Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report

Introduction

MDE routinely monitors shellfish harvesting waters for fecal coliform bacteria and conducts pollution source surveys to ensure that shellfish harvested in Maryland are safe for human consumption. In addition, MDE coordinates the State's Beach bacteria monitoring program. Beach sample collection and notification of advisories is delegated to the Counties in order to protect public health at Maryland's designated bathing beaches.

Fecal indicator bacteria are used in these programs since monitoring for actual pathogens is not feasible. It is assumed that if fecal indicator bacteria are present, then human pathogens may also be present. Since the primary goal of both the Shellfish and Beach programs is to ensure that public health concerns are addressed in a timely fashion, ongoing day-to-day management decisions by these programs are designed to be necessarily conservative. One such example is that beach advisories may be based on a single sampling event which shows a high level of indicator bacteria. However, bacteriological indicators are known to be variable in the environment and a single high measurement does not always coincide with fecal contamination. For this reason, this assessment methodology, developed for conducting Integrated Report (IR) assessments, will make use of larger longer-term sample sizes before making impairment determinations that could result in a Total Maximum Daily Load (TMDL).   Doing this allows MDE to continue to protect public health in a timely fashion (by both the Shellfish and Beach programs) but also allows for a higher level of confidence to be used prior to initiating a potentially costly TMDL development process. This helps to enhance the accuracy with which impairment determinations are made and enables the Department to focus on the highest priority impairments first.

The rules used by MDE to interpret bacteria data and apply the water quality standards are discussed below in the first three sections. The first section generally describes the protocols that MDE uses. The second and third sections describe how bacteria monitoring data is assessed to determine support of the shellfish harvesting designated use and the water contact recreation use, respectively. The fourth section describes recent changes to the methodology and how MDE will display, and not assess, information on sewage overflows moving forward.

I. Protocols

Data collected and analyzed using approved methods (FDA or EPA) and in accordance with strict QA/QC guidelines may be utilized for decision making with respect to designated use support status. All available data will be considered but may be used for

prioritization, additional study, or revised monitoring. In all cases, it is critical that bacteria sampling be carried out in a way that is representative of conditions in time and space. Per EPA's *Ambient Water Quality for Bacteria - 1986*, the calculated "densities are for steady state dry weather conditions." A sampling event means samples taken at a beach, or other waterbody to characterize bacterial concentrations with the number and placement of sampling stations sufficient to characterize conditions in the full extent of the beach area or waterbody. High spatial and temporal variability suggest that infrequent or moderately elevated bacteriological levels alone do not necessarily represent a human health risk or impairment. The bacteriological standard is descriptive and includes numerical criteria. The intent of this methodology is to allow the 'number' to be judged in conjunction with the shoreline and/or sanitary survey that identifies probable sources of bacteria and allows regulators to assess the probability of human health risk. The methodology recognizes the inherent variability of the bacterial measurement and recognizes the inadequacies of indicator organisms. The Most Probable Number (MPN) or Colonies Forming Units (CFU) test used to determine the level of bacteria is not a direct count but a statistical estimation subject to a high degree of variability.

The current analytical methods used for bacteria sample analysis are specific to the use being evaluated (e.g. shellfish harvest vs. water contact). For the shellfish harvesting use, FDA has approved the Multiple Tube Fermentation method which measures fecal coliform as MPN/100 ml. For evaluating the recreational use, EPA has approved two methods; the membrane filtration (MF) method and the most probable number (MPN) method. However, in Maryland, the most commonly used tests for recreational waters are both MPN methods; the ONPG-MUG (Colilert) test measures E. coli and the MUG media (Enterolert) test measures Enterococci.

II. Interpretation of Fecal Coliform Data for Assessing Use II Shellfish Harvesting Areas

The indicator and criteria used for shellfish (bivalve molluscan shellfish only) harvesting waters is established by the National Shellfish Sanitation Program (NSSP) and is promulgated in Code of Maryland Regulations (COMAR) 26.08.02.03-3. In order to demonstrate support of the shellfish harvesting designated use, the measured level of fecal coliform in water (expressed as MPN/100 ml) must have a median of less than 14 and a 90th percentile of less than 49, calculated from a minimum of 30 samples taken over a three year period. MDE conducts routine bacteria water quality sampling and pollution source surveys to assess shellfish harvesting areas so that waters can be assigned to one of three classifications used for protecting shellfish consumers. The following sections describe the different shellfish area classifications and how these classifications relate[1] to assessment categories on the Integrated Report.

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[1] Please note that shellfish area classifications do not directly relate to bacteria water quality. In some cases, certain shellfish area classifications are made based on administrative protection measures and not water quality data. In all cases, shellfish areas are assigned to categories on the Integrated Report (IR) based on water quality data alone.

A. Restricted: A restricted classification for shellfish waters means that no direct shellfish harvesting is permitted in those waters. This classification is used in the following three scenarios:

  1. Shellfish harvesting areas that do not meet the NSSP bacteria water quality standard for an approved classification (a fecal coliform median of 14 mpn/100 ml and a 90th percentile of <49) are classified as restricted and listed as impaired in Category 4 or 5 (depending on whether a TMDL was completed or not) of the IR.

  2. Shellfish harvesting waters located in the vicinity of wastewater treatment plant (WWTP) outfalls are classified as restricted as a preventative public health protection measure and is required under the NSSP. However, these waters typically meet the standard for an approved classification under the NSSP. Administrative closures of this type are not based on a water quality assessment but are designed to establish a protective buffer area in case of a system failure. Shellfish waters classified in this way but which have no evidence of actual bacteriological impairment are **NOT** listed as impaired (in Category 4 or 5) in the IR. MDE regularly evaluates treatment plant performance and its impact to shellfish harvesting waters. If bacteria data shows violations with State standards (notwithstanding the fact that the area is under an administrative closure or restriction) it will be listed appropriately on the impaired (Category 4 or 5) part of the IR.

  3. The upper Chesapeake Bay[2] typically meets the standard for an approved classification but is another area restricted to shellfish harvesting for administrative reasons which are not based on water quality readings. This area has insufficient shellfish resource for harvesting due to the fresh water input from the Susquehanna River. Since there is a lack of shellfish resource found here and the NSSP requirements for sanitary survey are not met, the area is classified as restricted. In this case, retaining the shellfish harvesting water designation helps to protect shellfish waters directly downstream from this area. Water quality is routinely monitored in this area for fecal coliform. If bacteria data demonstrates that State standards are being met, this area will not be listed as impaired (Category 4 or 5) on the IR. If bacteria data shows violations with State standards (notwithstanding the fact that the area is under an administrative closure or restriction) it will be listed as impaired (Category 4 or 5 of the IR) on the IR.

B. Conditionally Approved Waters: Certain shellfish harvesting areas are classified as conditionally approved and are closed to harvesting for three days following a rainfall event of greater than or equal to one inch in twenty-four hours. This classification has been assigned to certain shellfish waters based on previous studies which showed

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[2] The upper Chesapeake Bay, only as it's referred to in this paragraph, is defined as all of the area north of a line running in a southeasterly direction from the Robin's Point Tower to the Pooles Island Range Light, then easterly to the Worton Point Tower.

that after a 1 inch rainstorm, bacteria levels exceeded State standards for a period lasting up to two days. In these studies it was found that elevated bacteria levels were due to runoff which could not be traced to any source with public health significance. However, as a conservative management practice, no shellfish harvesting is permitted in these areas for three days following such a rainfall event. Conditionally approved harvesting areas generally meet the bacteriological water quality criteria for an approved classification (median of 14 MPN/100ml and 90th percentile <49MPN/100ml) at all other times and shellfish can be harvested from these areas when in the open status (other than three days following a rain event of one inch in twenty four hours). Therefore, these areas are not listed as impaired (Category 4 or 5) in the IR and are placed in Category 1 or 2 of the IR.

C. Approved Waters: Waters classified as approved for shellfish harvesting meet the water quality standards for shellfish harvesting waters and are placed in Category 1 or 2 (meeting water quality standards) of the IR.

D. Shellfish Waters – Geographic Scale of Assessment
For the purposes of the Integrated Report, MDE will georeference shellfish harvesting impairments as polygonal bodies of water within the larger estuarine waters (i.e. Chesapeake Bay segments, Coastal Bays, etc). The shape of these 'polygonal' areas of estuarine water will be determined by the spatial arrangement of monitoring stations and by nearby shoreline features.

III. Interpretation of Bacteria Data for Water Contact Recreation Use

A. Maryland has implemented the EPA recommended enterococcus (marine or freshwater) and *E. coli* (freshwater only) standards for all waters except shellfish harvesting waters, where the more stringent NSSP standard must be met.

According to EPA's *Ambient Water Quality Criteria for Bacteria -1986*, the indicators *E. coli* and enterococcus have been found through epidemiological studies to have the best quantifiable relationship between the density of an indicator in the water and the potential human health risks associated with swimming in sewage contaminated waters. "Indicator organisms are a fundamental monitoring tool used to measure both changes in environmental (water) quality or conditions and the potential presence of hard-to-detect pathogenic organisms. An indicator organism provides evidence of the potential presence or absence of a pathogenic organism that survives under similar physical, chemical, and nutrient conditions. (EPA Beach Guidance, June 2002).

Maryland's bacteria indicator criteria are conservative measures, which protect the public from the potential risks associated with swimming and other primary contact recreation activities. These criteria are used during the beach season by beach managers to issue advisories and to notify the public. A few high values of the indicators may or may not be indicative of impairment. Therefore, it is necessary to

evaluate the results from multiple sampling events over time to adequately quantify water quality conditions. EPA's recreational criteria were developed for waters where primary contact recreation was occurring and therefore apply to those activities. For waterbodies where primary contact is not possible or permitted, these criteria will not be used for assessing waters.

For the purposes of Integrated Report assessments, Maryland assesses two types of recreational waters; beaches and other recreational waters. Beaches are monitored more frequently than other recreational waters due to the frequency of use. Sections III.B. and III.C. further describe the differences between these divisions. However, it is worth noting that, for the purposes of the Integrated Report, both recreational water divisions are assessed using the same protocols detailed in section III.D.

B. Beaches
   Beaches are designated as "Beaches" from Memorial Day through Labor Day (Beach Season). During this time period, beaches are monitored closely using a tiered approach based on risk to human health from known pollution sources and frequency of use. High, Medium, and Low priority beaches are monitored weekly, biweekly, and monthly, respectively. Low priority beaches are re-evaluated regularly to determine if they should be prioritized higher or removed from the list of beaches. This ensures that all beaches will have the necessary number of sampling events needed to perform an adequate assessment.

   MDE has delegated the authority for designating beaches, monitoring beaches, and notifying the public regarding beach water quality conditions to local health departments. Local health departments can make administrative decisions to add or remove beaches based on the level of use. To do so, health departments must submit correspondence (form) to MDE notifying the department of their intention. When a local health department removes a beach from the list of beaches, it also effectively removes the beach/bathing area from Category 4 or 5 of the IR, if the beach was previously listed as impaired. This is done to avoid having to monitor a waterbody for contact recreation support when, in reality, the waterbody is not used for such activity.

   MDE's role in this process is to ensure that beaches state-wide are managed uniformly. MDE maintains a database of all designated beaches in Maryland including latitude and longitude coordinates of the endpoints identifying the beach segment, annual sanitary survey information provided by the local health departments, and monitoring results (all beach monitoring samples are submitted to DHMH for laboratory analysis). These data are used to determine which beaches are to be listed as impaired.

C. Other Recreational Waters (Non-Beaches)
   Other waters (non-beaches) may be assessed for the water contact recreation use. In the past, such waters have included non-tidal flowing waters or portions of estuarine waters. The frequency of use as well as the scale of assessment for these waters can

vary widely. The samples must be analyzed by Department of Health and Mental Hygiene or a laboratory approved by the State Laboratory Administration.

D. Assessing Support of Water Contact Recreation Use
The listing methodology for water contact recreation use waters applies to both beaches and other recreational waters.

Step 1 - A steady state geometric mean will be calculated with available data from the previous year where there are at least 5 representative sampling events. The data shall be from samples collected during steady state, dry weather conditions[3] and during the beach/swimming season (recognized as Memorial Day through Labor Day) to be representative of the critical condition (highest use). If the resulting steady state geometric mean is greater than 35 colony forming units (cfu)/100 ml enterococci in marine/estuarine waters, 33 cfu/100 ml enterococci in freshwater or 126 cfu/100 ml *E. coli* in freshwater, the water body will be included for further assessment in Step 2. If there are fewer than 5 representative sampling events for an area, data from the previous two years will be included in the dataset for evaluation. If any bacteria criterion is exceeded, that beach or recreational area will be included for assessment in Step 2. All beaches or recreational areas that meet the aforementioned criteria will be considered "not impaired".

Step 2 – Once a preliminary list is assembled, a steady state geometric mean will be calculated with available data from the previous five years (if available). The data shall be from samples collected during steady state, dry weather conditions and during the beach/swimming season (Memorial Day through Labor Day) to be representative of the critical condition (highest use). If the resulting geometric mean is greater than 35 cfu/100 ml enterococci in marine/estuarine waters, 33 cfu/100 ml enterococci in freshwater or 126 cfu/100 ml *E. coli* in freshwater, the water body will be listed on Category 3 (insufficient information) of the IR as requiring more data (Step 3). In some cases, the assessor may take into account whether bacteria levels are increasing or decreasing as this may indicate improving or worsening conditions. In all cases, MDE retains the ability to use best professional judgment in determining the appropriate assessment category.

Step 3 - Category 3 of the Integrated Report
Once waters are listed on Category 3 of the IR, an intensive sanitary survey must be conducted to identify potential sources of pathogenic bacteria. The following bullets describe the different scenarios that may occur and how they will be treated with respect to the Integrated Report.
- If the sanitary survey identifies significant sources of pathogenic bacteria and they are not corrected before the end of the next listing cycle, the waters will be moved to Category 5 of the IR (impaired, TMDL required).

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[3] Steady state, dry weather conditions are not met for a sampling event if the area being assessed has received an inch or more of rainfall over a 24 hour period within 48 hours of the bacteria sampling event.

- If the sanitary survey is conducted and all potential sources of pathogenic bacteria are remedied and the water meets the bacteria criterion, the waters will be moved from Category 3 to Category 2 (meeting standards for this designated use) of the IR.
- If the sanitary survey does not identify any pathogenic sources, the beach will remain in Category 3 and will be re-evaluated during the next listing cycle.
- If a sanitary survey is not conducted before the next listing cycle, the waters will be moved from Category 3 to Category 5.

Step 4 - Category 5 of the Integrated Report (Impaired, TMDL required)
For waters listed under Category 5 of the IR, a sanitary survey must be conducted if it was not conducted before or after the waters were listed on Category 3 of the IR. A water body can be removed from Category 5 of the IR and placed in Category 2 if it meets both of the following conditions:

    (a) it meets the steady state geometric mean standard referenced in Step 1 AND,

    (b) a sanitary survey is conducted at the water body and there are no sources of pathogenic bacteria found, or if sources of pathogenic bacteria were found, they have since been remedied.

E. Geographic Scale of Assessment

Beaches - For the purposes of the Integrated Report, waters identified and assessed as beaches will be georeferenced as linear stretches of water, having only the dimension of length. As a result, the water body size reported for beaches will be expressed in miles. Since bathing beaches are typically narrow bands of water where water contact recreation occurs, this will help focus the georeferencing process to those areas of shoreline where beach access occurs.

Recreational Waters (not beaches) - Recreational waters, as the term is used here, generally refers to all waters that are not identified by the local health department as beaches. For the purposes of the Integrated Report, when a bacterial monitoring station is assessed on non-tidal flowing waters, all upstream waters within the Maryland 8-digit watershed will be georeferenced as having the same assessment result. The only exception to this rule will be when there is an in-stream impoundment that significantly alters flow up and downstream of the dam. Recreational waters can also include tidal waters that may have had special assessments completed outside of the normal beach monitoring program. Assessments for these waters will be based on the spatial arrangement of monitoring stations and any nearby shoreline features. As a result, the geographic depiction of these assessments will show a polygonal body of water.

IV. Changes to the Section on Sewage Releases

In previous iterations of the Bacteria Assessment Methodology there was section that discussed sewage releases and how information on CSOs and SSOs was used in relation

to water quality data on bacteria levels. This part of the previous methodology specified that, in the absence of water quality data, "if any water body segment has received three or more spills greater than 30,000 gallons over the last 5 years, that water body would be considered impaired and therefore listed in the Integrated Report in Category 5." However, after further consideration, the Department has determined that this part of the methodology is not appropriate for 303(*d*) assessment purposes and instead, will maintain such a list of waters/collection systems only in the text portion of the Integrated Report rather than in the list of impaired waters. The rationale for this decision is described below.

First, Maryland already has in place other measures to protect public health and provide public notification. To protect public health, Code of Maryland Regulations (COMAR) Section 26.08.010 requires owner/operators of collection systems to report instances of overflows to the Department and the local health department within 24 hours of becoming aware of the overflow. Owner/operators must also coordinate the issuance of public notifications with the Department of Health and Mental Hygiene (DHMH) within 24 hours of an overflow (provided that DHMH deems it necessary). In addition, all overflows to waters of the state are communicated with other public health protection programs such as drinking water managers, and Beaches and Shellfish Harvesting programs to ensure that the public and the shellfish industry is properly notified and avoids contact with affected waters. And finally, all overflows reported to the Department are captured in a publically-accessible database at: http://mde.maryland.gov/programs/water/Compliance/Pages/ReportedSewerOverflow.aspx

Maryland also has other mechanisms in place (besides impairment listings and TMDLs) for correcting the causes of sewage overflows. Each overflow event that occurs is reviewed for consideration of a possible formal enforcement action, including the issuance of penalties to the owner/operator of the collection system. For many of the problematic collection systems, i.e., those with repeated violations and overflows, the Department has established formal enforcement actions, including Consent Orders or Consent Decrees to operate and maintain the collection system to eliminate sewer overflows within a specified time period. The Department also periodically reviews reported overflows to identify recurring problem locations for increasing numbers of overflows. If the Department finds that overflows are becoming more prevalent in a particular system, MDE will work with the collection system owner/operator to develop a consent order or remediation plan to eliminate the overflow.[4] This straight-to-implementation approach is more effective and appropriate than developing a TMDL, especially for water bodies where no water quality data exists. In addition, addressing sewer overflows directly through corrective actions can be required even in areas that meet the bacterial water quality standards, therefore making it a more protective approach.

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[4] It is worth noting that there will always likely be some instances of overflows due to aging infrastructure, extreme weather events, and the buildup of grease and other inappropriately disposed material.

Previous versions of the methodology provided insufficient scientific basis for determining that an overflow of 30,000 gallons was significant in a wide range of water body types. Differences in water body size, flushing characteristics, and residence times all have an effect on the public health risk level after a sewage overflow. In addition, the previous version of the methodology did not provide a scientific rationale for the frequency threshold of 3 overflows in a 5 year period that would trigger an impairment listing. In both cases, without water quality data, little can be determined regarding the actual public health risk.

The Department will continue to maintain a table in the text portion of the Integrated Report that provides statistics on the water bodies and collection systems that have repeated sewage overflows. However, such waters will not be listed in Category 5 of the Integrated Report so as to avoid overstating the potential water quality impairment where bacterial water quality data does not exist. This will not impact the Department's ability to protect public health or to remedy faulty infrastructure but will help the Department to avoid a costly and ineffective TMDL development process where a straight-to-implementation approach is more efficient.

References

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