding to implement controls, or coordinating TMDL development efforts with an adjoining state.

After the TMDL schedule has been developed, the order in which TMDLs are established might be subject to some modifications to accommodate logistical efficiencies or data availability. The process is a dynamic process and any priority ranking may be changed if substantial factors change or become apparent during the scheduling process.

APPENDIX A

Clean Water Act Sections

Sec.305. WATER QUALITY INVENTORY

(b) (1) Each State shall prepare and submit to the Administrator by April 1, 1975, and shall bring up to date by April 1, 1976, and biennially thereafter, a report that shall include—

(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required by the objective of this ACT (as identified by the Administrator pursuant to criteria published under section 304(a) of this Act) and the water quality described in subparagraph (B) of this paragraph;

(B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;

(C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what water such additional action is necessary;

(D) an estimate of (1) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of this Act in such State, (iii) the economic and social benefits of such achievement, and (iv) an estimate of the date of such achievement; and

(E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs. (2) The Administrator shall transmit such State reports, together with an analysis thereof, to Congress on or before October 1, 1975, and October 1, 1976, and biennially thereafter.

GRANTS FOR SEC. 106. POLLUTION CONTROL PROGRAM

(e) Beginning in fiscal year 1974 the Administrator shall not make any grant under this section to any State which has not provided or is not carrying out as a part of its program—

(1) the establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition), the quality of navigable waters and to the extent practicable, ground waters including biological monitoring; and provision for annually updating such data and including it in the report required under section 305 of this Act;

SEC. 204 LIMITATION AND CONDITIONS

(a) Before approving grants for any projection for any treatment works under section 201(g)(1) the Administrator shall determine—

"that (A) the State in which the project is to be located (1) is implementing any required plan under section 303(e) of this Act and the proposed treatment works are in conformity with such plan, or (ii) is developing such a plan and the proposed treatment works will be in conformity with such plan, and (b) such State is in compliance with section 305(b) of this Act;"

SEC. 314. CLEAN LAKES

(a) Each State shall prepare or establish, and submit to the Administrator for his approval—

"(A) an identification and classification according to eutrophic condition of all publicly owned lakes in such State;
"(B) a description of procedures, processes, and methods (including land use requirements), to control sources of pollution of such lakes;
"(C) a description of methods and procedures, in conjunction with appropriate Federal agencies, to restore the quality of such lakes;
"(D) methods and procedures to mitigate the harmful effects of high acidity, including innovative methods of neutralizing and restoring buffering capacity of lakes and methods of removing from lakes toxic metals and other toxic substances mobilized by high acidity;
"(E) a list and description of those publicly owned lakes in such State for which uses are known to be impaired, including those lakes which are known not to meet applicable WQ Standards or which require implementation of control programs to maintain compliance with applicable standards and those lakes in which water quality has deteriorated as a result of high acidity that may reasonably be due to acid deposition; and
"(F) an assessment of the status and trends of water quality in lakes in such State, including but not limited to, the nature and extent of pollution loading from point and nonpoint sources and the extent to which the uses of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

"(2) SUBMISSION AS PART OF 305(b) (1) REPORT. – The information required under paragraph (1) shall be included in the report required under section 305(b) (1) of this Act, beginning with the report required under such section by April 1, 1988.

APPENDIX B

Virginia Department of Environmental Quality
Biological Monitoring Program
305(b) Assessment Fact Sheet

Regional Office:
Regional Biologist's Signature: _____
Review Date:
River Basin:
Stream Name and Site Location:
Station ID #:
Reference Station ID #:
Assessment Method:
EPA RBP-II
Coastal Plain (MACS)

Biological Assessments for the Last Five Years

Year	Spring score	Spring assessment	Fall score	Fall assessment
2000				
2001				
2002				
2003				
2004	0.0		0.0	
Seasonal avg 5-yrs	0.0		0.0	
Seasonal avg last 2-yrs	0.0		0.0	
Final 5-yr average	0.0		0.0	
Final 2-yr average	0.0		0.0	

Note, because of the long, five-year time frame covered by this review and for a variety of reasons, some sites may not have been sampled during every year or season and/or an assessment ranking or score may not be available for every "cell" in the above table. The above table is intended to be a convenient method to summarize and review all the data available for the reporting period. The final assessment ranking for each site should be based on a review of all the available rankings shown in the above table and any pertinent supplemental data described below. For the purpose of Integrated Report preparation, if more recent bioassessment rankings differ significantly from earlier rankings, primary consideration should be given to the more recent assessed data. This is described in more detail of section 6.4.1 of the Integrated Report Guidance Manual.

Supplemental Information (if applicable):

Are any seasonal differences noted?

Summary of any comments associated with assessments.

Have any factors been observed in watershed that may be affecting the benthic community? Have there been any recent changes in activity in the watershed that may have affected the more recent bioassessments. Are these changes likely to affect the benthic community for a short or long term basis?

Final Assessment Rating:

APPENDIX C

Classification of Virginia's Shellfish Growing Areas
Robert E. Croonenberghs, PhD

The Division of Shellfish Sanitation (DSS) follows the requirements of the National Shellfish Sanitation Program (NSSP), which is regulated by the U.S. Food and Drug Administration. The NSSP classification uses the shoreline survey as its primary tool for classifying shellfish growing waters. Fecal coliform concentrations in seawater samples collected in the immediate vicinity of the shellfish beds function to verify the findings of the shoreline surveys, and to define the border between approved and condemned (unapproved) waters.

DSS uses the shoreline survey to locate as many sources of pollution as possible on the watersheds of shellfish growing areas. DSS conducts a property-by-property inspection of the onsite sanitary waste disposal facilities of most properties on un-sewered sections of watersheds, and investigates other sources of pollution such as wastewater treatment facilities (WWTF), marinas, livestock operations, landfills, etc. The information is compiled into a written report with a map showing the location of the sources of real or potential pollution found, and sends it to the various state agencies that are responsible for regulating these concerns and the city or county. The local health departments (LHDs) of the Virginia Department of Health (VDH) play a major role in the process by obtaining correction of the onsite sanitary waste disposal problems. Most of the Division's effort is focused on locating fecal contamination, and in this manner we prevent significant amounts of human pathogens from getting into shellfish waters. I believe that this is the primary reason why we have not had a confirmed shellfish-borne disease outbreak due to Virginia-grown shellfish in over 35 years. VDH is reducing the input of these pathogens to back yards, waterways, unofficial swimming areas and shellfish waters. The shoreline survey work is the heart of the shellfish program.

In addition to the shoreline survey, the NSSP requires that DSS collect seawater samples in the growing areas as part of the classification procedure. States must use the most recent 30 samples, collected randomly with respect to weather (scheduled one month in advance), to classify a station. The two part standard for fecal coliforms in waters for direct shellfish harvest to market is a geometric mean no greater than 14 MPN fecal coliforms/100 ml and an estimated 90th percentile no greater than 49. Exceeding either number requires closure of that station.

To a lesser degree, the Division collects shellfish samples from sentinel growing areas and has them analyzed for heavy metals and chlorinated hydrocarbons (pesticides and PCBs). Such toxic substances are not a public health threat in Virginia's waters, with the potential exception of the Elizabeth River and perhaps Little Creek, both of which are located in the Hampton Roads area.

Thus, classification based on fecal pollution is a multi-layered and multi-step process. Initially one uses the shoreline survey to determine if there are any actual or potential sources of fresh fecal pollution to the growing area. If so, then the area cannot be used for the direct harvest of shellfish for marketing. Hampton Roads is an example. Most of Hampton Roads is permanently closed, due to the tremendous amount of shipping and the concern of runoff from the urban watershed. However, microbiological results are generally acceptable.

Another example of actual or potential pollution that requires closure is a discharge, such as from a WWTF or the potential discharge from boats in marinas. DSS uses relatively simple computer models developed by VIMS, which employ fairly sophisticated mathematics, to determine the size of buffer zones around these sources. These models use inputs of fecal coliforms (from NPDES permits, or factors related to the number and size of boats in marinas), die-off factors, and readily available tidal current and channel configuration information. Buffer zones around marinas are only in effect during the warmer boating months (April 1 - Oct 31). Once these buffer zones are determined, they do not change in size unless the capacity of the WWTF or the marina changes.

Our third layer of classification, and our most common in Virginia, consists of evaluating areas that are not affected by urban runoff or significant wastewater discharges. One must evaluate the watershed for the potential impacts of known failing onsite sanitary waste facilities to estimate whether their input could be of such a magnitude as to require closure, even if the water quality data is acceptable. If the impact from these failing systems does not appear to pose an undue threat, then the water quality data can be used to *verify* whether the waters should be classified as approved or not.

Since DSS collects samples monthly, this means that our geometric mean incorporates data reaching back 2.5 years. Heavy rainfall or very high tides due to winds or moon phase can wash unusually high concentrations of fecal coliforms into shellfish growing areas that can increase the geometric mean or the 90th percentile beyond the allowed standard. As more data is collected and the unusually high concentrations fall off the trailing end of the data set, the water quality then appears to improve. This is one of the factors that can cause a continual fluctuation in the classification of the water quality at the interface between impacted upstream waters and the relatively unaffected downstream water body.

Since DSS is not a research organization, we cannot do much to determine the cause of water quality deterioration in areas. However, the Division has tried over the years to do so, and we have encouraged the State to put resources into determining those causes. The Division has found that *obviously* failing septic systems are almost never the cause of deteriorating water quality in a *large* body of water. We have seen areas where impacts on fecal coliform concentrations in smaller bodies of water occur due to failing onsite sanitary waste disposal systems, but these seem to be rare. This should not be taken to downplay the concern from such failing onsite sanitary waste disposal systems, since even small inputs of fecal coliforms from these systems are quite likely to contain significant concentrations of human pathogens. Indeed, failing onsite sanitary waste disposal systems are one of the types of pollution sources of greatest concern with regard to the consumption of bivalve molluscan shellfish. New data indicates that drainfields located in seasonally high water tables may contribute significant numbers of fecal coliforms to impact water quality, and research into this potential source is needed and ongoing.

In Virginia's urban suburban watersheds like the Lynnhaven River in Virginia Beach are clearly impacted by the flushing action of rapid runoff from storm drains. Water quality in the Lynnhaven River has deteriorated over the years right along with development, and high counts after runoff events are predictable. Other areas are much less predictable. Sometimes heavy rainfalls cause elevated counts in rural areas and sometimes they do not. Part of this is due to spotty thunderstorms that are not reflected by the relatively few rain gauge sources.

In more rural areas the wildlife component of fecal coliform inputs is significant, as can be the human input. Wildlife, such as raccoons, muskrats and deer, living near the intertidal zone, can have dramatic local impacts on fecal coliform concentrations in the adjacent shellfish waters. Wildlife within in a watershed are potential sources for *Cryptosporidium* and *Giardia* inputs, though the NSSP has not decided how to handle these problems specifically. New data indicates that wildfowl can have significant impacts on water quality too. Wildlife inputs of fecal material are basically accounted for by the seawater sampling data.

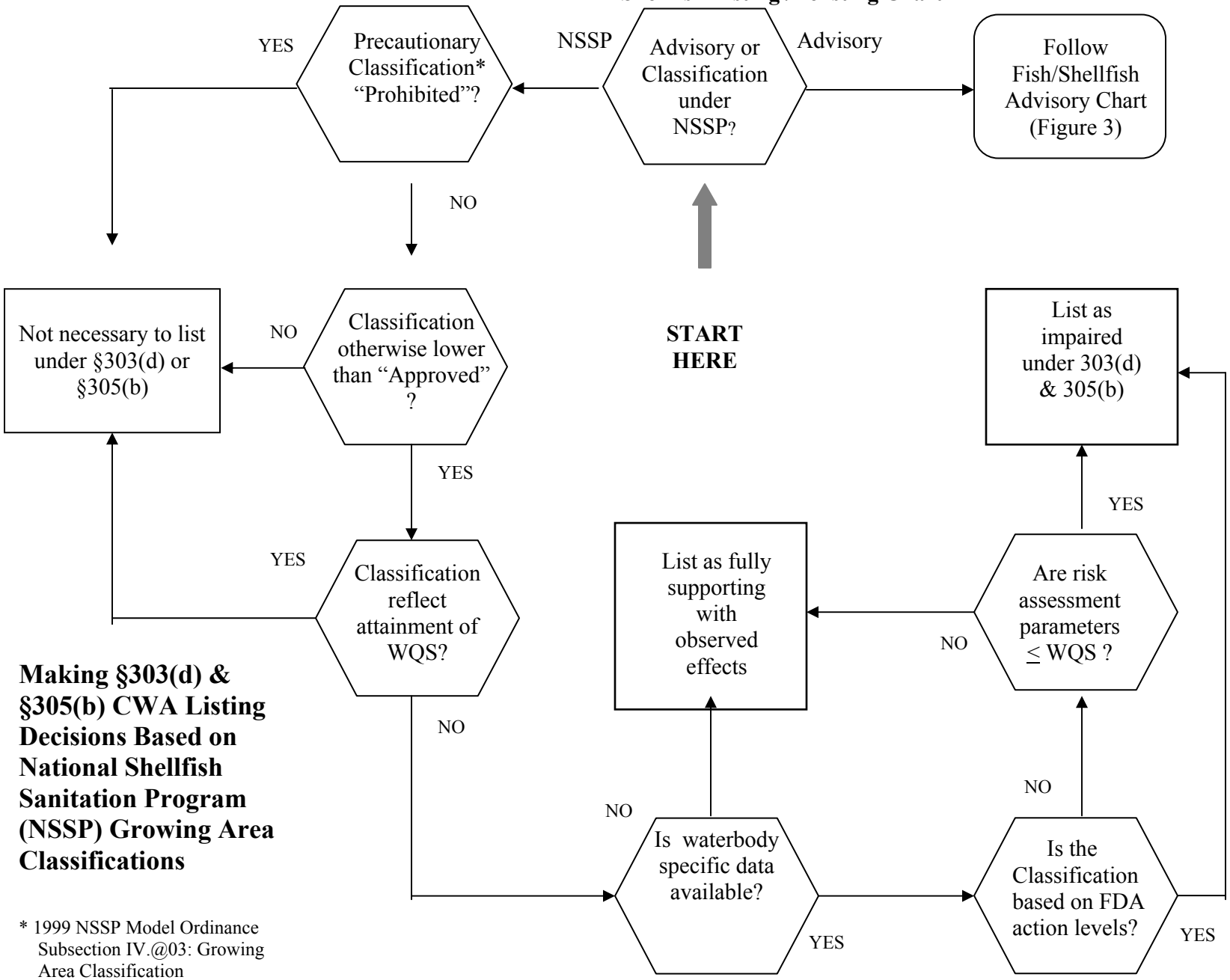
The Division is not seeing a steady increase in the number of acres of condemned in the state. Instead, what we see are fluctuations in the location of the border between acceptable and unacceptable water quality measurements moving up and down tributaries over time. Again, these fluctuations seem to be due largely to changing factors on the watershed, chance weather events (rain, high tides), changes in wildlife populations near shore or unknown factors (perhaps movement of livestock from one field to another, migratory bird flocks, or runoff from recently plowed fields that later contribute little when crops stabilize the soil).

Man does directly impact the fecal coliform counts in the waters. The headwaters of smaller streams are impacted by development due to the loss of the filtering and detention of runoff waters through upland swamps and other slow moving water areas. These natural detention areas provide the extended time element so that predators (rotifers and ciliates) and sunlight can reduce the numbers of fecal coliforms. When these are replaced with drainage systems the fecal coliforms are directly discharged into the shellfish waters.

In the past, without gene probes or other advanced tools to determine the type of animal/human source of fecal coliforms, the State has been thoroughly frustrated in trying to effect a change in the water quality of shellfish waters. Fortunately, this lack of "typing" is changing due to EPA's Total Maximum Daily Load (TMDL) requirement that pertains to fecal coliforms (along with other pollutants). The Department of Environmental Quality is developing TMDLs for shellfish waters, and DSS is collecting samples and actively working with DEQ and other State agencies to try to determine the types of sources of fecal coliforms to individual shellfish areas. This new data is exactly what has been needed for years to help in finding and correcting sources of fecal coliforms to shellfish waters.

Figure 4

EPA Shellfish Listing /Delisting Chart



Making §303(d) & §305(b) CWA Listing Decisions Based on National Shellfish Sanitation Program (NSSP) Growing Area Classifications

* 1999 NSSP Model Ordinance Subsection IV.@03: Growing Area Classification

APPENDIX D

Incorporating the *Proactive Approach* to delisting 303(d) listed segments into the 2006 Water Quality Assessment

For the 1998 assessment cycle, EPA changed the data analysis period for the 305(b) assessment from two to five years. Virginia's water quality assessments and the subsequent 303(d) list have since been based on a 5-year data window. For the 2006 assessment, the data window is January 1, 2000 through December 31, 2004.

In August 2001, the Office of Water Quality Programs negotiated with EPA an approach, termed the *Proactive Approach*, which results in the proposed delisting of waters on the Section 303(d) list through assessment of less than 5-years of data. Correspondence and information related to the issue is attached to this memorandum. In short, EPA Region III has consented that Virginia can delist a segment on the 303(d) list if the following requirements are met:

1) For conventional parameters, no more than one of twelve samples taken over a two-year period exceeds the water quality criteria (<10.5 percent exceedence for larger data sets).
2) For biological impairment, a minimum of 2 consecutive samples, taken over a one to two year period, show attainment of the applicable standard.
3) The samples are taken at the same location (monitoring station) which demonstrated the impairment.
4) A rationale document is submitted to EPA justifying why the State believes the waters are achieving WQ Standards. This rationale document can consist of a description of measures taken in the watershed which are considered to be responsible for improvement of the water quality.

Eligibility and Water Quality Assessment

The following procedure is to be used to consider the eligibility of, and to subsequently assess, any particular waterbody segment submitted for consideration for delisting under the *Proactive Approach*.

Locations where proactive measures are being taken to improve water quality through the TMDL or Water Quality Management Plan program such that the *Proactive Approach* is eligible for consideration are to be provided by the DEQ TMDL program. Assessment staff can recommend segments for consideration, but only those locations provided by the DEQ TMDL program as candidates for the *Proactive Approach* are to be considered for assessment under the *Proactive Approach*. Notification must be made in writing through memorandum to the affected regional assessment manager, copied to the DEQ 305(b) coordinator, and must include the required documentation supporting consideration of the *Proactive Approach*. At a minimum, this is to include documentation of those implementation measures considered to be responsible for improvement in water quality and subsequent achievement of WQ Standards.

Regional assessment staff members are responsible for assessment of water quality in their respective regions and for the defense of their assessments. Therefore, the decision for delisting consideration is to be made by regional assessment staff based on the analysis of the proactive measures being taken, available monitoring data, any ancillary information collected, and their professional knowledge of site specific influences on water quality in the affected segment.

Where there is agreement between TMDL program and assessment staff that it is appropriate to pursue delisting based on implementation of the *Proactive Approach*, the assessment must be performed based on the requirements outlined in 1, 2 and 3 above. For a scheduled 305(b)/303(d) assessment, only the last two years of the assessment window are to be used for assessment of eligible segments. For delisting assessment at any other time, the most recent two years of data must be used.

Assessment Documentation and Delisting Procedure

ADB Database	A segment meeting the above criteria is considered monitored, fully supporting. The assessment comments section should include the phrase *Proactive Approach Assessment*. The *Proactive Approach* data window used must be specifically identified.
Delisting Documentation	Documentation must include the information provided by the TMDL program related to control measures implemented using the *Proactive Approach* (requirement 4, above), and the results of data analysis related to requirements 1, 2, and 3 above.
EPA Review, Approval and Public Participation	Fulfillment of EPA review and approval requirements, and fulfillment of public participation requirements for removal of waterbody segments (delisting) at EPA required 303(d) list submittal dates, is the responsibility of the Monitoring and Assessments Program. At other times, fulfillment of these requirements in an effort to delist waters not needing TMDLs is the responsibility of the TMDL program. Final documentation for segments delisted by the TMDL program staff must be provided to the regional assessment manager and copied to the DEQ 305(b) coordinator at least five months prior to any EPA required 303(d) list submittal date, if time permits.

APPENDIX E-1

Fish Tissue Values (TV)

COMPOUND		NON CARCINOGEN	CARCINOGEN
		CRITERION BASED TISSUE VALUE (TV)	CRITERION BASED TISSUE VALUE (TV)
	CAS #	PPB	PPB
Acenaphthene	83-32-9	650,000	
Acrolein	107-02-8	170,000	
Acrylonitrile	107-13-1		200
Aldrin	309-00-2		6.3
Anthracene	120-12-7	3,200,000	
Antimony	7440-36-0	4,300	
Benzene	71-43-2		3,700
Benzidine	92-87-5		0.47
Benzo(a)anthracene	56-55-3		15
Benzo(b)fluoranthene	205-99-2		15
Benzo (k)fluoranthene	207-08-9		15
Benzo(a)pyrene	50-32-8		15
Bis2-chloroethyl ether	111-44-4		98
Bis2- chloroisoproply ether	108-60-1	430,000	
Bromoform	75-25-2		14,000
Butyl benzyl phthalate	85-68-7	2,200,000	
Carbon tetrachloride	56-23-5		830
Total Chlordane	57-74-9		310
Chlorobenzene	108-90-7	220,000	
Chlorodibromomethane	124-48-1		1,300
2-Chloronaphthalene	91-58-7	860,000	
Chloroform	67-66-3		18,000
2-Chlorophenol	95-57-8	54,000	
Chrysene	218-01-9		15
Cyanide	57-12-5	220,000	
DDD	72-54-8		450
DDE	72-55-9		320
Total DDT	50-29-3		320
Dibenz(a,h)anthracene	53-70-3		15
Dibutyl phthalate	84-74-2	1,100,000	
Dichloromethane	75-09-2		14,000
1,2-Dichlorobenzene	95-50-1	970,000	
1,3-Dichlorobenzene	541-73-1	140,000	
1,4-Dichlorobenzene	106-46-7	140,000	
3,3-Dichlorobenzidine	91-94-1		240
Dichlorobromomethane	75-27-4		1,700
1,2-Dichloroethane	107-06-2		1,200
1,1-Dichloroethylene	75-35-4	97,000	
1,2-Trans-dichloroethylene	156-60-5	220,000	
2,4-Dichlorophenol	120-83-2	32,000	
1,2-Dichloropropane	78-87-5		1,600
1,3-Dichloropropene	542-75-6	3,200	
Dieldrin	60-57-1		6.7
Diethyl phthalate	84-66-2	8,600,000	
Di-2-ethylhexyl phthalate	117-81-7		7,700
2,4-Dimethylphenol	105-67-9	220,000	
Dimethyl Phyhlate	131-11-3	110,000,000	
Di-n-butyl phthalate	84-74-2	1,1000,000	
2,4-Dinitrophenol	51-28-5	22,000	
2-Methyl-4,6-dinitrophenol	534-52-1	4,200	
2,4-Dinitrotoluene	121-14-2		350
Dioxin	1746-01-6		0.0062
1,2-Diphenylhydrazine	122-66-7		130

Endosulfan (1 and II)	115-29-7	65,000	
COMPOUND		**NON CARCINOGEN**	**CARCINOGEN**
		CRITERION BASED TISSUE VALUE (TV)	**CRITERION BASED TISSUE VALUE (TV)**
Endosulfan sulphate	1031-79-8	65,000	
Endrin	72-20-8	3,200	
Endrine aldehyde	7421-93-4	3,200	
Ethylbenzene	100-41-4	1,100,000	
Fluoranthene	206-44-0	430,000	
Fluorene	86-73-7	430,000	
Heptachlor	76-44-8		24
Heptachlor epoxide	1024-57-3		12
Hexachlorobenzene	118-74-1		67
Hexachlorobutadiene	87-68-3		1,400
Hexachlorocyclohexane (alpha-BHC)	319-84-6		17
Hexachlorocyclohexane (beta – BHC)	319-85-7		60
Hexachlorocyclohexane (lindane) (gama-BHC)	58-89-9		60
Hexachlorocyclopentadiene	77-47-4	75,000	
Hexachloroethane	67-72-1		7,700
Indeno(1,2,3-cd)pyrene	193-39-5		15
Isophrone	78-59-1		110,000
Mercury (Methyl)	22967-92-6	1,100	
Methyl bromide	74-83-9	15,000	
Monochlorobenzene	108-90-7	220,000	
Nickel	744-00-2	220,000	
Nitrobenzine	98-95-3	5,400	
N-nitrosodimethylamine	62-75-9		2.11
N-nitrosodiphenylamine	86-30-6		22,000
N-nitrosodi-n-propylamine	621-64-7		15
PCB Total/congeners	1336-36-3		54
Pentachlorophenol	87-86-5		900
Phenol	108-95-2	6,500,000	
Pyrene	129-00-0	320,000	
Selenium	7782-49-2	54,000	
1,1,2,2-Terachloroethane	79-34-5		540
Tetracholoethylene	127-18-4		2,700
Thalium	7440-28-0	730	
Toluene	108-88-3	2,200,000	
Toxaphene	8001-35-2		98
1,2,4-Trichlorobenzene	120-82-1	110,000	
1,1,2-Trichloroethane	79-00-5		1,900
Trichloroethylene	79-01-6		860
2,4,6-Trichlorophenol	88-06-2		9,800
Vinyl Chloride	75-01-4		72

APPENDIX E-2

RISK-BASED TISSUE SCREENING VALUE (TSVs) FOR FISH TISSUE UPDATED FROM INTEGRATED RISK INFORMATION SYSTEM (IRIS) FOR GENERAL POPULATION (ADULT)

BODY WEIGHT (KG)	70
RISK LEVEL	10^{-5}
CONSUMPTION RATE (KG/DAY)	0.0065

Fish Tissue Screening Values (TSV)

COMPOUND		**NON CARCINOGEN**	**CARCINOGEN**
		TISSUE SCREENING VALUE (TSV)	**TISSUE SCREENING VALUE (TSV)**
	CAS #	PPB	PPB
Arsenic (inorganic)	7440-38-2		72**
Barium	7440-39-3	750,000	
BHC isomers	608-93-1		20
Brominated Diphenyl ethers (BDEs)		5,000	
Cadmium	7440-43-9	11,000	
Chromium III	16065-83-1	16,000,000	
Chromium VI	18540-29-9	32,000	
Chlorpyrifos	2921-88-2	32,000	
Diazinon	333-41-5	970	
Dicofol	115-32-2	11,000	
Dioxin	1746-01-6		0.003**
Disulfoton	298-04-4	430	
Ethion	563-12-2	5,400	
Kepone	143-50-0	300	
Mercury (Methyl)	22967-92-6	300 (EPA2001)** (500VDH)**	
Methoxychlor	72-43-5	54,000	
Mirex	2385-85-5	2,200	
Oxyfluorfen	42874-03-3		830
PAHs (sum PEC) ***			15
Terbufos	13071-79-9	1400	
Tributyltin	56-35-9	320	

** These values are based on recent changes to the toxicological data used to calculate the screening values, or recent recommendations from U.S. EPA or the Virginia Department of Health. These screening values are not based on the same toxicological data that were used to develop the existing water quality criteria.

*** Mixtures of seven polynuclear aromatic hydrocarbons (PAHs) that are classed as probable human carcinogens were assessed based on a screening value concentration of 15 ppb calculated as a sum potency equivalency concentration (PEC) using methods described in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Vol. 1, (EPA 823-R-95-007) and Vol. 2 (EPA 823 B-00-008) using the following equation;

$$PEC = \sum_{i} (RPi \times Ci)$$

where; RPi = relative potency for the ith PAH
Ci = concentration of the ith PAH in fish tissue)

The relative potency estimates used for these PAHs were:

Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.145
Benzo(b) fluoranthene	0.167
Benzo(k)fluoranthene	0.020
Chrysene	0.0044
Dibenz(a,h)anthracene	1.11
Indeno(1,2,3-cd)pyrene	0.055

APPENDIX F

Freshwater Consensus- Based Sediment Screening Values (SVs)

Analyte (Metals)	**Consensus PEC (ppm) dry weight**	**99th Percentile**
Arsenic	33	
Cadmium	4.98	
Chromium	111	
Copper	149	
Lead	128	
Mercury	1.06	
Nickel	48.6	
Silver	NA	2.6
Zinc	459	
Analyte (Organics/Pesticides)	**Consensus PEC (ppb) dry weight**	**99th Percentile**
Acenaphthene	NA	170
Acenaphthylene	NA	121
Anthracene	845	
Benzo-a-pyrene	1,450	
Benz(a)Anthracene	1,050	
Chrysene	1,290	
Dibenz[a,h]Anthracene	NA	318
Fluoranthene	2230	
Fluorene	536	
Methylnaphthalene, 2-	NA	83
Naphthalene	561	
Phenanthrene	1,170	
Pyrene	1,520	
LMW PAHs	NA	
HMW PAHs	NA	
Total PAHs	22,800	
Chlordane	17.6	
DDD	28	
DDE	31.3	
DDT	62.9	
DDT, total	572	
Dieldrin	61.8	
Total PCBs	676	
Endrin	207	
Heptachlor Epoxide	16	
Lindane	4.99	
PECs taken from MacDonald et al. 2000		
NA = Not Available		

Estuarine NOAA-based ER-M Sediment Screening Values (SVs)

• **Trace Elements –parts per million (ppm), dry weight**		
Substance	**ER-M Value**	**99th %tile**
(Metals)	**ppm (dry weight)**	(dry weight)
Antimony (Sb)	NA	
Arsenic (As)	70	
Beryllium	NA	5.0
Cadmium (Cd)	9.6	
Chromium (Cr)	370	
Copper (Cu)	270	
Lead (Pb)	218	
Manganese (Mn)	NA	
Mercury (Hg)	0.71	
Nickel (Ni)	51.6	
Selenium (Se)	NA	20.0
Silver (Ag)	3.7	
Thallium	NA	13.5
Zinc (Zn)	410	

• **Pesticides and Other Organic Substances –parts per billion dry weight**			
CAS #	**Substance**	**ER-M Value**	**99th %tile**
		(dry weight) (ppb)	**(dry weight)**
1336363	Polychlorinated Biphenyls (PCBs)	180	
309002	Aldrin	NA	
57749	Chlordane	6	
NA	total DDT (include metabolites)	46.1	
72548	DDD	20	
50293	DDT	7	
72559	DDE	27	
60571	Dieldrin (EPA proposed criteria)	8	
72208	Endrin	NA	
76448	Heptachlor	NA	
1024573	Heptachlor epoxide	NA	
118741	Hexachlorobenzene	NA	
608731	Hexachlorocyclohexane	NA	
58899	Lindane	NA	
2385855	Mirex	NA	
108952	Phenol	NA	
117817	Di (2-Ehtylhexyl) Phthalate	NA	
84742	N-Butyl Phthalate	NA	
83329	Acenapthene	500	LMW PAH
208968	Acenapthylene	640	LMW PAH
120127	Anthracene	1100	LMW PAH
50328	Benzo-A-Pyrene	1600	HMW PAH
191242	Benzo [GHI] Perylene	NA	HMW PAH
56553	Benz[A] Anthracene	1600	HMW PAH
218019	Chrysene	2800	HMW PAH
53703	Dibenz [A,H] Anthracene	260	HMW PAH
206440	Fluoranthene	5100	HMW PAH
86737	Fluorene	540	LMW PAH

193395	Indeno (1,2,3-CD) Pyrene	NA	HMW PAH
91576	Methylnaphthalene , 2	670	LMW PAH
91203	Naphthalene	2100	LMW PAH
85018	Phenanthrene	1500	LMW PAH
129000	Pyrene	2600	HMW PAH
NA	Low Molecular Weight (LMW) PAH's	3160	
NA	High Molecular Weight (HMW) PAH's	9600	
NA	Total PAH's	44,792	

* Changes or updates to any of the ER-M or PEC screening values should be updated in the assessment spreadsheet used to calculate the estuarine weight of evidence.

DEQ acknowledges the use of the ER-M or PEC may be limited (for several reasons) in their ability to accurately predict biological effects. Given that DEQ continues to employ the collection of bulk sediment with chemical analysis as a cost-effective way to monitor a great number of sediment sites, these thresholds are an appropriate tool for assessing sediment data relative to its potential harm to aquatic life.

Citation:

Freshwater PECs: MacDonald, D.D., C.G. Ingersoll, T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol.* 39:20-31.

Estuarine ER-Ms: MacDonald, D.D., Long, E.R., Smith, S.L., Calder, F.D. 1993. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments.

APPENDIX G

SIGNIFICANT PUBLIC OWNED LAKES/RESERVOIRS BY REGION

Northern Regional Office – 16 Reservoirs/Lakes

Able Lake	Stafford Co.	185 (Acres)	PWS
Lake Anna	Louisa, Spotsylvania, Orange	9,600	
Aquia Reservoir (Smith Lake)	Stafford Co.	219	PWS
Beaverdam Reservoir	Loudoun Co.	350	PWS
Breckenridge Reservoir	Prince William Co.	85	PWS
Burke Lake	Fairfax Co.,	218	VDGIF
Goose Creek Reservoir	Loudoun Co.	140	PWS
Hunting Run Reservoir	Spotsylvania	430	PWS
Lake Manassas	Prince William Co.	741	PWS
Lunga Reservoir	Prince William Co.	420	PWS
Motts Run Reservoir	Spotsylvania Co.	160	PWS
Mountain Run Lake	Culpeper Co.	75	PWS
Ni Reservoir	Spotsylvania Co.	400	PWS
Northeast Creek Res.	Louisa Co.	49	PWS
Occoquan Reservoir	Fairfax Co.	1700	PWS
Pelham Lake	Culpeper Co.	253	PWS

Piedmont Regional Office – 11 Reservoirs/Lakes

Airfield Pond	Sussex Co.,	105	VDGIF
Amelia Lake	Amelia Co.,	110	VDGIF
Brunswick Lake	Brunswick Co.,	150	VDGIF
Lake Chesdin	Chesterfield Co.	3196	PWS
Chickahominy Lake	Charles City Co.	1500	PWS
Diascund Reservoir	New Kent co.	1700	PWS
Emporia Lake	Greensville Co.	210	PWS
Falling Creek Reservoir	Chesterfield Co.	110	
Great Creek Reservoir (Bannister Lake)	Lawrenceville	305	
Swift Creek Lake	Chesterfield Co.	156	
Swift Creek Reservoir	Chesterfield Co.	1800	PWS

South Central Regional Office – 24 Reservoirs/Lakes

Briery Creek Lake	Pr. Edward Co.,	845	VDGIF
Phelps Creek Reservoir	Campbell Co.	26	PWS
Cherrystone Reservoir	Pittsylvania Co.	118	PWS
Georges Creek Res.	Pittsylvania Co.	10	PWS
Lake Gordon	Mecklenburg Co.,	112	VDGIF
Graham Creek Res.	Amherst Co.	48	PWS
Banister Lake	Halifax Co.	381	PWS
Holiday Lake	Appomattox Co.	115	
Kerr Reservoir (Va.'s portion)	Halifax Co.,	33251	ACOE/PWS
Keysville Reservoir	Charlotte Co.	42	PWS
Lake Conner	Halifax Co.,	103	VDGIF
Lake Gaston (Va.'s portion)	Brunswick Co.	5530	PWS
Lunenburg Beach Lake	Town of Victoria	12	PWS

Mill Creek Reservoir	Amherst Co.	189	
Modest Creek Reservoir	Town of Victoria	21	PWS
Nottoway Falls Lake	Lunenburg Co.	32	PWS
Fort Pickett Reservoir	Nottoway Co.	198	
Nottoway Pond	Nottoway Co.	55	PWS
Pedlar Lake	Amherst Co.	117	PWS
Roaring Fork	Pittsylvania Co.	25	PWS
Sandy River Reservoir	Prince Edward Co.	740	
Stonehouse Creek Res.	Amherst Co.	125	
Thrashers Creek Res.	Amherst Co.	110	
Troublesome Creek Res (SCS Impoundment #2)	Buckingham Co.	72	PWS

Southwest Regional Office – 11 Reservoirs

Big Cherry Lake	Wise Co	106	PWS
J. W. Flannagan Reservoir	Dickenson Co	1143	ACOE/PWS
Hungry Mother Lake	Smyth Co	108	DCR
Lake Keokee	Lee Co	100	VDGIF
Laurel Bed Lake	Russell Co	210	VDGIF
North Fork Pound Reservoir	Wise Co	154	ACOE/PWS
South Holston Reservoir	Washington Co	1810	TVA/PWS
Wise Reservoir	Wise Co	30	WISE/PWS
Rural Retreat Lake	Wythe Co	85	VDGIF
Hidden Valley Lake	Russell Co	90	VDGIF
Bark Camp Lake	Scott Co	47	USFS

Tidewater Regional Office – 18 Reservoirs/Lakes

Lake Cahoon	Suffolk City	508	PWS
Lake Burnt Mills	Isle of Wight Co.	711	PWS
Harwood Mill Pound	York Co.	300	PWS
Lake Kilby	Suffolk City	226	PWS
Lee Hall Reservoir	Newport News	230	PWS
Little Creek Res.	Norfolk City	193	PWS
Little Creek Res.	James City Co.	860	PWS
Lone Star Lake F	Suffolk City	20	PWS
Lone Star Lake G	Suffolk City	50	PWS
Lone Star Lake I	Suffolk City	39	PWS
Lake Meade	Suffolk City	511	PWS
Lake Prince	Suffolk City	946	PWS
Lake Smith	Norfolk City	193	PWS
Speights Run Lake	Suffolk City	94	PWS
Waller Mill Res.	York Co.	315	PWS
Lake Whitehurst	Norfolk City	480	PWS
Western Branch Reservoir	Norfolk City	1265	PWS
Lake Drummond	Suffolk City	3198	

Valley Regional Office – 12 Reservoirs/Lakes

Beaver Creek Res.	Albemarle Co.	104	PWS
Douthat Lake	Bath Co.	35	
Coles Run Res.	Augusta Co.,	7	USFS/PWS
Elkhorn Lake	Augusta Co.	55	USFS/PWS
Lake Frederick	Frederick Co.	120	VDGIF

Ragged Mount Res.	Albemarle Co.	54	PWS
Rivanna Res.	Albemarle Co.	390	PWS
Silver Lake	Rockingham Co.	10.9	PWS
Staunton Dam lake	Augusta Co.	30	PWS
Switzer Lake	Rockingham Co.	110	USFS/PWS
Sugar Hollow Res.	Albemarle Co.	47	PWS
Totier Creek Res.	Albemarle Co.	66	PWS

West Central Regional Office – 18 Reservoirs/Lakes

Beaverdam Creek Res.	Bedford Co.	70	PWS
Bedford (Stony Cr.) Res.	Bedford Co.	25	PWS
Carvin Cove Res.	Botetourt Co.	668	PWS
Claytor Lake	Pulaski Co.	4349	PWS
Clifton Forge (Smith Cr.) Res.	Alleghany Co.	12	PWS
Falling Creek Res.	Bedford Co.	18	PWS
Fairystone Lake	Henry Co.	123	
Gatewood Res.	Pulaski Co.	182	PWS
Hogan Lake	Pulaski Co.	43	PWS
Leesville Res.	Bedford Co.	2728	PWS
Little River Res.	Montgomery Co.	63	PWS
Martinsville Res.	Henry Co.	192	PWS
Lake Moomaw	Bath Co.,	2303	ACOE
Philpott Res.	Henry Co.,	2893	ACOE
Smith Mountain Lake	Bedford Co.	19994	PWS
Spring Hollow Res.	Roanoke Co.	121	PWS
Talbott Res.	Patrick Co.	125	
Townes Res.	Patrick Co.	21	

Total 110 Significant Reservoirs/Lakes statewide
PWS = Public Water Supply
VDGIF = Virginia Department of Game and Inland Fisheries
ACOE = Army Corps of Engineers
TVA = Tennessee Valley Authority