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SORTING METHODOLOGY FOR THE DRAFT 2002 INTEGRATED 303(D) LIST

To facilitate public review, the draft 2002 Integrated 303(d) List is presented in four different sections. The first section is comprised of the body text of the Integrated List, with associated appendices, that describes the current listing process in detail. It is recommended that this section be read first so that reviewers have a clear understanding of the listing process before looking at the actual Integrated List. The next three sections contain the 2002 Integrated 303(d) List sorted in three different ways to facilitate public review. The numbered paragraphs below outline these sections in more detail and have an associated link (in blue) that will direct you to each section.

1. **Body Text of the 2002 Integrated 303(d) List**

   A complete verbal description of the process used to develop the 2002 Integrated 303(d) List. This document provides stakeholders with all of the background information necessary for understanding the listing process as well as the format of the list. It is highly recommended that this section be read first.

   All files below are in .pdf format.

2. **The 2002 Integrated 303(d) List**

   2a. Sorted By Attainment Status (.pdf file)

   Designed to sort those water bodies that may require a TMDL (attainment status of 5) from those waters which are tracked as part of the State's overall assessment of water quality (attainment status 4a, 4b or 6 in the current list).

   2b. Sorted By Water Body or Watershed (.pdf file)

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Designed for stakeholders interested in what listings have occurred in their local watershed. MDE has sorted the 2002 Integrated 303(d) List by watershed so that all the impairments in a given water body will appear consecutively in the list. This allows individuals to rapidly determine impairment and water quality attainment status information for the watershed of their interest.

2c. Sorted By Impairment Category (.pdf file)

Designed for those stakeholders concerned about waters impaired by a specific pollutant. This facilitates assessment of those waters that are impaired by a specific class of pollutants like metals or nutrients, for example.

Acrobat® Reader is required to view and print the PDF files. If you do not have it click on the icon to the right.

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4. Listing Methodologies

4.1. Listing Methodology for Implementation of COMAR §26.08.02.01-B(2): Biological Assessment of Water Quality

4.1.1. ABSTRACT

Biological assessment data from first to fourth order non-tidal streams will be used to assess waters of the State for the purposes of the Water Quality Inventory [305(b) Report] and the List of Impaired Waters [Integrated 303(d) List]. The method presented below relies on a statistical measure of uncertainty (confidence interval) to determine whether the mean of the results from the sites sampled in a watershed is above or below the Index of Biotic Integrity (IBI) value considered indicative of satisfactory water quality. Where at least 10 sites have been sampled in a watershed (8-digit), watershed-specific confidence intervals will be calculated. If the upper bound of the confidence interval is less than 3, that watershed will be determined to not meet water quality criteria. Where fewer sites have been sampled, subwatersheds (12-digit) will be the evaluation unit. In such cases, a default confidence interval has been calculated based on the coefficient of variation calculated from replicate samples (benthos) or sampling of proximate segments (fish). Certain exceptions are noted based on the empirical applicability of the IBI. The State is required to consider all readily available data and therefore guidelines for the incorporation of local biological data into the assessment process have also been provided. Local data that are based on Maryland Biological Stream Survey (MBSS) or comparable methods and that can be fully integrated with MBSS data to assess watersheds would be integrated into 12- and/or 8-digit watershed evaluations (Tier 1). Data of documented quality, but not based on methods comparable to MBSS will be used to supplement MBSS and local Tier 1 data. Data not meeting the requirements stated above may be helpful for non-regulatory purposes (e.g., targeting, education). Such data will be stored and documented for these uses.

4.1.2 SCOPE

All of the State's waters must be of sufficient quality to provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allow for recreational activities in and on the water [40 CFR §130.11 and COMAR §26.08.02.01-B(2)]. Biological criteria (biocriteria) provide a tool with which water quality managers may directly evaluate whether such balanced populations are present. Maryland's biocriteria uses two indices of biological integrity, one based on fish communities (F-IBI) and the other on benthic (bottom) communities of invertebrates (B-IBI). Both indices implicitly define "balanced populations" by comparison to biological communities in minimally impaired reference waterbodies and both will be used in Maryland to determine the extent to which aquatic life is being supported in Maryland streams. These indices, as described below, are based on several characteristics of fish and benthic communities judged to be relevant to assessing the ability of streams to support aquatic life, and can be calculated in a consistent and objective manner. This framework provides a method for evaluating biological data for the CWA requirements.

The (MBSS) program, on which these interim methods are based, is designed to assess water quality, biological communities and physical habitat condition in Maryland streams on a statewide and watershed scale. The first round of MBSS sampling was designed to assess major drainage basins. The second round was designed to assess finer (Maryland 8-digit) watersheds.

Data collected from this stratified random sampling design support the assessment of first, second, third and fourth order non-tidal streams (determined based on the solid blue line shown on the current edition of U.S. Geological Survey 1:100,000 scale maps) throughout the State. Although the MBSS data can also be used to evaluate the individual stream segments sampled, the locations of sampled segments are selected randomly and not targeted to assess the impacts of specific stressor locations. The use of random assignment of sampling locations within the population of first, second, third and fourth (fourth order in round two of sampling only) order streams supports the assessment of all of the State's waters. The results of biological sampling will be applied for management and regulatory purposes [i.e., CWA §303(d)] at the same spatial resolution (8-digit watersheds) used in the Water Quality Inventory [305(b) report]. When there are sufficient data, sampling results will be averaged within these watersheds and compared to the thresholds discussed below for determination of impairment. When there are not sufficient biological data to evaluate the 8-digit watershed, smaller 12-digit subwatersheds where biological samples indicate some level of degradation will be evaluated to determine whether the 12-digit subwatershed is impaired.

If a watershed or subwatershed is determined to be impaired, corrective action must be taken. That action may begin with additional monitoring and evaluation to determine the cause of the impairment. This is known as stressor identification. Once the stressor has been identified, in many cases it may be appropriate to develop an estimate of the Total Maximum Daily Load (TMDL) of the stressor that can be assimilated by the body of water and still allow it to achieve the water quality criteria necessary to maintain its designated use.

4.1.3 APPLICATION[1]

4.1.3.1 Stream Order

The fish and benthic indices shall be applied only in "wadeable" first, second, third, and fourth order non-tidal streams except as described below under "Exceptions." Biological indices and criteria will be developed in the future for other categories of waterbodies (e.g., larger streams, estuaries, and impoundments) that are currently assessed by chemical and physical monitoring programs. However, the streams to which the current indices apply account for about 90% of Maryland's stream miles. The sampling sites will be analyzed within 8- or 12-digit watersheds for the purposes of evaluation, application of management practices, and listing methods. Eight-digit watersheds are on average 90 square miles; 12-digit watersheds average 11 square miles.

4.1.3.1.1 Procedures for 8-digit watersheds

Data from at least 10 sites are needed within an 8-digit watershed in order to evaluate watersheds at the 8-digit level. In watersheds with 10 benthic IBI scores but less than 10 fish IBI scores, the benthic IBI alone will be used for the 8-digit analysis. In these cases, fish IBI scores will be incorporated into 12-digit subwatershed analysis to avoid losing information about possible impairments.

[1] Excerpts (with minor revisions) from Roth, N.E., M.T. Southerland, G. Mercurio, and J.H. Volstad. Maryland Biological Stream Survey 2000-2004, Volume I: Ecological Assessment of Watersheds Sampled in 2000. Prepared by Versar, Inc., Columbia, MD, for the Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. Draft, March 2001.

In general, MBSS currently employs 8-digit watersheds as primary sampling units. In a few cases, where individual 8-digit watersheds have a small number of stream miles, primary sampling units include more than one 8-digit watershed apiece. These are not assessed at the 8-digit level, because of insufficient sample size within individual 8-digit watersheds. Possible impairments in these areas will be assessed at the 12-digit subwatershed scale based on analysis of individual samples.

Where sufficient data are available within an 8-digit watershed (at least 10 sites with IBI scores), mean IBIs and one-sided 90% confidence interval values are calculated from the data as follows.

if IBI_{mean} is < 3, $CL_{Upper} = IBI_{mean} + (z * SE)$, or

if IBI_{mean} is ≥ 3, $CL_{Lower} = IBI_{mean} - (z * SE)$

Where

CL_{Upper} = upper confidence limit

CL_{Lower} = lower confidence limit

z = normal variate (in this case, z = 1.28 for one-sided 90% confidence interval, assuming a normal distribution for mean IBI)

SE = standard error of the mean = $sd / \sqrt{n}$, where sd = standard deviation

The following rules will be applied to give one of three ratings for 8-digit watersheds:

1. **Does not meet criteria:** If the mean and upper bound of the one-sided 90% confidence interval (CL_{Upper}) of either index (FIBI or BIBI) is less than 3.0, the 8-digit watershed is listed on Part-5 of the 303(d) as failing to meet the proposed criteria.

2. **Meets criteria:** If the mean and lower bound of the one-sided 90% confidence interval (CL_{Lower}) of both indices (FIBI and BIBI) are greater than or equal than 3.0, the 8-digit watershed is listed as meeting the proposed criteria.

3. **Inconclusive:** All other cases are inconclusive.

Within 8-digit watersheds that meet criteria, constituent subwatersheds may still be rated as not meeting criteria or inconclusive. Also, within 8-digit watersheds that are inconclusive, particular 12-digit subwatersheds within them may be rated as not meeting criteria. The 12-digit subwatershed analysis is described below.

4.1.3.1.2 Procedures for 12-digit (sub)watersheds

Data from individual sites are used to flag 12-digit subwatersheds that may be impaired. One-sided 90% confidence intervals associated with single samples are calculated using an average coefficient of variation (cv) of the IBIs from replicate samples, (for example, $cv = 0.08$, as derived from previous analysis of IBI variability (Roth et al. 2001)). Confidence intervals around scores for individual samples are calculated as follows:

if IBI is < 3, $CL_{Upper} = IBI + (z * SE_{Est})$, or

if IBI is ≥ 3, $CL_{Lower} = IBI - (z * SE_{Est})$

where

CL_{Upper} = upper confidence limit

CL_{Lower} = lower confidence limit

z = normal variate (in this case, z = 1.28 for one-sided 90% confidence interval, assuming a normal distribution for mean IBI)

SE_{Est} = estimated standard error of the mean = IBI x $(cv / \sqrt{n})$ (in this case, n=1)

Following the guidelines of the interim biocriteria framework, the following rules will be applied to give one of three ratings for 12-digit subwatersheds:

1. **Does not meet criteria:** If for any site, the value and upper bound of the one-sided 90% confidence interval (CL_{Upper}) of either index (FIBI or BIBI) is less than 3.0, the 12-digit subwatershed is listed on Part-5 of the 303(d) as failing to meet the proposed criteria.

2. **Meets criteria:** If for all sites, the value and lower bound of the one-sided 90% confidence interval (CL_{Lower}) of both indices (FIBI and BIBI) are greater than or equal than 3.0, the 12-digit subwatershed is listed as meeting the proposed criteria.

3. **Inconclusive:** All other cases are inconclusive.

If more than one site is sampled in a 12-digit watershed, each site result is evaluated separately. If any one result indicates impairment, that subwatershed will be listed as impaired. Although that single site may not be representative of the entire subwatershed, the State determined that it is more effective to manage at the watershed level of resolution. Further sampling for stressor identification and/or TMDL development will later define the extent of the impairment.

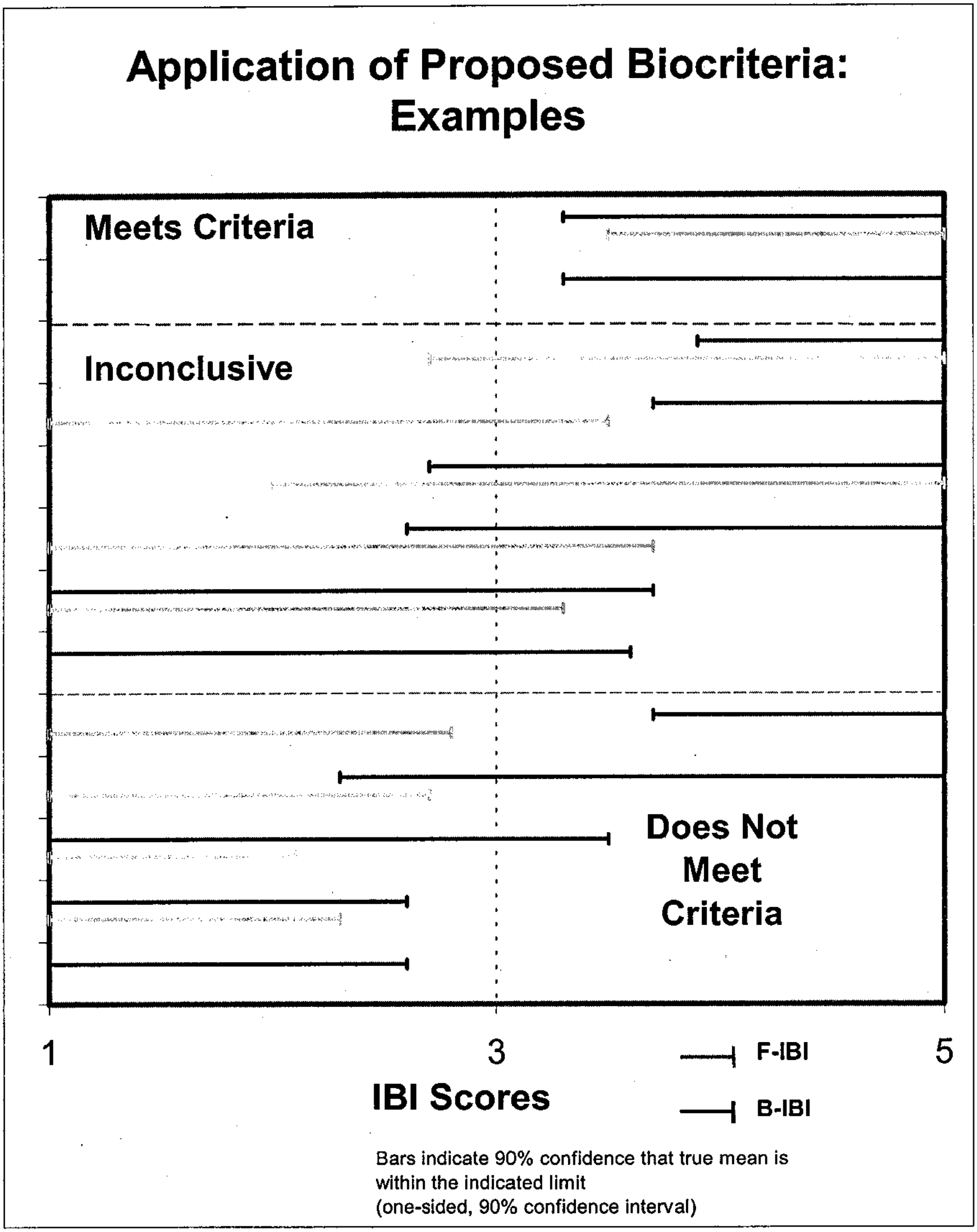

Figure 1: Biological impairment determination based upon confidence intervals.

4.1.4 PRIORITIZATION FOR WATERSHEDS WHERE MONITORING INTERPRETATION IS INCONCLUSIVE

Prioritization for additional monitoring to try to resolve inconclusive results and make a determination that the criteria are, or are not, met.

1a. Mean less than 3 (the lower the IBI score the higher priority for attention), and large confidence interval. Rationale: low IBI scores indicate more significant problems; large confidence intervals can be reduced efficiently with a moderate increase in the amount of data available.
1b. Large confidence interval where lower limit just includes 3 and mean much above. Rationale: in such cases, managers will be close to making a decision. Just a few additional samples may give a clear answer in one direction or the other.
2. Ecological importance, e.g., spawning area, chemical and physical data, habitat. Rationale: Areas that deserve high priority from a resource management perspective (e.g., spawning areas) should also be considered a high priority for monitoring and conclusive evaluation.

4.1.5 REPORTING

A. 305(b) Report - If a watershed is determined to not meet criteria based on biological data, the watershed will be identified in the 305(b) database as "Not supporting aquatic life uses". A watershed determined to meet criteria based on biological data will be identified in the 305(b) database as "Fully supporting aquatic life uses". If the result of the biological data is "inconclusive," the watershed will be listed as "inconclusive."

B. 303(d) List - If a watershed is determined to not meet criteria based on biological data provided for the 305(b) report and a review of other biological data, the watershed will be identified on Part-5 of the Integrated 303(d) List as "Impaired". A watershed determined to meet criteria or for which the data are inconclusive based on biological data will not be identified on the Integrated 303(d) List, but may require follow-up monitoring to clarify inconclusive results.

4.1.6 EXCEPTIONS

(a) The fish index (F-IBI) does not apply in watersheds smaller than 300 acres.
(b) In all Use III and IV streams (cold water streams), where brook trout are present and the F-IBI is less than 3.0, the stream will not be rated as impaired by the F-IBI; if the F-IBI is greater than or equal to 3.0, the stream will be rated as good. Cold-water streams tend to have a naturally low fish diversity and biomass. Brook trout are normally indicators of high quality waters. So although the index may be low, the presence of brook trout indicates that the water is not impaired.
(c) In blackwater streams (dissolved organic carbon greater than 8 mg/l and either pH less than 5 or acid neutralizing capacity (ANC) less than 200 µeq/L) and where the F- or B-IBI is less than 3.0, the stream will not be consider impaired. If the B-IBI or the F-IBI is greater than or equal to 3.0, the stream will be rated as good.
(d) For limestone streams (defined operationally in the Valley and Ridge physiographic region) with ANC greater than 600 µeq/L, if the F- or B-IBI is less than 3.0, it will be evaluated on a case-by-case basis because limestone streams typically have elevated

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alkalinity levels that favor the survival and reproduction of crustaceans such as scuds (Gammaridae). However, high alkalinities can also place physiological limitations on the survival and reproduction of other aquatic invertebrate taxa, including craneflies (Tipulidae) and some mayflies (Ephemeroptera), which results in hyper-abundance and dominance of selected species and overall lower species richness.

(e) If the number of organisms in a benthic sample is less than 60, that sample will not be used and the stream segment "not rated" unless supporting data (e.g., habitat rating, water quality data) indicate impairment and there is no evidence of sampling error or unusual natural phenomena.

(f) Samples taken within two weeks of runoff events (e.g., heavy rains, sudden heavy snow melt) that result in significant bedload movement (i.e., erosion and transport of sediment) may be considered invalid in the best professional judgement of state biologists and not used for evaluation of stream condition.

(g) Stream sampling sites that are tidally influenced, affected by excessive drought (seasonally dry) or impounded by beaver dams will not be evaluated in terms of affected Biotic Indices. For example, a site within a natural impoundment that was created by beaver activity between the spring benthic macroinvertebrate sampling and the summer fish sampling activities may be evaluated only in terms of benthic Biotic Index. Man-made alterations to selected stream segments (channelization, dredging) should be noted, but they do not disqualify the utility of these Biotic Indices.

4.1.7 APPROACH TO USE OF NON-MBSS DATA IN BIOCRITERIA

Given that a key use of these procedures is for the Integrated 303(d) List of Impaired Waters, and that the State is required to consider all readily available data, MDE recognizes the need to incorporate local biological data into the assessment process. Counties or other water monitoring programs that intend to submit their data to support decisions made using the biocriteria framework. should carefully follow the general guidelines below. All data will be placed in one of several data quality tiers and used appropriately according to the quality criteria of the data tier.

4.1.7.1 Tier 1

Data are documented to be of good quality and can be fully integrated with MBSS data. MBSS or comparable field and lab protocols are followed. MBSS or comparable IBI methodologies are used. Field, laboratory, and IBI methods will be considered comparable to MBSS if methods can be demonstrated to yield stream condition ratings that agree with, or can be calibrated to yield the same ratings as, those of the MBSS methods. A quality assurance/ quality control (QA/QC) document and monitoring protocol is available for the monitoring program. Data are provided in a format readily available for merging into the MBSS database. Benthic macroinvertebrate and/or fish communities are monitored and identified to the lowest practicable taxonomic level (generally genus for benthic macroinvertebrates and species for fish).

At the 12-digit level, the proposed biocriteria framework relies on IBI scores at one or more individual sites, along with the estimated expected sampling error for repeated sampling at a single site. Thus, a county or other program would need to supply fish and/or benthic IBI scores that are unbiased for a site and that have quantifiable precision. If MBSS field, lab, and IBI methods are used, the estimated variance previously derived for repeated sampling at a single site using the MBSS IBIs would apply and a new precision (standard error) estimate would not be required. If MBSS field, lab, and IBI methods are not used, the program would need to demonstrate (in accordance with guidance and technical direction from the State) the following:

- Calibrate the program's IBI scores with MBSS IBI scale to show how scores on the different scales yield stream ratings in agreement, so that a consistent threshold is used to determine impairment.

- Conduct variability analysis for the program's IBI, to estimate variability for repeated sampling at a single site. This variability estimate is needed to calculate the confidence interval around individual site results.

- At the 8-digit level, the proposed biocriteria framework relies on quantifiable estimates of watershed-wide IBI mean and standard error. In addition to the factors listed above, the County or other program must also provide (in accordance with guidance and technical direction from the State):

- An unbiased estimate of the watershed mean IBI, with 90% confidence interval. This can be achieved with various probability-based sampling approaches (e.g., simple or stratified random sampling), as long as derived estimates are consistent with a survey design that gives unbiased estimates of mean and variance (i.e., all sites have a known, non-zero probability of being selected for sampling, and areawide estimates account for sampling weights based on the inclusion probabilities). Supplemental information on the survey design, sample frame, and site selection procedures may be useful for integration of this watershed estimate with MBSS results.

4.1.7.2 Tier 2

Data are documented to be of good quality; however, MBSS field and lab protocols are not followed. A probability-based sampling approach may or may not be used. A QA/QC document and monitoring protocol including replicate data and development of known precision are available for the monitoring program. Data are provided in a format readily available for merging into database formats used by the State. Monitoring is generally limited to either the benthic macroinvertebrate or fish communities and may be identified to the lowest practicable taxonomic level

- Data will need to be assessed for general compatibility with MBSS methodology, consistency with good scientific practice, and documentation of adequate quality.

- Data will be used to supplement Tier 1 data. At the 12-digit level, tier 2 data can be used to augment assessments based on a single Tier 1 observation. At the 8-digit watershed level, tier 2 data can supplement watershed characterizations.

- Where local data support the State assessment, conclusions can be stated with greater confidence.

- Where local data contradict the State assessment, water quality assessors must understand the basis for the difference before a final determination is made. There may be many valid reasons for differences, but if local data over-ride conclusions based on State data, a rationale must be provided.

- Where there are no State data, local data may be used to make water quality assessment decisions, if in the determination of the assessor, the data meet quality criteria equivalent to those used in the MBSS program.

Other situations: *Data not meeting the requirements stated above may be helpful for non-regulatory purposes (e.g., targeting, education). Such data will be stored and documented for these uses. State biologists may refer submitters to information sources that will help them to improve the quality of their monitoring data.*

4.1.8 STRESSOR IDENTIFICATION

Stressor identification (cause/source identification) - If a watershed is determined to be impaired based on biological data, the cause of the impairment(s) will then be determined by a review of all of the relevant chemical, physical, and physical habitat data. If the source of the impairment(s) cannot be determined from the data, an on-site evaluation of the watershed may be undertaken including more detailed diagnostic testing such as sediment and water column chemistry and toxicity and geomorphic analyses. Habitat evaluation during sampling, with chemical and physical data will be used to evaluate the potential causes of impairments. It may be determined in some cases that the appropriate remedy is stream restoration rather than reduction of a specific chemical pollutant.

4.1.9 REFERENCES

Calculation of the IBIs:

Roth, N.E., M.T. Southerland, J.C. Chaillou, P.F. Kazyak, and S.A. Stranko. 2000. Refinement and validation of a fish Index of Biotic Integrity for Maryland streams. Prepared by Versar, Inc., Columbia, MD, with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-00-2.

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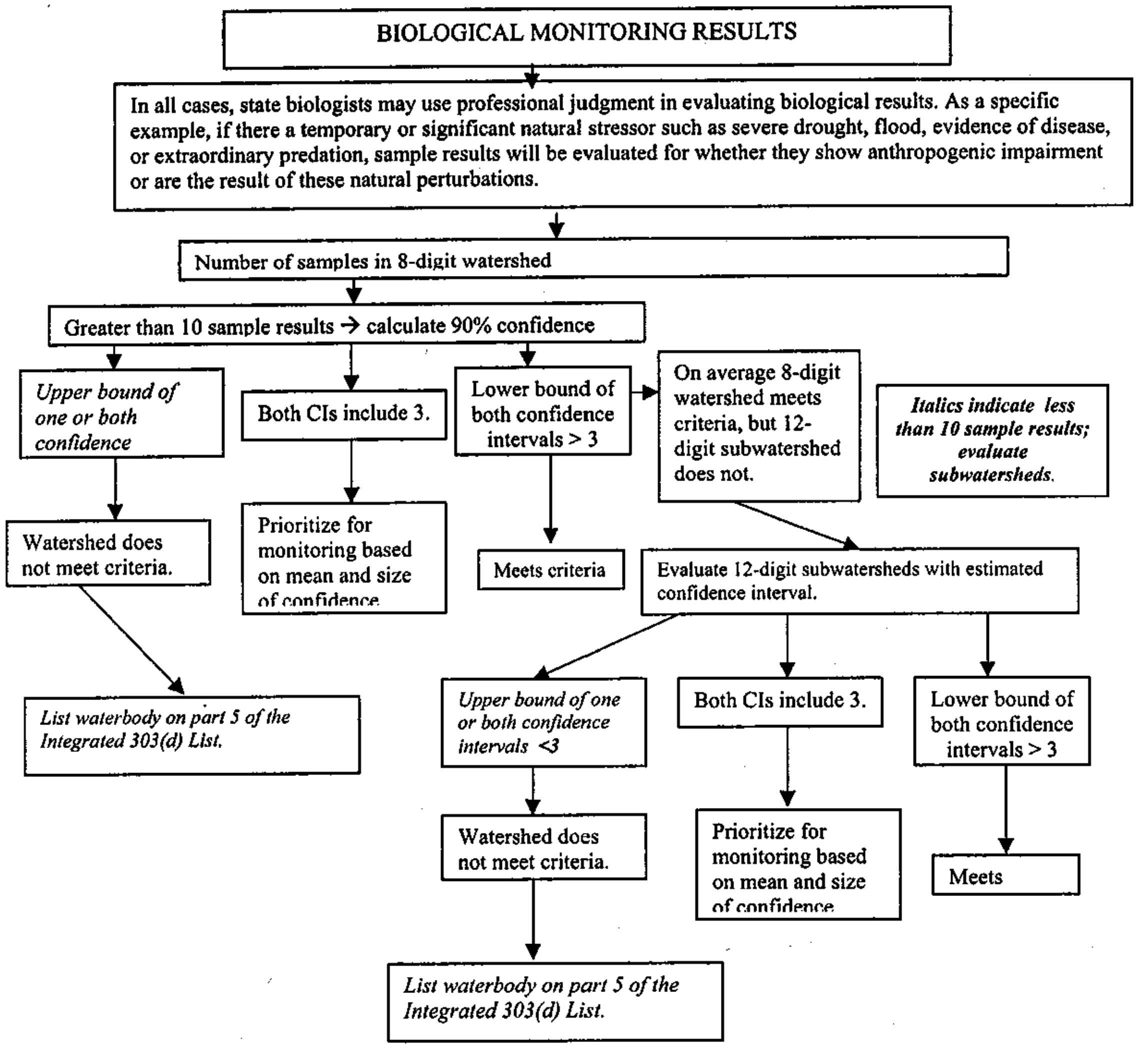

Figure 2: Biological Monitoring Decision Flow

4.2 Methodology for the Interpretation of Dissolved Oxygen Standards in Maryland's Thermally Stratified Lakes[2]

4.2.1 INTRODUCTION

Maryland has a minimum dissolved oxygen (DO) criterion of 5.0 mg/l for all waters at all times, except as resulting from natural conditions [COMAR 26.08.02.03-3A(2)]. Bottom waters in thermally stratified lakes may naturally become depleted of DO during periods of stratification (Wetzel 1975). In the absence of a standard specifically addressing stratified lakes, MDE is adopting an interim interpretation of the existing standard utilizing the percentage of oxygen saturation in the hypolimnion as a metric.

The natural evolution of lakes is toward eutrophication (Reid, 1961). Eventually, ecological succession by marsh, meadow and forest follows, unless human intervention slows or reverses the process. In view of this natural progression, selecting and maintaining an endpoint to represent attainment of a water quality standard is difficult. The challenge is to select a reasonable trophic status for a given lake. Upon selecting a reasonable trophic status to maintain, dissolved oxygen concentrations in the lake can be predicted.

4.2.2 BACKGROUND FOR PROPOSED INTERM INTERPRETATION OF DO STANDARDS AS APPLIED TO THERMALLY STRATIFIED LAKES IN MARYLAND

In idealized cases, lakes stratify into three distinct layers—the epilimnion, metalimnion and hypolimnion. The epilimnion is the well-mixed surface layer of relatively warm water. The metalimnion, the middle layer, is a zone of a distinct downward temperature gradient. The hypolimnion is the bottom layer of relatively cold and undisturbed water (Wetzel 1975).

Often, stratified lakes do not exhibit a separation into three distinct layers. The epilimnion is typically present as defined above; however, temperature in the underlying waters may decrease continuously down to the lake bottom. In this document, the term "hypolimnion" is used to define waters below the epilimnion, regardless of whether the lake exhibits three-layered thermal stratification.

Chapra (1997) describes hypolimnetic DO saturation as a function of lake trophic status. This relationship is summarized in Table 1 below.

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[2] Source: Maryland Department of the Environment, 1999

Table 1: Relationship between Lake Trophic Status and Dissolved Oxygen Saturation in the Hypolimnion of a Thermally Stratified Lake

Trophic Status	Hypolimnetic Dissolved Oxygen Saturation
Eutrophic	0% - 10%
Mesotrophic	10% - 80%
Oligotrophic	80% - 100%

Adapted from Chapra (1997)

Reid (1961) provides a means of computing a dissolved oxygen concentration in water at a given temperature, elevation, and percentage of oxygen saturation (see Figure 3). This expected hypolimnetic DO concentration provides a reasonable basis for a hypolimnetic DO criterion in lakes of a given trophic state.

Correction Factors for Oxygen Saturation at Various Altitudes

Altitude Feet	Altitude Metres	Pressure mm.	Factor
0	0	760	1.00
330	100	750	1.01
655	200	741	1.01
980	300	732	1.04
1310	400	723	1.05
1640	500	714	1.06
1970	600	705	1.08
2300	700	696	1.09
2630	800	687	1.11
2950	900	679	1.12
3280	1000	671	1.13
3610	1100	663	1.15
3940	1200	655	1.16
4270	1300	647	1.17
4600	1400	639	1.19
4930	1500	631	1.20
5250	1600	623	1.22
5580	1700	615	1.24
5910	1800	608	1.25
6240	1900	601	1.26
6560	2000	594	1.28
6900	2100	587	1.30
7220	2200	580	1.31
7550	2300	573	1.33
7880	2400	565	1.34
8200	2500	560	1.36

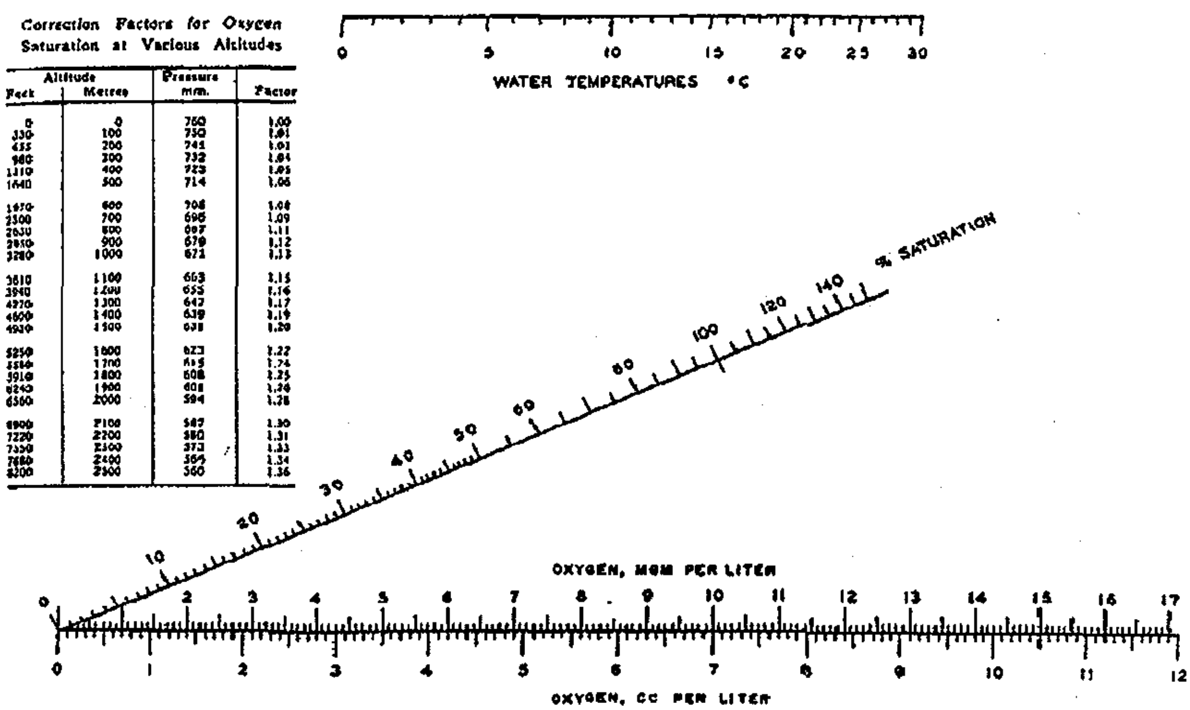

Figure 3: Nomogram showing relationship between water temperature, DO concentration, and DO saturation. ***Source*: Reid 1961.**

4.2.3 LISTING METHODOLOGY FOR INTERPRETATION OF DO STANDARD AS APPLIED TO THERMALLY STRATIFIED LAKES IN MARYLAND

MDE is adopting the following general procedure to define the interim interpretation of the dissolved oxygen criteria for lakes exhibiting seasonal thermal stratification:

- A minimum dissolved oxygen concentration of 5.0 mg/l will be maintained in the epilimnion at all times.

- The allowable minimum hypolimnetic dissolved oxygen concentration will be determined as follows, given the selection of a reasonable trophic status[3] to be maintained:

    1. The minimum percentage of dissolved oxygen saturation will be determined based on an adaptation of Table 1 above to accommodate Maryland's additional categories within the mesotrophic range (Table 2). This adaptation subdivides the mesotrophic range cited by Chapra into three zones each spanning approximately 23 percentage points.

Table 2: Extended Relationship between Lake Trophic Status and Dissolved Oxygen Saturation in the Hypolimnion of a Thermally Stratified Lake

Trophic Status	Minimum Hypolimnetic Dissolved Oxygen Saturation
Eutrophic	0%
Meso-eutrophic	10%
Mesotrophic	33%
Oligo-mesotrophic	56%
Oligotrophic	80%

2. Given observed water temperatures, minimum dissolved oxygen saturation (from above) and elevation, the expected range of dissolved oxygen concentrations will be determined using published nomograms such as that presented by Reid (1961), or comparable calculation methods[4].

As an example, consider a meso-eutrophic lake, at sea level, with an observed temperature within the hypolimnion of 10°C. The minimum allowable oxygen saturation in the hypolimnion would be 10%. Using the nomogram from Reid (1961), this would translate to a minimum allowable DO concentration of approximately 1.2 mg/l (see Figure 4).

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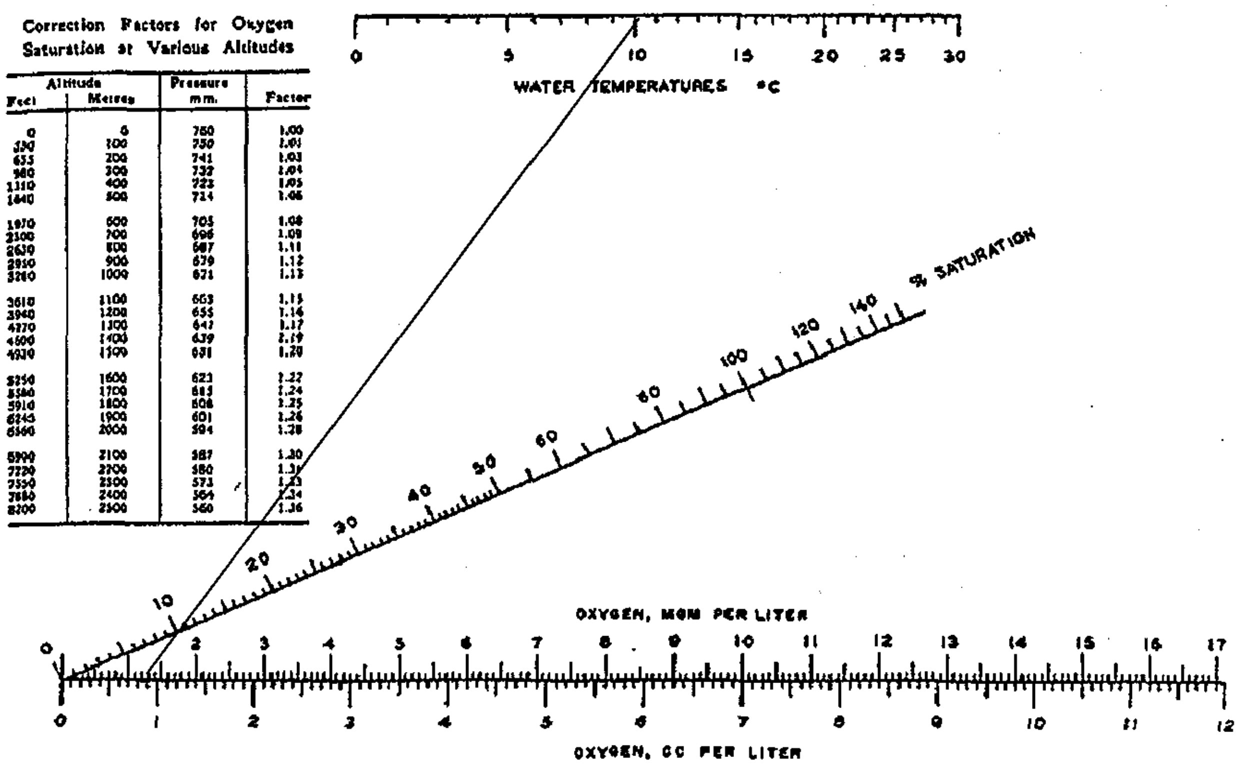
[3] Trophic status for the interim interpretation described will be that cited in the Maryland Lakes Water Quality Assessment Report, 1997 (Maryland Department of Natural Resources 1998). Future refinement of this interpretation will ensure that the selected trophic status is compatible with the lake's designated use.

[4] Although this interim procedure can yield high DO concentrations, it is not intended to result in a minimum DO criterion exceeding 5.0 mg/l.



Altitude Feet	Altitude Metres	Pressure mm.	Factor
0	0	760	1.00
330	100	750	1.01
655	200	741	1.03
980	300	732	1.04
1310	400	723	1.05
1640	500	714	1.06
1970	600	705	1.08
2300	700	696	1.09
2630	800	687	1.11
2950	900	679	1.12
3280	1000	671	1.13
3610	1100	663	1.15
3940	1200	655	1.16
4270	1300	647	1.17
4600	1400	639	1.19
4930	1500	631	1.20
5250	1600	623	1.22
5580	1700	615	1.24
5910	1800	608	1.25
6240	1900	601	1.26
6560	2000	594	1.28
6900	2100	587	1.30
7220	2200	580	1.31
7550	2300	573	1.33
7880	2400	566	1.34
8200	2500	560	1.36

Figure 4: Minimum allowable hypolimnetic dissolved oxygen saturation and concentration in a meso-eutrophic lake (T = 10°C).

4.2.4 REFERENCES

Chapra, Steven C. 1997. Surface Water Quality Modeling. McGraw – Hill.

Maryland Department of Natural Resources. 1998. Maryland Lake Water Quality Assessment Report, 1997.

Reid, G. K. 1961. Ecology of Inland Waters and Estuaries. D. Van Nostrand, Inc., New York, U.S.A.

Wetzel, R. G. 1975. Limnology. W. B. Saunders, Inc., Philadelphia, U.S.A.

4.3 <u>Listing Methodology for pH and Mine Impacted Waters</u>

All pH impairments are identified based on COMAR §26.08.02.03, which states that: "Normal pH values may not be less than 6.5 or greater than 8.5" in Use I, IP, II, III, IIIP, IV, or IVP waters. It is undesirable to incorrectly identify a waterbody as impaired when the observed condition is of a natural origin. Factors, such as the presence of a peat or black water bog or swamp would be considered as natural conditions, and therefore, not impaired under the CWA §303(d) listing process.

Other natural conditions, which should not be used to identify a waterbody as pH impaired would include an abundance of algae or aquatic plants that elevate pH levels above 8.5 as a result of photosynthetic driven chemical reaction, unless the condition is being caused by a defined nutrient enrichment source. Certain conditions in close proximity to limestone springs may also have natural pH values outside of the standards. Streams that do not meet the criterion for pH and which cannot be demonstrated to result from natural conditions will be listed as impaired.

Streams influenced by abandoned coal or clay mining operations (those that predate the permitting authority or designated as "pre-law") and having a pH below 6.5 would be listed as impaired.

Waterbodies displaying acidic conditions as a result of atmospheric deposition will be placed on the 303(d) list if it is determined that there is not adequate natural buffering capacity in the watershed.

The decision process for evaluating pH in Maryland waters is summarized in the following flowchart shown in Figure 5.

Decision process for listing pH Impaired waters

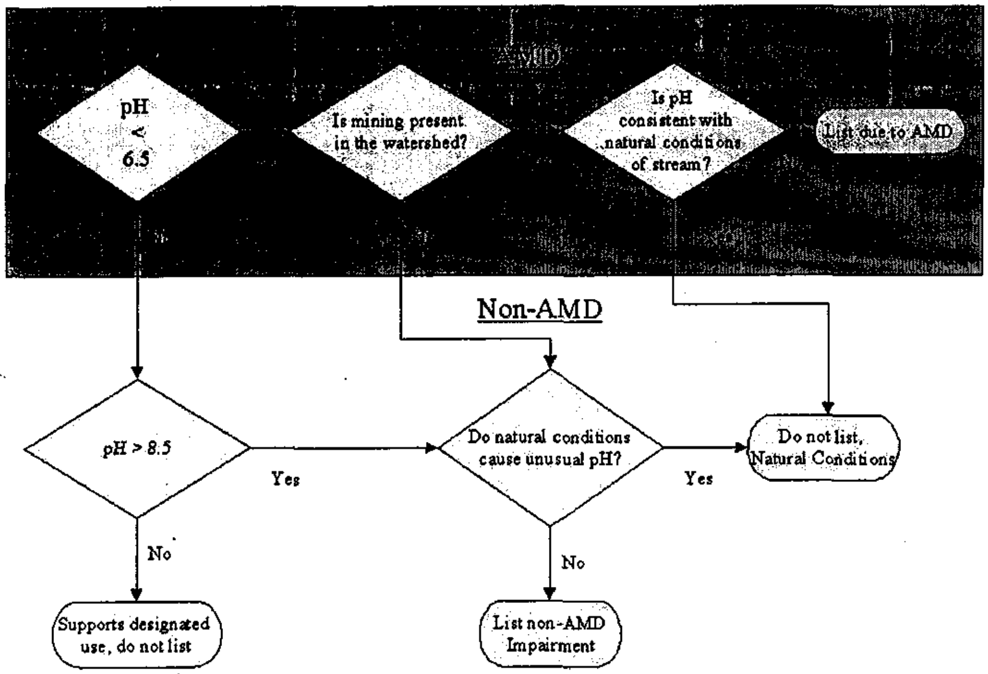


Figure 5: Decision flowchart for pH impaired waters.

1. The flow chart applies to Maryland 8-digit watersheds evaluated for the 303(d) list.
2. Ideally, an impairment decision should be based on a sufficient number of samples to adequately characterize potential diurnal and seasonal variations.
3. If 10% or more of the samples violate the pH numeric criteria and cannot be traced to naturally occurring conditions, the 8-digit stream watershed will be considered to not meet the standards for its designated uses and listed as impaired.
4. If less than 10% of the samples violate the pH numeric criteria, best professional judgement will be used to determine if the 8-digit watershed should be listed as impaired. In the event the waterbody is not listed, additional samples will be collected for future consideration.

4.4 Listing Methodology for Identifying Waters Impaired by Bacteria on Maryland's 303(d) List

4.4.1 INTRODUCTION

The rules used by MDE to interpret data and apply the water quality standards are discussed below in three sections. Each of those sections describes the application to a distinct water use: shellfish harvesting; permitted beaches; and general recreation waters. Although in each case a bacteriological indicator applies, the criterion and in some cases the indicator itself differs according to the requirements of the National Shellfish Sanitation Program (NSSP), water quality standards, or public health requirements.

4.4.2 INTERPETATION OF FECAL COLIFORM DATA IN USE II, SHELLFISH HARVESTING AREAS

(1) RESTRICTED:
Those areas restricted to shellfish harvesting because they do not meet State requirements for Use II waters or do not meet the strict requirements under the NSSP are listed. These requirements are found in the *National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish*, 1997 revision. Copies can be obtained from the U.S. Department of Health and Human Services, PHS, FDA. Data used to determine these restrictions include routine bacteriological water quality sampling, sanitary survey, and strict adherence to the NSSP procedures, protocols and requirements.

(1A)
Those areas restricted to shellfish harvesting because they are located in the vicinity of a wastewater treatment plant (WWTP) discharge pipe but where there is no evidence of actual bacteriological impairment are not listed. This restriction is an important application of the principals and practices of public health protection and is required under the NSSP. State law requires MDE to monitor these areas for fecal coliform bacteria. MDE also evaluates treatment plant performance and its impact to shellfish harvesting waters. These administrative closures are not based on water quality criteria but are designed to be protective buffer areas in case of a system failure. These areas meet the bacteriological portion of the standard. These areas are also closed as a requirement for compliance with the NSSP.

(1B)
The upper Chesapeake Bay is restricted to shellfish harvesting for administrative reasons and is not listed. This area is designated as Use II waters; however there is insufficient shellfish resource for harvesting due to the fresh water input from the Susquehanna River. Since there are no oysters or clams to harvest, MDE does not spend valuable staff resources to complete shoreline surveys. To remain in compliance with the NSSP, MDE must therefore classify the area as restricted. In order to protect shellfish waters directly below this area, the Use II designation is a valuable protective measure so the area remains designated Use II waters. Water quality is routinely monitored in this area for fecal coliform and meets the bacteriological portion of the standard. If the collected data shows violations with State standards (notwithstanding the fact that the area is under an administrative closure or restriction) it will be listed appropriately.

(2) CONDITIONALLY APPROVED WATERS:
Before being opened for conditional harvesting, areas need to meet the stringent shellfish bacteriological standards. However, those areas classified as conditionally approved are closed to harvesting for three days following a rainfall event of greater than or equal to one inch in twenty-four hours. This happens an average of 10 - 15 times per year when we cannot be completely certain that bacterial levels are not elevated in response to rain. The rest of the time, these areas meet the water quality standards for Use II waters, these areas are not listed.

(3)APPROVED WATERS:
Areas classified as approved for harvesting meet the water quality standards for Use II waters.

4.4.3 INTERPRETATION OF FECAL COLIFORM DATA FOR SWIMMING BEACHES

The 305(b) Report includes a table on beach closures. This table is derived by sending a survey out to the county health departments who have the authority to close bathing beaches. Most closures are short lived and related to an extreme storm event, sewage spill, etc. The cause of the closure is usually investigated quickly with appropriate action taken as soon as possible to abate the problem. It is not appropriate to assign impairments to areas based on intermittent bathing beach closures. However, those areas permanently closed or having long-term or chronic closures are listed.

Maryland has implemented the EPA recommended enterococcus (marine or freshwater) and *E. coli* (freshwater only) standards at permitted beaches. Where frequent or chronic closures based on these indicators occur, those waters will be listed.

4.4.4 INTERPRETATION OF FECAL COLIFORM DATA FOR USE I, II OR IV WATERS

Routine monthly sampling provides limited bacteriological information. MDE also routinely receives information from local health departments, reports on non-compliance with various water quality permits, etc. that covers areas of the State not included in the Water Quality Tributary Monitoring coverage.

Data generated by water monitoring programs will be used to plot a five-point moving average geometric mean of fecal coliform levels. Segments where the average exceeds 200 MPN/100 ml will be evaluated further by sanitary survey. In addition, information collected from other sources indicating a potential bacteriological impairment will be evaluated further by sanitary survey. The information generated for completing a sanitary survey is listed below.

1. A land use map of the segment in question will be studied to determine potential sources of fecal coliform pollution.

2. It will be determined if the area is served by individual on-site wastewater treatment or served by public or private sewer including the presence or absence of a combined storm water/wastewater system.

3. A regional Sanitarian, the local health department, the local agency responsible for wastewater treatment infrastructure, and Inspection & Compliance Program staff will be contacted to determine what potential or actual problems exist regarding on-site wastewater treatment in the vicinity or any other potential bacteriological pollution problems (such as collection system or sewage treatment plant problems, surface water quality permit violations, etc.)

4. Based on the result of the sanitary survey (see discussion below for more details on types of information and actions available for conducting a sanitary survey) or other information reported to the Department, a determination will be made to list or not to list the segment as impaired.

   a) Those segments impacted by faulty sewer lines, excess inflow and infiltration, or other impacts allowing a technological fix will be listed if the problem cannot be fixed before the next listing period. Attainment of water quality standards or the probability that water quality standards will be attained by the next listing period must be demonstrated.

   b) Those segments where no technological fix is feasible, or where that repair cannot be completed by the next listing period, or where there is a potential human health risk, are listed on Part-5 of the 303(d) List.

4.4.5 DISCUSSION

It is critical that the sampling be carried out in a way that is representative of conditions in time and space. High spatial and temporal variability suggest that infrequent or moderately elevated bacteriological levels alone do not necessarily represent a human health risk. The bacteriological standard is descriptive and includes numerical criteria. The intent of the criteria is to allow the 'number' to be judged in conjunction with the sanitary survey that identifies probable sources of fecal coliform and allows regulators to assess the probability of human health risk. The standard recognizes the inherent variability of the fecal coliform measurement and recognizes the inadequacies of fecal coliform as an indicator organism. The Most Probable Number (MPN) test used to determine the level of fecal coliform is not a direct count but a statistical estimation subject to a high degree of variability.

Maryland's fecal coliform standard protects the public from harmful human pathogens. One or two high values may or may not be indicative of impairment because fecal coliform is fairly ubiquitous in the natural environment and is used as an <u>indicator</u> of <u>possible</u> human fecal contamination from point and nonpoint sources. Therefore, it is necessary to evaluate the fecal coliform values along with sanitary survey information to assess bacteriological water quality conditions.

MDE has a fairly aggressive pollution prevention program and the authority to abate pollution problems. Chronic problems or serious public health issues are addressed through local health departments, MDE's Inspection and Compliance Program, and the local soil conservation districts. The local health departments conduct sanitary surveys, enforce requirements for on-site sewage treatment, and address citizen complaints regarding sewage pollution. MDE's Inspection and Compliance Program has the authority to address pollution concerns, inspect and abate pollution problems concerning on site sewage treatment and farm operations, inspect and enforce permit requirements for all dischargers, etc. The local conservation districts work with farmers to ensure best management practices. If an animal operation is identified as a source of fecal pollution to surface waters, MDE has the authority to abate the problem. Until a problem from agricultural sources is abated, impaired waters will be listed.

The intent of Maryland's bacteriological water quality criteria is for State regulators to have a tool (one of many) to provide adequate public health protection as well as water quality protection required under the CWA. Public health protection is most efficient and effective when the fecal coliform standard is interpreted in conjunction with the results of a sanitary survey.

4.5 Listing Methodology for Determining Impaired Waters By Chemical Contaminants for the Maryland 303(d) List

4.5.1 BACKGROUND

The designated uses define the water quality goals of a waterbody. At a minimum, the Maryland Department of the Environment (MDE) must provide water quality for the protection and propagation of fish, shellfish, and wildlife, and provide for recreation in and on the water, where attainable (CWA Section 101(a)). The MDE is required to adopt water quality criteria that protect designated uses. Such criteria must be based on sound scientific rationale, must contain sufficient parameters to protect the designated uses, and can be expressed in either numeric or narrative form. Narrative criteria are descriptions of the conditions necessary for a waterbody to attain its designated use, while numeric criteria are concentration or threshold values deemed necessary to protect designated uses. Narrative criteria can be used to assess water quality, and also to establish pollutant-specific discharge limits where there are no numeric criteria or where such criteria are not sufficient to protect the designated use.

Although several approaches exist to assess water quality (e.g., numeric criteria, whole effluent toxicity, etc.), few approaches exist to assess sediment quality due to its complexities. Nevertheless, sediments are an integral component of aquatic ecosystems, providing habitat, feeding, spawning, and rearing areas for many aquatic organisms and are, therefore, protected under the narrative criteria. Furthermore, sediment quality can affect whether or not waters are attaining designated uses. Consequently, it is necessary and appropriate to assess and protect sediment quality, as an essential component of the total aquatic environment, to achieve and maintain designated uses. The difficulty lies in implementing the narrative criteria, which is qualitative in nature. To circumvent this obstacle, MDE is implementing an approach to quantitatively interpret narrative criteria statements, and determine water quality standard violations from contaminated sediments.

4.5.2 INTRODUCTION

Under section 303(d)(1) of the Federal Clean Water Act (CWA), MDE is required to establish Total Maximum Daily Loads (TMDLs) for those waterbody segments that do not meet applicable water quality standards and are therefore considered "impaired". To achieve this, MDE is required to consider all existing and readily available water quality data and information, and develop methods to interpret this data for each potential impairing substance (e.g., pH, nutrient, fecal coliform, etc.).

EPA does not provide guidance for interpreting water quality data for the purposes of developing the 303(d) List. However, EPA does provide guidance on making "use support determinations" for the State Water Quality Assessments [305(b) Report] (EPA, 1997). In general, MDE adopted the 305(b) guidance for identifying waterbody segments impaired due to chemical contaminants. Even though the Department will adhere to these methods as closely as possible, there may be instances where determinations may vary based on scientifically defensible decisions. It is important to note that there maybe situations which do not support an impairment determination from chemical contaminants, but rather from another stressor (e.g., dissolved oxygen, biocriteria), and would therefore be addressed elsewhere. This document provides the specific methodology used by MDE for identifying waterbody segments impaired due to *chemical contaminants*.

It is not the intent of this methodology to include waters that do not meet water quality criteria solely due to natural conditions or physical alterations of the waterbody not related to anthropogenic pollutants. Similarly, it is not the intent of this chapter to include waters where designated uses are being met and where water quality criteria exceedances are limited to those parameters for which permitted mixing zones or other moderating provisions (such as site-specific alternative criteria) are in effect. The Department will examine these situations on a case-by-case basis, and evaluate the context under which the exceedance exists. Determination of compliance with water quality criteria may be facilitated through special analyses (e.g. normalization of metals to common reference element to determine anthropogenic influences), or monitoring (e.g. compliance monitoring for mixing zones).

MDE considers all existing readily available chemical, toxicological, and biological data from water column, sediments, and fish tissue in determining if a waterbody segment should be classified as impaired due to chemical contaminants and listed on the 303(d) List. As a result, MDE has divided the impairment evaluation process into three media categories (water column, sediment, and fish tissue). The Department will evaluate the monitoring plans, Quality assurance, and Quality Control (QA/QC) programs of data providers, and will use best professional judgment to include/exclude data where documentation does not exist.

4.5.3 WATER COLUMN

Ambient water column contaminant data are screened against numerical ambient water quality criteria if available. These water quality criteria are utilized because they represent science-based threshold effect values and are an integral part of the Maryland's water quality standards program. These criteria are divided into the following categories that directly relate to Maryland's surface water use designation classification (COMAR 26.08.02):

1) All surface waters of the state (USE DESIGNATIONS - I, II, III, & IV)

- *Criteria for the protection of aquatic life*
    - *Fresh water (Chronic & Acute)*
    - *Saltwater (Chronic & Acute)*
- *Criteria for the protection of human health from fish tissue consumption (Organism Only)*

2) Surface waters used for <u>public water supply</u> (USE DESIGNATION - P)

- *Criteria for the protection of human health from fish tissue consumption & drinking water (Water + Organism)*
- *Drinking water only (Maximum Contaminant Levels-MCLs)*

EPA does not provide guidance in interpreting water column data for the purposes of developing the 303(d) list but does for the development of the 305(b) Report (Maryland's Water Quality Inventory). The 305(b) guidance states that, with a minimum of 10 samples over a three-year period, the designated use is not supported if greater than 10% (i.e. 2 out of 10) of the samples exceed the appropriate benchmark (EPA 1997). MDE had adopted this rule to identify waterbodies impaired by chemical contaminants. In other words, with a minimum of 10 samples over a three-year period, an impairment would exist if greater than 10% of the samples exceed the criteria. An appropriate statistical procedure (e.g., confidence interval approach) will be applied if sample size for a segment is deemed adequate. If there are less than 10 samples for a given area, MDE interprets the available data on a case-by-case basis and determines if an impairment exists. In such cases, a number of factors are considered such as:

- *The magnitude of the criteria exceedance for any one contaminant,*
- *The number of criteria exceeded,*
- *Water column bioassay (toxicity) data indicating toxicity to test organisms.*
- *Data quality*

If it is determined that a potential impairment exists, but there is insufficient data to make an impairment determination, the segment will be placed on Part-3 (Insufficient data), or Part-4 (Impaired/Threatened but TMDL not required due to forthcoming compliance or previous completion of a TMDL). Segment will then be prioritized for additional monitoring. In these instances, the Department will use its best professional judgment based on the available data to make its determination.

In the case that no criteria are available for a particular contaminant or no criteria are exceeded, other impairment indicators (e.g., ambient water column toxicity data) will be evaluated using best professional judgment. During this evaluation process, if toxicity is indicated, a Toxicity Identification Evaluation (TIE) maybe considered to further identify the possible contaminant source(s) causing toxicity. A TIE is a comprehensive approach used in the Whole Effluent Toxicity (WET) Program to identify possible causes of toxicity. When warranted, MDE will also utilize spatial and temporal trend analyses as an additional evaluation tool for making impairment determinations.

As mentioned previously, MDE considers all existing and readily available data, including independent studies conducted by sources external to MDE. These ambient water column data are screened to determine if they are of acceptable quality (i.e., documented methods and an acceptable QA/QC plan). If the data are unacceptable (i.e., poor or no QA/QC) but suggest an exceedance of the appropriate criteria, the segment is targeted for additional monitoring, and evaluated using other approaches.

In many cases, there may be no ambient water quality data (chemical or toxicity) available for an impairment evaluation. In such cases, MDE will apply a weight-of-evidence approach using other data as described below.

4.5.4 SEDIMENT

Protecting sediment quality is an important part of restoring and maintaining the biological integrity of our State's waters. Sediment is an integral component of aquatic ecosystems, providing habitat, feeding, spawning, and rearing areas for many aquatic organisms. Sediment also serves as a reservoir for chemical contaminants and therefore a source of chemical contaminants to the water column and organisms. Chemicals that do not easily degrade can accumulate in sediments at much higher levels than those found in the water column.

Contaminated sediments can cause adverse effects in benthic or other sediment-associated organisms through exposure to pore water or direct ingestion of sediments or contaminated food. In addition, natural and human disturbances can release chemical contaminants to the overlying water, where water column organisms can be exposed. Sediment contaminants can reduce or eliminate species of recreational, commercial, or ecological importance, either through direct effects or by affecting the food supply that sustainable populations require. Furthermore, some chemical contaminants can bioaccumulate through the food chain and pose human health risks even when sediment-dwelling organisms are not themselves impacted. This specific pathway will be addressed later in the fish tissue approach.

MDE is using the following comprehensive weight-of-evidence approach in making impairment determinations. This approach, also referred to as the Sediment Quality Triad, consists of three components (Chapman, 1992):

- Ambient sediment bioassays - to measure toxicity
- *In situ* biological variables - to measure alteration of resident biota (*e.g.*, change in benthic community structure)
- Ambient sediment chemistry - to measure chemical contamination

These components provide complementary data to each other, that when combined may provide an efficient tool for determining an impairment. However, each component has its limitations, which necessitates a sound scientific interpretation of the data and best professional judgment on a case-by-case basis. The scientific community, in fact, has previously indicated that sediment assessments are strongest when the three data components are used in combination to balance their relative strengths and weaknesses (Chapman, 1992, Long et al., 2000, Anderson et al. 2001, Ingersoll et al., 1997, EPA 1997).

4.5.4.1 Ambient Sediment Bioassay Data

Ambient sediment bioassays are a type of biological data, in which test organisms are exposed under controlled conditions to the field collected sediment sample. Although we have confidence in this type of data because of the controlled conditions, it can be inconsistent, especially where toxicity is minimal or subtle. Laboratory artifacts, although generally controlled, can produce false results. For this reason, at least two or more non-microbial tests are required to exhibit toxicity to determine that the potential for adverse effects from contaminated sediment is high.

This type of data is essential in assessing sediment contaminants. If toxicity is exhibited to the tested benthic/epibenthic organisms, it is generally considered indicative of water quality that is incapable of supporting aquatic life, which is in violation of our State's water quality standards. Furthermore, it also suggests that the adverse effects observed in the toxicity tests may be related to chemical contaminants because other non-contaminant related causes (e.g. dissolved oxygen, pH, temperature) are controlled in the laboratory setting. In addition, the information from this data component is quantitative and can be correlated to the toxicity of other sediments or chemicals to the test species. For this reason, the greatest weight is given to toxicity test data among the three data components.

However, a limitation of this data is that it does not identify the causative pollutant, which necessitates the need for sediment chemistry data. The sediment chemistry data provides the best link for establishing an impairment determination resulting from contaminant exposure, which is the basis of this document. Additionally, the laboratory conditions under which bioassays are conducted may not accurately reflect field conditions of exposure to toxic chemicals, and thus introduces uncertainties when extrapolating to population dynamics. This point is important to understand because while attempting to control for non-contaminant related stressors (e.g., dissolved oxygen, pH, temperature), contaminants in the sediments may be rendered toxic to the test organisms that would not be toxic under field conditions, thus providing a false positive result (e.g., sulfide and ammonia in sediments, pH shift for metals).

4.5.4.2 Sediment Chemistry Data

Although EPA has been working on sediment quality criteria (SQC) for many years, no final numeric water quality criteria have been published. This is due to the difficulty in determining the fraction of the chemical contaminant that is biologically available to exert its toxic effect on the exposed population and in establishing a criteria derivation process that could be shown to be consistent with other evaluative tools. In fact, the EPA has redirected their efforts to derive equilibrium sediment guidelines (ESGs), rather than criteria, for the following five substances; acenaphthene (EPA, 1993a), fluoranthene (EPA, 1993b), phenanthrene (EPA, 1993c), dieldrin (EPA, 1993d), and endrin (EPA, 1993e).

In the absence of such guidelines, a set of screening values devised by National Oceanic and Atmospheric Administration (NOAA) has been generally accepted as a screening tool to evaluate the likelihood of adverse effects (Long and Morgan, 1990/NOAA, 1991; Long *et al.*, 1995). The Effects Range-Median (ER-M) values are defined as the median (50th percentile) of the distributions of the effects data for a particular contaminant. However, these values should only be used to screen sediments for levels of possible concern, and should not be construed to indicate an adverse effect in the absence of additional corroborative data (Long and MacDonald, 1998). In their development of a classification scheme for the National Sediment Quality Inventory, EPA also recognized the limitations of the ER-Ms by requiring that the bulk sediment chemistry data exceed two separate sediment benchmarks in classifying sediments as Tier I (probable adverse effects to aquatic life and human health) (EPA 1996).

In the absence of EPA ESGs and NOAA ER-M values, sediment quality benchmarks (SQBs) were derived by MDE for non-ionic organic substances using the EPA-recommended equilibrium partitioning approach, (e.g., alpha-BHC, beta-BHC, lindane, chlordane, chlorpyrifos, heptachlor, etc.). This is also consistent with EPA's National Sediment Quality Inventory. MDE will compare sediment chemistry data according to the described thresholds in the following order (see Table 4):

a) EPA ESGs,
b) NOAA ER-M values,
c) MDE derived SQBs, and
d) Other toxicological sediment benchmarks (*i.e.,* toxicity data)

Both the quality of sediment chemistry data and associated screening thresholds are considered when conducting an evaluation. Once the quality of data has been established, the potential for adverse effect from contaminated sediment is said to be high if either of the following conditions are met:

1. The sediment chemistry data exceeded the EPA ESG, or

2. The sediment chemistry data exceeded the ER-Ms or other screening values by a factor of two[5] for any one contaminant, or

3. The mean ER-M quotient[6] is greater than 0.5 (Long et al. 2000 & Anderson et al. 2001), or

4. The sediment chemistry data exceeded more than 5 ER-Ms[7] (Long et al. 2000 & Anderson et al. 2001).

Furthermore, various environmental conditions in the sediment can have a profound effect on the availability and toxicity of the sediments to aquatic environment (e.g., acid volatile sulfide for metals, organic carbon for organics, etc.). If data on these parameters are available, MDE will use best professional judgment to interpret the effects of these parameters on the sediment chemistry data.

When the measured chemical exceeds the appropriate sediment threshold, any observed adverse effects to the test species may be due to the measured chemical with the likelihood increasing as the chemical concentration increases. When a chemical is measured at a level below the threshold, any observed adverse effects are not likely to be due to the measured chemical. It is recognized, however, that sediments are rarely, if ever, contaminated by a single chemical. Therefore, in cases where a chemical is measured at a level below a threshold, the sediment may still cause adverse effects. Such cases could include, for example, contaminated sediments where chemicals not covered by a threshold are creating or contributing to toxicity, or where bioaccumulation or biomagnification up the food chain is a concern (EPA, 2000).

The mere exceedance(s) of a sediment threshold, however, does not in itself establish an adverse effect from toxicity, but helps to identify the chemical that might be responsible for any observed adverse effects from toxicity. Given these limitations, MDE does not believe that the exceedance(s) of sediment thresholds are appropriate as sole indicators of use attainment. Instead, we recommend using all three data components as a basis for interpreting narrative criteria and developing pollutant reduction strategies.

4.5.5 BIOLOGICAL BENTHIC ASSESSMENT DATA

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[5] The factor of two was derived as the geometric mean of the ratios for those substances for which ER-Ms and SQCs were available; acenaphthene (ER-M/SQC ratio=4.6), fluoranthene (ER-M/ESG ratio=0.6), and phenanthrene (ER-M/ESG ratio=1.6). Although it was possible to calculate a ratio for dieldrin (ER-M/ESG ratio=25), it was not considered because the ratio was greater than 5 times the highest of the other three ratios. This condition serves the purpose of confirming the severity of contamination for any one contaminant above background concentrations, and therefore demonstrating the potential for impairing that segment.

[6] An ER-M quotient is calculated as the ambient sample concentration over the ER-M (toxicity weighted average).

7 Long et al.,(2000) showed that there is a much higher probability (>48%) that samples would be toxic in which six or more ERM values are exceeded or in which mean ERM quotients exceed 0.5.

In freshwater, MDE currently uses biological community data independently in making an impairment determination. The methodology dealing with biological assessments is addressed elsewhere under the biocriteria framework. This type of data is generally considered a good water quality indicator, because it measures a community (population) response to water quality and integrates through time and cumulative impacts. Thus, if this assessment data or other types of assessment data (e.g. Chesapeake Bay restoration goals) do not indicate an alteration (or degradation) of the biological benthic community, the waterbody is not considered for an impairment determination, despite data from the other components because:

1. It is supportive of aquatic life (at a community level), and thus meets its designated use,

2. The biological assessment component is a more rigorous method of assessing water quality than chemical and bioassay data which may be highly dependent on uncontrollable variables

3. It measures a community response to water quality rather than subjective endpoints from the other components (e.g. ER-M, significant level of toxicity, toxicity to one species)

4. It is consistent with the biological assessments method developed elsewhere

It is more likely to observe an alteration of the biological community where none should be present (false positive) than not to observe alteration of the biological community where one should present (false negative). Anderson et al., 2001 found that laboratory toxicity tests were indicative of benthic impacts in Los Angeles and Long Beach Harbor stations in California. Single and multivariate correlations showed significant positive relationships between amphipod survival in laboratory toxicity tests and measured benthic community structure in field samples. For this reason, MDE would further investigate the chemistry and toxicity data where an alteration of the biological community has been observed. These data would be used to confirm that the community effect is due to exposure to contaminants and to identify the probable contaminant of concern. However, although biological assessment data alone could indicate an impairment, it would not necessarily result in a "toxics" impairment determination. This is because non-contaminant effects (e.g., competition, predation, sediment type, salinity, temperature, recent dredging) may confound interpretation of this data with respect to chemical contamination (Anderson et al., 2001).

4.5.6 WEIGHT-OF-EVIDENCE APPROACH (Sediment Quality Triad)

A comprehensive approach using multiple assessment methods helps eliminate false conclusions brought about by relying solely on one method of evaluation. Consequently, MDE would assess sediment quality, and thus an impairment determination, using a weight-of-evidence approach (Winger, et al., 2001). Biological assessments could be used to supplement findings of impaired waters, or as a prioritization tool to determine where additional testing should be performed. These components provide complementary data to each other, that when combined may, provide an efficient tool in determining an impairment. However, each component has its limitations, which necessitates a sound scientific interpretation of the data and best professional judgment on a case-by-case basis. Consequently, the individual use of these data components as sole indicators of use attainment is inappropriate. Instead, we recommend using all three data components as a basis for interpreting narrative criteria and developing pollutant reduction strategies.

Sediment chemistry data provide information on contamination, and when used with sediment thresholds or other indicators, also provide insight into potential biological effects. However, they provide little insight on the bioavailability of the contaminant unless data on other mitigating factors (e.g., AVS for metals, organic carbon for organic contaminants) are collected simultaneously. Sediment bioassays are an important component of sediment assessment because they provide direct evidence of sediment toxicity. However, they do not identify the causative pollutant. Additionally, the laboratory conditions under which bioassays are conducted may not accurately reflect field conditions of exposure to toxic chemicals. *In situ* biological studies (such as benthic community composition analyses) are useful because they account for field conditions. However, interpretation with respect to chemical contamination may be confounded by non-contaminant effects. Because each component alone has limitations, the Triad approach uses all three sets of measurements to assess sediment contamination. Table 3 lists possible conclusions that can be drawn from various sets of test results, followed by possible listing decisions.

Table 3: Possible Conclusions Provided by Using the Sediment Quality Triad Approach (Chapman, 1992)

Scenario	Toxicity	Chemistry	Community Alteration	Possible Conclusions	Listing Decision
1	+	+	+	Strong evidence for chemical contaminant-induced degradation.	**List (Part-5)**
2	-	-	-	Strong evidence for absence of chemical contaminant-induced degradation.	**Do not list for toxics**
3	-	+	-	Chemical contaminants are not bioavailable.	**Do not list for toxics Additional monitoring**
4	+	-	-	Unmeasured chemical contaminants or conditions may exist that have the potential to cause degradation.	**Do not list for toxics Additional monitoring**
5	-	-	+	Alteration is probably not due to chemical contaminants.	**Do not list for toxics**
6	+	+	-	Chemical contaminants are likely stressing the system. However, the waterbody is still meeting its designated use due to the presence of an unimpaired benthic community.	**Do not list for toxics Additional monitoring**
7	+	-	+	Unmeasured chemical contaminants are causing degradation.	**Do not list for toxics Additional monitoring**
8	-	+	+	Chemical contaminants are not bioavailable or alteration is not due to contaminants.	**Do not list for toxics Additional monitoring**

"+" Indicates measured difference between test and control or reference conditions.
"-" Indicates no measurable difference between test and control or reference conditions.

As indicated in Table 3, there may be scenarios where sediment chemistry data, sediment bioassays, and benthic community analyses produce conflicting results. In these scenarios, the interpretation becomes more complex, but it does not necessarily indicate that any of the data sets are "wrong", although this possibility should not be ruled out without sound evidence.

Scenario #1: This decision is due to the overwhelming evidence of impairment from all three data components.

Scenario #2: This decision is based on the overwhelming lack of evidence from all three data components.

Scenario #3: Without evidence of toxicity or a degraded biological community, the most likely conclusion is that the chemical contaminants, although elevated, are not bioavailable. If the biological community data shows no adverse effect, the water quality is deemed to be supportive of aquatic life and its designated use is fully supported.

Scenario #4: The basis for this decision is due to the biological community response, and is supported by sediment chemistry. The clear results from the healthy biological community and the lack of chemical concentrations consistent with toxic impacts suggests that the toxicity test results may be anomalous, due to artifacts and not to chemical contaminants. It is possible that there are unmeasured contaminants, but the impact is not sufficient to impair the designated use, as demonstrated by the biological community. However, if the magnitude of the effect observed in the bioassays were severe (e.g. less than 50% survival), the Department may re-evaluate its listing decision. Nevertheless, additional monitoring would be required to confirm the findings of the Triad, and to determine if further actions are required.

Scenario #5: Without evidence of toxicity or elevated chemical concentrations, the most likely conclusion is that the degraded biological community is not due to chemical contaminants. This scenario, however, is be captured by other Listing Methodologies.

Scenario #6: Where a good tool exists for evaluating the biological community, it is usually a good indicator of water quality in general and is very sensitive because it integrates impacts from different stressors as well as impacts through time. Practical experience has shown that where "IBI"-type indicators are considered, they indicated impairments not supported by the other data components (i.e., toxicity and chemistry). Therefore, where biological community data of this type exist showing non-degraded biological communities, it will be considered as sufficient evidence of a supported designated use, despite the implications of toxicity and chemistry.

However, where no such data exists or where those indicators are not applicable, the Department will apply its best professional judgment, but will likely determine that the designated use is not supported.

Scenario #7: The basis for this decision is the adverse response observed from the toxicity and biological community data. In this scenario, the water quality is not supportive of aquatic life and is likely due to chemical contaminantion with no applicable chemical threshold or some unmeasured chemical contaminant. This scenario would require listing on Part-3 of the new 303(d) list. Additional monitoring would be required to determine the impairing substance(s).

Scenario #8: The basis of this decision is the absence of effect in the bioassays. Although the biological community show adverse effects, the lack of toxicity in the tests are indicative that the adverse effect is not due to chemical contaminants, or that they are not bioavailable. If chemical contaminants were truly affecting the designated use, the impacts of those contaminants should have been observed in the bioassay.

These bioassays control for confounding factors such as low D.O., or habitat impacts. This scenario, however, is be captured by other Listing Methodologies.

The scientific community has indicated that in order to obtain a reliable and consistent assessment, data from all three components (i.e., toxicity, chemistry, and biological community) are required (Chapman, 1992, Ingersoll et al., 1997, Long et al., 1998, Long et al., 2000; and Anderson et al., 2001). However, if data are not available for all three components, the Department will use its discretion but will consider an impairment determination if;

a) The magnitude of any single indicator is overwhelmingly suggesting an impairment determination,
b) A Toxicity test shows toxicity and is confirmed either by chemistry data or a degraded biological community, its designated use is not likely supported and an impairment determination will likely be concluded.
c) All other cases are considered to present insufficient evidence of impairment and will be prioritized for additional monitoring as resources become available.

Under the Triad approach, MDE would evaluate appropriate lethal and sublethal sediment bioassays. A finding of toxicity may trigger a sediment chemistry analysis, if one has not already been performed. Sediment chemistry data would be used to support an impairment determination. The chemical analysis should be performed on samples originating from the same composited homogenate used for the bioassays, so that paired data can be obtained (Chapman, 1992). The chemistry data can be compared to sediment thresholds to help determine which chemicals may be causing toxicity. If no sediment thresholds are exceeded, sediment Toxicity Identification Evaluation (TIE) should be performed to determine a chemical cause, if possible.

Chemistry data themselves are useful in determining sediment contamination trends, and may also help identify areas that may have the potential for adverse impacts. MDE uses sediment chemistry data, as an effective prioritization tool to help determine which sediments should be targeted for additional monitoring. That is, other factors being equal, sediments with chemical concentrations exceeding sediment thresholds would have higher priority for additional monitoring compared with sediments that meet the sediment thresholds. Chemical concentrations exceeding these thresholds could also indicate the need to monitor and assess water column concentrations for those chemicals. Sediment chemistry alone should not, however, be used to make an impairment determination.

4.5.7 FISH TISSUE

Section 101(a)(2) of the CWA establishes as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable." These are commonly referred to as the "fishable/swimmable" goals of the Act. Section 303(c)(2)(A) requires water quality standards to protect the public health and welfare, enhance the quality of water, and serve the purposes of the Act (EPA 2000). EPA, along with the Department, has interpreted these regulations to mean that not only should waters of the State support thriving and diverse fish and shellfish populations, but when caught, may also be safely consumed. Some waterbodies may have elevated levels of contaminants, especially in the sediment. Some of these contaminants (especially mercury and PCBs) tend to bioaccumulate to elevated levels in the tissues of gamefish and "bottom-feeders" (largemouth bass and catfish, respectively). When tissue levels of a contaminant are sufficiently elevated to increase the risk of chronic health effects if the fish is consumed regularly, the State has the responsibility to issue a fish consumption advisory to protect public health. Fish consumption advisories are designed to protect the general population as well as sensitive populations (i.e. young children; women who are or may become pregnant). If a consumption advisory is issued for a waterbody, it's designated use may not be supported and that waterbody may be listed as impaired for the contaminant(s) responsible for the fish consumption advisory.

The Department of the Environment has defined "fishable" as the ability to eat AT LEAST 4 meals/month (general population level) for common recreational fish species from a given waterbody. The tissue level corresponding to this will be the upper threshold at the 4 meal/month level for a given contaminant. In addition to this, if the tissue concentration is within 5% of the threshold, the waterbody's designated use will be considered impaired. The 5% "safety factor" accounts for the uncertainty and spatial/temporal variability in monitoring data and sampling regimes. This safety factor is designed to protect and maintain the "fishable" designated use status of a waterbody. When tissue levels in fish are observed within this range, enhanced monitoring will be recommended to ensure the fishable use of the waterbody is not impaired. To determine if a waterbody is impaired, the appropriate measure of central tendency (i.e. geometric mean) for a contaminant from the fillet samples of common recreational fish species will be compared to the established threshold. If the threshold is exceeded, the waterbody's designated use is not met, and the waterbody is considered impaired.

4.5.7.1 Data Requirements

The data required to list a waterbody as impaired are similar to the data requirements for the development of a fish consumption advisory. The same decision rules are used to test data adequacy, and spatial and temporal representation. Consumption advisories based on the minimum required samples that resulted in an impairment decision will be re-sampled prior to TMDL development to insure that the advisory was not due to a localized condition, and that the impairment is still temporally relevant. The data requirements for listing a waterbody are:

a. The advisory is based on fish and shellfish tissue data. All available data will be used.
b. The data are collected from the specific waterbody in question.
c. A minimum of 5 fish from a given species (individual or composite analysis) for a given waterbody.
d. Species used to determine impairment should be representative of the waterbody; migratory and transient species may be used if they are the dominant recreational species, but should only be used in conjunction with resident species, especially in the case of tidal rivers of the Chesapeake Bay.
e. Contaminant thresholds used will reflect concentrations used to set consumption recommendations for the general population. The general population is defined as women beyond the years of childbirth (~45); and adult males.

4.5.7.2 Contaminant Thresholds

The acceptable contaminant thresholds are based on a risk assessment calculation that incorporates numerous risk parameters such as contaminant concentration, Reference dose/cancer slope factor, exposure duration, lifetime, and for some contaminants, cooking loss. The concentration thresholds for the contaminants of concern are currently:

Mercury: 235 ppb	4 meals/month	General Population
PCBs : 39 ppb	4 meals/month	General Population

Over time, advances in science may require changes in risk assessment parameters that may increase or decrease the contaminant thresholds, and also the levels at which impairment decisions are made for a waterbody's designated uses. When this happens, waterbodies that may have been impaired may no longer be impaired, as well as new impairments for waterbodies that were previously not impaired.

In some instances, it may be inappropriate to consider certain fish and shellfish consumption advisories in making an impairment determination. For example, a State may have issued a statewide or regional warning, based on data from a subset of waterbodies and species or a higher consumption value may have been used in determining the need for an advisory to protect a specific sensitive population compared to the value used in establishing water quality criteria for the protection of human health. In such instances, these types of advisories were not considered for making an impairment determination. This approach is consistent with EPA's current recommendations regarding impairment determinations using contaminant data from fish advisories.

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Table 4: Table of Sediment Screening Values

Contaminant	Sediment Screening Values (ppb)		
	EPA ESGs	NOAA ERMs	MDE SQBs
α-BHC			4,357
Acenaphthylene		640	
Acenaphthene	2,300	500	
Anthracene		1,100	
Arsenic		70,000	
β-BHC			9,406
Benz(a)anthracene		1,600	
Benzo(a)pyrene		1,600	
Cadmium		9,600	
Chlordane		6	51
Chlorpyrifos			4,214
Chromium		370,000	
Chrysene		2,800	
Copper		270,000	
DDT Sum		46	
Dibenz(a,h)anthracene		260	
Dieldrin	200	8	3,616
Endrin	7.6		7,368
Fluoranthene	3,000	5,100	
Fluorene		540	
Heptachlor			1,433
Heptachlor epoxide			1,433
Hexachlorobenzene			6,114,892
Lead		218,000	
Mercury		710	
Methyl naphthalene, 2-		670	
Naphthalene		2,100	
Nickel		51,600	
p,p-DDD (TDE)		20	
p,p-DDE		27	
p,p-DDT		7	
PAHs (High MW)		9,600	
PAHs (Low MW)		3,160	
PAHs (Total)		44,792	
PCB (Polychlorinated Biphenyl)		180	
Phenanthrene	2,400	1,500	
Pyrene		2,600	
Silver		3,700	
Zinc		410,000	

4.6 Listing Methodology for Solids

In the existing Water Quality Inventory [303(d) List], there are numerous impairments for "sediments." Many of these were assessed and projected based on land use and the likelihood of such impairments. Unfortunately, the term "sediments" does not accurately inform the public as to the nature of the impairment, nor provide helpful guidance to those who need to develop TMDLs to remediate the problem.

In this current list, impairments previously listed for sediments, and new impairments evaluated for this report will be determined and listed as described below.

4.6.1 FREE-FLOWING STREAMS

4.6.1.1 Water Clarity

Impairing substance: Total Suspended Solids (TSS)
Measure: Turbidity as measured in Nephelometer Turbidity Units (NTUs)
Criterion: Turbidity criteria are addressed in COMAR §26.08.02.03-3(A)(5):

4.6.1.1.1 Turbidity

(a) Turbidity may not exceed levels detrimental to aquatic life.
(b) Turbidity in the surface water resulting from any discharge may not exceed 150 units at any time for 50 units as a monthly average. Units shall be measured in NTUs.

4.6.1.2 Erosional and Depositional Impacts (limited to wadeable streams)

Impairing substance: Soils or sediment
Measure: Biocriteria. The application of biocriteria for assessment decisions for the Integrated 303(d) List is addressed elsewhere in this document.
Criterion: Addressed under the narrative criteria:

26.08.02.02(B) Specific designated uses.

- (1) Use I: Water Contact Recreation, and Protection of Aquatic Life. This use designation includes waters which are suitable for:
  - (c) The growth and propagation of **fish** (other than trout), **other aquatic life**, and wildlife
- (4) Use III: Natural Trout Waters. This use designation includes waters which have the potential or are:
  - (a) Suitable for the growth and propagation of **trout**; and
  - (b) Capable of supporting self-sustaining **trout** populations and **their associated food organisms**.
- (5) Use IV: Recreational Trout Waters.
  - (a) Capable of holding or supporting adult trout for put-and-take fishing; and

(b) Managed as a special fishery by periodic stocking and seasonal catching.

Waters must be protected for these designated uses (26.08.02.02(A)). Key phrases supporting the use of biocriteria to protect against impacts from eroded or deposited sediments are highlighted.

- If MBSS data indicates impairment, the habitat data related to sediments will be assessed.
- If there is no indication of a sediment problem (e.g., embeddedness does not indicate a problem), follow-up monitoring will occur to determine the stressor affecting the biological community.
- If there does appear to be a sediment problem, it will be listed for soils or sediment.

4.6.2 IMPOUNDMENTS

Maryland has no natural lakes. This decision rule covers reservoirs and other manmade lakes. Estuaries, such as Chesapeake Bay will be covered under new regulations currently being developed and which specifically address water clarity and sediment.

4.6.2.1 Water Clarity

Impairing substance:	Total Suspended Solids (TSS)
Measure:	Turbidity as measured in Nephelometer Turbidity Units (NTUs)
Criterion:	Turbidity criterion are addressed in COMAR §26.08.02.03-3(A)(5):

4.6.2.1.1 Turbidity

(d) Turbidity may not exceed levels detrimental to aquatic life.
(e) Turbidity in the surface water resulting from any discharge may not exceed 150 units at any time for 50 units as a monthly average. Units shall be measured in Nephelometer Turbidity Units.

If turbidity exceeds the indicated levels, chlorophyll shall also be measured. If chlorophyll is high, the impairment will be attributed to excessive nutrient enrichment, rather than solids. Exceptions may be made and professional judgment applied in areas where soil and local geologic conditions would normally have high sediment runoff.

4.7 Listing Methodology – Sewage Releases

4.7.1 INTRODUCTION

Bacteria released during single or rare combined sewer overflows, sanitary sewer overflows or other releases will dissipate naturally after several hours, days, or weeks. However, repeated sewage releases of significant size may result in violations of the water quality standards, particularly if the volumes are large or frequent and the waterbodies are small, slow moving or poorly flushed. Under such spill conditions, violations are presumed to have occurred even in the absence of actual monitoring data. Notwithstanding such documented spill events, if the water quality is consistent with the bacterial water quality standards at that time, a Water Quality Analysis demonstrating the lack of such an impairment will be completed and the waterbody will become eligible for de-listing. However, if data indicates that water quality standards are not being met the waterbody will remain listed.

4.7.2 METHODOLOGY

Based on data in MDE's spill databases, if any waterbody segment has received two spills greater than 30,000 gallons over any 12-month period or after system improvements have been made, that waterbody will be considered as impaired. This listing methodology will be applied only in the absence of bacterial monitoring data; if such monitoring data are available, the decision methodology for bacteria will apply. Further, the part of the list on which the waterbody is listed may be determined by the existence of consent orders, enforcement agreements, work in progress, or other factors that may negate the need for a TMDL.

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Maryland's 2002 Section 303(d) List

The final 2002 Integrated 303(d) List is presented on the Web in two different sections. Section 1 includes the body text of the Integrated List (Chapters 1-6), the Integrated List sorted by attainment status or the part of the list on which a water body belongs (Chapter 7), and the appendices (Chapter 8). This section includes everything you need to know about Maryland's 2002 Integrated 303(d) List, its methodology and scope. The next two sections contain just the 2002 Integrated 303(d) List or Chapter 7 of the larger document sorted in two different ways. They will assist stakeholders who may wish to look at the Integrated list by watershed (i.e., the Patapsco River, the Patuxent River, etc.) or by impairment (i.e., bacteria, metals, nutrients, etc.). The paragraphs below outline these sections in more detail and have an associated link (in blue) that will connect you to each section.

Click here for watershed profiles and numerical designations (8-digit Maryland Basin codes).

Section 1- Body Text of the 2002 Integrated 303(d) List

A complete verbal description of the process used to develop the 2002 Integrated 303(d) List. This document provides stakeholders with all of the background information necessary for understanding the listing process as well as the format of the list. It is highly recommended that this section be read first.

All files below are in .pdf format.

EPA Letter Approving Maryland's 2002 303(d) List and Integrated Assestment of Water Quality
Cover Page, Table of Contents, List of Acronyms & Acknowledgements
Chapter 1 - 2 Preface, Overview
Chapter 3 Framework for Identifying and Tracking Impaired Waters for the 2002 Integrated 303(d) List
Chapter 4 Listing Methodologies
Chapter 5 The 2002 303(d) List
Chapter 6 Priority Ranking and TMDL Completion Scheduling
Chapter 7 303(d) List and Integrated Assessment of Water Quality, including:

> Section 7.1 - Part 3 of the List - waterbodies having insufficient data or information to determine impairment status.
> Section 7.2 - Part 4a of the List - waterbodies having a completed TMDL.
> Section 7.3 - Part 4b of the List - waterbodies where a technological fix is expected to rectify the impairment in the near future.
> Section 7.4 - Part 5 of the List - waterbodies impaired by one or more pollutants and requiring a TMDL.
> Section 7.5 - Part 6 of the List - waterbodies that have been de-listed or removed from the list.

Chapter 8: Appendices

> Appendix A April 16, 2001 Request for Data
> Appendix B Specific Data Sources
> Appendix C Memo to Interested 303(d) Decision Methodology Reviewers
> Appendix D Response to Comments for Listing Methodologies
> Appendix E Comment Response Document for the Draft 2002 List of

Impaired Surface Water [303(d) List] and Integrated Assessment of Water Quality in Maryland
Appendix F Summary of changes from the Draft to the Final 2002 Integrated 303(d) List
Appendix G Maryland's Watershed Cycling Strategy
Appendix H 1996 and 1998 303(d) Lists

Section 2 - The 2002 Integrated 303(d) List Sorting

2a. Sorted By Waterbody or Watershed

Designed for stakeholders interested in what listings have occurred in their local watershed. MDE has sorted the 2002 Integrated 303(d) List by watershed so that all the impairments in a given water body will appear consecutively in the list. This allows individuals to rapidly determine impairment and water quality attainment status information for the watershed of their interest.

2b. Sorted By Impairment

Designed for those stakeholders concerned about waters impaired by a specific pollutant. This facilitates assessment of those waters that are impaired by a specific class of pollutants like metals or nutrients, for example.

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