Maryland's Draft 2016 Integrated Report of Surface Water Quality

Submitted in Accordance with Sections 303(d), 305(b), and 314 of the Clean Water Act

Maryland
Department of the Environment

Larry Hogan, Governor
Boyd Rutherford, Lt. Governor

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Submittal Date:
EPA Approval Date:

Published and distributed by:
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ACKNOWLEDGEMENTS

This report, developed by the Environmental Assessment and Standards Program (EASP) of the Maryland Department of the Environment (MDE) would not have been possible without the contributions from countless others. Special thanks goes to Leonard Schugam, Timothy Fox, and Mark Trice for their assessment contributions and to Rebecca Lang, Tim Rule, and Dinorah Dalmasy for writing portions of the report. In addition, the authors would like to thank those who helped review and edit the report including Lee Currey and Rebecca Lang. Much of the data compiled by EASP were supplied by other Science Services Administration programs including: Field Services, TMDL Technical Development, and Water Quality Protection and Restoration Programs. In addition, many data were provided by the Maryland Department of Natural Resources with staff also assisting with water quality assessments.

Last but not least, MDE would like to thank all non-state government groups and individuals who provided data for this report. This report used a variety of chemical, physical, and biological data provided by non-state partners. This information has been valuable for improving both the spatial and temporal resolution of assessments of state waters. To view a full list of individuals and organizations that provided data during the data solicitation period please see Table 3.

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EXECUTIVE SUMMARY

Maryland's 2016 Integrated Report (IR) is submitted in compliance with sections 303(d), 305(b) and 314 of the federal Clean Water Act (CWA). This biennial report describes ongoing efforts to monitor, assess, track and restore the chemical, physical and biological integrity of Maryland waters. This report also presents the current status of water quality in Maryland by placing all waters of the State into one of five categories.[1] In addition, the report provides information about the progress on addressing impaired waters (Categories 4 & 5) by documenting:

- Completed Total Maximum Daily Loads (TMDLs), which re-categorize impairments from Category 5 (impaired and needs a TMDL: the "list of impaired waters") to Category 4a (TMDL completed, but still impaired).
- Analyses of new water quality data that shows areas previously identified as impaired that are attaining standards. This can result from remediation, changes in water quality standards, or improved monitoring and/or data analysis.
- Assessment methodologies and watershed segmentation that enhance the use of available data and provide consistency with management and implementation strategies.
- Statewide water quality statistics for Maryland's surface waters.
- Maryland's prioritization of impairments for TMDL development.

The 2016 IR incorporates several changes this year which include the implementation of revised assessment methodologies for bacteria and toxics data. In addition, the Department has expanded its trend analysis section with the intention of describing the incremental changes to pollutant concentrations in waters throughout the state. Continuing with this IR, Maryland has made significant efforts to incorporate non-state government data in ways that increase the resolution of the state's water quality assessments. Datasets used included those collected by federal agencies, county governments, water utility agencies, and non-profit watershed organizations. As with previously submitted Integrated Reports (IR), the 2016 IR will include a GIS submittal that provides coverages for streams, impoundments, and estuarine waters which depict assessment information at appropriate scales. MDE also continues to make Integrated Reporting data available to the public in several user-friendly formats. Through the use of MDE's searchable IR database and the interactive online pollutant maps, users can query IR information and explore water quality information in a graphic format. The searchable IR database and clickable map application are available online at http://www.mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/303d.aspx and the interactive pollutant maps can be found at http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/ImpairmentMaps.aspx. Please note that these applications will be updated with information from the 2016 IR once the IR has gone through public review and comment and been approved by the Environmental Protection Agency.

[1] The Integrated Report places all waters of the State into one of five "categories": Category 1 indicates that a water body is meeting all standards, Category 2 means it is meeting some but not all standards, Category 3 indicates that there is insufficient data to determine whether standards are being met, Category 4 means that water quality standards are not being met but a TMDL is not needed, either because it has already been completed, other more immediate fixes are available, or the impairment is not load related, and finally, Category 5 indicates that a water body is impaired and a TMDL is needed.

Maryland's Water Quality Highlights

Trend monitoring data continues to document significant long-term improvement in nitrogen, phosphorus, and sediment levels at many stations throughout Maryland and the Chesapeake Bay watershed. Even though many waters are still impaired for these pollutants, these trends suggest that the substantial nutrient and sediment reduction efforts undertaken by the state have been making a difference. With year-to-year variability in precipitation and ongoing changes to landuse, it can often be difficult to observe temporal patterns in pollutant levels. The fact that these improving trends in nitrogen, phosphorus, and sediment are evident in the water quality data underscores the immense efforts going into reducing these pollutants and emphasize the large effort still needed in order to meet our ultimate water quality goals. The continued collection and analysis of this data will be important for measuring progress as Maryland continues to implement the Chesapeake Bay TMDLs and other TMDLs.

Trend analysis has also highlighted two environmental challenges. For example, trend analyses for conductivity in Maryland's non-tidal streams increasingly show more stations with degrading or worsening (greater conductivities) conditions. Several recent water quality symposia in Maryland (e.g. Maryland Water Quality Monitoring Conference, Road Salt Usage and Environmental Impacts Workshop, and Groundwater Symposium) have featured speakers on this trend, suggesting that the primary causes of increasing conductivity are the widespread use of road salt deicers combined with increasing road and parking areas. Consistent with this trend, Maryland has increasingly documented the impairment of state streams due to elevated chloride levels, an important determinant of high conductivity measurements. Worth noting, increasing chloride and conductivity levels have also been measured at many of the state's drinking water sources raising concern for the management of these critical resources. Another water quality trend has been documented in the case of stream temperatures. Separate studies by USGS and DNR have revealed long-term increases in temperature at many stations throughout Maryland and the Chesapeake Bay watershed. Maryland's coldwater streams are particularly susceptible to chronic increases in stream temperature. Potential sources for this trend are climate change, stormwater runoff from development, dams, and other sources of thermal pollution.

Maryland has established 553 TMDLs out of a total of 816 water body-pollutant impairments. The water body size addressed by TMDLs for each major pollutant-type is shown in the figures below. As is evident from these figures, some pollutants have been almost completely addressed by TMDLs while others have not (e.g. chlorides, sulfates, stream temperature). For chlorides and stream temperature, the state is in the process of developing new water quality modeling methodologies for estimating loads and impacts. Another important development for water quality is the documentation of Maryland's prioritization of impairments for TMDL development. This documentation, included as Part G of this report, not only covers TMDL development priorities but also discusses Maryland's continuing work on the Chesapeake Bay and Tidal Tributary TMDLs and Watershed Implementation Plans (WIP). In conjunction with the public review period associated with this Integrated Report, the Department seeks the public's review and comment on this prioritization methodology. Another important TMDL priority is the Chesapeake Bay TMDLs 2017 Midpoint Assessment. The Midpoint Assessment will evaluate progress, take stock of the current science and update the Watershed Implementation Plans to ensure that the State meets the Bay TMDLs by 2025.

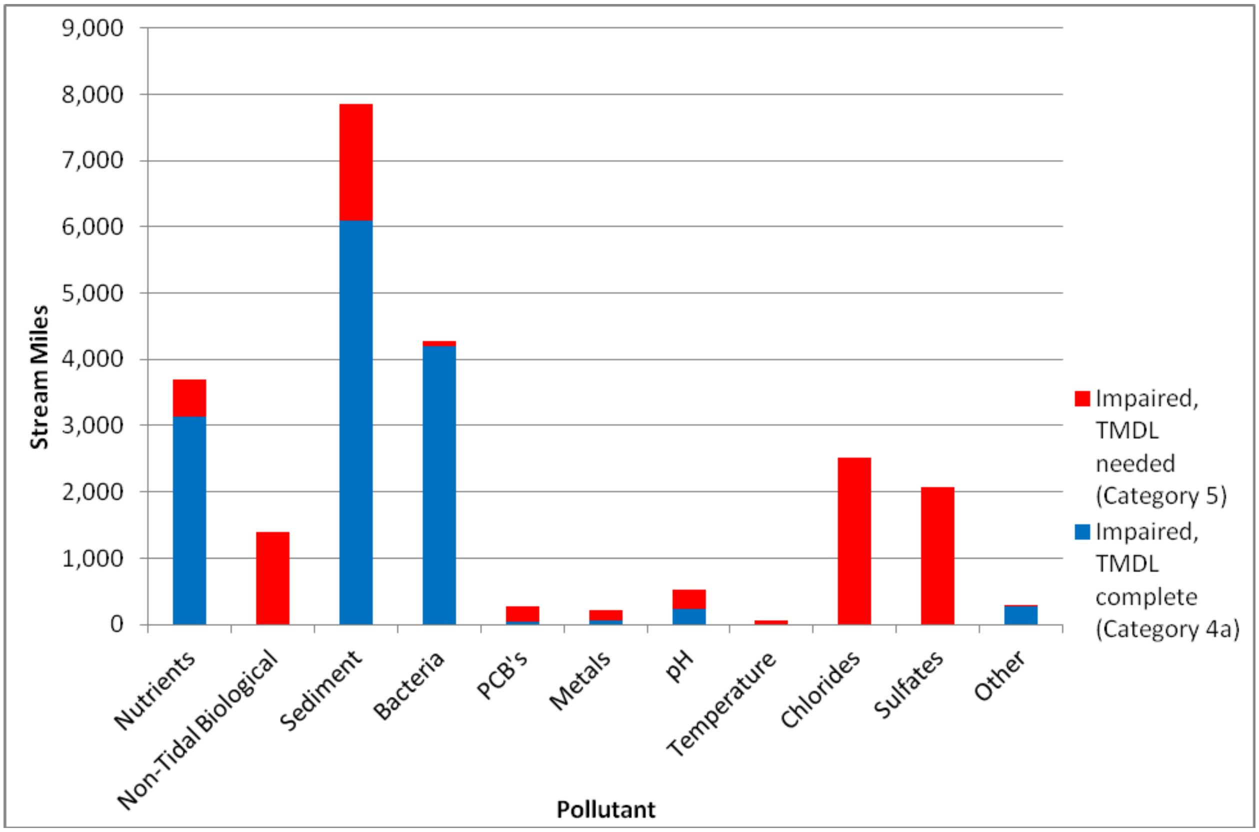


Figure 1: Stream miles impaired by various pollutants. Colors denote the stream miles currently addressed by TMDLs (blue) and those that still require TMDLs (red).

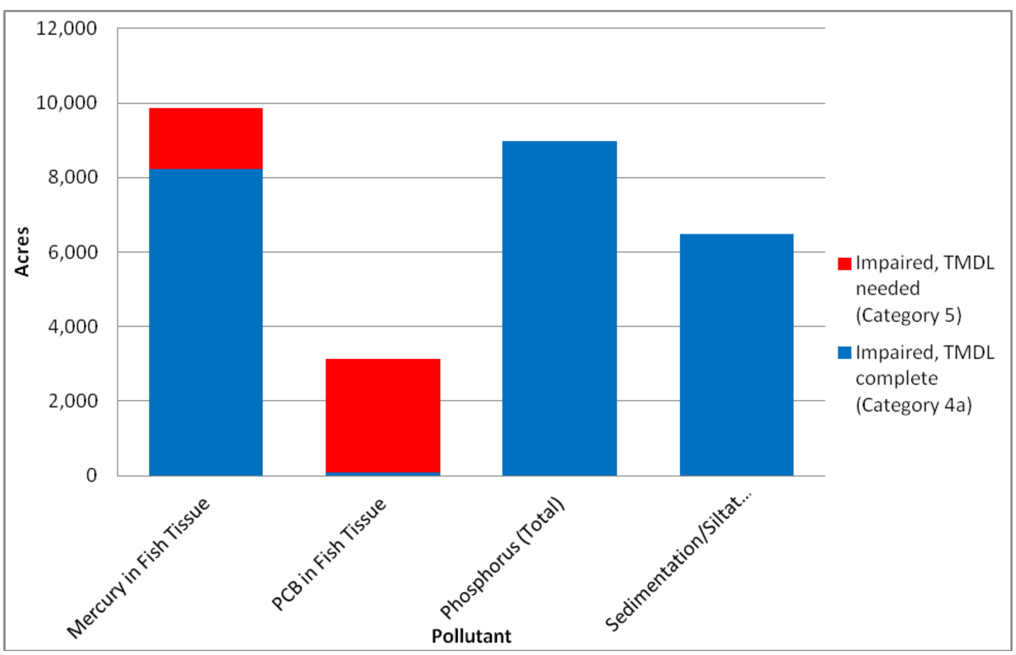


Figure 2: Impoundment size impaired by various pollutants. Colors denote the impoundment acres currently addressed by TMDLs (blue) and those that still require TMDLs (red).

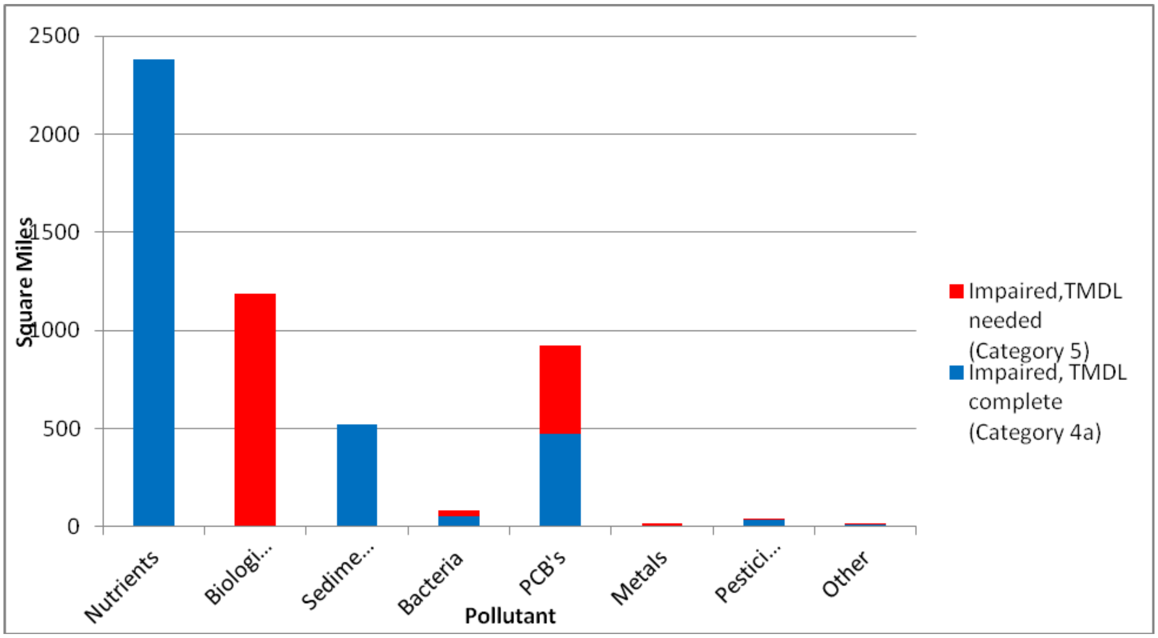


Figure 3: Size of estuarine waters impaired by various pollutants. Colors denote the square mileage of estuarine waters currently addressed by TMDLs (blue) and those that still require TMDLs (red).

Maryland also continues to administer various programs to fund and implement water quality restoration projects. Now in its 13th year, the Bay Restoration Fund (BRF) has financed the installation of enhanced nutrient removal technology at 48 out of 67 major (>500,000 gallons/day) wastewater treatment plants in the state and will ultimately reduce nitrogen loadings by 7.5 million pounds per year and phosphorus by 0.22 million pounds per year. The Chesapeake and Coastal Bays Trust Fund has leveraged state and local funding to achieve 34% of the urban nitrogen and 29% of the agricultural phosphorus goals as of December 2015. In addition, a variety of agricultural cost-share programs have also helped to reforest riparian buffers, build manure storage areas, and plant cover crops. As of August 2016, Maryland farmers committed a state-record, 691,743 acres of land to cover crops. Still, much work remains as the state looks to develop rules for nutrient trading and a growth policy to offset new and/or increased pollutant loads. In addition, stormwater runoff pollution from older developments remains a significant challenge both in financing and implementation. Maryland currently has ten Phase I MS4 permits that require both TMDL implementation plans and financial assurance plans and issue new Phase II General permits by March 2017.

Changes in the 2016 Integrated Report

There are a total of 16 additions to the list of Category 5 (impaired, TMDL needed) waters in 2016. Nine of the new Category 5 waterbody-pollutant combinations (also referred to as listings or assessment records) resulted from MDE's Biological Stressor Identification Analyses. Of these 9 new 'biostressor' listings, four are for total suspended solids, three are for sulfates, and two are for chlorides. In addition, there are four new PCB listings and three new fecal coliform listings in shellfish harvesting waters. One new Category 5 listing, not counted as part of the other 16, resulted from the spatial splitting of a previous listing for the Lower Patuxent River for PCBs. So although this new listing didn't result in any new waters being determined as impaired, this action (splitting) caused what was one listing in 2014 to become two listings in 2016.

Table 1: Changes to Category 5 Listings from 2014 to 2016

Integrated Report Year/Status	Category 5 Listings
2014 Total Category 5 Listings	**262**
2016 New Category 5 Listings	16
2016 New listing resulting from the splitting of previous impairment listing	1
2016 New Delistings (Category 5 to Category 2 or 3) *(See Table 2)*	-11
Approved TMDLs (since the 2014 IR)	-5
2016 Grand Total Category 5 Listings	**263**

Eleven waterbody-pollutant combinations were removed from Category 5 (impaired, TMDL needed) in 2016. Four biological listings without a specified impairing substance have been replaced by specific pollutant listings enumerated by the Biological Stressor Identification analyses (BSID). Another four (of the 11) listings, for fecal coliform in shellfish harvesting areas, were removed from Category 5 because new data showed that water quality standards were either being met (2) or that assessments were inappropriate in those waters (2). Two more listings, one for mercury in fish tissue and another for low pH, were moved to Category 2 because new data demonstrated that these waters were now meeting water quality criteria for these parameters. The remaining delisting (moved from Category 5 to Category 3, insufficient information) occurred as a result of a correction to a PCB in fish tissue listing.

Some of these listings were originally based on limited data. In these cases, it is not possible to attribute these waters now meeting standards to a particular restoration action. It is possible that the extensive restoration practices that have been applied statewide might be playing a contributory role but it may also be true that these listings were made based upon insufficient data. Table 2 shows the general water body-pollutant combinations that have been delisted from Category 5.

Table 2: 2016 Delistings (water body-pollutant combinations removed from Category 5 (impaired, TMDL needed) and placed in Category 2 or 3 (non-impaired).

Type of Impairment Listing	Number of Listings Removed from Category 5
Generic Biological Listings – specific pollutant now specified (BSID process)	4
Fecal Coliform – meeting water quality criteria for the shellfish harvesting use	2
Fecal Coliform – removed from the IR completely, inappropriate listings for administratively closed shellfish areas	2
Hg - fish tissue concentrations now meeting fishing designated use	1
pH – water quality criteria now met	1
PCBs in fish tissue – moved to Category 3 – correction to historical data and recent levels are low	1
2016 Total Number of Delistings	**11**

In addition, there were other water quality listings removed from the impaired part of the IR but which were not counted in Table 2 because they were previously in Categories 4a (impaired, TMDL approved) and 4b (impaired, technical fix implemented). For instance, the tidal fresh portion of the Chester River was previously impaired and had a TMDL for total suspended solids (TSS). Recent data now demonstrates that this segment meets water quality standards for TSS (Category 2). In another case, a portion of the San Domingo Creek in Talbot County had a TMDL (Category 4a, impaired, TMDL completed) completed for a bacteria impairment but also now meets water quality criteria. In a third instance, a Category 4b (impaired, technological fix) copper listing in the Patapsco River, associated with an industrial point source, was removed from the impaired part of the list based on recent discharge monitoring report (DMR) data and ambient water quality monitoring data. These data demonstrated that effluent limits were being met and that nearfield water met ambient water quality criteria. For more details on the Category 4b delistings in PATMH please see Section C.3.

Another particularly noteworthy assessment captured on the 2016 IR and which was not counted in Table 2, was the removal of the low pH impairment to Big Laurel Run in the Casselman River watershed in Garrett County, MD. Although Big Laurel Run was never previously listed as impaired on Maryland's IR (no data had been available for previous reporting), it was anecdotally known to be impacted by acidic mine drainage from an abandoned mine. Here, using Clean Water Act Section 319(h) funding, MDE's Bureau of Mines Division coordinated the construction of an acid mine drainage treatment system designed to increase stream pH to levels within Maryland's pH criteria range (6.5 – 8.5). State staff collected water quality data from both before and after treatment system construction which demonstrated the success of this project and resulted in a Category 2 (meeting some water quality criteria) listing on the 2016 IR. This is the second recent instance where a specific restoration project, undertaken by the State, has been directly linked to attainment of water quality criteria.

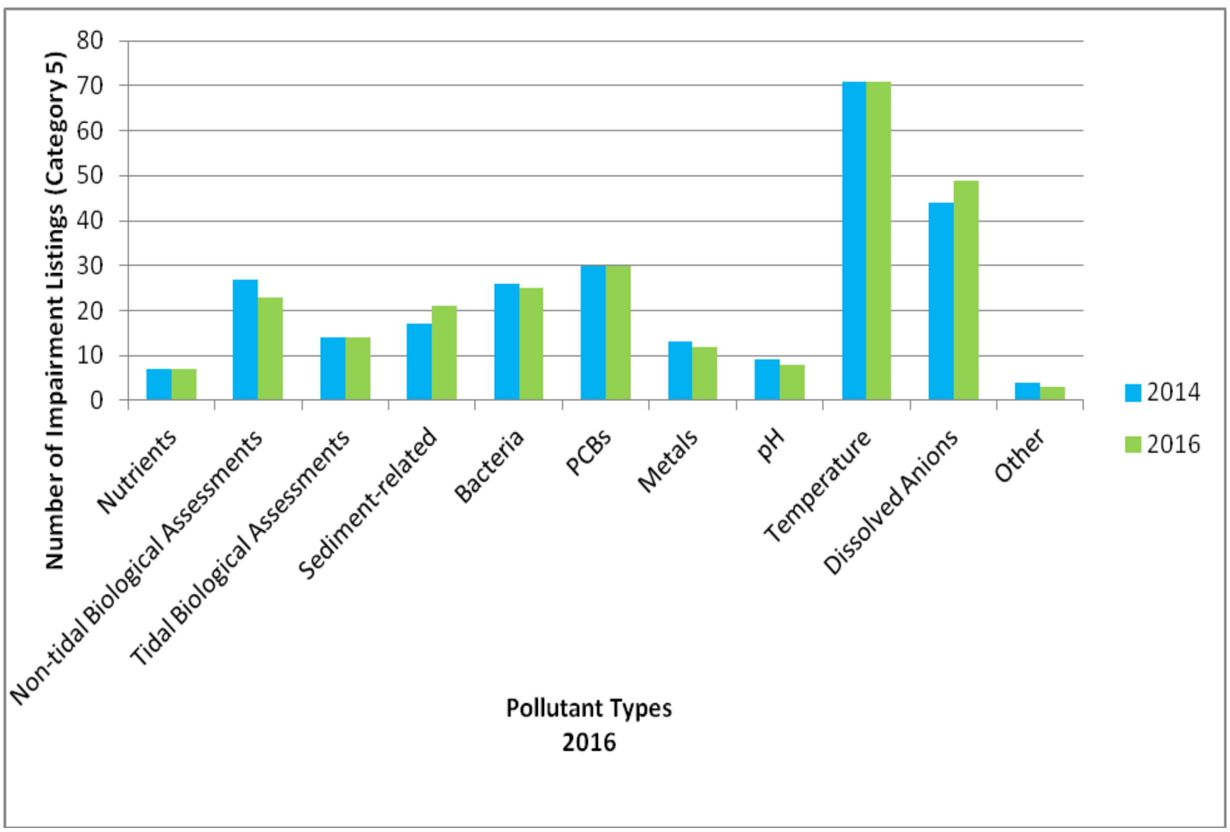


Figure 4: Comparison of the Number of Category 5 (impaired, TMDL not yet completed) Listings Between the 2014 and 2016 Integrated Reporting Cycles per Pollutant Group.

Since the 2014 IR, Maryland has continued to make progress in addressing impaired waters having completed a total of five TMDLs, one Water Quality Analyses and four Biostressor Identification

Analyses in 2015 and 2016. Most notably, one of the TMDLs Maryland completed was one developed for trash in the Baltimore Harbor area. This is the second trash TMDL completed in Maryland and marks an important step forward in the effort to clean up the Baltimore Harbor. Another important development in Maryland's implementation of Clean Water Act Section 303(d) is the documentation of Maryland's prioritization of impairments for TMDL development. This documentation, included as Part G of this report, not only covers TMDL development priorities but also discusses Maryland's continuing work on the Chesapeake Bay and Tidal Tributary TMDLs and Watershed Implementation Plans (WIP). In addition, Part G provides summary information on the Chesapeake Bay TMDL 2017 Midpoint Assessment. In conjunction with the public review period associated with this Integrated Report, the Department seeks the public's review and comment on this prioritization methodology.

Other notable new actions taken by the State include:

- The formation of the Water Quality Trading Advisory Committee (WQTAC) to guide and support the development of a nutrient trading framework that will help the state meet the nutrient reduction goals under the Chesapeake Bay TMDLs. The committee met regularly between January and May of 2016 with the goal of developing Maryland's Water Quality Trading and Offset Policy and Guidance Manual.
- Passage of the Phosphorus Management Tool regulations in 2015. These new regulations describe how the state will use soil test information with the latest scientific findings on phosphorus transport to identify the potential risk of phosphorus loss from farm fields and to prevent the additional buildup of phosphorus in soils that are already saturated.
- An increase in the level of funding for the Chesapeake and Coastal Bays Trust Fund which finances projects that support Maryland's Watershed Implementation Plan by reducing nonpoint source pollution.
- Passage of House Bill 462, which returns $60 million over the next two fiscal years to Program Open Space including increasing the funding to Baltimore City to $6 million per year.
- The allocation of $16.4 million for an Energy-Water Infrastructure Program designed to increase energy efficiency at wastewater treatment plants through combined heat and power projects and energy-related upgrades. An example of one such upgrade includes using digester gas for generating electricity onsite.

Maryland continues to work closely with EPA's Chesapeake Bay Program (CBP) and other state partners (VA, PA, D.C., NY, and DE) on the assessment process for the Chesapeake Bay water quality criteria. Maryland has adopted an assessment process that was created and agreed to by the partner states and the CBP. This assessment process split the Chesapeake Bay into 53 segments (in the Maryland portion) based on the salinity regime. The current Chesapeake Bay assessments will continue to evolve as new assessment methodologies are developed and as additional data are collected and incorporated from a variety of partners. More details on the Chesapeake Bay assessments can be found at: http://www.chesapeakebay.net/about/programs/monitoring.

Finally, in February 2016, in what represents a major victory for Maryland's water quality and specifically that of the Chesapeake Bay, the U.S. Supreme Court decided not to review a lower court's affirmation of the Chesapeake Bay TMDLs. Five years earlier, the American Farm Bureau Federation filed suit challenging the establishment of the Chesapeake Bay TMDLs for nitrogen, phosphorus, and sediment. Upholding the Chesapeake Bay TMDLs allows Maryland to continue to work together with EPA and the partner Bay states to make progress in reducing these pollutants in the most cost-effective manner and supports the science and process used to develop these TMDLs.

PREFACE

Maryland's Integrated Report, when approved by the US Environmental Protection Agency, will satisfy Sections 303(d), 305(b) and 314 of the federal Clean Water Act (CWA). The following lists the requirements of these sections.

Clean Water Act §303(d) (Impaired waters) Requirements

- A list of water quality-limited (impaired) waters still requiring TMDL(s), pollutants causing the impairment and priority ranking for TMDL development (including waters targeted for TMDL development within the next two years).
- A description of the listing methodologies used to develop the list.
- A description of the data and information used to identify waters, including a description of the existing and readily available data and information used.
- A rationale for any decision to not use any existing and readily available data and information.
- Other reasonable information such as demonstrating good cause for not including waters on the list.

Clean Water Act §305(b) (Water quality inventory) Requirements

- A description of the quality of all waters in the state and the extent to which the quality of waters provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water.
- An estimate of the extent to which control programs have or will improve water quality, and recommendations for future actions necessary and identification of waters needing action.
- An estimate of the environmental, economic and social costs and benefits needed to achieve the objectives of the CWA and an estimate of the date of such achievement.
- A description of the nature and extent of nonpoint source pollution and recommendations of programs needed to control each category of nonpoint sources, including an estimate of implementation costs.
- An assessment of water quality of all publicly owned lakes as specified in §314(a)(1).

Clean Water Act §314 (Clean Lakes) Requirements

- An identification and classification according to eutrophic condition of all publicly owned lakes.
- A description of procedures, processes, and methods (including land use requirements), to control sources of pollution of such lakes.
- A description of methods and procedures, in conjunction with appropriate federal agencies, to restore the quality of such lakes.
- Methods and procedures to mitigate the harmful effects of high acidity, including innovative methods of neutralizing and restoring buffering capacity of lakes and methods of removing from lakes toxic metals and other toxic substances mobilized by high acidity.
- A list and description of those publicly owned lakes for which uses are known to be impaired and those in which water quality has deteriorated as a result of high acidity that may be due to acid deposition.
- An assessment of the status and trends of water quality in lakes, including but not limited to, the nature and extent of pollution loading from point and nonpoint sources and the extent to which the use of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

PART A: INTRODUCTION

In Maryland, the Departments of Natural Resources (DNR) and the Environment (MDE) are the two principal agencies responsible for water resources monitoring, assessment and protection. DNR is the primary agency responsible for ambient water monitoring. MDE sets water quality standards, compiles and assesses water quality data, and submits the Integrated Report, regulates discharges to Maryland waters through multiple permits, enforcement and compliance activities, and develops Total Maximum Daily Loads (TMDLs) for impaired waters. Historically, water quality monitoring results were submitted in two separate reports, the annual §305(b) reports and the biennial §303(d) List (list of impaired waters). Since 2002 and in compliance with Environmental Protection Agency guidance on 303(d) listing and 305(b) reporting, these formerly independent responsibilities have evolved into a combined reporting structure called the Integrated Report (IR).

The IR utilizes five reporting categories that not only include impaired waters requiring TMDLs, but also waters that are clean or need additional monitoring data to make an assessment. These categories are:

Category 1: water bodies that meet all water quality standards and no use is threatened;

Category 2: water bodies meeting some water quality standards but with insufficient data and information to determine if other water quality standards are being met;

Category 3: Insufficient data and information are available to determine if a water quality standard is being attained. This can be related to having an insufficient quantity of data and/or an insufficient quality of data to properly evaluate a water body's attainment status.

Category 4: one or more water quality standards are impaired or threatened but a TMDL is not required or has already been established. The following subcategories are included in Category 4:

- **Subcategory 4a**: TMDL already approved or established by EPA;
- **Subcategory 4b**: Other pollution control requirements (i.e., permits, consent decrees, etc.) are expected to attain water quality standards; and,
- **Subcategory 4c**: Water body impairment is not caused by a pollutant (e.g. habitat is limiting, dam prevents attainment of use, etc).

Category 5: Water body is impaired, does not attain the water quality standard, and a TMDL or other acceptable pollution abatement initiative is required. This is the part of the IR historically known as the 303(d) List.

Maryland uses these categories by placing each 'water body-pollutant' combination into one of the five categories. Doing this often causes a single water body to be included in multiple categories for different pollutants. For example, Loch Raven Reservoir is listed in Category 4a (impaired, TMDL completed) for sedimentation/siltation and also in Category 2 (meets water quality standards) for having low levels of copper. This helps Maryland track the status of each pollutant for which a water body has been assessed.

A.1 Data Sources and Minimum Requirements

Section 130.7(B)(5) of the Clean Water Act requires that states "assemble and evaluate all existing and readily available water quality-related data and information" when compiling their Integrated Report. This includes but is not limited to the following:

(i) Waters identified by the state in its most recent Section 305(b) Report as "partially meeting" or "not meeting" designated uses;

(ii) Waters for which dilution calculations or predictive models indicate non-attainment of applicable water quality standards;

(iii) Waters for which water quality problems have been reported by local, state, or federal agencies; members of the public or academic institutions; and,

(iv) Waters identified by the state as impaired in a nonpoint source assessment submitted to EPA under Section 319 of the CWA or in any updates of the assessment.

With the integration of sections 305(b) and 303(d) of the Clean Water Act and the adoption of a multi-category reporting structure, Maryland has maintained a two-tiered approach to data quality. Tier 1 data are those used to determine impaired waters (e.g., Category 5 waters or the traditional 303(d) List) and are subject to the highest data quality standards. Maryland waters identified as impaired using Tier 1 data may require a TMDL or other regulatory actions. These data should be accompanied by a Quality Assurance Project Plan (QAPP) consistent with EPA data guidance specified in Guidance for Quality Assurance Project Plans. Dec 2002. EPA /240/R-02/009 available at http://www.epa.gov/quality/qs-docs/g5-final.pdf. Tier 1 data analysis must also be consistent with Maryland's Assessment Methodologies (see Section C.2).

Tier 2 data are used to assess the general condition of surface waters in Maryland and may include land use data, visual observations of water quality condition, or data not consistent with Maryland's Assessment Methodologies. Such data may not have a QAPP or may have one that is not consistent with EPA guidance. Waters with this level of data may be placed in Categories 2 or 3 of the IR, denoting that water quality is generally good or that there are insufficient data to make an assessment, respectively. However, Tier 2 data alone are not used to make impairment decisions (i.e., Category 5 listings requiring a TMDL) because the data are of insufficient quantity and/or quality for regulatory decision-making. Table 3 below identifies the organizations and/or programs that submitted data to MDE for the 2016 IR.

Table 3: Organizations/Programs that submitted water quality data for consideration in the 2014 Integrated Report.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Audubon Naturalist Society	Non-tidal biological monitoring data from streams around Montgomery County.	Benthic Index of biological integrity	2	Data used for informational purposes - Benthic index of biotic integrity calculated using family level identification. Integration with state dataset not yet possible.
Port Tobacco River Conservancy and United States Geologic Survey	Screening level data on organics, bacteria, and other chemical parameters in the Port Tobacco and Nanjemoy River systems.	A variety of chemical parameters including organics, nutrients, bacteria, and physical parameters such as DO, temperature, salinity and conductivity.	2	Data used for informational purposes - The purpose of this data was for screening purposes and therefore was not sampled with the temporal frequency to be assessed for the 2016 Integrated Report.
Dr. Harriette Phelps, University of the District of Columbia Professor Emeritus	Data on the concentration of various contaminants accumulated in clam tissue in parts of the Anacostia River.	Total metals, Total PAHs, Total PCBs, Total pesticides, Technical Chlordane	2	Data not used due to the lack of reliable coordinates and QAPP documentation. Also outside the collection period for this IR.
Restore Rock Creek	Water column data for the tidal portion of Rock Creek in Anne Arundel County.	DO, turbidity, temperature, conductivity, salinity, pH, fecal coliform	2	Data Used for information purposes - Data needs to be accompanied by QAPP or similar documentation. Since this is tidal Ches. Bay tributary data, it will need to be integrated into Bay Program Assessments for future Integrated Reports.
Department of Natural Resources Fisheries Service	Mostly physical parameters collected from various subestuaries year to year.	DO, pH, conductivity, total ammonia nitrogen, temperature, salinity	1	Data used for informational purposes - Data covers areas for shorter temporal periods to address specific fisheries research concerns. Not suited for water quality impairment determinations.
Miles/Wye Riverkeeper	Data taken from tidal creeks of the Miles and Wye Rivers	Water depth, temp, DO%, DO mg/L, DO mg/L at bottom, salinity, pH, Secchi Disk, total nitrogen, total phosphate, chlorophyll a	2	Tidal data needs to be coordinated and integrated with the Chesapeake Bay Program methodology for collection and assessment.
Miles/Wye Riverkeeper	Physical and chemical data from an upstream tributary of Wye Mills Community Lake	Dissolved oxygen, temperature, nutrients, BOD, pH	2	Data used to prioritize followup assessments. However, additional data are needed to represent appropriate time period and spatial extent for a conclusive assessment.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
West/Rhode Riverkeeper	Tidal Nutrient and water quality data	total nitrogen, total phosphorus, DO, temperature, conductivity, salinity	2	Dataset needs station coordinate information. Tidal DO data will need to be integrated with the Chesapeake Bay interpolator assessments for future IR.
Lake Linganore Association	E. coli data collected from Lake Linganore	E. Coli and Nutrients	1	Data used to assess two beaches that had not previously been assessed.
Choptank Riverkeeper	Data collected from the tidal creeks of the Choptank	Water depth, temp, DO%, DO mg/L, DO mg/L at bottom, salinity, pH, Secchi Disk, Secchi score, total nitrogen, total phospate, chlorophyll a	2	Tidal data needs to be coordinated and integrated with the Chesapeake Bay Program methodology for collection and assessment.
Chester Riverkeeper	Both tidal and nontidal creek data collected.	Water depth, temp, DO%, DO mg/L, DO mg/L at bottom, salinity, pH, Secchi Disk, total nitrogen, total phosphate, chlorophyll a	2	Tidal data needs to be coordinated and integrated with the Chesapeake Bay Program methodology for collection and assessment. Nontidal data does not measure all parameters in-situ. More information needed in QAPP and protocols documentation.
Baltimore Harbor Waterkeeper/Blue Water Baltimore	Bacteria, nutrient, and physical parameters for the Gwynns Falls and Jones Falls watersheds as well as bacteria, nutrient, and physical parameters for the tidal Patapsco River.	Nitrate, Nitrite, Total Nitrogen, Total Phosphorus, Total Kjeldahl Nitrogen, Chlorophyll a, enterococcus, total depth, secchi, temperature, pH, specific conductance, salinity, dissolved oxygen %, DO mg/L, phycoerythrin	1	Data used to update the bacteria assessments. Tidal DO data will need to be integrated with the Chesapeake Bay Program assessments for future IR.
Versar submitting on behalf of Howard County	Biological data accompanied by water quality, physical habitat and geomorphic analyses.	Benthic Macroinvertebrates, fish, geomorphic and physical habitat parameters, and water quality	1	Data will be used for future biological assessments. The Department needs this data in spreadsheet format so as to QAQC IBIs and will seek to work with submitter in prep for the 2018 IR.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Calvert County	Dissolved oxygen, water clarity and chlorophyll a data for tidal creeks of Calvert County. Nutrient data for nontidal creeks.	Dissolved oxygen, Secchi disk readings, chlorophyll a	2	Data used to confirm existing tidal impairment. However tidal data needs to be coordinated and integrated with the Chesapeake Bay Program methodology for collection and assessment. Raw data and QAPP-like documentation needed in the future.
Baltimore County Dept. of Environmental Protection & Sustainability	Bacteria	total coliform (MPN) and E. coli (MPN)	1	Data used to update bacteria assessments in nontidal waterways.
Baltimore County Dept. of Environmental Protection & Sustainability	Nutrient, ion, and metals water quality data for nontidal sites around Baltimore County	TSS, total solids, total kjeldahl nitrogen, nitrate-nitrite, total phosphorus, orthophosphorus, BOD, COD, total copper, total lead, total zinc, total cadmium, chloride, sodium, hardness, magnesium, calcium, sulfate	2	Data may be used in the future but issues with data transcription and proper headings prevented confident assessment. Cleanup required.
Baltimore County Dept. of Environmental Protection & Sustainability	Non-tidal benthic monitoring data	Benthic index of biological integrity, habitat.	2	Dataset may be used in the future. However there were issues with the QAQC of IBI calculations due to missing fields in the benthic table.
Sassafras Riverkeeper	Physical, biological and nutrient data from non-tidal waters in the Sassafras River watershed.	DO, turbidity, temperature, conductivity, salinity, pH, nutrients, benthic macroinvertebrate IBI scores.	2	Data had suspect locational information. Some anomalous values found in data table.
Sassafras Riverkeeper	Physical, chlorophyll a, and nutrient data for the tidal Sassafras River	DO, Secchi depth, chlorophyll and nutrients	1	Tidal data needs to be coordinated and integrated with the Chesapeake Bay Program in order to be used for tidal tributary assessment.
Washington Suburban Sanitary Commission	Physical and chemical water quality data from the Patuxent Reservoirs	chlorophyll a, nutrients, turbidity, chlorides, DO	1	Data used as information to confirm existing listing. Greater temporal and spatial coverage needed to support delisting. Also need DO data to augment assessment.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Nanticoke Watershed Alliance	Physical water quality parameters, nutrients, chlorophyll a, and bacteria samples collected from both tidal and nontidal waters in the Nanticoke River watershed.	DO, salinity, Secchi depth, temperature, fecal coliform, enterococcus, chlorophyll a, nutrients	2	Coordinates need greater precision as stations do not always plot in appropriate location. More detailed rainfall data needed to assess bacteria data. Tidal data needs to be coordinated and integrated with the Chesapeake Bay Program methodology for collection and assessment.
MDE – Fish Tissue Monitoring Program	Fish Tissue data on Chlordane, PCBs and Hg content	Concentration of Chlordane, PCBs, and mercury in fish tissue	1	Data used to update fish consumption assessments for PCBs, mercury, and chlordane.
MDE - Compliance Program's Sewage Overflow Database	Web-accessible Sewage Overflow Database provides data on location and volume of sewage overflows	gallons of untreated sewage discharged from leaky infrastructure	2	Data summarizes the areas with most frequent sewage overflows. No actual water quality data.
MD DNR - MANTA Program	Core Trend Non-tidal monitoring data	Nutrients, turbidity, water temperature, pH, conductivity, DO	1	Data used to update non-tidal assessments.
MDE – BEACH Certification Program	Bacteria data collected at designated bathing beaches by County HDs.	Enterococcus levels	1	Data used to update beach assessments.
MDE - Environmental Assessment & Standards Program, Field Services Program	Metals and cyanide monitoring data collected near NPDES outfalls of two major dischargers	Cu, Pb, Cr, Ni, As, Cd, Se, Ag, Zn, Hg, CN	1	Data used to reassess previous Category 4b listings that remained from the historical 304l list.
MDE - Environmental Assessment & Standards Program, Field Services Program	Metals monitoring data collected along the mainstem of the Choptank River	Cu, Pb, Cr, Ni, As, Cd, Se, Ag, Zn	1	Data used to confirm the lack of a copper impairment on the Choptank as shown in previous NOAA study.
MD DNR and Virginia Institute of Marine Science	Assessments of Sediment levels in the Chesapeake Bay through the use of the SAV indicator	SAV coverage and water clarity acres	1	Data used to update the SAV/sediment assessments for the Chesapeake Bay and its tidal tributaries

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
MDE - Biostressor Identification Program	Analysis that provides the pollutants impairing a watersheds biotic integrity	Biological Index Scores and the correlation to stressors	1	Data used to update biological assessments to reflect actual impairing substance.
MDE – Shellfish Certification Program	Bacteria data for stations in the Tidal areas of the Chesapeake Bay and Coastal Bays in MD	Fecal coliform	1	Data used to update bacteria assessments as they relate to the shellfish harvesting designated use.
MD DNR and Chesapeake Bay Program	Results of Water Quality Interpolator Model, based on measured DO levels in Chesapeake Bay	Percent exceedance of CFD curves	1	Data used to update the DO/nutrient assessments for the Chesapeake Bay and its tidal tributaries
MDE - Science Services Field Services Program	pH data provided for previously impaired segments in the Evitts Creek and Casselman River watersheds.	pH	1	Data used to update these pH assessments.

Worth noting, in the coming years, MDE will be reevaluating the current data quality tier system (2 tier system) to determine if changes are necessary to establish consistency with the Chesapeake Bay Monitoring Cooperative and further refine the data evaluation process.

A.1.1 Quality Control of Water Quality Datasets

Data quality in Maryland's water monitoring programs is defined through implementation of the agency's quality control program (e.g., DNR's and MDE's Quality Management Plan), Quality Assurance Project Plan (QAPP) for each monitoring program, and field and laboratory Standard Operating Procedures (SOP). Water monitoring programs conducted under contract to the US Environmental Protection Agency (EPA) must have QAPPs approved by the EPA Regional or Chesapeake Bay Program Quality Assurance (QA) Officer prior to initiating monitoring activities.

Details in each program's QAPP define data quality indicators by establishing quality control and measurement performance criteria as part of the program's planning and development. Such measures help ensure there is a well-defined system in place to assess and ensure the quality of the data.

Water monitoring programs conducted by a local agency, educational institution, consultant or citizen group may not have a QAPP. Unless there are contractual requirements, water monitoring QAPPs for these groups are not reviewed or approved by the State. While it is recommended that a QAPP or equivalent planning document be developed, some water quality monitoring programs may have no QAPP or documentation on quality control. For state analysts to review these contributed data with any confidence the quantitative aspects of these data need to be defined.

Some of the data quality aspects that need to be considered include:

Precision - How reproducible are the data? Are sample collection, handling and analytical work done consistently each time samples are collected and processed?

Accuracy/Bias - How well do the measurements reflect what is actually in the sample? How far away are results from the "true" value, and are the measures consistently above or below this value?

Representativeness - How well do the sample data characterize ambient environmental conditions?

Comparability – How similar are results from other studies or from similar locations of the same study, or from different times of the year, etc.? Are similar sampling and analytical methods followed to ensure comparability? Do observations of field conditions support or explain poor comparability?

Completeness – Is the quality and amount of data collected sufficient to assess water quality conditions or can these data be appended to other, existing data collected at the same site or nearby to provide enough information to make an assessment decision?

Sensitivity - Are the field and/or laboratory methods sensitive enough to quantify parameters at or below the regulatory standards and at what threshold can an analytical measure maintain confidence in results?

QAPPs will likely not address all of these issues and there are often no quantitative tests or insufficient Quality Control (QC) data available to do so. In these instances, best professional judgment may be required as these aspects can be difficult to address, even if there is a monitoring QAPP. For some issues, there is no quantitative test and often little, if any, quality assurance data are provided with contributed data. In most instances, an analyst's review of available monitoring program documentation and data are subjective. Once data quality is considered acceptable (or at least not objectionable), the dataset review process moves to a more quantitative review stage.

A.1.2 Water Quality Data Review

The designated uses defined in the Code of Maryland Regulations are assessed by relatively few field and analytical measures. Water temperature, dissolved oxygen, pH, turbidity, water clarity (Secchi depth or light extinction), acres of estuarine grasses, ammonium, biological integrity and certain bacteria levels define the principal data used to assess criteria attainment. Various measures of nitrogen and phosphorus (nutrients) have not been defined in terms of criteria, although exceedance of oxygen criteria or nuisance levels of algae are attributed to high nutrients levels. Except for special studies or as a discharge permit requirement, metals, inorganic and organic parameters defined as criteria are not routinely measured due to the high cost of analysis and because few of these substances are found in ambient waters at levels exceeding criteria. Specific toxics known to be directly related to human health (i.e., mercury and PCBs) are assessed through MDE's fish and shellfish monitoring programs.

Water quality datasets reviewed for assessing use support are first examined in terms of QAPP or other reports that define monitoring objectives and quality control. For selected parameters, the data are reviewed for sufficient sample size, data distribution (type and outliers/errors) and spatial and temporal distribution in the field. Censored data and field comments are examined for unusual events that may affect data quality (e.g., storm event). Data are examined for seasonality and known correlations (e.g., conductivity and salinity) are reviewed. Censored data are noted and may be excluded from the analysis.

Not all water quality criteria are assessed using this approach. Some assessments are conducted by other state programs using peer-reviewed or defined methods (e.g., Maryland's assessment methodologies) and are not re-evaluated using other approaches. Examples include; assessment of algal samples, the State's statistical non-tidal living resource survey (MD Biological Stream Survey), fish kill and bacterial assessments, bathing and shellfish harvesting restrictions, and toxic contaminants in fish tissue, shellstock and sediments.

Some criteria assessments are conducted externally. In these circumstances, the assessment methods are peer reviewed and results are provided to the State. Criteria assessed in this manner are not re-evaluated. Examples include, for Maryland's Chesapeake Bay and tidal tributaries, benthic community criteria (Versar, Inc. and Old Dominion University), aquatic grass coverage (VA Institute of Marine Science), water clarity (MD DNR), and dissolved oxygen (US Environmental Protection Agency's Chesapeake Bay Program).

MDE supports the use of computer models and other innovative approaches to water quality monitoring and assessment. Maryland and the Bay partners have also relied heavily on the Chesapeake Bay model to develop loading allocations, assess the effectiveness of best management practices, and guide implementation efforts. Several different modeling approaches have also been used in TMDL development. With the large number of biological impairments in Category 5 of the IR, Maryland has been relying more heavily on land use analyses, GIS modeling, data mining, and other innovative approaches to identify stressors, define ecological processes, and develop TMDLs.

PART B: BACKGROUND

B.1 Total Waters

Maryland is fortunate to have an incredible diversity of aquatic resources. The low-lying, coastal plain region in the eastern part of the State includes the oceanic zone as well as the estuarine waters of both the Coastal and Chesapeake Bays. Moving further west and up through the rolling hills of the Piedmont region, the tidal influences give way to flowing streams and the Liberty, Loch Raven and Prettyboy reservoir systems. Along the western borders of the State is the Highland region where the State's highest peaks are located, and which includes three distinct geological provinces (the Blue Ridge, the Ridge and Valley province, and the Appalachian Plateaus). Estimates of Maryland's total surface waters across these regions are given in Table 4.

Table 4: Scope of Maryland's Surface Waters.

<table>
<tr><th colspan="2"></th><th>Value</th><th>Scale</th><th>Source</th></tr>
<tr><td colspan="2">State population</td><td>5,773,552</td><td>N/A</td><td>U.S. Census Bureau, 2010</td></tr>
<tr><td rowspan="2">Surface Area</td><td>Total (square miles)</td><td>12,193</td><td rowspan="2">Unknown</td><td rowspan="2">MD DNR 2001</td></tr>
<tr><td>Land (square miles)</td><td>9,844</td></tr>
<tr><td colspan="2">Rivers and streams (miles)</td><td>19,127</td><td>1:24,000 NHD Coverage</td><td>National Hydrography Dataset, 2012</td></tr>
<tr><td rowspan="2">Impoundments</td><td>All Lakes/Reservoirs (number/acres)</td><td>947 lakes / 77,965</td><td>1:100,000 (RF3)</td><td>US EPA, 1991</td></tr>
<tr><td>Significant Publicly-owned (number/acres)</td><td>60 lakes / 21,876</td><td>1:24,000 NHD Coverage</td><td>USGS, MDE, 2012</td></tr>
<tr><td colspan="2">Estuaries/Bays (square miles)</td><td>2,451</td><td>1:24,000</td><td>Chesapeake Bay Program, MDE, 2012</td></tr>
<tr><td colspan="2">Ocean coast (square miles)</td><td>107</td><td>1:24,000</td><td>MDE, 2012</td></tr>
<tr><td rowspan="2">Wetlands</td><td>Freshwater (acres)</td><td>528,877</td><td>Unknown</td><td>Genuine Progress Indicator, 2013</td></tr>
<tr><td>Tidal (acres)</td><td>237,042</td><td>Unknown</td><td>Genuine Progress Indicator, 2013</td></tr>
</table>

*Most of these numbers are based on the use of the 1:24,000 scale, USGS National Hydrography Dataset (NHD) coverage.

B.1.1 Water Quality Standards

A water body is considered "impaired" when it does not support a designated use [see Code of Maryland Regulations §26.08.02.02 at http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.02.htm]. Maryland's Water Quality Standards (WQS) assign use classes or groupings of specific designated uses to each body of water. The following is a generalized list of the four primary use classes. Each of these may also be given a "-P" suffix which denotes that the water body also supports public water supply.

Use I waters: Water contact recreation, and protection of non-tidal warmwater aquatic life;
Use II waters: Support of estuarine and marine aquatic life and shellfish harvesting;
Use III waters: Non-tidal cold water; and,
Use IV waters: Non-tidal Recreational trout waters.

Each use class then has an appropriate subset of specific designated uses. Water bodies assigned a use class are expected to support the entire subset of designated uses for that class. Table 5 illustrates the specific designated uses that apply to each use class. This table shows all possible use classes in the column headings.

Table 5: Specific Designated Uses that apply to each Use Class.

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use*			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use*			✓	✓				
Open-Water Fish and Shellfish Use*			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use*			✓	✓				
Seasonal Deep-Channel Refuge Use*			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

*These particular designated uses apply only to the Chesapeake Bay and its tidal tributaries. They are discussed in more detail in Section B.1.1.1.

Each of the designated uses has associated water quality criteria that are then used to determine if the designated use is being supported. Such criteria can be narrative or numeric. Numeric Water Quality Criteria establish threshold values, usually based upon risk analyses or dose-response curves, for the protection of human health and aquatic life. These apply to pollutants that can be monitored and quantified to known levels of precision and accuracy, such as toxics concentrations, pH, and dissolved oxygen. Narrative criteria are less quantitative in nature but generally prohibit any undesirable water quality conditions that would preclude a water body from supporting a designated use.

The Federal Clean Water Act and its amendments require that states update their water quality standards every three years, subject to review and approval by the US Environmental Protection Agency (http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/Programs/WaterPrograms/TMDL/wqstandards/index.aspx). Maryland's water quality standards are updated through changes to the regulatory language in the Code of Maryland Regulations (COMAR) and go through a public review process.

B.1.1.1 Water Quality Standards for Chesapeake Bay and its Tidal Tributaries

Maryland has detailed water quality standards for Chesapeake Bay and its tidal tributaries to protect both aquatic resources and to provide for safe consumption of shellfish. The current aquatic resource protection standards are subcategories under Use Class II waters and establish five designated uses (see Figure 2) for Chesapeake Bay and its tidal tributaries, including:

Seasonal Migratory Fish Spawning and Nursery Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced populations of ecologically, recreationally, and commercially important anadromous, semi-anadromous and tidal-fresh resident fish species inhabiting spawning and nursery grounds from February 1 through May 31.

Seasonal Shallow-Water Submerged Aquatic Vegetation Designated Use –includes tidal fresh, oligohaline and mesohaline waters of the Chesapeake Bay and its tributaries that have the potential for or are supporting the survival, growth, and propagation of rooted, underwater bay grasses in tidally influenced waters between April 1 and October 1.

Open-Water Fish and Shellfish Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced, indigenous populations of ecologically, recreationally, and commercially important fish and shellfish species inhabiting open-water habitats. This subcategory applies to two distinct periods: summer (June 1 to September 30) and non-summer (October 1 through May 31). In summer, the open-water designated use in tidally influenced waters extends from shoreline to adjacent shoreline, and from the surface to the bottom or, if a pycnocline exists (preventing oxygen replenishment), to the upper measured boundary of the pycnocline. October 1 through May 31, the boundaries of this use include all tidally influenced waters from the shoreline to adjacent shoreline and down to the bottom, except when the migratory spawning and nursery designation (MSN) applies.
NOTE: If a pycnocline exists but other physical circulation patterns, such as the inflow of oxygen-rich oceanic bottom waters, provide oxygen replenishment to the deep waters, this use extends to the bottom. This is mostly prevalent in the Virginia portion of the Bay.

Seasonal Deep-Water Fish and Shellfish Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced, indigenous populations of important fish and shellfish species inhabiting deep-water habitats from June 1 through September 30:
NOTE 1: In tidally influenced waters located between the measured depths of the upper and lower boundaries of the pycnocline, where a pycnocline is present and presents a barrier to oxygen replenishment; or
NOTE 2: From the upper boundary of the pycnocline down to the sediment/water interface at the bottom, where a lower boundary of the pycnocline cannot be calculated due to the depth of the water column.
NOTE 3: From October 1 to May 31, criteria for Open Water Fish and Shellfish Subcategory apply.

Seasonal Deep-Channel Refuge Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival of balanced, indigenous populations of ecologically important benthic infaunal and epifaunal worms and clams, which provide food for bottom-feeding fish and crabs. This subcategory applies from June 1 through September 30 in tidally influenced waters where a measured pycnocline is present and presents a barrier to oxygen replenishment. Located below the measured lower boundary of the pycnocline to the bottom.
NOTE: From October 1 to May 31, criteria for Open Water Fish and Shellfish Subcategory apply.

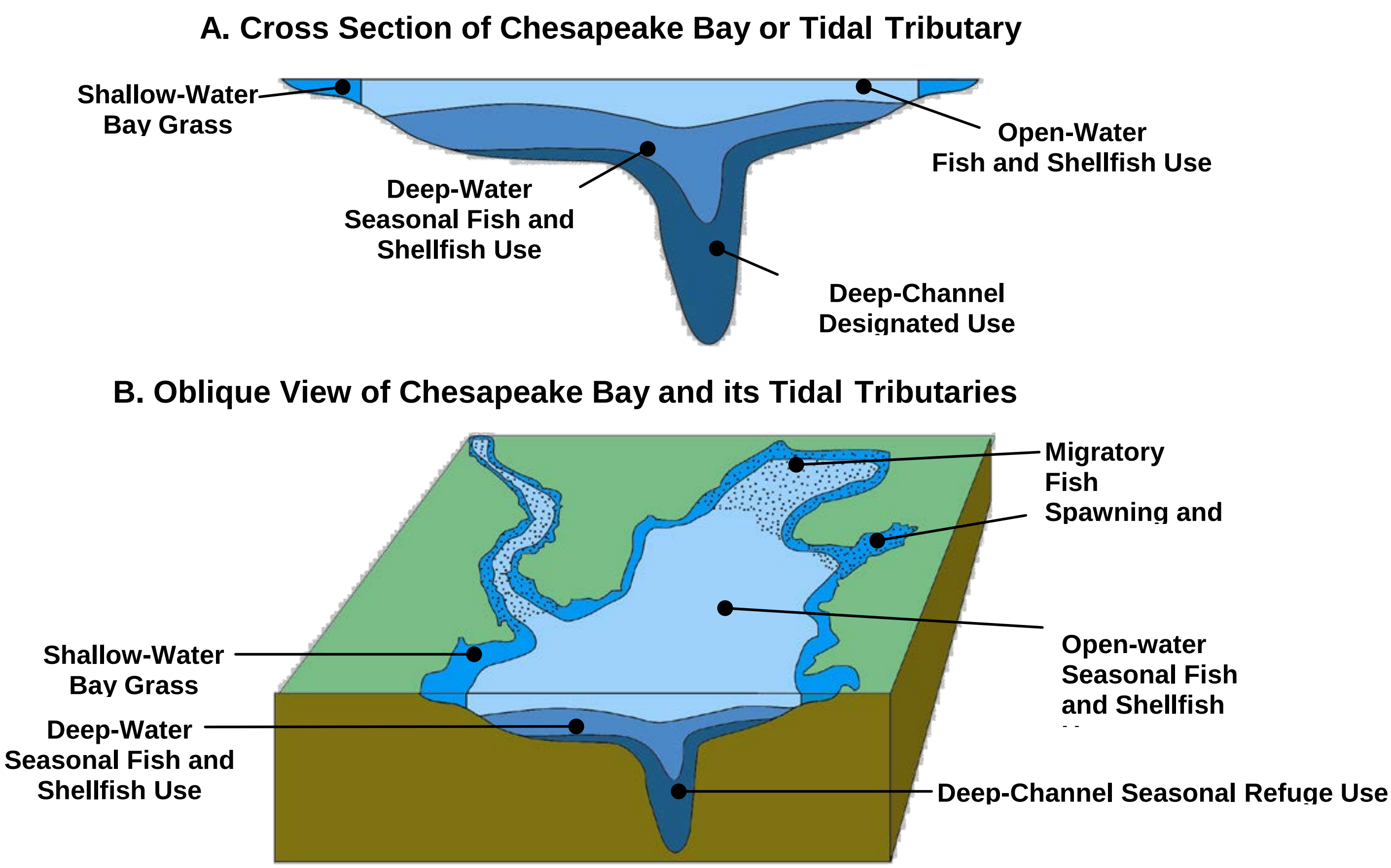


Figure 5: Illustration of the designated uses for Chesapeake Bay (Chesapeake Bay Program, 1998). Uses are both overlapping and three-dimensional.

B.2 Water Pollution Control Programs

Maryland implements a host of water pollution control programs to ensure that water quality standards are attained, many of which are funded by federal dollars under the Clean Water Act. Some programs are administered by different state agencies within Maryland or by local jurisdictions. Some of the programs administered by MDE are briefly cited below and web links are provided for access to more detailed information.

B.2.1 Permits

MDE is responsible for administering several permit programs to reduce the impacts of surface water and groundwater discharges to state waters. More detailed information on the State's water permits is available at http://www.mde.state.md.us/Waterpermits.

B.2.2 Tier II Waters and Antidegradation

Maryland continues to implement antidegradation regulations to better protect state waters where data indicate that water quality is significantly better than that required to support the applicable designated uses (COMAR 26.08.02.04). MDE is in the process of developing Tier II implementation guidance to help the Department as well as regulated entities better understand and implement these regulations. The antidegradation program aims to protect high quality waters by requiring more rigorous permit application reviews. The reviews identify practices that avoid and minimize the amount of buffering capacity (i.e., assimilative capacity) used by a permitted discharge. More information on Tier II can be found at http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/Antidegradation_Policy.aspx.

B.2.3 Grant Programs

A number of financial assistance programs are offered and/or facilitated by the Maryland Department of the Environment. Funding may be in the form of grants, low interest loans, or direct payments for specific projects. More detailed information on the range of programs administered by the Department can be found at http://www.mde.state.md.us/WQFA.

B.2.4 Total Maximum Daily Loads (TMDLs)

Waters listed on Category 5 of this Integrated Report may require a Total Maximum Daily Load (TMDL). A TMDL is an estimate of the amount or load of a particular pollutant that a water body can assimilate and still meet water quality standards. After a total load has been developed, upstream discharges will be further regulated to ensure the prescribed loading amounts are attained. More information on Maryland's TMDL program can be found at http://www.mde.state.md.us/TMDL. Changes to assessments in this Integrated Report that are based on newly approved TMDLs (TMDLs approved by EPA within the last two years) are described in this document in Section C.3.1.

One recent and important development in Maryland's TMDL program is the documentation of the State's prioritization of impairments for TMDL development. This document, included as Part G of this report, addresses EPA's "New Vision" or set of recommendations that urge states to formalize their TMDL prioritization decisions. Part of this "New Vision" also includes recommendations of opportunities for meaningful public engagement so that state TMDL prioritization is informed by a variety of stakeholders. As such, the public review period for this IR will also be used to invite and accept comment on this TMDL prioritization document.

B.2.5 Stream Restoration

Due to expected increases in proposals to restore or enhance streams and wetlands to meet watershed restoration objectives in the Chesapeake and Coastal Bays, MDE needs to advance its capabilities and provide additional guidance to applicants regarding restoration proposals. Assessments are needed for assessing both adverse impacts and benefits of restoration projects when the projects are proposed in regulated resources.

To meet this need, in 2013 MDE entered into an interagency agreement with the U.S. Fish and Wildlife Service (USFWS) to facilitate the assessment, review, enhancement and creation of technical services that will allow the Department to meet its goals and objectives for restoring and enhancing the quality of Maryland's water and floodplain resources. USFWS developed guidelines for a function-based stream assessment process, a rapid field function-based stream assessment method, and a stream restoration design review method for typical projects in Maryland. The Service also conducted training in September 2014. The training is adapted from the guidelines provided in the document: *A Function-based Framework for Stream Assessment and Restoration Projects* (Harman et al., 2012) (Stream Functions Framework). The assessment and checklists created from this effort were used for a one year test period while the Service considered changes and comments. The final guidance document describing the process of conducting an assessment for a restoration project will be completed in summer 2016. Documents may be found at: http://www.fws.gov/chesapeakebay/stream/protocols.html.

While the stream restoration guidance will greatly aid in the review and design of stream restoration projects, an accompanying assessment for adjacent wetlands is lacking. MDE will be investigating approaches to be used or adapted for regulatory review.

B.2.6 Drinking Water Supply and Protection

MDE is charged with ensuring that all Marylanders have a safe and adequate supply of drinking water. The Department has programs to oversee both public water supplies, which serve about 84 percent of the population's residential needs, and individual water supply wells, which serve citizens in most rural areas of the State. More information on Maryland's Water Supply Programs can be found at http://www.mde.state.md.us/WaterSupply.

B.2.7 Corsica River Targeted Watershed

The Corsica River Watershed Project is a pilot program designed to demonstrate that a tidal tributary of Chesapeake Bay can be successfully restored. The goal of this targeted watershed restoration is to remove the Corsica River from the Impaired Waters List. For more information, go to http://www.corsicariver.com.

B.2.8 Program Coordination

State agency staff participate in many work groups, committees, task forces, and other forums to coordinate and communicate state efforts with interested stakeholders. Coordination with the Chesapeake Bay Program and participation by state staff in the associated subcommittees and goal implementation teams continues to be a nexus for Maryland's water quality restoration activities. MDE staff also communicate regularly with other state agencies on topics including water quality standards development, water quality monitoring and assessment, TMDL development, and permitting. State staff also participate in groups such as the Maryland Water Monitoring Council, to ensure program coordination with local and federal government agencies, as well as the private sector, academia, non-governmental organizations, and Maryland's citizens.

Prioritization Approach for Integrated Report and NPS Management Plan

In December of 2013, EPA finalized its documentation of a Long-Term Vision for Assessment, Restoration, and Protection under the CWA Section 303(d) program (the 'New Vision'), with a focus on demonstrable improvement in water quality for watersheds prioritized by states. The vision goals incorporate the concept of adaptive management, placing an emphasis on the need for states to set their own priorities and pace, and allowing flexibility for states to make decisions regarding their waters' protection efforts.

The New Vision consists of six elements or goals, which, along with their expected timelines for adoption by the states, are specified by EPA. The elements are enhanced Engagement (completed in 2014); watershed Prioritization (2016); Protection (2016); programmatic Integration (2016); incorporation of TMDL Alternatives (2018), and Assessment (2020). Overall evaluation will take place in 2022. Details of the New Vision, and full descriptions of these elements, are available from EPA at https://www.epa.gov/tmdl/new-vision-cwa-303d-program-updated-framework-implementing-cwa-303d-program-responsibilities.

The Prioritization goal, as the foundation to guide planning and implementation of the other goals, requires that by 2016, states review, prioritize, and report priority watersheds or waters for restoration and protection. To that end, Maryland has established a methodology to prioritize the State's watersheds for TMDL development, TMDL revision and, where appropriate, alternative means of protection and restoration. In keeping with the Engagement goal, MDE developed this methodology in a transparent manner, and has included it in this Integrated Report as Part G. The methodology sets a pace for development of these TMDLs for the period spanning 2016-2022, when states will evaluate accomplishments. MDE will maintain its commitments and responsibilities to address impaired waters as outlined in the 2012 MOU.

B.3 Cost/Benefit Assessment

One specific reporting requirement of the Clean Water Act under §305(b), is a cost-benefit analysis of water pollution control efforts to ensure that the benefits of these programs are worth the costs. Economists have defined various ways to measure water quality benefits (e.g., Smith and Desvousges, 1986) and a number of agencies have produced estimates of water quality values based on uses (e.g., flood control value of wetlands – Leschine et al., 1997) or specific activities (e.g., recreational fishing - US Fish and Wildlife Service, 1998). Data for these efforts are often difficult to obtain, the results are complex or often address only a single use, and comparability between states or regions can be impossible. There are increasing efforts, lead primarily by the academic community, to establish ecosystem service values for a variety of attributes provided by natural areas and waters. However, it is difficult at this time to apply values broadly across a range of regional and jurisdictional boundaries.

B.3.1 Program Costs

A substantial level of federal funding for water pollution control efforts comes from some agencies (US Environmental Protection Agency) while funding for aquatic resource protection and restoration may be substantially provided by other federal agencies (e.g., US Fish and Wildlife Service). Funds usually are transferred to states through a variety of appropriations – for example, certain provisions of the federal Water Pollution Control Act and its amendments provide for grants to states, including Sections 104(b) (NPDES), 106 (surface and ground water monitoring and permitting), 117 (Chesapeake Bay Program), 319 (nonpoint source pollution control), and 604(b) (water quality planning). These funds often provide seed money or low-interest loans that must be matched by state or local funds or documented in-kind efforts used on the project. A summary of federal water quality/aquatic resource-related grants to state agencies is shown in Figure 3.

While some new water programs are occasionally initiated, overall, there has been a general decline of federal funding available to states for various water quality-related programs. The figure below shows a summary of EPA budget data from traditional water grants (Clean Water Act §106, §319, §104b planning, wetlands, targeted watersheds, public water supply, and beach monitoring).

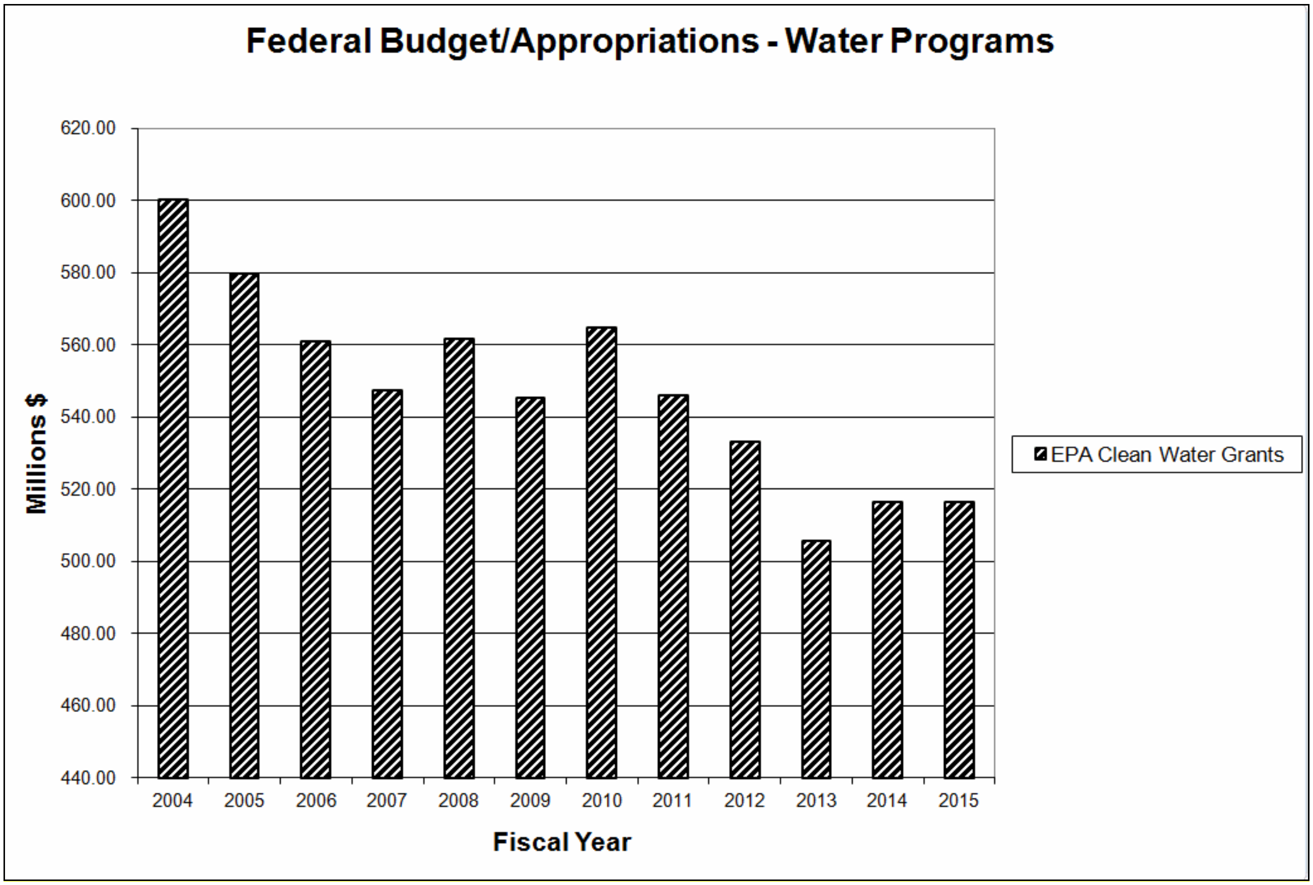


Figure 6: Federal Budget Appropriations to Water Programs (2004-2015). (Source: Association of Clean Water Administrators (ACWA) President's FY2017 Budget Request Funding Chart, Updated 2-10-16)

Although the changes may appear gradual, the loss for state programs is increased when programs that require matching funds are reduced. An example of the impact of national funding variance in §319 funding appropriation and what Maryland received is shown in Figure 4.

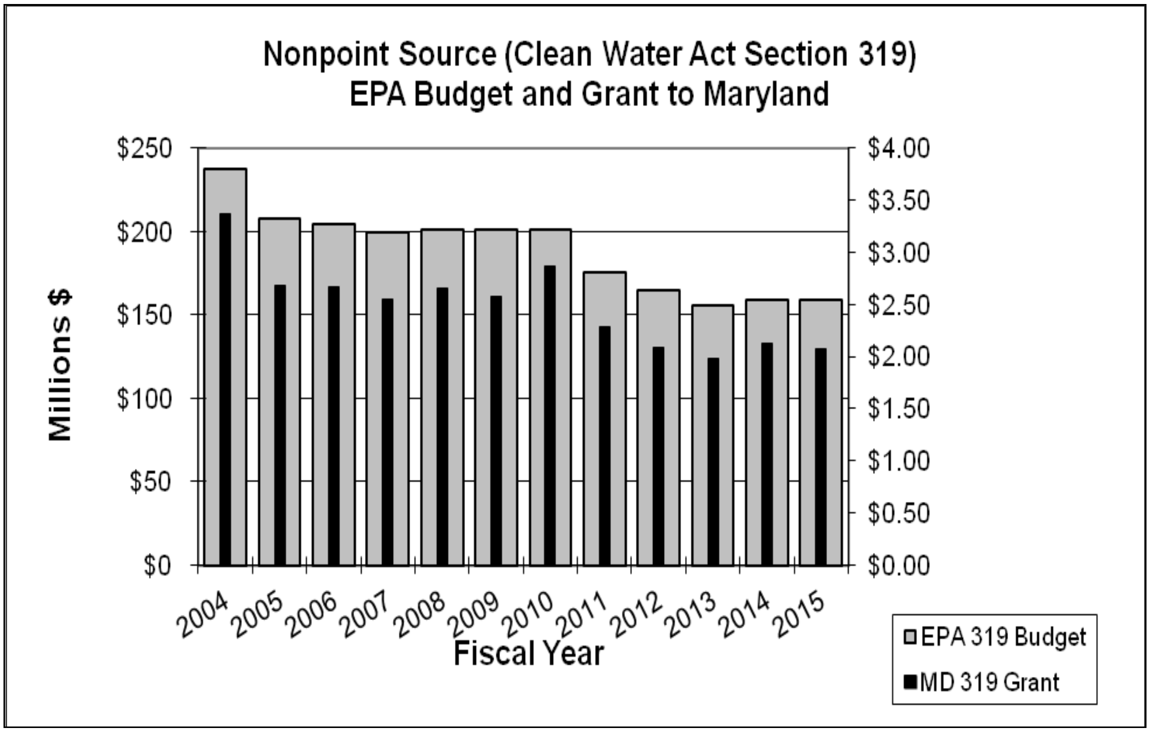


Figure 7: Federal nonpoint source total budget allocation including the Maryland totals. (Sources: Association of Clean Water Administrators FY2017 Report and MDE's 319 Annual Report)

As the federal funding for water programs vary and program costs increase annually, maintenance of nearly every water program activity requires either an increased share from state/local budgets or reductions in program function.

B.3.2 Program Benefits

Clean water offers many valuable uses to individuals and communities as direct and indirect economic benefits. Beautiful beaches, whitewater rivers, and calm, cool lakes add to aesthetic appeal and contribute to a recreation and tourism industry. A plentiful supply and good quality drinking water encourages economic growth and development, increased property values, and water-based recreational opportunities and commerce. But while environmental quality ranks high in the public's perception of livable communities, an economic valuation of each of these benefits is difficult to develop.

Most often, economic benefits are determined for single uses (e.g., fishing). For example, approximately 347,000 Maryland residents are anglers (about one in 17) and residents comprise more than 81 percent of the State's anglers. In 2011, these anglers spent $535 million in the State on fishing expenses - an average of $1,212 per angler per year. Most of these expenses (62 percent) were equipment-related which included things like fishing equipment, clothing, boats, tents, etc. Trip-related costs (food, lodging, transportation, equipment rental) accounted for another large portion (37 percent) and other items (membership dues, magazines, permits, stamps and leases) amounted to $7 million (1%) (US Fish and Wildlife Service, 2013).

B.3.3 Summary

Water pollution control efforts are very costly. Much of the federal funds provided to the State and cost-shared with additional state and local funds are used to implement local pollution control and/or restoration programs. On an annual basis, the funds available are but a fraction of the estimated cost.

EPA needs to clearly define meaningful and comparable cost/benefit information that would enable states to assess the value of implementing directives of the Clean Water Act. A pilot state or regional program or a national study with recognized economists and federal and state participation could help simplify the complexities of this economic analysis.

B.4 Special State Concerns and Recommendations

The Chesapeake Bay continues to be the major focal point for water quality planning and restoration efforts across the State. Since the Chesapeake Bay TMDL was finalized in December 2010, states have completed Phase I and Phase II Watershed Implementation Plans (WIP) which allocate the nutrient and sediment reductions necessary to support the water quality goals for the Chesapeake Bay and tidal tributaries. States are currently developing Phase III WIPs in preparation for the 2017 midpoint assessment which will provide information on what actions are needed by states (in 2018-2025) to meet the pollution reduction goals of the Bay TMDL by 2025. Maryland continues to measure progress in achieving the two-year milestones that serve as interim goals to help track Maryland's progress in restoring the Bay. The recently finalized 2015 Progress Report shows that Maryland met its 2015 milestones for phosphorus and sediments and is on pace to meet its 2017 milestone for nitrogen reduction. In fact, according to modeling results produced by EPA for the 2015 progress run, Maryland has already met its 2025 TMDL goals for phosphorus and sediment reduction.[2] Still, much work needs to be done as reductions of nitrogen from agriculture, urban areas, and septic systems have not yet been met. Maryland will need to continue to leverage important funding vehicles such as the Bay Restoration Fund, the Chesapeake Bay and Atlantic Coastal Bays Trust Fund, and others to make future progress and ensure that the state keeps pace with increasing pressures from development. Additionally, the state will need to come to consensus on nutrient trading rules as well as an 'Aligning for Growth' policy if it hopes to expedite nutrient reduction efforts from non-regulated sectors and offset new loads from development.

In addition to the Chesapeake Bay work, Maryland is increasingly engaged in protecting its high quality waters. MDE has continued its outreach to local governments by identifying high quality waters in their jurisdictions needing special protection (COMAR 26.08.02.04) and raising awareness on the need for antidegradation reviews. Maryland also continues to review wetlands and waterways permits, NPDES permits, and water and sewer plans to ensure that Tier II waters receive adequate protection to maintain high quality status. Maryland also continues its targeted watershed work utilizing the 319 Nonpoint Source Program and the Chesapeake Bay and Atlantic Coastal Bays Trust Fund. Both funding programs

[2] Caution is warranted when interpreting the Phosphorus progress results. Two studies by the United States Geological Survey (USGS), released in 2013 and 2015, indicate increasing phosphorus trends on Maryland's Eastern Shore. Based on these monitoring results and other available science, such as phosphorus saturation and transport in soils, EPA believes that the level of effort to manage phosphorus may increase and has advised Maryland to consider additional actions to manage phosphorus in its 2016-2017 milestones and Phase III WIP.

provide grants and assistance to organizations interested in completing water quality restoration projects. Worth noting, Governor Hogan's 2017 Fiscal Year State Budget includes $53 million in funding for the Chesapeake Bay and Atlantic Coastal Bays Trust Fund and returns $60 million over the next two fiscal years to Program Open Space.

Maryland faces many emerging issues in the effort to reduce the amount of pollutants entering state waters. An ongoing concern is the detection of endocrine disrupting chemicals in Maryland waters that are believed to be linked to ecological impacts such as intersex fish (e.g. intersex fish have been found in the Potomac River and several waters that flow into Maryland such as the Shenandoah and Susquehanna Rivers). These chemicals are being studied for effects on fish reproduction and, in some cases, have been linked to low reproductive success. These substances will be increasingly investigated to determine the magnitude of their effect on fish stocks and whether it is feasible to control them at the source.

Another emerging water quality issue is the salinization of state fresh waters due to road salt application. Spikes in stream conductivity and declining aquatic biological communities have been linked to increasing chloride levels throughout the State. As of this Integrated Report, Maryland now has 27 non-tidal watersheds listed as impaired for chlorides. In addition, data collected from tributaries to drinking water reservoirs also show upward trends for chloride levels, creating concern for the health of consumers and concerns regarding the longevity of drinking water infrastructure (due to increased corrosivity). In response, MDE has developed draft chloride thresholds for assessing impacts to aquatic life and is currently working on a pilot TMDL study in the Cabin John Branch watershed in Montgomery County.

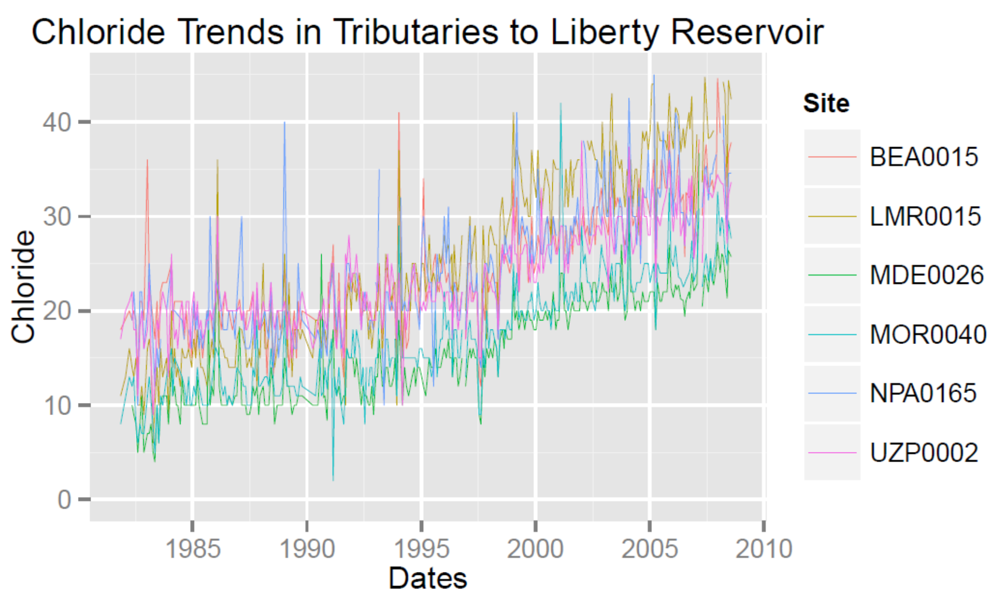


Figure 8: Chloride Trends in Tributaries to Liberty Reservoir (Baltimore City-owned drinking water source) (Graphic courtesy of the Center for Watershed Protection).

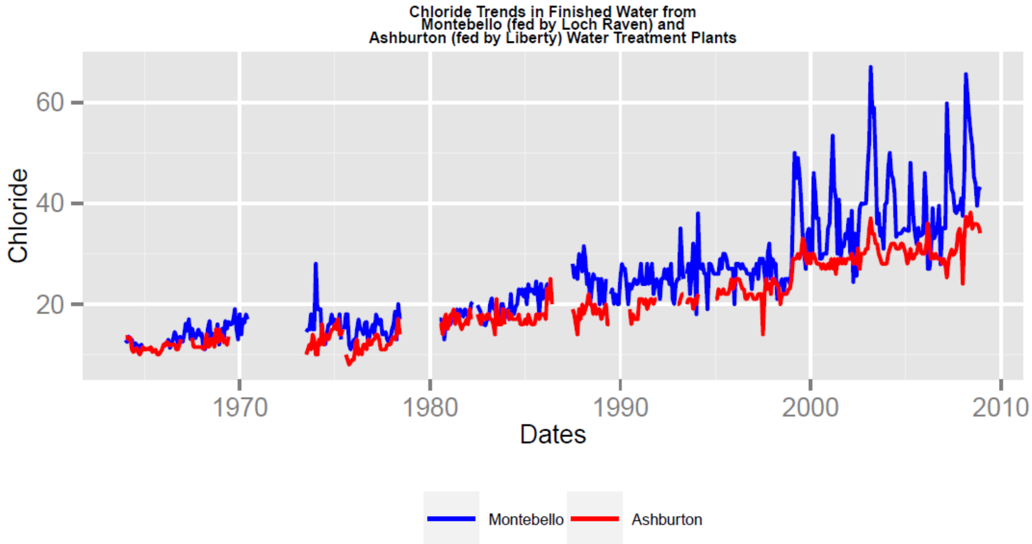


Figure 9: Chloride Concentrations in treated (finished) water from the Montebello and Ashburton Water Treatment Plants in Baltimore City (Graphic courtesy of the Center for Watershed Protection).

Another notable development is that the Maryland State Legislature (2016) passed HB 797 that makes the state wetland mitigation regulations consistent with the 2008 Federal Mitigation Rule (published by the U.S. Army Corps of Engineers and EPA). This bill removes disincentives to establishing wetland mitigation banks with the intent of encouraging the development of wetland mitigation projects in areas of most ecological benefit.

Maryland has developed extensive documentation evaluating the risks, best practices, and economic impacts associated with the practice of hydraulic fracturing (for methane extraction) in the Marcellus Shale formation. To support safe drilling of Marcellus Shale, the Department initially proposed a draft set of regulations for oil and gas exploration in 2015 and subsequently developed a series of issue papers to outline potential revisions and rationale. The Department accepted public comment on these issue papers in June-July of 2016. State law requires that the Department adopt final oil and gas exploration regulations by October 1, 2016. To meet this deadline, MDE will propose a revised set of regulations for public comment in advance of the October 1 deadline. The goal of these regulations is to protect public health, safety, and natural resources while avoiding unnecessary barriers to responsible development of the State's natural gas resources. Water quality monitoring will be an important part of ensuring that drilling standards are observed and water resources are maintained.

Maryland continues to meet its commitments to EPA and other stakeholders in developing Total Maximum Daily Loads for restoring impaired waters. However, to achieve its water quality goals, Maryland will have to find more effective ways to ramp up both restoration and protection efforts. The limiting factors for making restoration progress continue to be funding constraints and unsustainable growth patterns. The State's efforts to increase environmental funding as well as current efforts to better align monitoring and assessment programs through a coordinated state monitoring strategy will help to address these limiting factors. Meanwhile, new development in suburban and rural watersheds threatens the progress being made in other areas by creating new pollution sources. More sustainable development patterns, consistent with Smart Growth, will be needed if the State expects to reduce losses of open space and preserve water quality for future generations. To protect water quality, the State must continue to implement its antidegradation policy for high quality waters as well as develop clarifying guidance consistent with both water quality goals and the State's Smart Growth Initiative. To do this effectively, Maryland will have to work more closely with local jurisdictions and the public and be willing to face any associated legal challenges.

PART C: SURFACE WATER MONITORING AND ASSESSMENT

C.1 Monitoring Program

In December 2009, Maryland completed the last update of its comprehensive water monitoring strategy (http://www.mde.state.md.us/programs/ResearchCenter/EnvironmentalData/Documents/www.mde.state.md.us/assets/document/Maryland_Monitoring_Strategy2009.pdf). Maryland's water quality monitoring programs are designed to support State Water Quality Standards (Code of Maryland Regulations Title 26, Subtitle 08) for the protection of both human health and aquatic life. This strategy identifies the programs, processes and procedures that have been institutionalized to ensure state monitoring activities continue to meet defined programmatic goals and objectives. The strategy also discusses data management and quality assurance/quality control procedures implemented across the State to preserve data integrity and guarantee that data are of sufficient quality and quantity to meet the intended use. Finally, this document serves as a road map for assigning monitoring priorities and addressing gaps in current monitoring programs. It has proven to be especially useful during the recent recession as declining monitoring budgets have increased the need for greater monitoring efficiency.

C.2 Assessment Methodologies Overview

Starting in 2002, Maryland developed and solicited public review of the assessment methodologies used to document the State's assessment of its water quality standards (WQS) and which establish objective and statistically based approaches for determining water body impairment. These methodologies are designed to provide consistency and transparency in Integrated Reporting so that the public and other interested stakeholders understand how assessment decisions are made and can independently verify listing decisions. The assessment methodologies are living documents that can be revised as new statistical approaches, technologies, or other improved methods are identified. The public is invited to review and comment on any of these methodologies during the public review period for the Integrated Report.

For the 2016 reporting cycle, changes were made to the bacteria and toxics assessment methodologies. The only substantive change to the bacteria assessment methodology is in how it handles information on combined and sanitary sewer overflows. In the previous version of the bacteria assessment methodology, information on the number of sewage overflows of a minimum volume and frequency was used to list waters as impaired where bacteria data were not available. However, after careful consideration, the Department has determined that this assessment practice is not appropriate for 303(*d*) assessment purposes and does not add any value to the department's efforts to correct overflows. Therefore, this information will no longer be used for impairment determinations. The Department will continue to maintain a list of those waters that have multiple sewage overflows but will do so only within the text of this report rather than in Category 5. The rationale for this decision is explained in the full text of this methodology as provided below in Section C.2.1.

For the toxics assessment methodology, the most substantive changes were made to the procedure that the state uses for assessing water column data. Previously the Department used a minimum of 10 samples assessed according to the 10% rule to determine whether the aquatic life designated use was impaired. Both the acute and chronic criteria were assessed using this same method. The new procedures, which overwrite the previous, establish different assessment methods for acute and chronic criteria. Under the new procedures a water body is listed as impaired if the acute criterion is exceeded more than once over a three-year time span. Meanwhile the assessment of chronic criteria now requires the collection of additional samples so as to capture the 4-day average represented by the criterion. These changes align the new assessment methods with how the acute and chronic criteria for toxics were developed and ensure that the Department accurately identifies impairments where they exist. The full text of the toxics assessment methodology is provided below in Section C.2.2.

These and all other assessment methodologies are also available on MDE's Web site at http://www.mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/programs/waterprograms/tmdl/maryland%20303%20dlist/ir_listing_methodologies.aspx. The public is invited to review and provide comments on any of the assessment methodologies on this web page. All comments should be submitted in writing to Matthew Stover at matthew.stover@maryland.gov.

C.2.1 Assessment 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 90^{th} 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[3] to assessment categories on the Integrated Report.

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 <u>no evidence of actual bacteriological impairment</u> 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 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 are no oysters or clams to harvest 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 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

[3] 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.

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[4] 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

[4] 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.

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).
- 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://www.mde.state.md.us/programs/water/overflow/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.[5] 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.

Finally, it should be noted that there was no scientific basis, in the previous assessment methodology, for determining that an overflow of 30,000 gallons is 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. There was also no scientific basis for the specified frequency of 3 events over a 5 year period because, there again, without water quality data, little can be determined regarding the actual public health risk.

In closing, 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 have no impact to 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 effective.

References

National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. 2011 Revision. U.S. Food and Drug Administration. Accessed on August 27, 2013 at: http://www.fda.gov/downloads/Food/GuidanceRegulation/FederalStateFoodPrograms/UCM350344.pdf.

United States Environmental Protection Agency, Ambient Water Quality Criteria for Bacteria - 1986, Office of Water Regulations and Standards Criteria and Standards Division, Washington, DC 20460, EPA440/5-84-002, January 1986.

United States Environmental Protection Agency, National Beach Guidance and Required Performance Criteria for Grants, Office of Water (4305T), Washington, DC 20460, EPA-823-B-02-004, June 2002.

[5] 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.

C.2.2 Toxics Assessment Methodology

BACKGROUND

The designated uses define the water quality goals of a water body. 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)(2)). 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 water body to attain its designated use, while numeric criteria are concentration 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 (WET), 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.

INTRODUCTION

Under Section 303(d)(1) of the federal Clean Water Act (CWA), the MDE is required to establish Total Maximum Daily Loads (TMDLs) for those water body 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 water body segments impaired due to chemical contaminants. Even though the Department will adhere to these methods as closely as possible, there may be instances where our determinations may vary based on scientifically defensible decisions. It is important to note that there may be situations that do not support an impairment determination from chemical contaminants, but rather from another stressor (e.g. dissolved oxygen, pH), and would therefore be addressed elsewhere. This document provides the specific methodology used by MDE for identifying water body 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 water body segment should be classified as impaired due to chemical contaminants and listed on Category 5 of the Integrated Report. 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 programs of data providers, and will use best professional judgment to include/exclude data where documentation does not exist.

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):

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)

Surface waters used for public water supply (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)

The water column assessment methodologies using human health criteria and aquatic life criteria will be addressed separately below.

PROTECTION OF HUMAN HEALTH FROM FISH TISSUE CONSUMPTION, DRINKING WATER, AND FISH TISSUE CONSUMPTION PLUS DRINKING WATER

For the assessment of human health endpoints using water column data, EPA provided the following recommendation in the Consolidated Assessment and Listing Methodology (CALM 2002) guidance document:

"Water quality criteria to protect human health are generally based on protecting against long-term exposure to low concentrations of a toxic pollutant. When a chemical human health criterion is applied to water quality standards attainment decisions, EPA recommends evaluating comparing the mean (or geometric mean if appropriate for a skewed data set) of the measured concentrations with the criterion. However, some states have adopted human-health-based chemical criteria that establish instantaneous maximum concentrations, for which any exceedance constitutes nonattainment. If the mean or geometric mean exceeds the criterion, the WQS is not being attained."

Based on this guidance and the fact that Maryland's human health criteria have been developed to address long-term exposure scenarios, Maryland will compare a mean of water column data to the applicable human health criterion when making assessments for the Integrated Report. If the mean exceeds the applicable criterion, that water body will be listed as impaired on Category 5. To ensure that the mean is reflective of ongoing water quality conditions, Maryland will collect and assess a minimum of 10 samples collected over a representative temporal period and spatial extent.

AQUATIC LIFE

Aquatic life water quality criteria are composed of three components: magnitude, frequency and duration. USEPA (1985) provides guidance regarding the calculation of the magnitude component as well as the interpretation of the frequency and duration components of acute and chronic aquatic life criteria. The magnitude of acute criteria (also known as the Criteria Maximum Concentration or CMC) is not to be exceeded based on a one-hour average more than once every three years. When discussing the CMC duration component, USEPA (1985) states:

> *One hour is probably an appropriate averaging period because high concentrations of some materials can cause death in one to three hours. Even when organisms do not die within the first hour or so, it is not known how many might have died due to delayed effects of this short of an exposure. Thus it is not appropriate to allow concentrations above the CMC to exist for as long as one hour (page-5).*

Furthermore, the magnitude of chronic criteria (also known as the Criterion Continuous Concentration or CCC) is not to be exceeded based on a four-day average more than once every three years. When discussing the CCC duration component, USEPA (1985) states:

> *An averaging period of four days seems appropriate for use with the CCC for two reasons. First, it is substantially shorter than the 20 to 30 days that is obviously unacceptable. Second, for some species it appears that the results of chronic tests are due to the existence of a sensitive life stage at some time during the test, rather than being caused by either long-term stress or long-term accumulation of the test material in the organism. The existence of a sensitive life stage is probably the cause of acute-chronic ratios that are not much greater than*

1, and is also possible when the ratio is substantially greater than 1. In addition, some experimentally determined acute-chronic ratios are somewhat less than 1, possibly because prior exposure during the chronic test increased the resistance of the sensitive life stage. A four-day averaging period will probably prevent increased adverse effects on sensitive life stages by limiting the durations and magnitudes of exceedences of the CCC (page-5).

In regards to the frequency component of aquatic life criteria, USEPA (1985) states:

The abilities of ecosystems to recover differ greatly, and depend on the pollutant, the magnitude and duration of the exceedence, and the physical and biological features of the ecosystem. Documented studies of recoveries are few, but some systems recover from small stresses in six weeks whereas other systems take more than ten years to recover from severe stress. Although most exceedences are expected to be very small, larger exceedences will occur occasionally. Most aquatic ecosystems can probably recover from most exceedences in about three years.

The nationally recommended criteria frequency and duration components are summarized in the following table. Maryland's assessment of water quality for the protection of aquatic life will incorporate these recommendations.

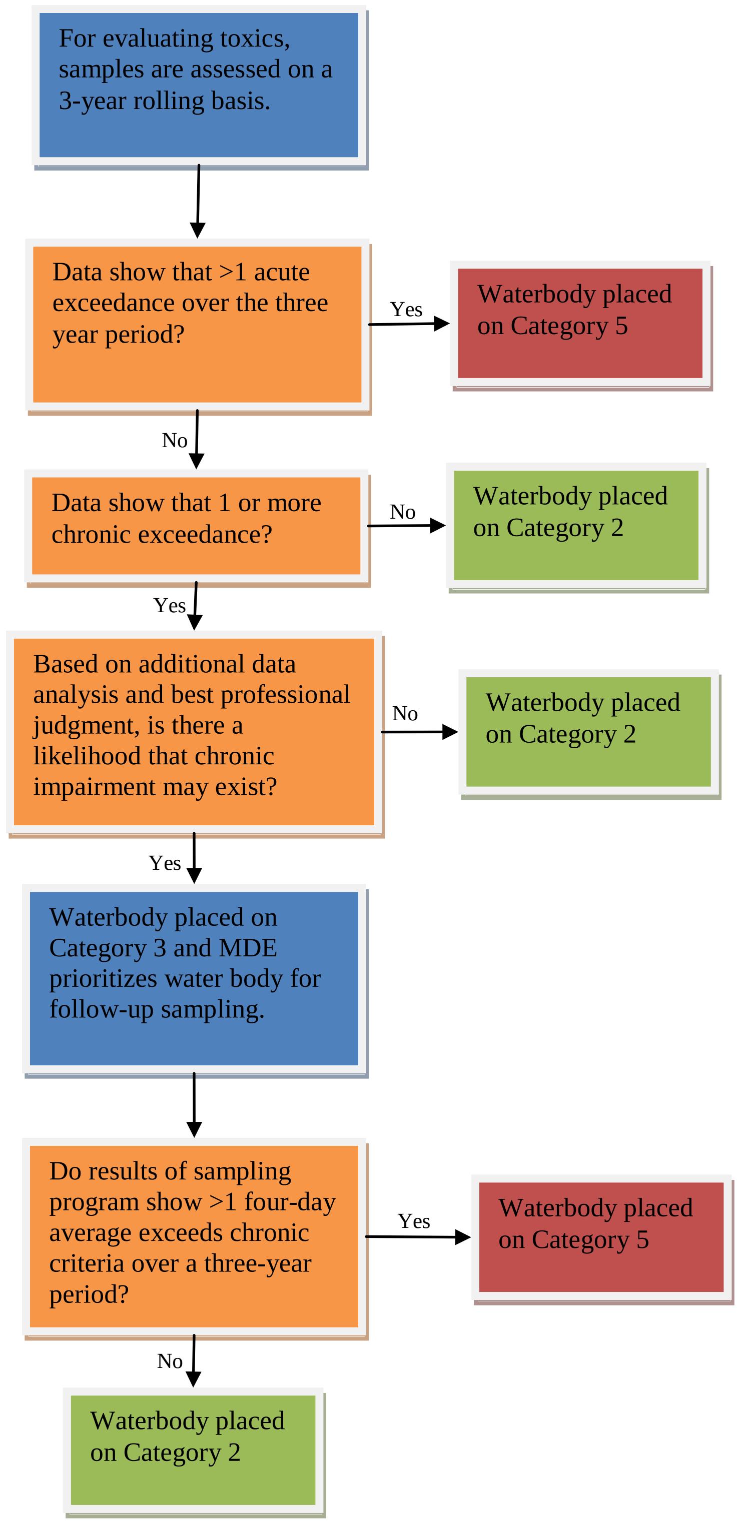
CRITERION	DURATION	FREQUENCY
ACUTE	1-HOUR AVERAGE	NOT TO BE EXCEEDED MORE THAN ONCE EVERY THREE YEARS
CHRONIC	4-DAY AVERAGE	

Assessment using Acute Aquatic Life Criteria

The duration component of acute aquatic life criteria is a one-hour average (USEPA 1985). The ambient concentrations of water chemistry parameters are unlikely to vary significantly during a one-hour period. Furthermore, taking multiple samples during a one-hour period to estimate a one-hour average is often not practicable. Therefore, MDE will consider one water column sample showing a pollutant concentration above the magnitude component of the associated acute water quality criterion to be an exceedance. The aquatic life designated use is not supported if >1 of the samples exceed the acute aquatic life criteria. As a general rule, Maryland will attempt to collect a minimum of 10 representative sampling events in a water body upon which to base an assessment. However, it should be noted that even with fewer than 10 samples, a water body will be listed as impaired on the Integrated Report if the acute aquatic life criterion is exceeded two or more times.

Assessment using Chronic Aquatic Life Criteria

The nationally recommended duration component of chronic aquatic life criteria is a four-day average (USEPA 1985). Unlike, the acute criteria, it is unlikely that a chronic exceedance can be identified using one sample because MDE cannot assume that one grab sample represents a four-day average. However, one or more grab samples showing a chronic exceedance may suggest that a chronic impairment is present. Therefore, MDE may perform additional statistical analysis on current data to determine the likelihood of a chronic exceedance. If MDE determines that a chronic exceedance may be present, then the waterbody will be placed on Category 3 and MDE will prioritize the water body for additional sampling efforts. The goal for such sampling efforts will consist of selecting 10 four-day periods over a 3-year time-span. For each four-day period, a minimum of 4 samples will be taken in order to calculate a four-day average. This will enable assessors to calculate 10 independent four-day averages. If >1 four-day period demonstrates an exceedance of the chronic criterion, then the waterbody will be placed on Category 5.


For evaluating toxics, samples are assessed on a 3-year rolling basis.
Data show that >1 acute exceedance over the three year period?
Yes
Waterbody placed on Category 5
No
Data show that 1 or more chronic exceedance?
No
Waterbody placed on Category 2
Yes
Based on additional data analysis and best professional judgment, is there a likelihood that chronic impairment may exist?
No
Waterbody placed on Category 2
Yes
Waterbody placed on Category 3 and MDE prioritizes water body for follow-up sampling.
Do results of sampling program show >1 four-day average exceeds chronic criteria over a three-year period?
Yes
Waterbody placed on Category 5
No
Waterbody placed on Category 2

<u>OTHER CONSIDERATIONS FOR WATER COLUMN ASSESSMENT</u>

In addition to the ambient water quality data itself, Maryland will consider other factors 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 in Category 3 (Insufficient data). The 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) may be 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.

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 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. 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).

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).

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.) see Appendix A. 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:

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[6] for any one contaminant, or

3. The mean ER-M quotient[7] 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[8] (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., AVS 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 exceedence(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 exceedence(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.

Biological Benthic Assessment Data

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

[6] 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.
[7] An ER-M quotient is calculated as the ambient sample concentration over the ER-M (toxicity weighted average).
[8] 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.

it measures a community (population) response to water quality and integrates through time and cumulative impacts. To determine toxicity for parameters without a water or sediment quality criterion, if these 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 water body may not be 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 by toxics (Anderson et al., 2001).

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, which 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. The table below lists possible conclusions that can be drawn from various sets of test results, followed by possible listing decisions.

Table 6: 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
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.	List (Part 3) Additional monitoring
7	+	-	+	Unmeasured chemical contaminants are causing degradation.	List (Part 3) 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 the table above, 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. <50 percent 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, will be captured by other decision rules.

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 a chemical contaminant(s) with no applicable chemical threshold or some unmeasured chemical contaminant. This scenario would require listing in Category 3 of the Integrated Report. 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, will be captured by other decision rules.

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) If the magnitude of any single indicator is overwhelmingly suggesting an impairment determination,
b) If 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 further testing 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.

FISH TISSUE

Section 101(a)(2) of the Clean Water Act established as a national goal the attainment of "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water." This is commonly referred to as the "fishable/swimmable" goal of the Act. Additionally, 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. Environmental Protection Agency (EPA), along with Maryland Department of the Environment (MDE), interprets these regulations to mean that not only should waters of the State support thriving and diverse fish and shellfish populations, but they should also support fish and shellfish which, when caught, are safe to consume by humans.

Some of the contaminants found in Maryland waters (mainly mercury and PCBs) tend to bioaccumulate to elevated levels in the tissues of gamefish (e.g. largemouth bass) and bottom-feeders (e.g. catfish). When tissue levels of a specific contaminant are elevated to increase the risk of chronic human health effects, the State has the responsibility to issue a fish consumption advisory. Fish consumption advisories are designed to protect the general as well as sensitive populations (i.e., young children; women who are or may become pregnant). In addition to such advisories, which stop at 4 meals per month, the Department provides fish consumption recommendations, which stop at 8 meals per month. These additional recommendations are issued in order to protect the frequent fish consumers.

It has been accepted that when a fish consumption advisory (not a recommendation) is issued for a waterbody, the designated use of that waterbody is not being supported. This usually results in listing a waterbody as impaired for the specific contaminant. To determine if a waterbody is impaired, a median of the contaminant level in the edible portion of a common recreational fish species is compared to the established threshold/criterion.[9] If the threshold/criterion is exceeded, the waterbody's designated use is not met, and the waterbody is listed as impaired. The existing fish tissue criteria are used as the listing thresholds (e.g. methylmercury fish tissue criterion: 300 ppb). For the contaminants that do not have an existing criterion (e.g. PCBs), MDE has defined "fishable" as the ability to consume AT LEAST 4 meals per month of common recreational fish species by a 76 kg individual. In such cases, the fish tissue concentration threshold used for impairment listing is the concentration that results in 4 meals per month advisory (see Contaminant Thresholds Section).

[9] Note: This median is calculated either from the analysis of individually run fish or from the results of multiple fish composites (e.g. 2 composites of 5 fish each) depending on how the fish tissue samples were analyzed. Sometimes for mercury samples, individual fish in a composite are analyzed separately while for PCBs, usually all of the fish in a composite are combined before analyzing.

Data Requirements

Data requirements for listing a waterbody as impaired are similar to the data requirements for issuing a fish consumption advisory. These include:

1. All available data should be reviewed when making impairment decisions.
2. Only data results taken from the part of the fish or shellfish typically consumed will be used for assessment purposes. Maryland publishes advisories based on concentrations found in fillets only; therefore, only data on fillets are to be considered for making impairment decisions. For shellfish, only the soft tissue portion will be considered.
3. The data needs to be collected from the specific waterbody in question.
4. The size of the fish sampled should be within the legal slot limit. If no slot limit exists for a specific species, best professional judgment for a minimum size of a given species will be applied.
5. Minimum data requirement: 5 fish (individual or composite of the same resident species) for a given waterbody. At times, in order to protect more sensitive populations MDE might issue an advisory that is based on an incomplete dataset (fewer than 5 fish of the same species), existence of such an advisory does not automatically result in an impairment listing. In other words, the minimum data requirement needs to be met in order to list a waterbody as impaired.
6. All fish that comprise a composite sample must be within the same size class, i.e., the smallest fish must be within seventy-five percent of the total length of the largest fish.
7. 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 tributaries of the Chesapeake Bay.
8. To ensure that the impairment is temporally relevant, impairments based on the minimum required samples should be re-sampled prior to TMDL development.

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 span, and for some contaminants, cooking loss.

Table 7: Concentration thresholds/criterion for the contaminants of concern.

Contaminant	Threshold/Criterion	Basis	Group
Mercury10	300 ppb (ng/g – wet weight)	EPA/MDE Fish Tissue Human Health Consumption	76 kg Individual

[10] Per EPA recommendation, total mercury concentrations, as opposed to methylmercury, will be used in MDE fish consumption risk-calculation. This approach is deemed to be most protective of human health and most cost-effective.

		Criteria	
PCBs	39.0 ppb (ng/g – wet weight)	4 meals/month concentration level	76 kg Individual

Over time, advances in science may require changes in risk assessment parameters that may increase or decrease the currently used contaminant thresholds, and consequently the levels at which impairment decisions are made. When this happens, waterbodies that were listed as impaired may no longer be considered impaired, or new waterbodies may need to be listed.

GEOGRAPHIC SCALE OF ASSESSMENT

Starting with the 2012 Integrated Report (IR), all water quality assessments will be georeferenced according to the real-world waters that they represent. In order to maintain consistency with respect to assessment scale, MDE has adopted the following protocols for specific toxics assessments.

Water Column and Sediment

Toxics data collected as part of a water column or sediment study will be assessed on a reasonable and flexible scale. In some cases, only a single location may have been sampled, while in others, samples may have been collected in transect. In either case, MDE will exercise best professional judgment in applying assessment results to a particular geographic area. Unique geographic and/or data scenarios require maximum flexibility to ensure that assessments are representative of a particular water body. For this reason, MDE will adapt it's water column and sediment toxics assessment scale to circumstances as necessary.

Fish Tissue

Fish tissue data are typically collected from the following three water body types: 4^{th} order or greater non-tidal rivers, impoundments, and estuarine segments. Since fish are mobile, MDE uses this data to assess appropriately sized expanses of water. For non-tidal rivers, MDE assigns the assessment result from a composite to the entire mainstem of the sampled stream up to the headwaters. Side tributaries to the mainstem are not included in the assessment as they do not always support gamefish in sufficient numbers or size to enable sampling. For impoundments, assessment results will only be applied to the polygonal area of the impoundment's surface. Fish tissue results will not be applied to any parts of the upstream watershed. Lastly, fish tissue data collected from estuarine waters will be used to assess only the tidal waters of the 8-digit watershed from which the fish were collected. Again, the assessment for a tidal water body will not be applied to any upstream waters, regardless of whether the upstream waters are tidal or not.

REFERENCES

Anderson, B.S., Hunt, J.W., Phillips, B.M, Fairey, R., Roberts, C.A., Oakden, J.M., Puckett, H.M., Stephenson, M., Tjeerdema, R.S., Long, E.R., Wilson C.J., and Lyons, J.M. 2001 Sediment Quality in Los Angeles Harbor, USA: A Triad Assessment. Environmental Toxicology and Chemistry, Vol. 20. No. 2, pp. 359-370.

Chapman, P.M. 1992. Sediment Quality Triad Approach. In: Sediment Classification Methods Compendium; EPA 823-R-92-006 Ch.10 pp. 10-1,10-18.

Federal Water Pollution Control Act. [As Amended Through P.L. 107-303, November 27, 2002]. Title I –Research and Related Programs, Declaration of Goals and Policy. Section 101(a).

US Environmental Protection Agency 1993a Sediment Quality Criteria for the Protection of Benthic Organisms: ACENAPHTHENE. EPA-822-R-93-013

US Environmental Protection Agency 1993b Sediment Quality Criteria for the Protection of Benthic Organisms: FLUORANTHENE. EPA-822-R-93-012

US Environmental Protection Agency 1993c Sediment Quality Criteria for the Protection of Benthic Organisms: PHENANTHRENE. EPA-822-R-93-014

US Environmental Protection Agency 1993d Sediment Quality Criteria for the Protection of Benthic Organisms: DIELDRIN. EPA-822-R-93-015

US Environmental Protection Agency 1993e Sediment Quality Criteria for the Protection of Benthic Organisms: ENDRIN. EPA-822-R-93-016

US Environmental Protection Agency 1996. The National Sediment Quality Survey: A Report to Congress on the Extent and Severity of Sediment Contamination in Surface Waters of the United States. EPA-823-D-96-002.

US Environmental Protection Agency 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates. EPA-841-B-97-002A and EPA-841-B-97-002B. Volume II Section 3 Making Use Determinations. pp. 3-22.

US Environmental Protection Agency 2000. Memorandum from Geoffrey Grubs and Robert Wayland. EPA's recommendations on the use of fish and shellfish consumption advisories in determining attainment of water quality standards and listing impaired waterbodies under section 303(d) of the Clean Water Act (CWA).

US Environmental Protection Agency 2000. Draft Implementation Framework For The Use Of Equilibrium Partitioning Sediment Guidelines. Guidance for using Equilibrium

Partitioning Sediment Guidelines in water quality programs. United States Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC

Long, E.R. and Morgan, L.G. 1990. The potential for biological effects of sediment sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, Washington

Long, E.R., MacDonald, D.D., Smith, S.L., and Calder, F.D. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19, 1, 81-97.

Long, E.R. and MacDonald, D.D. 1998. Recommended Uses of Empirically Derived, Sediment Quality Guidelines for Marine and Estuarine Ecosystems. Human and Ecological Risk Assessment; Vol. 4, No. 5, pp. 1019-1039.

Long, E.R., MacDonald, D.D., Severn, C.G., and Hong. C.B. 2000. Classifying Probabilities of Acute Toxicity in Marine Sediments with Empirically Derived Sediment Quality Guidelines. Environmental Toxicology and Chemistry, Vol. 19, No. 10, pp. 2598-2601.

MDNR-Maryland Department of Natural Resources, 2000. 2000 Maryland Section 305(b) Water Quality Report.

Ingersoll C.G., Dillon T and Biddinger G.R. 1997. Ecological Risk Assessment of Contaminated Sediments. SETAC Press. Chapter 7.

Winger, P.V., Lasier, P.J., and Bogenrieder, K.J. 2001. Combined Use of Rapid Bioassessment Protocols and Sediment Quality Triad to Assess Steam Quality. SETAC Nashville, TN, Poster Presentation. USGS Patuxent Wildlife Research Center, Georgia

Appendix A: Table of Sediment Screening Values.

Contaminant	*Sediment Screening Values (ppb)*		
	EPA SQCs	*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*	

C.3 Assessment Results

Maryland assesses state waters using data generated by both long-term ongoing monitoring programs as well as short-term targeted monitoring efforts. These monitoring programs predominantly sample three water body types (flowing waters, impoundments, and estuarine waters) found throughout Maryland and collect water quality samples for both conventional and toxic pollutants. Although many assessments are still based on data collected by state agencies, the Department continues to make greater use of data collected by Federal agencies, County governments, utility managers, and nongovernmental organizations (NGO). Using datasets from such organizations can help to fill data gaps and create valuable partnerships for meeting clean water goals. The following sections provide assessment summaries for the whole state as well as for particular water body types found throughout the Maryland.

C.3.1 Assessment Summary

The following table summarizes the water quality status of all of Maryland's waters. It should be noted that it represents a conservative estimate for the size of waters assigned to each Category, defaulting to the Categories that symbolize impairment (4a, 4b, 4c, or 5) when a single water body has been assessed for multiple pollutants and is impaired for at least one. The reader is cautioned against using these numbers to track statewide progress with respect to water quality between the periods of 2008-2010 and 2012 on. Beginning with the 2012 IR, Maryland used the 1:24,000 scale National Hydrography Dataset (NHD) to calculate water body sizes.[11] In contrast, the water body sizes used for the 2008 and 2010 IR cycles were calculated using the 1:100,000 scale NHD coverage. This, by itself, causes discrepancies in the total stream miles, estuarine square mileage, and impoundment acreage represented. In addition, in some cases, the water body size reported in Category 1 or 2 (unimpaired status) can increase or decrease cycle to cycle simply because assessments were corrected or made with better data and instrumentation. Other useful water quality tracking information can be found at Maryland's BayStat Program website (http://www.baystat.maryland.gov/) which provides information not only for water quality tracking but also information and progress related to water quality implementation.

[11] Although converting to the 1:24,000 scale NHD made it harder to track progress between IR cycles, the benefits of a higher resolution stream scale enable greater mapping capabilities and increased geographic precision.

Table 8: Size of Surface Waters Assigned to Reporting Categories.

Waterbody Type	Category							Total in State	Total Assessed
	1	2	3	4a	4b	4c	5		
River/stream miles	0	6489.17	2294.90	4512.21	0	0	5843.85	19,185.29	16,845.23
Lake/pond acres	0	1201.83	531.04	13606.52	0	0	4684.43	21,876.08	19,492.78
Estuarine square miles	0	0	44.32	846.63	0	0	1565.80	2,456.74	2,412.42
Ocean square miles	0	0	107.39	0	0	0	0	107.39	0.00
Freshwater wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tidal wetland acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*Maryland utilizes a multi-category report structure for the IR which can potentially report a single water body in multiple listing categories. For the purposes of this table, water body sizes were not double-counted. If a water body was listed in Category 5 for one pollutant and Category 2 for another, the water body size was assigned to Category 5 to represent a worst-case scenario. In the case where a water body was listed in Categories 4a, 4b, and 4c for different pollutants, the water body size defaulted to Category 4a.

C.3.1.1 New Impairment Listings

There are 16 additions to the list of Category 5 (impaired, TMDL needed) waters in 2016. Nine of the new Category 5 listings resulted from MDE's Biological Stressor Identification Analyses. The purpose of these analyses, as discussed in the Biological Assessment Methodology for Non-tidal Streams, is to identify the probable pollutants that are responsible for impairing watershed biological integrity. Of these nine new 'biostressor' listings, four are for total suspended solids, three are for sulfates, and two are for chlorides. In addition, there are four new PCB listings for fish tissue, and three new fecal coliform listings in shellfish harvesting waters. Table 9 below provides more detailed information regarding these new listings.

Table 9: New Category 5 (impaired, may need a TMDL) Listings on the 2016 Integrated Report.

Assesment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-02140109	Port Tobacco River	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02140203	Piscataway Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-CHOMH1-Black_Walnut_Cove	Lower Choptank River	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-POTMH-Cuckold_Creek	POTMH - Lower Potomac River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-TANMH-Big_Thorofare	TANMH - Tangier Sound Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform

Assesment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-PAXTF	PAXTF - Middle Patuxent River Tidal Fresh	Chesapeake Bay segment	Fishing	PCB in Fish Tissue
MD-02130904-Mainstem_upper	Jones Falls	River Mainstem	Fishing	PCB in Fish Tissue
MD-02130905-Mainstem	Gwynns Falls	River Mainstem	Fishing	PCB in Fish Tissue
MD-GUNOH-Seneca_Creek	Gunpowder River	Tidal subsegment	Fishing	PCB in Fish Tissue
MD-02140503	Marsh Run	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02140109	Port Tobacco River	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-05020203	Deep Creek Lake	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02130305	Nanticoke River	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02140203	Piscataway Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02140109	Port Tobacco River	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02140503	Marsh Run	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)

There are 3 assessment records which were placed directly in Category 4 (impaired, TMDL not needed[12]) in the 2016 IR without first being listed as impaired in Category 5 (impaired, TMDL needed). Two of these assessment records, placed in Category 4a, resulted from the approval of the Coastal Bays TMDLs which identified phosphorus as a significant pollutant impacting water quality in these waters. The third assessment record, based on a Biological Stressor Identification analysis, identified channelization of streams as a major stressor impacting biological communities in the Nanticoke River watershed (Category 4c – impaired, pollution not caused by a pollutant).

[12] Category 4 includes 4a (impaired, TMDL completed), 4b (impaired, TMDL not needed because a technological solution initiated), and 4c (impaired, TMDL not needed because the pollution is not caused by a pollutant).

Table 10: Listings that were put directly in a Category 4 impairment status without being previously listed in Category 5.

Assessment Unit	Basin Name	Basin Code	Water Type	Designated Use	Listing Category	Pollutant	Notes
MD-02130105-T-NEWPORT_BAY	Newport Bay	02130105	ESTUARY	Aquatic Life and Wildlife	4a	Phosphorus (Total)	Data collected to support TMDL development in the Newport Bay watershed led to the identification of phosphorus as a significant pollutant in the mainstem portion of Newport Bay.
MD-02130105-T-NEWPORT_CREEK	Newport Bay	02130105	ESTUARY	Aquatic Life and Wildlife	4a	Phosphorus (Total)	Data collected to support TMDL development in the Newport Bay watershed led to the identification of phosphorus as a significant pollutant in Newport Creek.
MD-02130305	Nanticoke River	02130305	RIVER	Aquatic Life and Wildlife	4c	Channelizatio n	The Biostressor analysis indicated that stream channelization due to agricultural ditching is a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.

One unusual scenario that can occur with Maryland's Integrated Report (IR) assessments is when water body-pollutant combinations change impairment status multiple times over the course of several IR cycles. In order to promote transparency, the Department highlights (in this paragraph and subsequent table) those particular scenarios where a water body-pollutant combination goes from Category 2 back to an impaired Category (Categories 4 or 5). This scenario often occurs with water bodies that approach or just barely exceed the threshold for impairment and seems to happen most often with shellfish harvesting area assessments.[13] In 2016, there were 2 assessment records that moved from Category 2 (not impaired) back to Category 4a (impaired, TMDL completed) on the basis of new data. Both of these assessment records were previously listed as impaired on some prior Integrated Report (IR) cycle, had a TMDL completed, and were then delisted (moved to Category 2) on a subsequent IR. For the 2016 IR, these waters were reassessed using new water quality data which demonstrated exceedance of water quality criteria. And, since a TMDL has already been established for this water body-pollution combination, the assessment record has been placed back into Category 4a. These 'relistings', as they are commonly called, are captured in Table 11.

[13] MDE staff believe shellfish harvesting area assessments are one of the most volatile because the indicator used (fecal coliform) is subject to a high degree of variability and natural sources (e.g. waterfowl) can have significant affect on levels.

Table 11: Summary of records that have had an assessment result that went from impaired to not-impaired and then back to impaired over the course of several Integrated Reporting cycles.

Assessment Unit ID	Basin Name	Basin Code	Water Type Detail	Designated Use	IR Category	Cause	Notes
MD-CHOMH2-Whitehall_Creek	Lower Choptank River	02130403	Tidal Shellfish Area	Shellfishing	4a	Fecal Coliform	TMDL completed in 2006.
MD-RHDMH-Bear_Neck_Creek	RHDMH - Rhode River Mesohaline	02131004	Tidal Shellfish Area	Shellfishing	4a	Fecal Coliform	New data shows this area is now exceeding the shellfish harvesting area criteria. A TMDL was previously completed in 2006.

Several other impairment 'relistings' also occurred but on a more limited spatial scale. In the following instances, each water body-pollutant combination shown on the 2014 IR was reassessed at a finer spatial scale on the 2016 IR. The reassessment for each revealed that some portion of the original water body remained unimpaired while another portion now exceeded water quality criteria. As a result, the assessment record for the original water body-pollutant combination was split so as to characterize the change in impairment status at different spatial scales. The table below describes the listing Category changes and assessment record split that occurred in the case of Carthagena and Tar Creek.

Table 12: Crosswalk table showing how the original assessment unit was split in the case of Carthagena Creek and Tar Creek.

Former (2014) Assessment Unit ID	Basin Code	Designated Use	Pollutant	Category	New (2016) Split Assessment Unit ID	2016 Category	Rationale
MD-POTMH-Carthagena_Creek	02140103	Shellfish	Fecal Coliform	2	MD-POTMH-Carthagena_Creek1	2	TMDL approved in 2005. However, recent data shows that the downstream portion of this creek meets the shellfish bacteria water quality standards.
					MD-POTMH-Carthagena_Creek2	4a	TMDL approved in 2005. Recent data shows the upstream portion of Carthagena Creek as exceeding the shellfish harvesting area criteria.
MD-CHOMH1-Tar_Creek	02130403	Shellfish	Fecal Coliform	2	MD-CHOMH1-Tar_Creek-1	2	TMDL approved in 2005. However, this downstream portion of Tar Creek continues to meet the shellfish harvesting water quality criteria.
					MD-CHOMH1-Tar_Creek-2	4a	TMDL was previously completed for this area. Newer data shows this smaller portion of Tar Creek as failing to meet the shellfish harvesting criteria.

C.3.1.2 Impairment Listings Reassessed as Not-impaired

There were a total of eleven waterbody-pollutant combinations removed[14] from Category 5 in 2016 (Table 13). Four of these were generic biological listings (cause unknown) that did not specify a particular pollutant or stressor as the cause of impairment. These listings have now been replaced by specific pollutant/stressor listings enumerated by the Biological Stressor Identification analyses (Table 33).

Four other delistings resulted from reassessments using newer data and one resulted from a Water Quality Analysis (WQA). New assessments or reassessments are simply an analysis of more recent water quality data collected by ongoing monitoring and assessment programs. WQAs are completed when State scientists collect detailed information for a listed water body in anticipation of a TMDL and find that the water body is not impaired.

The final two delistings (of 11) were the result of uncommon scenarios occurring with previous shellfish harvesting assessments. The first one, Daugherty Creek (MD-TANMH-Daugherty_Creek) was removed from the Integrated Report because it was discovered that it was originally listed in error. In this case, Daugherty Creek was administratively closed and will remain closed (or restricted) due to its proximity to the Crisfield wastewater treatment plant (WWTP). The Department has a long-standing policy to close or restrict shellfish harvesting near WWTPs so as to protect public health in the case of a plant malfunction. According to Maryland's Bacterial Assessment Methodology, Maryland will not list these waters since shellfish harvesting is not permitted in these areas and the restricted status is due to location rather than water quality. As a result, the Daugherty Creek assessment record was removed from the Integrated Report.

The second unusual delisting scenario occurred with Wells Cove (MD-PAXMH-Wells_Cove). Wells Cove had previously been considered as a potential location for an aquaculture operation and was therefore monitored as part of standard MDE protocol. The aquaculture business owner eventually pursued another site for their operation and, as result; this site no longer required monitoring. Since Wells Cove does not contain wild harvestable shellfish and does not support an aquaculture operation, it is inappropriate to continue monitoring and assess for the shellfish harvesting use. For these reasons, this listing has been removed from the Integrated Report.

[14] The number eleven does not include partial delistings (Table 15), listings that were addressed by a TMDL (moved to Category 4a, Table 37), or listings that were in Categories 4a, 4b, or 4c but which are now meeting standards (Tables 16, 17, and 19).

Table 13: New Delistings for 2016 (removed from Category 5).

ID	Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Pollutant	Summary Rationale for Delisting of Segment-Pollutant Combinations*
1812	MD-021410020107-Rocky_Gap_Run	Evitts Creek	02141002	RIVER	Aquatic Life and Wildlife	pH, Low	1
2030	MD-02140304-Big_Pipe_Creek	Double Pipe Creek	02140304	RIVER	Fishing	PCB in Fish Tissue	1
2078	MD-021311070941-Rocky_Gorge_Reservoir	Rocky Gorge Dam	02131107	IMPOUNDMENT	Fishing	Mercury in Fish Tissue	1
2231	MD-CHOMH1-San_Domingo_Creek_mainstem	Lower Choptank River	02130403	ESTUARY	Shellfishing	Fecal Coliform	1
2232	MD-LCHMH-Little_Choptank_River	LCHMH - Little Choptank River Mesohaline	02130402	ESTUARY	Shellfishing	Fecal Coliform	1
923	MD-02130305	Nanticoke River	02130305	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
936	MD-02140203	Piscataway Creek	02140203	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
951	MD-02140503	Marsh Run	02140503	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1058	MD-02140109	Port Tobacco River	02140109	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
2076	MD-PAXMH-WELLS_COVE	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Shellfishing	Fecal Coliform	2
2235	MD-TANMH-Daugherty_Creek	TANMH - Tangier Sound Mesohaline	02130206	ESTUARY	Shellfishing	Fecal Coliform	2

*This table does not include waterbody-pollutant combinations for which a TMDL was established, i.e., listings that changed from Category 5 to Category 4a.

Table 14: Key for the last column in Table 13.

*Summary Rationale for Delisting of Segment/Pollutant Combinations	Explanation
1	State determines water quality standard is being met
2	Flaws in original listing
3	Other point source or nonpoint source controls are expected to meet water quality standards
4	Impairment due to non-pollutant
5	Original listing was based on a bioassessment, specific pollutants are now identified in place of biological listing

It is worth noting that there was one partial delisting in the 2016 IR that was not counted as part of the 11 'whole' delistings mentioned above and in Table 13. A partial delisting can occur in cases where an assessment unit that was previously entirely listed as impaired had new data that demonstrated use support in some smaller geographic portion. In order to reflect this new information and the fact that a portion of these waters now meets standards, MDE may split the original assessment unit into two assessment units, one which is still impaired and another that is not. Table 15 below shows the one instance in 2016 where this occurred. This partial delisting was not counted as one of the 11 total delistings since it did not have any effect on the total number of Category 5 listings. However, the impact of this delisting is reflected in the summary numbers (e.g. Tables 8, 22, etc) that describe the size of waters impaired for various pollutants.

Table 15: Crosswalk table showing the Partial Delisting of Broad Creek in 2016 (Category 5 to Category 2).

Former (2014) Assessment Unit ID	Basin Code	Designated Use	Pollutant	2014 Category	New (2016) Split Assessment Unit ID	2016 Category	Rationale
MD-CHOMH1-Broad_Creek	02130403	Shellfishing	Fecal Coliform	5	MD-CHOMH1-Broad_Creek-1	5	The impaired portion of Broad Creek is now only listed as the headwaters.
					MD-CHOMH1-Broad_Creek-2	2	New data shows that the downstream portion of Broad Creek meets shellfish harvesting area criteria.

Another subset of whole listings/geographic areas that are now no longer considered impaired include two that were previously (2014) in Category 4a (impaired, TMDL completed) and one that was in Category 4b (impaired, TMDL not needed as other pollution control requirements have been initiated). In all three cases new assessment data demonstrated that water quality criteria were being met and consequently resulted in these assessment records being moved to Category 2 (meeting some standards).

Table 16: Whole Listings that moved from Category 4a (impaired, TMDL complete) or Category 4b (impaired, technological solution initiated) to Category 2 (meeting some standards).

Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	2014 Category	2016 Category	Cause
MD-CHSTF	CHSTF - Upper Chester River Tidal Fresh	02130510	ESTUARY	Aquatic Life and Wildlife	4a	2	Total Suspended Solids (TSS)
MD-CHOMH1-San_Domingo_Creek_NW_Branch	Lower Choptank River	02130403	ESTUARY	Shellfishing	4a	2	Fecal Coliform
MD-PATMH-Erachem-001	PATMH – Patapsco River Mesohaline	02130903	ESTUARY	Aquatic Life and Wildlife	4b	2	Copper

There were also two partial removals of Category 4a impairment (TMDL completed) listings on the 2016 IR. These partial removals resulted from shellfish harvesting areas that were previously assessed as impaired (and had a TMDL completed) and which subsequently had new data which demonstrated that a portion of the water body was meeting water quality criteria.

Table 17: Crosswalk table showing the Partial Delisting of St. Inigoes Creek and Nanticoke River in 2016 (Category 4a to Category 2)

Former (2014) Assessment Unit ID	Basin Code	Designated Use	Pollutant	Category	New (2016) Split Assessment Unit ID	2016 Category	Rationale
MD-POTMH-St.Inigoes_Creek	02140103	Shellfishing	Fecal Coliform	4a	MD-POTMH-St.Inigoes_Creek-1	4a	The upstream area of St. Inigoes Creek is still exceeding the shellfish harvesting area criteria.
					MD-POTMH-St.Inigoes_Creek-2	2	Recent data shows that the shellfish harvesting criteria are being met in the middle portion of St. Inigoes Creek.
					MD-POTMH-St.Inigoes_Creek-3	4a	This downstream embayment within St. Inigoes Creek is still restricted to shellfish harvesting.
MD-NANMH-Nanticoke_River	02130305	Shellfishing	Fecal Coliform	4a	MD-NANMH-Nanticoke_River-1	4a	This shellfish harvesting area was split in the 2016 IR because two stations are now meeting the shellfish harvesting criteria. This listing record still captures the remaining impaired portion of the Nanticoke River.
					MD-NANMH-Nanticoke_River-2	2	This portion of the previous fecal coliform listing for the Nanticoke River was separated because two stations (1405144A and 1405144B) are now meeting the shellfish harvesting criteria. This listing captures the area

Former (2014) Assessment Unit ID	Basin Code	Designated Use	Pollutant	Category	New (2016) Split Assessment Unit ID	2016 Category	Rationale
							represented by those two stations.

One final small subset of impairment removals (that were not named in any of the previous tables) that simultaneously resulted in two assessment units being split is shown in Tables 18 and 19 below. This unique scenario happened due to the reassessment of two Category 4b (impaired, technological solution to be implemented) listings in the tidal portion of the Patuxent River (PAXMH). These assessment records were originally added to the 2002 IR due to the oil spill on April 7, 2000 at the Chalk Point Power Plant in Prince George's County. A long term monitoring system was undertaken to determine the impact of the oil spill over time after all feasible cleanup activities were completed. A part of this monitoring system continues today in the form of a qualitative survey which assesses the presence/absence of oil in the shoreline areas near the site of the original spill. When a survey determines that no residual oil is present, that particular shoreline segment is removed from the impaired part of the list (in this case Category 4b).

Originally, the listings for impacts from the oil spill were consolidated in only a few assessment records (Table 18). To better characterize the spatial extent of these shoreline areas, these listings were split out into the 7 current assessment records (Table 19). At the same time, recent survey data demonstrated that the areas within Cremona and Washington Creeks no longer had residual oil and were thus moved from Category 4b to Category 2 (not impaired). The State will continue the qualitative monitoring survey to document the remaining impacted areas and to identify those areas that are no longer impacted.

Table 18: Category 4b listings in the tidal Patuxent River (PAXMH) from the 2014 Integrated Report.

ID	Assessment Unit ID	Basin Name	Basin Code	Designated Use	Listing Category	Cause	Notes
740	MD-PAXMH-OIL_SPILL1	PAXMH - Lower Patuxent River Mesohaline	02131101	Aquatic Life and Wildlife	4b	Oil spill - PAHs	Listed due to the April 7th, 2000 PEPCO oil spill. Only those segments which have not met Phase I or Phase II clean-up status are considered impaired. Includes Swanson,Washington, Trent Hall, Persimmon, Indian, and Cremona Creeks.
747	MD-PAXMH-OIL_SPILL2	PAXMH - Lower Patuxent River Mesohaline	02131101	Aquatic Life and Wildlife	4b	Oil spill - PAHs	Listed due to the April 7th, 2000 PEPCO oil spill. Only those segments which have not met Phase I or Phase II clean-up status are considered impaired. Includes Craney Creek and Buena Vista.

Table 19: The resultant (2016 Integrated Report) listings caused by splitting the Category 4b listings in PAXMH and from reassessing new ambient water quality data.

ID	Assessment Unit	Waterbody Name	Basin Name	Basin Code	Water Type	Designated Use	Listing Category	Cause	Notes
2618	MD-PAXMH-Cremona_Creek	Cremona Creek Segment W10	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	2	Oil Spill - PAHs	Cremona Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Originally listed due to the April 7th, 2000 PEPCO oil spill. Has now met Phase I and Phase II clean-up criteria.
2617	MD-PAXMH-Persimmon_Creek	Persimmon Creek Segment W9	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	4b	Oil Spill - PAHs	Listing for Persimmon Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Impairment due to the April 7th, 2000 PEPCO oil spill. Only segments which have not met Phase I or Phase II clean-up status are considered impaired.
2616	MD-PAXMH-Washington_Creek	Washington Creek Segment W8	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	2	Oil Spill - PAHs	Washington Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Originally listed due to the April 7th, 2000 PEPCO oil spill. Has now met Phase I and Phase II clean-up criteria.
2615	MD-PAXMH-TRENT_HALL_CREEK	Trent Hall Creek Segment W7	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	4b	Oil Spill - PAHs	Listing for Trent Hall Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Impairment due to the April 7th, 2000 PEPCO oil spill. Only segments which have not met Phase I or Phase II clean-up status are considered impaired.
2614	MD-PAXMH-INDIAN_CREEK	Indian Creek Segment W5	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	4b	Oil Spill - PAHs	Listing for Indian Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Impairment due to the April 7th, 2000 PEPCO oil spill. Only segments which have not met Phase I or Phase II clean-up status are considered impaired.

ID	Assessment Unit	Waterbody Name	Basin Name	Basin Code	Water Type	Designated Use	Listing Category	Cause	Notes
2613	MD-PAXMH-Swanson_Creek	Swanson Creek Segments W1 and W2	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	4b	Oil Spill - PAHs	Listing for Swanson Creek split out from previous MD-PAXMH-Oil_Spill1 assessment unit. Impairment due to the April 7th, 2000 PEPCO oil spill. Only segments which have not met Phase I or Phase II clean-up status are considered impaired.
747	MD-PAXMH-Ramsey_Creek	Ramsey Creek Segment E2	PAXMH - Lower Patuxent River Mesohaline	02131101	ESTUARY	Aquatic Life and Wildlife	4b	Oil Spill - PAHs	Spatial scale corrected to show Ramsey Creek area. Listed due to the April 7th, 2000 PEPCO oil spill. Only segments which have not met Phase I or Phase II clean-up status are considered impaired.

C.3.1.3 Split and Aggregated Water Body Segments with no Categorical Change

As discussed previously, the State has split or aggregated water bodies/assessment units where data and information are supportive. Assessment records are most often split when newer data demonstrate differences in water quality status at refined spatial scales. However, this is not the only reason. Assessment records may also be split to accommodate specific monitoring, assessment, management, and/or modeling scales. An example of this occurred with the Lower Patuxent River-PCB in fish tissue assessment. Previously, the state assessed this area as one large assessment unit. However, the Department made the decision moving forward to break this assessment unit into two parts according to salinity region so as to have better resolution in the assessment scale and to facilitate future water quality modeling. In this particular case, additional data was also collected to support the water quality assessment for each new unique assessment unit (See table below).

Table 20: Crosswalk table showing how the Lower Patuxent River PCB listing was split in the 2016 IR.

Former (2014) Assessment Unit ID	Basin Code	Designated Use	Pollutant	2014 Category	New (2016) Split Assessment Unit ID	Basin Name	2016 Category
MD-PAXMH-OH-02131101	02131101	Fishing	PCB in Fish Tissue	5	MD-PAXOH	Lower Patuxent River Oligohaline	5
					MD-PAXMH	Lower Patuxent River Mesohaline	5

There were also two assessment units aggregated on the 2016 IR. Ayer Creek and Kitts Branch, previously separate listings for two different pollutants (total nitrogen and biochemical oxygen demand) on the 2014 IR, were aggregated into one assessment unit so as to be consistent with modeling scale used for the respective TMDL approved in 2014. At the same time, the previously established TMDLs for Ayer Creek (total nitrogen) and Kitts Branch (BOD) were superseded by the new TMDLs for total nitrogen and total phosphorus). The table below illustrates this listing scale change.

Table 21: Crosswalk table showing the change in pollutant and the spatial aggregation of Ayer Creek and Kitts Branch in the 2016 IR.

Former (2014) Assessment Unit ID	Basin Code	Designated Use	2014 Pollutants	2014 Category	New (2016) Aggregate Assessment Unit ID	2016 Pollutants	2016 Category
MD-02130105-T-AYER_CREEK	02130105	Aquatic Life and Wildlife	Nitrogen (Total)	4a	MD-02130105-T-AyerCreek_and_KittsBranch	Nitrogen (Total)	4a
MD-02130105-T-KITTS_BRANCH	02130105	Aquatic Life and Wildlife	BOD, Biochemical oxygen demand	4a	MD-02130105-T-AyerCreek_and_KittsBranch	Phosphorus (Total)	4a

C.3.2 Estuarine Assessments

This section provides assessment results and water quality summaries for Maryland's estuarine systems that include both the Chesapeake and Coastal Bays. The Chesapeake Bay assessments continue to evolve as new criteria and assessment methodologies are implemented and as Maryland utilizes the newer salinity-based segmentation. Comparatively, the Coastal Bays fall behind the Chesapeake in terms of public awareness and resource allocation for monitoring and assessment activities. However, the completion and approval of TMDLs for all of Maryland's Coastal Bays does represent significant progress towards improving water quality. For additional details on Chesapeake Bay assessments, please see http://www.mde.maryland.gov/assets/document/2008%20Ambient%20Water%20Criteria.pdf. For additional information on Maryland's Coastal Bays, please visit http://www.mdcoastalbays.org/.

Tables 22 and 23 show the size of estuarine waters assigned to each category for each pollutant. For the 2016 cycle, these numbers were calculated in the same fashion as they were for the 2014 cycle. For nutrient listings, the entire size of a Chesapeake Bay segment was assigned to one category, defaulting to the least desirable category (in this order, 5, 4a, 3, 2, 1). In other words, regardless of the magnitude of impairment for that segment, a segment's whole size will be reported in Category 5 for nutrients (TP or TN) if any percentage of the segment fails to meet the applicable water quality criterion.

Table 22: Square mileage of estuarine waters assigned to categories according to the pollutant assessed.

Size of Estuarine Area (sq. miles) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Arsenic		35.43					
BOD, Biochemical oxygen demand				32.26			
Cadmium		85.68					
Chlordane		0.09		36.99			
Chlorpyrifos		48.73					
Chromium		79.00					
Copper		94.83					
Copper* (Point Source)		*3			*1		
Cyanide* (Point Source)					*3		
Debris/Floatables/Trash				0.09			
Estuarine Bioassessments		938.50	213.52				1188.69
Enteroccoccus				0.69			4.27
Fecal coliform		129.64		50.17			29.32
Heptachlor Epoxide							0.09
Lead		87.59					1.30
Mercury in Fish Tissue		324.91	83.12				
Nickel		38.79					
Nickel* (Point Source)		*5					
Nitrogen (Total)			82.30	2368.92			
Oil spill - PAHs		0.30			1.03		
PCBs		61.99	86.52	473.10			448.09

Size of Estuarine Area (sq. miles) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Phosphorus (Total)			82.30	2368.90			
Selenium		34.50					
Silver		35.43					
Total Suspended Solids (TSS)**		150.90	151.66	380.39			
Toxics							2.00
Zinc		47.89					16.87

Point* - These listings are remnants of the 304(L) list and were originally listed due to the presence of point sources. Thus these listings have no associated sizes and the values are the number of point sources.
**The total size of areas assessed for TSS do not total the area assessed for the Shallow Water designated use (DU) due to TSS listings for the aquatic life designated uses.

Table 23: Size of Estuarine Waters in Linear Distance per Category According to Pollutant.

Size of Estuarine Linear Distance (shoreline distance in miles) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Debris/Floatables/Trash				9.50			
Enterococcus		1.27	0.20	0.22			
Fecal coliform		0.01					

Table 24 depicts the status of estuarine waters with respect to different designated uses. Similar to Table 8, the numbers provided for the open water, deep water, and deep channel designated uses are calculated using a binary method. Instead of calculating the percent-area-impaired using data supplied with the dissolved oxygen assessments, Maryland used the 'impaired or not' approach to determine the column in which a water-segment's size should be placed. This approach simplifies the calculations and improves general understanding of the geographic scope of impairment.

Table 24: Designated Use Support Summary for Maryland's Estuarine Waters.

Designated Use		Size of Estuarine Waters (square miles)				
		State Total	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife		2,451.2	2,260.3	912.8	1,347.5	190.9
Fishing		2,451.2	983.2	61.99	921.185	1,468.0
Water Contact Recreation	General Recreational Waters	2,451.2	6.4	1.4	4.963	2,444.8
	Public Beaches*	146	146	146		0
Shellfish Harvesting		2,136.2	2,136.2	2,056.7	79.5	0
Migratory Spawning and Nursery**		1,338.8	1,256.5	0	1,256.5	82.3
Shallow Water SAV**		667.6	611.8	238.9	372.9	55.8
Open Water**		2,342.3	2,260.0	0	2,260.0	82.3
Deep Water**		1,402.1	1,402.1	0	1,402.1	0
Deep Channel**		1,329.7	1,329.7	0	1,329.7	0

*Public Beach results are reported as the number of beaches, not as surface area or linear extent of water affected.
**Chesapeake Bay specific uses. Note: Areas are based on total segment surface area. Surface area sizes for each specific designated use have not been defined. For the Deep Channel statistics, a small change in calculation was made for the PATMH segment. The size previously used for PATMH was 4.44 sq miles. However, to be more consistent with the way other segments were calculated (for deep channel statistics), this assessment was given the full PATMH size (36.15 square miles).

Table 25: Size of Estuarine Waters Impaired by Various Sources.

Waterbody Type - Estuary	
Sources	Water Size in Square Miles
Agriculture	471.00
Channel Erosion/Incision from Upstream Hydromodifications	0.09
Contaminated Sediments	324.97
Discharges from Municipal Separate Storm Sewer Systems (MS4)	30.83
Innappropriate Waste Disposal	9.59
Industrial Point Source Discharge *	3
Livestock (Grazing or Feeding Operations)	18.01
Manure Runoff	16.82
Municipal Point Source Discharges	42.45
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	3.62
Pipeline Breaks	1.03
Source Unknown	2,151.44
Upstream Source	439.59
Upstream/Downstream Source	12.84
Urban Runoff/Storm Sewers	37.11
Wastes from Pets	12.20
Wildlife Other than Waterfowl	0.43

*These listings are remnants of the 304(L) list and were originally listed due to the presence of point sources. Thus these listings have no associated sizes and the values are the number of point sources.

The summary table provided below is submitted for consistency with EPA guidance and to allow for statewide biological condition estimates. Please note that this table is identical to that provided in the 2014 Integrated Report (IR) as new assessments were not available in time to make the 2016 IR.

Table 26: Attainment Results for the Chesapeake Bay Calculated Using a Probabilistic Monitoring Design.

Project Name	Chesapeake Bay Benthic Assessment
Owner of Data	Chesapeake Bay Program and Versar Inc.
Target Population	Tidal waters of the Chesapeake Bay (reporting only the MD portion)
Type of Waterbody	Chesapeake Bay Estuary
Size of Target Population	2342.3 (only the MD portion)
Units of Measurement	Square Miles
Designated use	Aquatic Life
Percent Attaining	40.1%
Percent Not-Attaining	50.8%
Percent Nonresponse	9.1%
Indicator	Biology - Estuarine Benthic macroinvertebrate IBI
Assessment Date	4/1/2014
Precision	unknown

C.3.2.1 The Coastal Bays

Maryland's Coastal Bays, the shallow lagoons nestled behind Ocean City and Assateague Island, comprise a complex ecosystem. Like many estuaries, Maryland's Coastal Bays display differences in water quality ranging from generally degraded conditions near tributaries to better conditions in the more open, well-flushed bay regions. Showing the strain of nutrient enrichment, the Coastal Bays exhibit high nitrate levels in the freshwater reaches of streams, excess algae, chronic brown tide blooms, macroalgae blooms, and incidents of low dissolved oxygen.

Like water quality, the status of Coastal Bays living resources is mixed. While the Bays still support diverse and abundant populations of fish and shellfish, human activities are affecting their numbers. Forage fish, the major prey item for gamefish, have been in steady decline since the 1980s and reports of fish kills, usually the result of low oxygen levels, are increasing. Hard clam densities are lower than historic levels but have been generally stable over the past 10 years. Blue crab populations are fluctuating but do not appear to be in decline, despite a relatively new parasite causing summer mortality in some areas. Oysters, which were historically abundant in the Coastal Bays, remain only as small, relict populations. Bay scallops have recently returned after being absent for many decades and are now found throughout the Bays, although numbers are low. Seagrass coverage has decreased in recent years after large increases were seen in the 1980s and 1990s.

In terms of overall water quality, living resources, and habitat conditions, the Bays were given the following ranking from best to worst: Sinepuxent Bay, Chincoteague Bay, Assawoman Bay, Isle of Wight Bay, Newport Bay, and St. Martin River. For more information, refer to the 2014 Coastal Bays Report Card (http://www.mdcoastalbays.org/coastal-bays-report-card). The Maryland Department of the Environment completed and submitted nutrient TMDLs for all of the Coastal Bays in April 2014. EPA subsequently approved these TMDLs in August of 2014. To read the full text of these TMDLs

please visit:
http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/TMDL_final_MD_Coastal_Bays_nutrients.aspx.

C.3.2.2 2007 National Estuary Program Coastal Condition Report

In spring of 2007, the US Environmental Protection Agency (EPA) released its third in a series of coastal environmental assessments which focused on conditions in the 28 National Estuary Program (NEP) estuaries (online at: http://water.epa.gov/type/oceb/nep/index.cfm). In this Coastal Condition Report (CCR), four estuarine condition indicators were rated for individual estuaries:

- water quality (e.g., dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll a, water clarity, and dissolved oxygen);
- sediment quality (e.g., sediment toxicity, sediment contaminants, and sediment total organic carbon);
- benthic index and;
- fish tissue contaminants index

For each of these four key indicators, a score of good, fair, or poor was assigned to each estuary which were then averaged to create overall regional and national scores. Based on these calculations, the overall condition of the nation's NEP estuaries was generally fair. Specifically for the estuaries in the Northeast Coast region where Maryland's two NEP estuaries are located (Coastal Bays; Chesapeake Bay), the water quality index was rated as fair; sediment quality, benthic, and fish tissue contaminants indices were poor and the overall condition was rated as poor. However, considered altogether, the NEP estuaries showed the same or better estuarine condition than US coastal waters overall.

The report describes a number of major environmental concerns that affect some or all of the nation's 28 NEP estuaries. The goal of this report is to provide a benchmark for analyzing the progress and changing conditions of the NEPs over time. The top three issues, which also affect Maryland's estuaries include:

- Habitat loss and alteration (including dredging and dredge-disposal activities; construction of groins, seawalls, and other hardened structures; and hydrologic modifications);
- Declines in fish and wildlife populations (associated with habitat loss, fragmentation or alteration, water pollution from toxic chemicals and nutrients, overexploitation of natural resources, and introduction of invasive species); and
- Excessive nutrients (nitrogen and phosphorus runoff from agriculturally and residentially applied fertilizers and animal wastes, discharges from wastewater treatment plants, leaching from malfunctioning septic systems, and discharges of sanitary wastes from recreational boats).

C.3.2.3 The National Coastal Condition Assessment (NCCA)

The National Coastal Condition Assessment is a statistical survey of the condition of the Nation's marine and Great Lakes Coasts.[15] The NCCA is designed to report on the water quality, ecological, and recreational health of the nation's waters. Another key goal is to use this survey to determine the key

[15] Much of this text was borrowed from EPA web pages on this survey (https://www.epa.gov/national-aquatic-resource-surveys/what-national-coastal-condition-assessment#tabs-1.

stressors that impact these uses. Field data collection for the NCCA, in its current form, occurred in 2010 and again in 2015. In both years, Maryland's Department of Natural Resources participated in collecting and submitting data. This information is not generally used for IR assessment purposes, however it does help to inform regional comparisons in coastal conditions. For more information about this survey and to view available reports please visit: https://www.epa.gov/national-aquatic-resource-surveys/ncca.

C.3.3 Lakes Assessment - Clean Water Act §314 (Clean Lakes) Report

In the federal Clean Water Act (CWA), §314 addresses the Clean Lakes program, which was designed to identify publicly owned lakes, assess their water quality condition, implement in-lake and watershed restoration activities and develop programs to protect restored conditions. This section also requires regular reporting of State efforts and results.

In Maryland, all significant (> 5 acres surface area), publicly-owned lakes are man-made impoundments. A number of specific assessment, planning and restoration activities in Maryland were funded by §314 as early as 1980 until Congress rescinded Clean Lakes funding in 1994. Section 314 has since been reauthorized (2000) under the Estuaries and Clean Water Act of 2000 but no funds have yet been appropriated to states. The US Environmental Protection Agency currently encourages states to use funds in the §319 (Nonpoint Source Program) to address Clean Lakes priorities; however, no Clean Lake projects have been funded in Maryland through this program because of limited funding and higher priorities (e.g., Chesapeake Bay restoration, Total Maximum Daily Loads).

C.3.3.1 Trophic status

One measure of lake water quality is through classification by overall level of productivity ("trophic condition"). This measure often is based on relative nutrient levels which can affect not only biological community structure, but also certain physical characteristics of lakes:

- **oligotrophic lakes** - usually deep, with low levels of nutrients, plankton and low production rates - often serve well as drinking water sources or as lakes for boating or swimming, but having limited gamefish populations.
- **eutrophic lakes** - generally shallow, with high plankton levels and production rates - often supporting sportfishing for some species, but oxygen may be depleted below the thermocline and during periods of ice cover and may result in fish kills. Diurnal oxygen and pH levels may vary widely. Sportfishing for some fish species may be excellent, but water clarity will be reduced.
- **mesotrophic lakes** - have moderate productivity levels between the above two classifications and serve well as recreational lakes for fishing, boating and swimming activities.

Two other lake trophic classes not found in Maryland include: dystrophic or "bog" lakes characterized as having low nutrient levels, but very high color from humic materials and often acidified, and hypereutrophic lakes characterized by extremely high nutrient/productivity levels.

The most recent Statewide trophic survey of Maryland's significant, publicly-owned lakes was conducted in 1991 and 1993. For this survey, 58 lakes were identified as meeting the definition of significant, publicly-owned lakes. Since then, two other lakes have been added to this listing:

1. Big Piney Reservoir (Allegany Co.; Casselman River segment) - 110 ac. Frostburg water supply reservoir that was being rebuilt during this survey when public access was restricted, and
2. Lake Artemesia (Prince George's Co.; Anacostia River segment) - a recreational lake created from Metro construction.

In addition to publicly-owned lakes, water quality issues at a number of privately-owned lakes have been evaluated and water quality determined to be impaired. Several of these lakes have been addressed through TMDLs including: LaTrappe Pond, Lake Linganore, and Lake Lariat. Trophic condition has not been determined for these lakes.

The table below provides the 8-digit basin code, surface area size, owner, and trophic status for each of the State's 60 significant, publicly-owned lakes. Table 28 provides an overall summary of the trophic status for Maryland's publicly-owned lakes.

Table 27: Trophic status of Maryland's significant, publicly-owned lakes.

BASIN	LAKE NAME	SIZE (acres)	OWNER/MANAGER	TROPHIC ASSESSMENT
02120204	Conowingo Pool	2,936.0	Exelon Generation Co.	Meso/Eutrophic
02130103	Bishopville Pond	5.7	Worcester Co.	Eutrophic
02130106	Big Mill Pond	60.2	Worcester Co.	Eutrophic
02130203	Adkins Pond	17.2	MD State Hwy/Wicomico Co.	Eutrophic
02130301	Coulbourn Pond	8.6	Wicomico Co.	Meso/Eutrophic
02130301	Mitchell Pond #2	8.6	City of Salisbury	Eutrophic
02130301	Mitchell Pond #3	5.8	City of Salisbury	Eutrophic
02130301	Schumaker Pond	48.6	City of Salisbury	Meso/Eutrophic
02130301	TonyTank Lake	42.0	Wicomico Co.	Eutrophic
02130301	TonyTank Pond	41.3	MD State Hwy Admin.	Eutrophic
02130303	Allen Pond	35.8	Somerset/Wicomico Co.	Meso/Eutrophic
02130304	Johnson Pond	104.0	City of Salisbury	Eutrophic
02130304	Leonards Mill Pond	45.9	Wicomico Co.	Eutrophic
02130306	Chambers Lake	9.4	Town of Federalsburg	Meso/Eutrophic
02130306	Smithville Lake	40.0	MD DNR	Meso/Eutrophic
02130405	Tuckahoe Lake	86.0	MD DNR	Eutrophic
02130503	Wye Mills Community Lake	61.5	MD DNR	Eutrophic
02130509	Urieville Community Lake	35.0	MD DNR	Meso/Eutrophic
02130510	Unicorn Mill Pond	48.0	MD DNR	Meso/Eutrophic
02130805	Loch Raven Reservoir	2,400.0	Baltimore City	Mesotrophic
02130806	Prettyboy Reservoir	1,500.0	Baltimore City	Mesotrophic
02130904	Lake Roland	100.0	Baltimore City	Eutrophic
02130907	Liberty Reservoir	3,106.0	Baltimore City	Mesotrophic
02130908	Piney Run Reservoir	298.0	Carroll Co.	Meso/Eutrophic
02131001	Lake Waterford	12.0	Anne Arundel Co.	Meso/Eutrophic
02131103	Allen Pond	9.5	City of Bowie	Eutrophic
02131104	Laurel Lake	12.0	City of Laurel	Meso/Eutrophic
02131105	Centennial Lake	50.0	Howard Co.	Eutrophic
02131105	Lake Elkhorn	49.0	Columbia Assn.	Eutrophic
02131105	Lake Kittamaqundi	107.0	Columbia Assn.	Eutrophic
02131105	Wilde Lake	23.0	Columbia Assn.	Eutrophic
02131107	Duckett Reservoir	773.0	Wash. Suburban Sanitary Comm.	Meso/Eutrophic
02131108	Triadelphia Reservoir	800.0	Wash. Suburban Sanitary Comm.	Mesotrophic
02140103	St. Mary's Lake	250.0	MD DNR	Meso/Eutrophic
02140107	Wheatley Lake	59.0	Charles Co.	Mesotrophic
02140111	Myrtle Grove Lake	23.0	MD DNR	Eutrophic
02140203	Cosca Lake	11.0	MD-NCPPC	Eutrophic
02140205	Greenbelt Lake	21.5	City of Greenbelt	Eutrophic
02140205	Pine Lake	5.0	MD-NCPPC	Meso/Eutrophic
02140205	Lake Artemesia	38.0	MD-NCPPC	Unknown
02140206	Lake Bernard Frank	56.0	MD-NCPPC	Eutrophic
02140206	Lake Needwood	74.0	MD-NCPPC	Eutrophic
02140208	Little Seneca Lake	505.0	Wash. Suburban Sanitary Comm.	Mesotrophic
02140208	Clopper Lake	90.0	MD DNR	Mesotrophic
02140303	Hunting Creek Lake	46.0	MD DNR	Mesotrophic
02140501	Big Pool (C&O Canal)	92.4	National Park Service	Meso/Eutrophic
02140502	City Park Lake	5.2	City of Hagerstown	Mesotrophic
02140502	Greenbrier Lake	27.0	MD DNR	Oligo/Mesotrophic
02140508	Blairs Valley Lake	32.2	MD DNR	Meso/Eutrophic
02141002	Lake Habeeb	208.5	MD DNR	Oligo/Mesotrophic
02141005	Wm. Jennings Randolph Reservoir	952.0	Army Corps of Engineers	Oligo/Mesotrophic
02141006	Savage River Reservoir	360.0	Upper Potomac River Assn.	Oligo/Mesotrophic
02141006	New Germany Lake	13.0	MD DNR	Meso/Eutrophic
05020201	Youghiogheny River Lake	593.0	Army Corps of Engineers	Meso/Eutrophic

BASIN	LAKE NAME	SIZE (acres)	OWNER/MANAGER	TROPHIC ASSESSMENT
05020201	Herrington Lake	41.5	MD DNR	Mesotrophic
05020202	Broadford Lake	138.0	Town of Oakland	Meso/Eutrophic
05020203	Deep Creek Lake	4,500.0	MD DNR	Oligo/Mesotrophic
05020204	Cunningham Lake	20.0	Univ. Maryland	Mesotrophic
05020204	Big Piney Reservoir	110.0	City of Frostburg	Unknown

Source: MD Department of the Environment, 1993; 1995

Table 28: Trophic Status Summary of Maryland's significant, publicly-owned lakes.

	Number of lakes	Lake size (acres)
Total lakes	60	21,167.6
Lakes assessed	58	21,009.6
Dystrophic	0	0.0
Oligotrophic	0	0.0
Oligotrophic-Mesotrophic	5	6,047.5
Mesotrophic	11	8,572.7
Mesotrophic-Eutrophic	19	5,380.0
Eutrophic	23	1,009.4
Hypereutrophic	0	0.0
Unknown	2	158.0

Source: MD Department of the Environment, 1993; 1995

C.3.3.2 Pollution control programs

Various existing point and nonpoint source management programs described in this report can be effective in managing pollutant inputs directly to lakes and to lake watersheds. Unlike other water types, lakes have features that complicate the water management process, but also provide more options than other water body types. Some of these factors include: “residence time” - the time it takes water to pass through a lake, seasonal stratification, and the ability, at some lakes, to control water levels by selectively bypassing certain layers.

Unless the impoundment is a run-of-the-river system, lakes (and estuaries) have a longer residence time than free-flowing streams, allowing organic and inorganic substances more time to interact with the biota (primary producers) and sediments. If the lakes are large enough to develop seasonal stratification, new water masses develop, in-lake residence time is modified, and water movements altered. The ability to manage water levels and withdrawals provides management options, but adds to the complexity of managing lake waters for the best possible uses.

Most lakes in Maryland do not have a comprehensive lake or watershed management plan that addresses both point and nonpoint source pollution, land cover, or appropriate management options. In most instances, pollutant sources do not directly discharge to a lake but instead discharge to the lake’s upstream watershed. While large water supply systems invest in lake management plans, often their effectiveness in addressing pollution sources varies since lake watershed areas often are not controlled by the lake owners. Effective lake management plans require a cooperative relationship with upstream land managers (public agencies and private land owners) in order to develop agreements which address land use, pollution control and funding priorities so as to protect lake resources.

C.3.3.3 Lake Restoration Programs

One aspect of the now un-funded §314 Clean Lakes Program was to provide grants for lake restoration activities. After the Clean Lakes Program was de-authorized in 1994, restoration funding for lakes was added to the list of fundable activities for the §319 Nonpoint Source Program. Grant requirements, priorities and limited funding in this program, however, do not allow for much needed in-lake reclamation activities (e.g., removal/dredging of excess sediments and nutrients, aquatic vegetation control, aquatic and wildlife habitat enhancement, and shoreline stabilization).

Without a directed management program and federal funding support and with comparatively low priority for accessing State water management funding, current lake restoration activities are generally initiated by lake managers (often the owners). With few lake management plans in place, there is often little planning activity or actual effort to address lake water issues until they become severe (and more difficult and costly to address). Lake managers can take advantage of expert resources available from various State agencies (DNR, MDA, MDE), federal agencies (EPA, US Dept. Agriculture) and non-governmental organizations (e.g, North American Lake Management Society; regional lake management organizations in PA and VA) to assist in developing lake management plans and finding available funding sources.

C.3.3.4 Acidification of lakes

Poorly buffered lakes or lakes in mining areas are subject to acidification due to atmospheric deposition or through acid mine drainage. Although several of Maryland's significant, publicly-owned lakes receive acid mine drainage or naturally acidic drainage from free-flowing tributaries (Deep Creek Lake, Jennings Randolph Reservoir), dilution and natural buffering prevent these lakes from becoming acidified.

With support from the US Department of Interior's Office of Surface Mining Reclamation and Enforcement, the MD Bureau of Mines has completed several projects in Cherry Creek (tributary to Deep Creek Lake in Garrett Co.) to remediate high acidity due to acid mine drainage (AMD). Completion of these AMD projects has measurably reduced mineral acidity, though natural organic acidity from the wetlands remain. It is worth noting however, that even prior to installing the acid remediation projects; the acidic inflow to Deep Creek Lake was quickly buffered by a natural limestone layer. Because of this, even in an acidic state, the water quality of Cherry Creek is not a threat to water quality of Deep Creek Lake.

Wm. Jennings Randolph Reservoir (Garrett Co.; Upper North Branch Potomac River segment) receives acid mine drainage from numerous tributaries that drain directly to the lake and also from tributaries well upstream of the lake (in both Maryland and West Virginia). Constructed primarily to manage flows for downstream water quality, the lake volume varies considerably. Although the lake was designed to manage an expected acidic layer, data show that acidic stratification did not occur. The lowest pH levels in the lake are rarely acidic and water quality below the dam is good enough to support a trout hatchery in the tailwaters of the dam. As AMD is managed upstream of the lake, pH levels should only improve, helping to increase productivity and support a robust sport fishery.

Information about acidification in small lakes and privately-owned lakes is not widely known, but water quality impacts can be significant and restoration can be successful. Lake Louise (Garrett Co.; Casselman River segment), a privately-owned, 30-acre lake, had a renowned trout fishery. In the 1970s, sulphide-bearing fill material was used in the construction of Interstate 68 through the upper lake watershed. Acidic leachate from this material entered tributaries to the lake, and within two years, caused severe ecosystem degradation and loss of the sport fishery. In the 1990s, the State Highway Administration installed a passive treatment system in the upper lake watershed in an effort to reduce the acidic runoff. In 1999, following restoration of water quality in the lake, an aquatic resource restoration program was implemented to re-establish the aquatic community and sport fishery. More information on this restoration project can be found at: http://www.hpl.umces.edu/ERI/lakes.html.

C.3.3.5 Lake Status and Trends

Maryland agencies do not include lakes in their ambient monitoring programs, although contaminants in selected fish species are tested in some reservoirs on a cyclical basis (MDE). Infrequent sampling is done to address fish kills and algal bloom complaints (DNR, MDE) and some water sampling is done to provide input for pollutant loading models (Total Maximum Daily Loads, MDE). Some water supply reservoirs have routine water monitoring programs in their lakes (e.g., Baltimore City, Washington Suburban Sanitary Commission reservoirs) and, in a few cases, local agencies and citizen groups will monitor particular lakes. Based on available data, a summary of the status of Maryland lakes and reservoirs is given in the table below.

Table 29: Designated use support summary for Maryland's lakes and reservoirs (acres), 2016.

Designated Use		Size of Impoundments (acres)				
		Total Impoundment Acres	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife		21,876	13,765	4,775	8,990	8,111
Fishing		21,876	18,976	5,967	13,009	2,900
Water Contact Recreation	General Recreational Waters	21,876	3,039	3,039	0	18,837
	Public Beaches*	27	27	27	0	0

*Public beaches were reported as the number of beaches in each category rather than providing a size.

C.3.3.5.1 Causes and sources of impairment

Since the water quality of lakes is largely dependent on the upstream watershed, there are numerous pollutants that can potentially impact a lake (Table 30). Overall, one of the principal lake problems is due to the accelerated eutrophication process that characterizes most reservoir systems. Upstream watershed sources, both natural and anthropogenic, supply nutrients and sediments to lakes on a continual basis which can lead to nuisance algal blooms, decreased dissolved oxygen levels (harmful to aquatic organisms), and loss of drinking water storage capacity. Other prevalent lake impairments include high levels of mercury in fish tissue, PCBs in fish tissue, and other contamination by metals.

Table 30: Impoundment acreage assigned to Categories according to the pollutant assessed.

Size of Impoundments (acres) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	Cat. 1	Cat. 2	Cat. 3	Cat. 4a	Cat. 4b	Cat. 4c	Cat. 5
Arsenic		3,708					
Cadmium		3,708					
Chlordane		98					

Size of Impoundments (acres) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Chromium (total)		5,113					
Chromium, hexavalent		1,508					
Copper		3,708					
Fecal Coliform		3,039					
Lead		6,621					
Mercury in Fish Tissue		9,271		8,226			1,635
Nickel		3,708					
Nitrogen (Total)		27					
PCB in Fish Tissue		12,785	198	98			3,049
Phosphorus (Total)		4,775	3,207	8,990			
Sedimentation/Siltation		281	33	6,485			
Selenium		3,708					
Zinc		1,508					

The Department has found elevated concentrations of mercury and PCBs in fish tissue at a number of publicly and privately-owned lakes throughout Maryland. To protect public health, the Department publishes fish-consumption advisories that provide recommended meal limits for certain fish found to have high levels of these contaminants. For more information on fish consumption advisories please visit: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/index.aspx. Table 31 shows the predominant sources of pollutants to impaired lakes.

Table 31: The total size of impoundments impaired by various sources, 2016.

Waterbody Type - Impoundment	
Sources	**Water Size in Acres**
Agriculture	4,535.2
Atmospheric Depositon - Toxics	9,861.8
Contaminated Sediments	3,039.4
Crop Production (Crop Land or Dry Land)	4,362.0
Municipal Point Source Discharges	170.9
Source Unknown	9.7
Urban Runoff/Storm Sewers	2,331.0
Upstream Source	98.0

The Baltimore City water supply reservoirs (Loch Raven, Prettyboy, Liberty Reservoirs), are still in various states of eutrophication and need both improvement and continued protection. Sedimentation is monitored periodically to assess the practical storage capacity of these systems - last reported as: Loch Raven Reservoir losing about 11 percent of its original volume followed by Prettyboy Reservoir (losing 7.5 percent), and Liberty Reservoir (losing 3.3 percent) (Baltimore Metropolitan Council 2004). Finally, of increasing concern are the rising levels of chlorides and conductivity found at lake tributary stations and in the treated water at the Ashburton (Liberty) and Montebello (Loch Raven) treatment plants. It is believed that road salt is one of the largest contributors to this trend. For more information please see Section B.4.

C.3.3.5.2 National Lake Survey

As part of a national effort to assess the quality of the nation's waters in a statistically-valid manner, every five years EPA randomly selects lakes in each state to be sampled using a nationally-consistent set of protocols (stratified by state, EPA Region and ecological region). So far, this lake survey was completed in 2007 and again in 2012. Prior to both sampling events, DNR biologists were trained by EPA to collect data on field water quality, biological community, habitat, and sediment conditions. Lakes were intensively sampled a single time during the late summer with one additional lake being sampled as a replicate for QC purposes. Water, sediment and biological samples were sent to national labs for analysis and field data were submitted to EPA. For the 2012 survey season, roughly 100 lakes in Maryland were included in the nationwide pool from which only nine were actually sampled. The next National Lakes Survey is currently planned for the summer of 2017 with 10 lakes slated to be sampled in Maryland. More information on the national survey can be found at http://water.epa.gov/type/lakes/lakessurvey_index.cfm.

C.3.3.5.3 Total Maximum Daily Loads for Lakes

MDE has completed thirty eight (38) TMDLs for various lake-pollutant combinations in Maryland through July 2016. These TMDLs addressed substances including: methylmercury, phosphorus, chlordane, PCBs, and sediments (Section F.4). Another four (4) lake-pollutant combinations are currently identified as impaired and need TMDLs for the pollutants mercury and PCBs.

C.3.4 Non-tidal Rivers and Streams Assessment

The State of Maryland has two major monitoring programs for assessing non-tidal flowing waters. One is the probabilistic Maryland Biological Stream Survey (MBSS) and the other is the CORE/TREND program for assessing water quality trends at fixed locations (both conducted by MD DNR). The MBSS program uses fish and aquatic insects as indicators of aquatic health while the CORE/TREND program focuses on conventional water quality parameters (temperature, pH, etc.) and nutrient species. In addition to these two monitoring programs, Maryland also makes use of other ad-hoc stream monitoring data as well as data submitted by non-state organizations to assess state waters. Since the 2014 Integrated Report (IR), Maryland has now also integrated biological stream data from specific counties (Baltimore and Frederick) to provide better sampling resolution for stream bioassessments. The summary tables below therefore reflect the data supplied from this variety of sources.

The table below provides the most recent results from a statewide probabilistic biological assessment in first through fourth order streams. The reader will notice that this table has not changed since the 2014 IR. The Department generally conducts statewide biological assessments every other IR cycle as these assessments are extremely time intensive due to the level of quality control needed. The results shown below incorporate biological monitoring performed by the Maryland Biological Stream Survey (DNR), Baltimore County, and Frederick County.

Table 32: Statewide results for probabilistic biological sampling. This data assesses support of the aquatic life designated use.

Project Name	Maryland Biological Stream Survey and County Biological Data
Owner of Data	MD Dept. of Natural Resources (MANTA), Baltimore Co. Frederick Co.
Target Population	All 1st through 4th order non-tidal wadeable streams in MD
Type of Waterbody	1st through 4th Order Wadeable Streams
Size of Target Population	19,127.0
Units of Measurement	Miles
Designated use	Aquatic Life
Percent Attaining	56.55%
Percent Not-Attaining	42.99%
Percent Nonresponse	0.50%
Indicator	Biology - freshwater fish and benthic macroinvertebrate IBIs
Assessment Date	4/1/2014

Table 33 shows 8-digit watersheds which were previously listed as impaired (Category 5) based on a biological assessment but which now have a completed stressor identification analysis. Provided in this table is the attributable risk percentage for each identified stressor. For more information about this Biological Stressor Identification (BSID) process and how the attributable risk is calculated please visit the BSID website at: http://www.mde.state.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/bsid_studies.aspx.

Table 33: Watersheds previously listed as biologically impaired that have undergone BSID analysis. As a result of this analysis, the biological listings have been replaced by listings for the specific pollutants/stressors identified below.

8-digit watersheds that were previously in Category 5 based on impaired biological communities (cause unknown)	Stressors Identified through BSID Analysis	IR Category	Attributable Risk
Marsh Run	Sediments	5	100%
	Sulfates	5	92%
Nanticoke River	Sediments	5	22%
	Channelization	4c	62%
Piscataway Creek	Chlorides	5	55%
	Sediments	5	79%
Port Tobacco River	Chlorides	5	42%
	Sulfates	5	42%
	Sediments	5	51%
Deep Creek Lake Watershed	Sulfates	5	34%

The following tables present statewide assessment summaries on the wide range of pollutants and sources of pollutants to non-tidal flowing waters. Much of the data used for these assessments is from state-led monitoring efforts but increasingly more data from federal agencies, counties, non-profits, and academia are also being used. These other data sources have helped to supplement the state-led programs and increase the overall spatial resolution at which certain parameters are measured. Tables 34 – 36 provide statewide assessment data for non-tidal rivers and streams.

Table 34: Extent of River/Stream Miles assigned to each category according to the pollutant assessed.

Number of River Miles per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Aluminum		160.1		26.2			
Ammonia		317.4					
Arsenic		663.7					
BOD, Biochemical oxygen demand		132.2		277.5			
BOD, carbonaceous		447.1		72.1			
BOD, nitrogenous		447.1		72.1			
Cadmium		1235.5					

Number of River Miles per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Cause Unknown/Combination Benthic and Fish Bioassessments		4655.5	1867.1				1402.5
Channelization						1914.4	
Chlordane		48.0					
Chlorides							2510.3
Chromium (total)		292.4					
Chromium, hexavalent		266.0					
Chromium, trivalent		105.3					
Copper		684.6					
Cyanide		98.4					
Debris/Floatables/Trash				277.5			
Enterococcus		6.8		383.9			67.3
Escherichia coli		491.2	613.3	3450.5			
Fecal coliform		563.2	569.1	368.2			
Heptachlor Epoxide							21.5
Iron		126.1		58.5			
Lack of Riparian Buffer						1565.1	
Lead		764.3					
Manganese		186.3					
Mercury		477.4					
Mercury in Fish Tissue		247.0	56.2				151.7
Nickel		663.7					
Nitrogen (Total)		1545.7	243.3	277.5			
PCB in Fish Tissue		113.0	165.9				223.6
PCBs - water				39.5			
pH, High		4.7	12.7				143.2
pH, Low		1199.6		236.4	1.1		142.2
Phosphorus (Total)		4034.9	243.3	3071.0			551.9
Selenium		663.7					
Silver		186.3					
Sulfates							2065.9
Temperature, Water		45.9	42.7				65.1
Total Suspended Solids (TSS)		851.7		6102.3			1758.8
Zinc		910.1					

Table 35: Designated Use Support Summary for Non-tidal Rivers and Streams.

Designated Use		Size of River/Stream Miles				
		Total River miles	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife		19,127.0	16,981.6	7,249.9	9,731.7	2,145.5
Fishing		19,127.0	445.6	124.27	321.4	18,681.4
Water Contact Recreation	General Recreation Waters	19,127.0	5,331.2	1,061.2	4,270.0	13,795.8
	Public Beaches*	1	1	1	0	0
Agricultural Water Use		19,127.0	19,127.0	19,127.0	0	0
Industrial Water Use		19,127.0	19,127.0	19,127.0	0	0
Public Water Supply		8,154.0	8,154.0	8,154.0	0	0

*Data on public beaches is measured as a beach count rather than as stream mileage.

Table 36: Summary of Sizes of Riverine Waters Impaired by Various Sources.

Waterbody Type - River	
Sources	**Water Size in Miles**
Acid Mine Drainage	270.3
Agriculture	3,593.5
Anthropogenic Changes to Stream Channel	512.6
Anthropogenic Land Use Changes	210.9
Atmospheric Deposition - Acidity	155.2
Atmospheric Deposition - Toxics	150.2
Combined Sewer Overflows	205.7
Contaminated Sediments	121.9
Crop Production (Crop Land or Dry Land)	2,609.2
Discharges from Municipal Separate Storm Sewer Systems (MS4)	383.9
Inappropriate Waste Disposal	277.5
Lack of riparian buffer and upstream impoundments	1.1
Livestock (Grazing or Feeding Operations)	2,163.5
Loss of Riparian Habitat	337.0
Manure Runoff	481.1
Municipal (Urbanized High Density Area)	774.5
Municipal Point Source Discharges	72.1
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	71.7
Post-development Erosion and Sedimentation	53.1
Sanitary Sewer Overflows (Collection System Failures)	914.9
Source Unknown	2,062.0
Urban Development in Riparian Buffer	441.6

Waterbody Type - River	
Sources	**Water Size in Miles**
Urban Runoff/Storm Sewers	3,577.5
Wastes from Pets	879.8

C.3.4.1 National Rivers and Streams Assessment (NRSA)

The National Rivers and Streams Assessment is a national probability-based survey of rivers and streams that collects data on physical, chemical and biological parameters.[16] Similar to the other National Aquatic Resource Surveys (NARS), this survey is meant to report on the health of rivers and streams and provide information on the predominant stressors impacting their health. Additionally, this survey is used to compare the condition of streams to an earlier national survey. Field sampling for this survey was conducted in the 2008-2009 and 2013-2014 time-frames. Maryland DNR participated in both surveys. The next survey is currently planned for 2018-2019. Though this information is not generally used for IR assessment purposes it does help to inform regional comparisons in stream conditions. For more information about this survey and to access reports, please visit: https://www.epa.gov/national-aquatic-resource-surveys/nrsa.

[16] Much of the text in this section was borrowed from EPA's web pages on this survey (https://www.epa.gov/national-aquatic-resource-surveys/what-national-rivers-and-streams-assessment#tab-1).

C.3.5 Total Maximum Daily Loads

Maryland continues to make progress completing Total Maximum Daily Loads (TMDL) for waters listed as impaired on Category 5 of the IR. TMDLs determine the sources of pollution for an identified impairment as well as the estimated reductions necessary to bring the water body back into compliance with Water Quality Standards. Once Maryland completes a TMDL for a water body-pollutant combination, it must then be approved by EPA, in order for it to take force. When this has occurred, the water body-pollutant combination will get moved to Category 4a on the IR. Table 37 lists the water bodies with TMDLs completed since the last IR cycle.

Table 37: Recently Approved TMDLs in Category 4a of the Integrated Report. This list does not include any TMDLs that were captured on the 2014 Integrated Report.

Cycle First Listed	Assessment Unit	Basin Name	Water Type Detail	Designated Use	Pollutant	Sources
2008	MD-PATMH-Middle-NorthwestHarbor-littoral	PATMH - Patapsco River Mesohaline	Tidal subsegment	Water Contact Sports	Debris/Floatables/Trash	Inappropriate Waste Disposal
2006	MD-MAGMH	MAGMH - Magothy River Mesohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Contaminated Sediments
2006	MD-SEVMH	SEVMH - Severn River Mesohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Contaminated Sediments
2002	MD-SOUMH	SOUMH - South River Mesohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Contaminated Sediments
2006	MD-WST-RHDMH-02131004	West River	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Contaminated Sediments

Tables 38 and 39 list those waters for which TMDLs will likely be initiated over the next two years.

Table 38: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2016.

Listing Year	Listed Water body	Impairing Substance	2012 303(d) List Count
2006	Potomac River Allegany County	Biological*	1
2004	Nanticoke River	Biological*	1
2004	Rocky Gorge Dam	Biological*	1
2004	Potomac River Lower Tidal	Biological*	1
2008	Port Tobacco River	Biological*	1
2006	Potomac River Upper Tidal	Biological*	1
2004	Piscataway Creek	Biological*	1
2004	Lower Pocomoke River	Biological*	1
2004	Marsh Run	Biological*	1
2002	Town Creek	Biological*	1
2006	Lower North Branch of Potomac River	Biological*	1
2006	Little Youghiogheny River	Biological*	1
2006	Potomac River Frederick County	Biological*	1
2014	WICMH – Wicomico River Mesohaline (Ellis Bay)	Bacteria	1
2010	WICMH – Wicomico River Mesohaline (extended area)	Bacteria	1
2010	Lower Choptank River (extended area)	Bacteria	1
2002	Bush River Oligohaline	PCBs	1
2008	Patuxent River Lower	PCBs	1
2006	Gunpowder River	PCBs	1
2008	Bird River	PCBs	1
1998	Lake Habeeb (revise previously developed TMDL)	Nutrients	1
2012	Back River	Sediment	1
2012	Lower Gunpowder Falls	Sediment	1
2014	South River	Sediment	1
2014	Other West Chesapeake Bay	Sediment	1
Total Listings Addressed from 2012 303(d) List			**25**

*These biological listings (cause unknown) will be addressed by the BSID analysis to identify the specific stressors causing biological community degradation.

Table 39: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2017.

Listing Year	Listed Waterbody	Impairing Substance	2012 303(d) List Count
2014	PAXMH- Lower Patuxent River Mesohaline (upstream portion of Battle Creek)	Bacteria	2
2012	Patuxent River Lower (Buzzard Island Creek)	Bacteria	1
2012	Patuxent River Lower (Wells Cove)	Bacteria	1
2010	Patuxent River Lower (extended area)	Bacteria	1
2010	Youghiogheny River Lake	Mercury	1
2006	Middle River	PCBs	1
2002	Concocheague Creek	pH	1
2014	Patuxent River Middle	Sediment	1

Listing Year	Listed Waterbody	Impairing Substance	2012 303(d) List Count
2014	Baltimore Harbor	Sediment	1
2014	Patuxent River Lower	Sediment	1
2012	Upper Chester River	Sediment	1
1996	Aberdeen Proving Ground	Toxics	1
1998	Lake Linganore (revise previously developed TMDL)	Nutrients	1
Total Listings Addressed from 2012 303(d) List			**14**

In an effort to continue to make progress in developing TMDLs for waters and pollutants where they are most needed, Maryland has developed a prioritization of impairments for TMDL development. This prioritization methodology describes Maryland's ongoing work on the Chesapeake Bay TMDLs and Watershed Implementation Plans (WIP) and lays out the different high priority pollutants that will be addressed between 2016 and 2022. In conjunction with the public review period associated with this Integrated Report, the Department seeks the public's review and comment on this prioritization methodology.

C.4 Wetlands Program

C.4.1 Wetland Monitoring Strategy

MDE completed the project to develop a wetland monitoring strategy. The report contains background information on goals and objectives; discussions and decisions made to date; pilot project summaries that may guide strategy development; and other related monitoring efforts. Wetland monitoring and assessment is undertaken in Maryland to meet various objectives. The strategy includes recommendations and tasks for two options: those that can be done with existing resources, and those that are recommended, but will need additional resources. Recommendations were prepared for monitoring and assessment related to Maryland's wetland permit programs; voluntary restoration, large scale landscape assessments; preservation; and Clean Water Act requirements.

MDE and DNR developed a draft classification system in 2007 to present to the Wetland Work Group. The classification is a modified version of the Hydrogeomorphic (HGM) classification, which can also be translated into the classification system used for wildlife habitats. A unique addition is the designation of a separate class for wetlands that are constructed, whether for mitigation, restoration, or water quality improvement. The class is under consideration to recognize that newly established wetlands are often built for a specific purpose, are built in a disturbed area, and are in an early successional stage. Comparison of these wetlands with a more mature natural system, at least for an initial period, may incorrectly indicate that these wetlands are in poor condition or not performing desired functions. The creation of a separate class prevents this problem. The draft classification was completed in 2007.

There are multiple objectives for Maryland's wetland monitoring and assessment program (shown below), which will be related to other regulatory and non-regulatory wetland management programs. Monitoring will be designed to assess both wetland condition and wetland function and to:

1) Meet 305(b) reporting requirements;
2) Improve existing wetland and waterway regulatory programs;
3) Provide additional information for targeting wetland/waterway restoration and protection efforts;
4) Comply with TMDL requirements, if applicable;
5) Develop use designations and water quality standards for wetlands;
6) Assist in evaluating the effectiveness of compensatory mitigation and voluntary restoration projects;
7) Improve our ability to comprehensively assess landscape and watershed function;
8) Develop the capability to study and assess the status of wetland condition over time; and,
9) Make wetland condition and functional value information available for use in federal, State, local and citizen group-driven natural resource conservation and restoration efforts (examples include TMDL implementation plans, Green Infrastructure Assessment, Strategic Forest Lands Assessment, etc.).

Deliverables from the strategy development effort include literature reviews of existing GIS-based landscape assessments (Level 1); rapid field assessments (Level 2); and more intensive field assessments (Level 3). In addition, the work group also prepared a template for an intensive long-term Level 3 monitoring approach and a conceptual framework for water quality standards specific to wetlands. The final Maryland Wetland Monitoring Strategy was completed in September of 2010 (http://www.mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Documents/www.mde.state.md.us/assets/document/wetlandswaterways/Final%20Strategy%20Report%20commentsNRCSaddr2.pdf). More details on Maryland's wetlands strategy can be found on MDE's web site at http://www.mde.maryland.gov/programs/water/wetlandsandwaterways/aboutwetlands/pages/programs/waterprograms/wetlands_waterways/about_wetlands/monitoring.aspx.

C.4.2 National Wetland Condition Assessment

Maryland continues to participate in the National Wetland Condition Assessment (NWCA), part of the National Aquatic Resources Survey. In the first wetland condition assessment (field work completed in 2011), data were collected at 27 sites in Maryland, with the majority in tidal wetlands. MDE helped review the draft report that has now been finalized and released (See https://www.epa.gov/national-aquatic-resource-surveys/national-wetland-condition-assessment-2011-results).

MDE will again participate in the NWCA scheduled for 2016. As MDE's subcontractor, Riparia at Pennsylvania State University will be sampling fifteen sites with broader distribution across Maryland than what was previously sampled in 2011. Additional information about the National Wetland Condition Assessment can be found at: https://www.epa.gov/national-aquatic-resource-surveys/nwca.

C.4.3 Wetland Program Plan

MDE received a State Wetland Program Development Grant in 2014 to develop, with other State agencies (DNR, MD Department of Agriculture, and State Highway Administration) a Wetland Program Plan to identify actions the State will undertake over the next several years. Tasks will include those related to regulatory, monitoring and assessment, voluntary restoration, preservation, and wetland water quality standards. A draft plan was submitted to EPA for review in 2015 and comments were incorporated. A draft final and final plan will be submitted to EPA in 2016. Consistent with the aforementioned Wetland Monitoring Strategy, the Wetland Program Plan includes the following draft goals for monitoring and assessment:

> Objective: Develop capacity and tools to improve assessment of wetland condition, function, vulnerability to stressors and ecosystem service benefits in order to better inform regulatory and non-regulatory programs for restoration and preservation.
>
> Rationale: Maryland agencies implement a wide range of programs for wetland management, including regulatory programs for review of activities which may result in wetland loss, restoration programs in degraded resources, and preservation programs to protect vital resources. Tools are needed to better predict outcomes of management actions.

MDE and associated agencies will seek grants for tasks needed to accomplish the objective and meet the goals.

C.4.4 Mitigation

MDE's Wetlands and Waterways Program continues attempts to improve assessment of mitigation sites to determine if they are on the proper trajectory to replace lost wetland acreage and functions. The Program is a member of the State/federal Interagency Review Team considering establishing revised performance standards for compensatory mitigation projects.

New in 2016, Maryland amended nontidal wetland legislation to remove disincentives to mitigation banking, and generally designate mitigation banking as highest preference for compensatory mitigation. Mitigation banks result in larger sites providing greater ecological benefits, as they are often more successful, provide more functions, and require less time to manage than smaller permittee-responsible mitigation projects. Monitoring and assessment, both pre-and post-construction, is more efficient and effective in ensuring success of these larger sites than in many small, scattered sites. Data from monitoring and assessment of mitigation bank sites is evaluated by an Interagency Review Team to further increase likelihood of project success.

C.5 Trend Monitoring

C.5.1 Introduction

Although water quality trend results are not used in the State's water quality assessment methodologies or listing process, they can be a useful tool for measuring incremental improvements in water quality. Typically, such datasets must be collected over sufficiently long temporal periods so as not to draw conclusions from changes caused by natural variability. Most trend analyses applicable to Maryland waters come from two sources, the United States Geological Survey (USGS) and the Maryland Department of Natural Resources (MD DNR).

USGS currently calculates nutrient and sediment trends for the entire Chesapeake Bay watershed using a weighted regressions on time, discharge and season (WRTDS) method (Hirsh et al. 2010). The WRTDS method is applied to data generated from the Nontidal Water-Quality Monitoring Network (NTN) which measures nitrogen, phosphorus and suspended sediment concentrations throughout the Bay Watershed. This monitoring program includes stations in all 7 of the Chesapeake Bay jurisdictions (Delaware, D.C., Maryland, New York, Pennsylvania, Virginia, and West Virginia). The primary purpose of this monitoring program is to assess the trends in loads that are delivered downstream to the Bay. The NTN program began in 2004 and now has 117 stations spread throughout the Bay watershed (see figure below). The 117 NTN stations include 9 tidal River Input Monitoring (RIM) stations that have been in place since 1985 (see figure 8). Located in non-tidal waters along the fall line, the RIM stations are used to determine trends in loads delivered from the watershed to the tidal waters. Although there are only 9 RIM stations, their placement along major Bay tributaries allows USGS to account for pollutant loading from 78 percent of the 64,000 square-mile-watershed. Since these RIM stations have been monitored for over 30 years, USGS splits their analysis to include both long term (1985-2014) and short term trends (2005-2014). The analysis for the rest of the NTN stations only includes short term trends (2005-2014) since most (87, including the 9 RIM stations) stations have only been monitored since 2005 and the remaining (30) stations have less than 5 years of data). Within this analysis, decreasing loads are classified as improving conditions, while increasing loads are classified as degrading conditions.

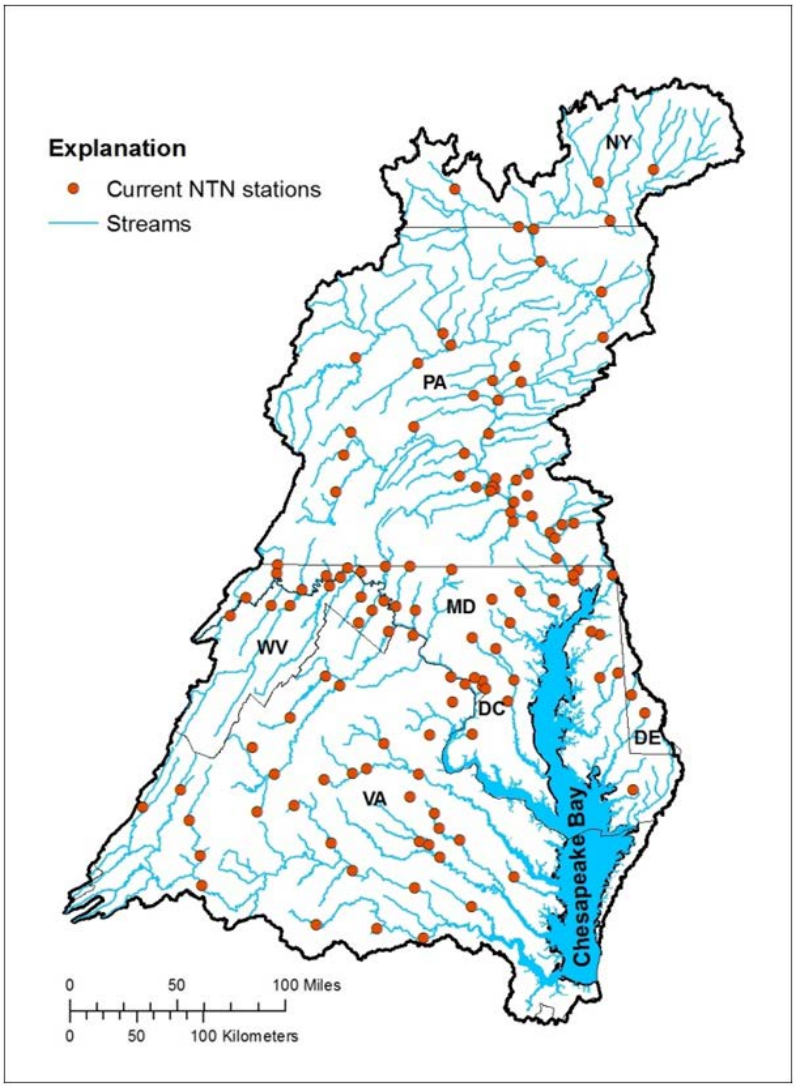


Figure 10: Map showing the non-tidal water quality network monitoring stations (USGS).

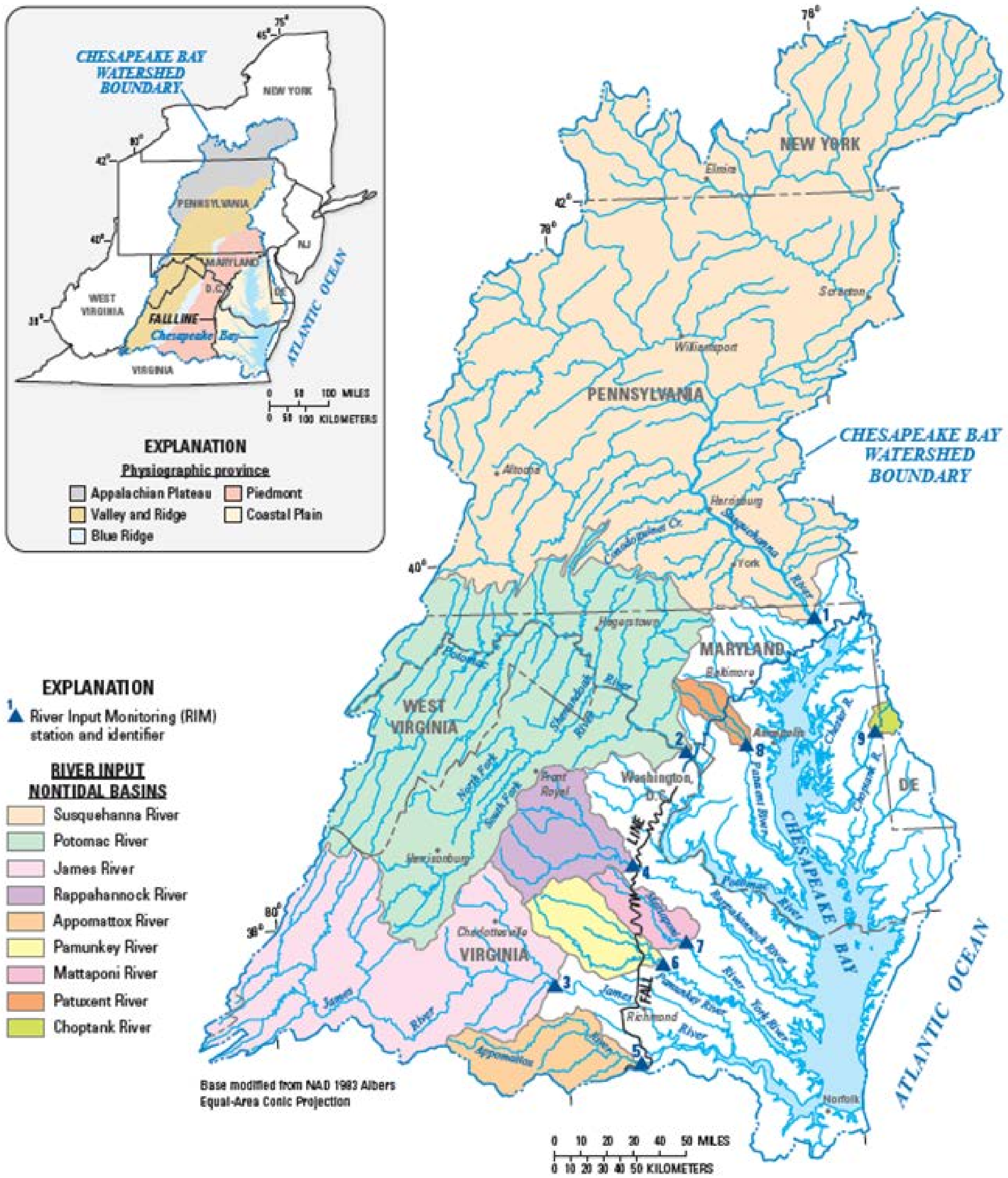


Figure 11: Map showing the location of the 9 tidal RIM stations monitored by USGS.

The Maryland Department of Natural Resources (MD DNR) analyzes trends for a variety of water quality parameters in both the tidal and non-tidal waters of Maryland. Since 1999, DNR has monitored 54 non tidal and 71 tidal stations (125 total stations). Besides nutrients and sediments, DNR collects temperature, dissolved oxygen, water clarity, conductivity, alkalinity, and pH measurements. These data are used to calculate trends both for the purpose of tracking progress with Chesapeake Bay restoration efforts (mainly concerning nutrient and sediment reductions) but also for tracking changes in the health of non-tidal river systems. DNR split their analysis three ways to include combined trends (125 total stations) and separate trends for tidal and non-tidal waters. MDNR's Core/Trend stations (54 out of 125) are shown in the figure below. As with the USGS analyses, decreasing nutrient concentrations are classified as improving conditions, while increasing concentrations are classified as degrading conditions.

Figure 12: Map showing Maryland's 54 Core Trend Monitoring Stations (Maryland DNR).

Each of the parameter-specific (e.g. phosphorus, temperature, etc.) sections below discuss the USGS trend data (if available) and are then followed by a discussion of Maryland DNR trend data. The reader should note the different spatial scales represented by each trend monitoring program (i.e.; USGS-Chesapeake Bay watershed; Maryland DNR-Maryland waters).

C.5.2 Water Quality Trends

Nitrogen

For the Chesapeake Bay watershed, long term nitrogen trends (1985-2014) calculated from the USGS RIM stations showed improving conditions (decreasing nitrogen levels) at 7 of the 9 stations, while 1 station showed degrading conditions and 1 did not demonstrate a significant trend. Short term trend (2005-2014) analyses for the RIM stations showed only 3 stations with improving conditions while 4 stations had degrading conditions and 2 did not demonstrate significant change. For the other USGS NTN sites (excluding the RIM sites) that have only been monitored since 2004, only short term trends are available. For these NTN sites, fifty-four percent (44 of 81) of stations had improving trends, 27% (22 of 81) of stations had degrading conditions and 19% (15 of 81) did not demonstrate a significant trend.

Maryland DNR data from non-tidal flowing waters (1999-2014) showed overall improvements in nitrogen concentrations as 39% (21 of 54) of stations showed improving/decreasing levels, 13% (7 of 54) showed degrading/increasing levels, and 48% (26 of 54) showed no change. Analysis of tidal data

(1999-2015) showed improving conditions for nitrogen in 52% (37 of 71) of stations and degraded conditions in only 1% (1 of 71) of stations (46%, 33 of 71, showed no change).

Phosphorus

USGS RIM stations did not demonstrate an overall long term trend for the Chesapeake Bay watershed with 4 stations showing improvement and 4 stations showing degradation (1 site had no trend). Short term USGS RIM station analysis showed 2 stations with improving conditions, 4 stations showing degrading conditions and 3 stations showing no trend. The USGS NTN sites showed improvement in phosphorus loads with 68% (41 of 60) of stations showing improving trends, 20 % (12 of 60) of stations showing degrading trends and 12% (7 of 60) having no discernible trend.

Maryland DNR data for non-tidal waters showed phosphorus levels improve in 69% (37 of 54) of stations while 2% (1 of 54) showed degrading conditions and 30% (16 of 54) did not appreciably change. DNR tidal water trend analysis showed phosphorus levels improving in 38% (27 of 71) of stations, degrading in 7% (5 of 71) of stations, and 55% (50 of 71) did not change.

Sediments

The USGS RIM stations showed that long term suspended-sediment loads had a slight improving trend for the Chesapeake Bay Watershed where 4 stations showed improvement, 3 stations showed degradation and 2 stations had no trend. The USGS RIM stations showed a degrading short term trend for the Chesapeake Bay watershed where only 3 stations improved, 5 sites showed degradation and 1 showed no trend. The USGS NTN sites had 50% (29 of 59) of stations demonstrating improving trends, 30% (19 or 59) of stations showing degrading trends and 20% (11 of 59) with no trend.

DNR analysis of non-tidal waters showed improvements in 17% (9 of 54) of stations, degradation in 4% (2 of 54) of stations, and 80% (43 of 54) showed no change. Maryland's tidal stations, demonstrated improvements in suspended sediment levels in 20% (14 of 71) stations, degradation in 10% (7 of 71) stations and no significant trend in 70% (50 of 71) of stations.

Temperature

Collection and analysis of water temperature data has become an increasing focus of many monitoring and assessment efforts due to concerns about the effects of climate change and increased water quality impacts from urban stormwater. Studies completed in 2014 by USGS explored the potential relationship between rising water temperatures and the impact on eutrophication of the Chesapeake Bay (Rice and Jastram 2015). In this study, the authors describe the potential for rising water temperatures to cause chemical reductions of iron and manganese oxides. The reduction of these oxides could then trigger the release of soluble reactive phosphorus (SRP) and nitrates from the sediments and thereby exacerbate current water quality problems caused by excess nutrients. In analyzing the water temperatures of streams in the Chesapeake Bay watershed, this study revealed that temperatures have risen, on average, 1.4°C (2.52 °F) between 1960 and 2010. In addition, the authors compared two time periods, 1960-1985 and 1986-2010, and found that the 1986-2010 time-frame is statistically significantly warmer than the 1961-1985 time-frame. Additional monitoring will be necessary to assess the potential impact of rising temperatures on nutrient levels in the Chesapeake Bay even as major efforts are underway to drastically reduce the quantity of nutrients discharged to the Bay.

Maryland DNR also assessed trends in water temperature, doing so for both tidal and non tidal waters. Maryland's non-tidal waters showed an increase in temperature at 15% (8 of 54) of stations without any stations showing a decrease in temperature (85 %, 46 of 54, of stations did not exhibit a trend). Maryland's tidal waters also showed increases in temperature with 17% (12 of 71) of stations showing an increase, and 1% (1 of 71) showing a decrease and 82% (58 of 71) of stations showing no significant change.

Dissolved Oxygen

Dissolved oxygen (DO) is measured at all DNR Core/Trend and Chesapeake Bay and tributary stations. For the tidal stations especially, DO serves as an important indicator of healthy habitat. Dissolved oxygen data from tidal Maryland DNR sites (1999-2014) suggest slight improvement in DO with 24 % (17 of 71) of stations showing increases in DO, 7% showing decreases (5 of 71), and 69% showing no change (49 of 71).

Water Clarity

Water clarity is an important water quality measure for assessing impacts from excess sediment and algal blooms. Water clarity data collected by DNR at Maryland's tidal stations showed degrading (less water clarity) conditions in 34% (24 of 71) of stations and improvement in 3% (2 of 71) of stations. Fifty-one percent (36 of 71) of stations showed no change.

Conductivity

Conductivity, or the ability of water to conduct electrical current, is influenced by the level of ions (e.g. chloride) in solution. Conductivity is strongly negatively correlated with the health of aquatic life in non-tidal freshwater streams and can be used to estimate levels of ions that have aquatic toxicity effects. As a result, increasing conductivity measurements are an important indicator of water quality degradation. Data from DNR's Core/Trend Monitoring Program currently demonstrate an increase (degrading condition) in conductivity levels at 43% (23 of 54) of stations and a decrease (improving condition) at only 6% (3 of 54) of stations (52% (17 of 54) did not show a change).

Current and Future Trend Analyses

USGS currently uses the WRTDS model as described in Hirsh et al. (2010) to compute trends at NTN and RIM sites. "The WRTDS model uses a sparse set of discrete water-quality observations combined with a continuous daily discharge record to estimate concentration on days for which no water-quality data are available. Daily concentration and load estimates are then aggregated to monthly and annual time scales. An algorithm is then applied to estimate the trend in "flow-normalized load," namely a trend that minimizes the confounding effect of any concurrent trend in discharge" (USGS 2016). This method has largely been used since 2010.

However, efforts are underway in 2016 at the Chesapeake Bay Program, MDDNR, and partner agencies to analyze the Chesapeake Bay tidal water quality data for trends over time using a new approach based on Generalized Additive Models (GAMs, Wood 2006). Tidal water quality data has been collected for more than 30 years, and over that time there have been many different influences from human actions in the watershed, natural cycles, and climatic forces. GAMs will be used on data sets including nutrient concentrations, dissolved oxygen, and chlorophyll-a, to first identify both linear and nonlinear changes over time, and ultimately to test hypotheses of the relevant factors affecting these changes. The implementation is currently being reviewed, and will be used to generate maps of tidal water quality trends and conduct integrated analyses across the tidal waters in the coming years.

C.6 Public Health Issues

C.6.1 Waterborne Disease

In the report "Outbreaks of Illness Associated with Recreational Water – United States, 2011-2012" (Centers for Disease Control 2015), data was summarized from the Waterborne Disease and Outbreak Surveillance System, a system that tracks the occurrences and causes of waterborne disease and outbreaks associated with recreational waters (both natural and artificial (e.g., pool, spa waters are included). During 2011 and 2012, waterborne disease and outbreaks associated with recreational water were reported by more than half of the states (32 states and Puerto Rico). However, there were no outbreaks of illness reported for untreated waters in Maryland during the years 2011 and 2012.

The Cholera and Other Vibrio Illness Surveillance (COVIS) system, also supported by the CDC, identifies illnesses due to the naturally-occurring aquatic bacteria, *Vibrio sp*. "Most people become infected by *Vibrio* by eating raw or undercooked shellfish, particularly oysters. Certain *Vibrio* species can also cause a skin infection when an open wound is exposed to brackish or salt water" (CDC 2016). In 2012, a total of 944 *Vibrio* cases were reported from 42 different states. Cases classified as confirmed or probable non-foodborne (likely associated with recreational water) comprised approximately 37% (335) of this total. Food-borne cases accounted for 54% (492) with the remaining 8% having an unspecified transmission route. A total of forty-seven cases of *Vibrio sp*. illness (both food-borne and non-foodborne) were reported in Maryland waters in 2012. In this report, the majority of all *Vibrio* patients had illness onset in the summer months with the illness records peaking in the July-August timeframe.

C.6.1.1 Research Summary

In 2006, US Environmental Protection Agency's (EPA) Office of Research and Development and Office of Water published a series of papers summarizing the research conducted on waterborne disease in the last 10 years. The work includes research supported by EPA and others and is limited to gastrointestinal illness as the health effect of concern. The 1996 Safe Drinking Water Act Amendments mandated that EPA and the US Centers for Disease Control (CDC) and Prevention conduct five waterborne disease studies and develop a national estimate of waterborne disease. In response, EPA, CDC, and other authors produced a series of papers that reviews the state of the science, methods to make a national estimate of waterborne disease, models that estimate waterborne illness, and recommendations to fill existing data gaps. The papers represent the most comprehensive review conducted in the last 25 years and the first publication of modeling information that estimates waterborne illness on a national level. The papers have been published and are online at: http://www.epa.gov/nheerl/articles/2006/waterborne_disease.html.

C.6.2 Drinking Water

The Maryland Department of the Environment (MDE) is charged with ensuring that all Marylanders have a safe and adequate supply of drinking water. The Department has programs to oversee both public water supplies, which serve about 84 percent of the population's residential needs, and individual water supply wells, which serve citizens in most rural areas of the State. Marylanders use both surface water and ground water sources to obtain their water supplies. Surface water sources such as rivers, streams, and reservoirs serve approximately two-thirds of the State's 5.8 million citizens. The remaining one-third of the State's population obtains their water from underground sources. For more details on the State's drinking water programs, go to http://www.mde.state.md.us/programs/Water/Water_Supply/Pages/Programs/WaterPrograms/water_supply/index.aspx.

C.6.3 Shellfish Harvesting Area Closures

Maryland's Chesapeake Bay waters have long been known for their plentiful shellfish. The Maryland Department of the Environment is responsible for regulating shellfish harvesting waters so as to safeguard public health.

Shellfish include clams, oysters, and mussels. The term shellfish does not include crabs, lobsters, or shrimp. Shellfish are filter-feeding animals: they strain the surrounding water through their gills which trap and transfer food particles to their digestive tract. If the water is contaminated with disease-causing bacteria, the bacteria are also trapped and consumed as food. If shellfish are harvested from waters which the Department has restricted (closed) and eaten raw or partially cooked, they have the potential to cause illness. Therefore, it is mandatory for oysters and clams to be harvested from approved (open) shellfish waters only.

Shellfish harvesting waters which are open or approved for harvesting are those where harvesting is permitted anytime during the shellfish season. Areas which are conditionally approved mean that shellfish harvesting is permitted except for the three days following a rain event of greater than one inch in a twenty-four hour period. Runoff from such a rainfall can carry bacteria into surface waters from adjacent land. Information about which areas have conditional closures is updated daily on the web and via a phone message. Click http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/harvesting_notices/index.aspx to find out which conditional closures are in effect or call 1-800-541-1210. The Department of the Environment has also created an online interactive map that provides timely information showing approved shellfish harvesting areas, conditionally approved areas, and closed or restricted areas. This map can be accessed at: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/pop_up/shellfishmaps.aspx.

MDE's Science Services Administration (SSA) is responsible for regulating shellfish harvesting waters. This effort has three parts: 1) identifying and eliminating pollution sources, 2) collecting water samples for bacteriological examination; and 3) examining shellstock samples for bacteriological contamination and chemical toxicants.

C.6.4 Toxic Contaminants Fish Consumption Advisories

The U.S. Food and Drug Administration (FDA) issues fish consumption guidance for common commercial fish (fish bought in stores and restaurants) sold throughout the nation. The Maryland Department of the Environment (MDE) is responsible for monitoring and evaluating contaminant levels in recreationally-caught fish (includes fish, shellfish and crabs) in Maryland waters. The tissues of interest for human health include the edible portions of fish (fillet), crab (crabmeat and "mustard"), and shellfish ("meats"). Such monitoring enables MDE to determine whether the specific contaminant levels in these species are within safe limits for human consumption. Results of such studies are used to issue consumption guidelines for fish, shellfish, and crab species in Maryland (http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/index.aspx). Additionally, since fish, shellfish, and crabs have the potential to accumulate inorganic and organic chemicals in their tissues (even when these materials are not detected in water), monitoring of these species becomes a valuable indicator of environmental pollution in a given water body.

C.6.4.1 Fish Tissue Monitoring

The Maryland Department of the Environment has monitored chemical contaminant levels in Maryland's fish since the early 1970s. The current regional sampling areas divide the State waters into five regions:

- Eastern Shore water bodies,
- Harbors and Bay,
- Baltimore/Washington urban waters,
- Western Bay tributaries, and
- Western Maryland water bodies.

Maryland routinely monitors watersheds within these four zones on a 5-year cycle. When routine monitoring indicates potential hazards to the public and environment, additional monitoring of the affected area may be conducted to verify the initial findings and identify the appropriate species and size classes associated with harmful contaminant levels. Findings from such studies are the basis for the fish consumption guidelines found at: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/index.aspx.

The types of fish sampled include important predatory game species (such as small mouth bass and striped bass), common recreational panfish species (white perch, bluegill, crappie) as well as bottom dwelling accumulator species with relatively high fat content (such as carp, catfish and American eel). Also, periodically, MDE conducts intensive surveys of contaminant levels in selected species in specific water bodies. Past targets of intensive surveys conducted in Patapsco River/Baltimore Harbor included: white perch, channel catfish, eel, and striped bass.

C.6.4.2 Shellfish Monitoring

In the 1960s, the Maryland Department of the Environment began surveying metal and pesticide levels in oysters and clams from the Chesapeake Bay and its tributaries. Prior to 1990, this effort was conducted every one or two years. In response to low levels of contaminants found and very little change from year to year, shellfish are not monitored routinely for chemical contaminants. This allows MDE to devote its limited resources toward intensive surveys in areas where contamination is more likely.

While monitoring has shown no chemical contaminants at levels of concern in any of the oysters sampled, recreational harvesters should still be aware of possible bacterial contamination and avoid shell-fishing in areas that are closed to commercial shellfish harvesting.

C.6.4.3 Crab Monitoring

Between 2001 and 2003 a study of blue crab (Callinectes sapidus) tissue revealed elevated levels of polychlorinated biphenyls and other contaminants in the “mustard” (hepatopancreas) of crabs caught from the following locations:

- Cedar Point,
- Fairlee Creek,
- Hart-Miller Island,
- Middle River, and
- Patapsco River/Baltimore Harbor.

Crabmeat was found to be low in contaminants. Specific recommendations for crab “mustard” have not been developed for all locations. However, in general, it is advised that the “mustard” from crabs taken from the Northern Chesapeake Bay (above Magothy River) should be consumed in moderation, while “mustard” from the previously mentioned locations should be eaten sparingly and avoided for the crabs from the Patapsco River/Baltimore Harbor area.

C.6.5 Harmful Algal Blooms

Algae are a natural and critical part of our Chesapeake and Coastal Bays ecosystems. Algae, like land plants, capture the sun’s energy and support the larger food web that leads to fish and shellfish. They occur in size range from tiny microscopic cells floating in the water column (phytoplankton) to large mats of visible “macroalgae” that grow on bottom sediments.

Algae may become harmful if they occur in an unnaturally high abundance or if they produce a toxin. A high abundance of algae can block sunlight to underwater bay grasses, consume oxygen in the water leading to fish kills, produce surface scum and odors, and interfere with the feeding of shellfish and other organisms that filter water to obtain their food. Some algal species can also produce chemicals that are toxic to humans and aquatic life. Fortunately, of the more than 700 species of algae in Chesapeake Bay, less than 2 percent of them are believed to have the ability to produce toxic substances. MDE and DNR conduct algal bloom complaint response and monitoring that provides useful water quality data, a priori data related to fish kills, and protection for recreational water users and shellfish consumers. MDE also employs ELISA technology to test water and shellfish tissue for ambient and bio-accumulated toxins in support of this effort. MDE, DNR, and DHMH work cooperatively to issue health advisories as warranted.

MDE is the lead agency with the responsibility for investigating, responding, and reporting on fish kills throughout the state. DNR jointly investigates when fish kills are the result of disease and provides other support as needed. The two agencies operate with a standard monitoring plan to ensure that basic information is obtained in a timely manner. Depending upon the nature of the event and the condition of the fish, field investigators will collect, count, and identify affected organisms. Appropriate water, algae identification and enumeration, and tissue samples are collected for laboratory analysis. This includes samples for nutrients, pesticides, (and other hazardous materials), the presence of harmful algae species and their toxins. Field measurements, such as temperature, pH, dissolved oxygen, and other related water quality measures are taken and recorded. Fish and fish tissue samples for histological and pathological examination are collected, when required, and transported to cooperating laboratories.

In the three year period from 2013 to 2015, the State identified and investigated 28 HAB events where significant risk to human health from contacting or ingesting water existed (18 Contact advisories were initiated), 2 fish kills associated with toxic algae, and 6 fish kills associated with oxygen deprivation caused directly by non-toxic algal blooms. An additional 26 fish kills occurred that were attributed to low dissolved oxygen with indirect links to algae and nutrient enrichment. Both MDE and DNR will continue to work with the Bay Program to develop, where appropriate, standards or other measures to protect both human health and aquatic life from harmful algal blooms.

For more information on harmful algal blooms or fish kill investigations please visit http://www.dnr.state.md.us/bay/hab/index.htm or http://www.mde.maryland.gov/programs/water/319nonpointsource/pages/mdfishkills.aspx.

C.6.6 Bathing Beach Closures

In October 2000, the U.S. Environmental Protection Agency (EPA) passed the Beaches Environmental Assessment and Coastal Health (BEACH) Act and provided funding to improve beach monitoring in coastal states. The BEACH Act allows states to define and designate marine coastal waters (including estuaries) for use for swimming, bathing, surfing, or similar water contact activities. The State of Maryland defines beaches in the Code of Maryland Regulations (COMAR, http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.09.01.htm) as "natural waters, including points of access, used by the public for swimming, surfing, or other similar water contact activities." Beaches are places where people engage in, or are likely to engage in, activities that could result in the accidental ingestion of water. In Maryland, the beach season is designated from Memorial Day to Labor Day. Maryland's water quality standards and regulations for beaches are published in COMAR 26.08.09 and 26.08.02.03. Some important points are:

1. *E. coli* and Enterococci are the bacteriological indicators for beach monitoring;

2. Prioritization of monitoring of beaches is based on risk; and
3. All beaches, whether permitted or not, now receive protection.

The Maryland Department of the Environment works with local health departments to enhance beach water quality monitoring and improve the public notification process to protect the health of Marylanders at public bathing beaches. The State Beaches program is administered by MDE; however, the responsibility of monitoring and public notification of beach information is delegated to the local health departments (http://www.mde.maryland.gov/programs/Water/Beaches/Pages/beaches_healthdepts.aspx). To protect the health of citizens visiting beaches across Maryland, MDE's Beaches Program is working to standardize and improve recreational water quality monitoring. In addition, MDE provides access to timely information to inform the public of beach closures, advisories, and algal blooms before they head to the beach. This information is accessible through the web or by downloading a smartphone application from the following web page (http://www.marylandhealthybeaches.com/current_conditions.php).

Worth noting, in November 2012, the United States Environmental Protection Agency (EPA) released new recommendations for recreational water quality criteria to meet the requirements of the amendments to the Clean Water Act by the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, the federal law that refined standards for water quality at public beaches. Maryland will be adopting the new nationally recommended recreational water quality criteria in its 2016 Triennial Review of Water Quality Standards. The criteria adopted are shown in the following table.

Table 40: Maryland Proposed (for the 2016 Triennial Review) Recreational Water Quality Criteria.

	Geometric Mean (Counts/100 mL)	**Statistical Threshold Value (Counts/100 mL)**
E. coli (freshwater) - culturable	126	410
Enterococci (freshwater or marine) - culturable	35	130

C.6.7 Combined and Sanitary Sewer Overflows

Previously, Maryland's bacteria assessment methodology (2014) included a decision process for assessing water bodies that were affected by combined sewer overflow (CSO) and/or sanitary sewer overflow (SSO) events in the absence of water quality data. In response to public comments provided for the 2014 Integrated Report, in 2015 MDE reviewed the basis for this decision process and decided that it was inappropriate to list waters (as impaired) based solely on overflow information alone. Rationale for this change centered on the shortcomings of using CSO/SSO records as a surrogate for the standard public health assessment methods that use indicator counts and sanitary surveys. The wide variability in water body size, flow characteristics, and residence time also made it difficult to apply this decision process with the scientific rigor necessary to make impairment determinations.[17] In addition,

[17] Additional more-detailed justification is provided in Section C.2.1.

the Department noted the various mechanisms, already in place, that are designed to remediate and provide public notification of CSOs and SSOs. As a result, the Department has decided that it will not assess waters on the basis of CSO or SSO event information alone. Instead, for general notification purposes, MDE will provide tables showing those waters that have received 3 or more overflows of 30,000 gallons or more in the previous 5 year period. The Department will also include information in these tables on whether a consent decree has been established and/or whether water quality data has already been collected and resulted in an impairment listing. Doing this will continue to provide the public with information on which sewage collection systems are most in need of repair without making unsupported water quality impairment determinations. The tables below describe the pertinent overflow events.

Table 41: Summary of combined sewer overflows (CSO) of 30,000 gallons or more that occurred 3 or more times over the past 5 years (2010-2014).

Receiving Waters	NPDES Permit	# Exceedences (≥30,000 gallons) from 2010 thru 2014	City/County	Consent Decree	IR Status for Bacteria
Braddock Run	MD0067547	156	La Vale/Allegany	✓	Listed and TMDL complete
Choptank River	MD0021636	253	City of Cambridge/Dorchester	✓	Multiple shellfish areas listed with TMDLs complete
Evitts Creek	MD0021598	3	City of Cumberland/Allegany County	✓	Not listed
George's Creek	MD0067384	14	Westernport/Allegany	✓	Listed and TMDL complete
George's Creek	MD0067407	80	Dept. Public Works/Allegany	✓	Listed and TMDL complete
George's Creek	MD0067423	62	Frostburg/Allegany	✓	Listed and TMDL complete
Jennings Run	MD0067423	4	Frostburg/Allegany	✓	Listed under Wills Cr. And TMDL complete
North Branch Potomac River	MD0021598	473	City of Cumberland/Allegany County	✓	Listed on Category 3 (insufficient information)
Sand Spring Run	MD0067423	11	Frostburg/Allegany	✓	Listed and TMDL complete
Wills Creek	MD0021598	126	City of Cumberland/Allegany County	✓	Listed and TMDL complete

Table 42: Summary of sanitary sewer overflows (SSO) of 30,000 gallons or more that occurred 3 or more times over the past 5 years resulting from the same facility or occurring within the same jurisdiction (2010-2014).

Receiving Waters	Owner of Collection System	# Exceedences (≥30,000 gallons) from 2010 thru 2014	City/County	Consent Decree	IR Status for Bacteria
Back River	City of Baltimore/Baltimore County DPW	5	City of Baltimore/Baltimore County		Listed and TMDL complete
Big Hunting Creek	Town of Thurmont	10	Frederick County	✓	Listed and TMDL complete
Broad Creek	Washington Suburban Sanitation Commission	10	Prince George's County	✓	Not listed
Bush River	Harford County DPW/Dept. of the Army	7	Harford County		Not listed
Chesapeake Bay	Calvert County DPW/Anne Arundel County DPW/ Town of Chesapeake Beach	3	Calvert County/Anne Arundel County		Not listed
Conocheague Creek	Washington County Dept. of Water Quality	4	Washington County		Listed and TMDL complete
Deep Creek Lake	Garrett County DPW	3	Garrett County		Not listed
Falls Creek	Washington County Dept. of Water Quality/ Washington County DPW	6	Washington County		Listed and TMDL complete
Gwynns Falls	City of Baltimore/Baltimore County DPW	54	City of Baltimore/Baltimore County	✓	Listed and TMDL complete
Herring Run	City of Balimore/Baltimore County DPW	39	City of Baltimore/Baltimore County	✓	Listed and TMDL complete
Jennings Run	Allegany County DPW	25	Allegany County	✓	Listed under Wills Cr. and TMDL complete
Jones Falls	City of Baltimore/ Baltimore County DPW	15	City of Baltimore/Baltimore County	✓	Listed and TMDL complete
Little Patuxent River	Howard County DPW/Dept. of the Army	4	Howard County/Anne Arundel County		Listed on Category 3 (insufficient information)
Maidens Choice Creek	Baltimore County DPW	31	Baltimore County	✓	Listed and TMDL

Receiving Waters	Owner of Collection System	# Exceedences (≥30,000 gallons) from 2010 thru 2014	City/County	Consent Decree	IR Status for Bacteria
					Complete
North Branch Potomac River	Allegany County DPW	35	Allegany County	✓	Listed on Category 3 (insufficient information)
Northeast Creek	Baltimore County DPW	3	Baltimore County	✓	Not listed
Tidal Patapsco including Inner Harbor	City of Baltimore/	8	City of Baltimore/Baltimore County	✓	Listed on Category 5, TMDL not yet complete
Non-tidal Patapsco River	Baltimore County DPW/ Carroll County DPW/ Howard County DPW	8	Baltimore County/Carroll County/Howard County	✓	Listed and TMDL Complete
Pea Vine Run	Allegany County DPW	28	Allegany County	✓	Not listed
Piscataway Creek	Washington Suburban Sanitation Commission	9	Prince George' County	✓	Listed and TMDL complete
Port Tobacco River	Town of La Plata/ La Plata WWTP	3	Charles County	✓	Listed on Category 5
Potomac River	Charles County DPW	3	Charles County		Not Listed
Stemmers Run	Baltimore County DPW	17	Baltimore County	✓	Not Listed
Swan Creek	City of Aberdeen	3	Harford County		Not listed
Tributary to Port Tobacco Creek	La Plata WWTP	3	Charles County	✓	Listed on Category 5
Unnamed Tributary to Evitts Creek	Allegany County	10	Allegany County		Not Listed
Warrior Run	Allegany County DPW	30	Allegany County	✓	Listed in Category 3
Western Branch	Washington Suburban Sanitation Commission	6	Prince George's County	✓	Not listed
Wicomico River	City of Salisbury	5	Wicomico County		Not Listed
Wills Creek	Allegany County DPW/City of Cumberland	40	Allegany County/Washington County	✓	Listed and TMDL complete

C.7 Invasive aquatic species

'New' species of viruses, animals, and everything in-between (e.g., amphibians, reptiles, birds, insects, plants, fish, shellfish, even jellyfish) are being introduced at an increasing rate into Maryland. Since colonization, new species have been introduced through a variety of pathways, including ship ballast, in packing materials, and through deliberate import for various uses. While most of these introduced species are beneficial or benign, about 15 percent become invasive - showing a tremendous capacity for reproduction and distribution throughout its new environment. These invasive species can have a negative impact on environmental, economic, or public welfare priorities.

Many introduced species once thought to be beneficial (e.g., grass carp, mute swans, and nutria) have demonstrated invasive characteristics and are proving difficult to control - out-competing native species (species of plants and animals that have evolved in the State and have developed mutually-sustaining relationships to each other over geologic time) for food, shelter, water or other resources, as well as affecting economic interests and human welfare.

Some of the many aquatic invasive species that have recently consumed a significant level of state and federal agency resources include:

- mute swans (*Cygnus olor*)
- nutria (*Myocaster coypus*)
- zebra mussels (*Dreissena polymorpha*)
- Hydrilla (*Hydrilla verticillata*)
- water chestnut (*Trapa patens*)
- phragmites (*Phragmites australis*)
- purple loosestrife (*Lythrum salicaria*)
- wavyleaf basketgrass (*Oplismenus hirtellus ssp. undulatifolius*)
- Chinese mitten crab (*Eriocheir sinensis*)
- several species of crayfish
- snakehead (*Channa argus*)
- Didymo (*Didymosphenia Geminata*)
- Blue catfish (*Ictalurus furcatus*)
- Flathead catfish (*Pylodictis olivaris*)

Information about these and other invasive species are available online from the Department of Natural Resources (http://www.dnr.state.md.us/invasives/), the Smithsonian Research Center, and the US Department of Interior's Fish and Wildlife Service and Geological Survey.

In 2007, the Department of Natural Resources created an Invasive Species Matrix Team to study and direct scientifically-based policy and management responses to the ecological, economic, and public health threats of invasive species in Maryland's native ecosystems (contact Jonathan McKnight at: 410-260-8539; mailto: jonathan.mcknight@maryland.gov. Specific objectives of this intra-agency team are to:

- Provide recommendations to the Secretary of Natural Resources on invasive species policies and regulations.

- Develop a framework for surveillance and monitoring programs designed to detect invasive species introductions and track their dispersal.
- Coordinate rapid response efforts when new invasive species are detected.
- Recommend agency actions and public education programs to prevent new introductions and control the increase/spread of invasive species into non-infested landscapes/waters.
- Develop a list of non-native species introductions into Maryland.
- Share and interpret data, knowledge, and experience on invasive species within Maryland, as well as other state, local, interstate, and federal agencies.
- Develop an Invasive Species Management Plan for Maryland, in cooperation with other organizations, that provides a coordinated, multi-agency strategy to achieve the objectives listed above.

The Invasive Species Management Plan for Maryland is currently under development. It clarifies and strengthens the roles and relationships between agencies in conducting all anti-invasive species efforts.

PART D: GROUND WATER MONITORING AND ASSESSMENT

Groundwater is a finite natural resource that sustains Maryland's natural ecosystems in addition to supporting significant and growing human water supply demands. Approximately one third of Maryland's population currently depends on groundwater for drinking water. As the population in Maryland continues to grow, the demand for groundwater for drinking, irrigation, industry, and other uses is increasing, while threats to groundwater quality related to that development increase as well.

Senate Joint Resolution No. 25 of 1985 requires the Maryland Department of the Environment (MDE) to provide an annual report on the development and implementation of a Comprehensive Ground Water Protection Strategy in the State and on the coordinated efforts by state agencies to protect and manage ground water. Since the development of the original strategy, a variety of state programs at MDE, the Maryland Department of Agriculture (MDA) and the Maryland Department of Natural Resources (DNR) have endeavored to protect ground water resources and characterize the quality and quantity of these resources.

Programs to better understand and manage this critical resource must be strengthened to ensure that an adequate supply of groundwater is available for existing and future generations. Continuation and enhancement of programs that protect this resource must remain a priority, yet the financial support for this important program is often overlooked. In order to ensure the long-term viability of Maryland's groundwater resource, MDE will need additional resources to facilitate a better understanding and implement a comprehensive strategy for the protection of this critical resource.

The most recently approved groundwater protection report provides an overview of the Fiscal Year 2013 activities and accomplishments of state programs that are designed to implement Maryland's Comprehensive Ground Water Protection Strategy. Highlights of groundwater management initiatives coordinated by the State during fiscal year 2013 (July 1, 2012 – June 30, 2013) include:

- As part of the Fractured Rock Water Supply Study, four reports were published, including the Fractured Rock Science Plan. Two other reports assessed factors affecting well yield in the fractured rock areas of Maryland and the impacts of water withdrawals on the hydroecological integrity of fractured rock streams. The fourth report is a statistical classification of fractured rock catchments (groups of watersheds) into hydrogeologic regions, based on climatic, topographic, and geologic variables. Lack of funding in FY2013 precluded any significant activity on the Coastal Plain Groundwater Study.
- Work continued under the Marcellus Shale Safe Drilling Initiative to determine whether and how gas production from the Marcellus Shale can be accomplished without unacceptable risk. MDE contracted with the University of Maryland Center for Environmental Science, Appalachian Laboratory, to survey best practices for Marcellus Shale drilling. A suite of best practices suitable for Maryland was presented in a report of recommendations to MDE.
- The USGS published a study on groundwater impacts from the Pearce Creek Dredge Material Containment Area (DMCA) in Cecil County. The study concluded that the dredge spoils disposal site has degraded water quality in nearby residential wells. The Cecil County Department of Health is working to test potentially affected residential wells to determine if the water is acceptable for drinking and other household uses. Additionally, MDE is working with the US

Army Corps of Engineers to study the influence of the Courthouse Point Dredge Material Disposal Area, also in Cecil County, on groundwater quality.

- MDE worked with contractors to develop wellhead protection plans for 20 communities with drinking water wells that are vulnerable to contamination. Recommended actions for source protection include outreach measures, land ordinances, agricultural best management practices, and protection of undeveloped lands.
- MDE published a final regulation that requires nitrogen-removal technology for all on-site sewage disposal systems serving new construction on land draining to the Chesapeake Bay and Atlantic Coastal Bays, or in other areas impaired by nitrogen. On-site sewage disposal systems each discharge an average of 23 pounds of nitrogen per year to groundwater. Systems with the best available nitrogen removal technology will produce half as much pollution as their traditional counterparts.
- Work on the recommendations made by the Governor's Advisory Committee on the Management and Protection of the State's Water Resources (Wolman Commission) came to a halt due to lack of funding.

Stakeholders interested in reading the full FY2013 groundwater report can visit: http://mde.maryland.gov/programs/Water/Water_Supply/Pages/Publications%20and%20Reports.aspx.

PART E: PUBLIC PARTICIPATION

MDE utilizes a public participation process for Integrated Report (IR) similar to that used for promulgation of new regulations. The Administrative Procedures Act mandates that a minimum of 30 days from the date of publication in the Maryland Register must be allowed for public review and comment. The Department is granting 32 days for public review of the draft 2016 Integrated Report of Surface Water Quality. Besides posting an announcement in the Maryland Register (on December 23, 2016), MDE is also posting announcements through the following outlets:

- The MDE home web page,
- MDE's Integrated Report web page,
- Several of MDE's social media outlets (e.g. Facebook),
- The Maryland Water Monitoring Council Announcement web page (http://dnr2.maryland.gov/streams/Pages/MWMC/BulletinBoard.aspx), and
- Targeted emails to the TMDL contact list (approximately 500+ contacts) which includes representatives of federal, state, and local government, academia, and other non-government organizations.

The draft Integrated Report is made available in electronic format to the public via the Internet (http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/2016IR.aspx) and in hard copy format by special request to Rebecca Lang at rebecca.lang@maryland.gov or 410-537-3947. *Please note that the Department charges a fee (36¢/page) for printing and shipping hard-copy reports.*

During the open comment period for the IR, an informational public meeting will be held at MDE's headquarters to facilitate dialogue between MDE and stakeholders concerning the format, structure, and content of the draft IR. MDE is also engaging interstate river basin commissions, non-government organizations (NGOs), and watershed councils during the public comment period and will provide full presentations on the Maryland Integrated Report if requested.

All comments or questions should be directed in writing to the Department. All comments submitted during the public review period will be fully addressed below in the comment response section included with the final Integrated Report submitted for EPA approval.

E.1 Informational Public Meeting Announcement

Department of the Environment
Informational Public Meeting Announcement:
Maryland's Draft 2016 Integrated Report of Surface Water Quality

The Federal Clean Water Act requires that States assess the quality of their waters every two years and publish a list of waters not meeting the water quality standards set for them. This list of impaired waters is included in the State's biennial Integrated Report (IR) of Surface Water Quality. Waters identified in Category 5 of the IR are impaired and may require the development of Total Maximum Daily Loads (TMDLs). The Maryland Department of the Environment (MDE) is announcing the availability of the Draft 2016 IR for public review and comment. The public review period will run from **December 23 to January 23, 2017**. The Draft IR is being posted on MDE's website at http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx. Hard copies of the Draft IR may be requested by calling Ms. Rebecca Lang at (410) 537-3947. *Please note that the Department charges a fee to cover printing and shipping costs.*

The Department is hosting an informational public meeting and conference call in Baltimore at 6pm on January 9, 2017. Any hearing impaired person may request an interpreter to be present at the meeting by giving five (5) working days notice to Rebecca Lang at rebecca.lang@maryland.gov or by calling (410) 537- 3947. Anyone wanting to participate in this meeting via conference call should also contact Rebecca Lang, in advance, for instructions. Given enough interest, the Department may schedule additional meetings. Comments or questions may be directed in writing to Mr. Matthew Stover, MDE, Science Services Administration, 1800 Washington Blvd., Baltimore, Maryland 21230, emailed to matthew.stover@maryland.gov, or faxed to the attention of Mr. Matthew Stover at 410-537-3873 on or before **January 23, 2017**. After addressing all comments received during the public review period, a final IR will be prepared and submitted to the U.S. Environmental Protection Agency for approval.

Public Meeting Announcement
Date: January 9, 2017
Start Time: 6:00 p.m.
Location: MDE Headquarters
Lobby Conference Rooms (*to the left after entering the front door*)
1800 Washington Blvd.
Baltimore MD, 21230
Parking: Red Lot, Front (south) of building

E.2 Attendance List from Informational Public Meeting

Placeholder

E.3 Comment-Response for the 2016 Integrated Report

Table 43: Placeholder for the List of Commentors.

Author	Affiliation	Date Received	Comment Numbers