MARYLAND DEPARTMENT OF THE ENVIRONMENT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMITS

2021 MS4 MONITORING GUIDELINES:

BMP EFFECTIVENESS AND

WATERSHED ASSESSMENTS

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INTRODUCTION

The Maryland Department of the Environment (the Department, or MDE) is updating the monitoring requirements outlined in the *Assessment of Controls* portion of National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permits issued to Phase I jurisdictions within the State. The overall goal is to evaluate the effects of best management practice (BMP) implementation and other management strategies on local water quality. The requirements include *BMP Effectiveness* monitoring and *Watershed Assessment* monitoring.

BMP Effectiveness monitoring requires permittees to conduct chemical, biological, and physical monitoring at a stream of choice in a subwatershed within their jurisdiction. The permittee must choose an outfall and an in-stream location along that stream to collect samples. A monitoring location is chosen where the density of proposed restoration BMPs is comparatively high relative to the watershed size. *Watershed Assessment* monitoring requires permittees to conduct biological, bacteria, and conductivity monitoring throughout the jurisdiction. Results of both monitoring programs will be used to evaluate the effects of BMP implementation, salt management practices, and bacteria control strategies to assess the overall health of biological communities in these watersheds.

Permittees also have the option to participate in a pooled monitoring program ("pool") coordinated through the Chesapeake Bay Trust (CBT) to meet the *BMP Effectiveness* and/or the *Watershed Assessment* monitoring requirements. Permittees participating in the pool to meet either or both monitoring requirements must establish a Memorandum of Understanding (MOU) with CBT and collaborate with other State-wide funding partners. A copy of the MOU between the CBT and the individual jurisdiction is available in Appendix I for the *BMP Effectiveness* monitoring and in Appendix II for the *Watershed Assessment* monitoring requirements. A jurisdiction may elect to participate in either or both MOUs. In addition, the MOU for the Watershed Assessment monitoring allows a jurisdiction to participate in the pool for either the biological/habitat monitoring, or the bacteria monitoring, or the chloride monitoring, or all 3 requirements. These agreements function similarly to a contract with CBT to perform specific

work for a given jurisdiction. The pooled funds will contribute to the CBT Restoration Research Program which is intended to support scientific research and answer key questions to expand the knowledge of watershed restoration efforts across the State. Participation in the pool will offer permittees an efficient process for meeting permit requirements by collaborating monetary resources and decreasing the burden of overall monitoring expenses at the local level. However, permittees may choose to conduct their own monitoring as outlined in the permit based on local priorities and resources.

This document will provide technical guidelines and criteria for performing the required monitoring in accordance with the Assessment of Controls section of the MS4 permit. The Department requests that each jurisdiction develop a Quality Assurance Project Plan (QAPP) for all monitoring requirements. QAPP development will allow for smoother incorporation of the data into State regulatory analyses and programs. Jurisdictions should consult the United States Environmental Protection Agency's (EPA) guidance documents and informational materials when developing their monitoring QAPPs. This information can be found on EPA's website here: https://www.epa.gov/quality/epa-region-3-quality-assurance-project-plans.

BMP EFFECTIVENESS MONITORING

OBJECTIVES

The objective of *BMP Effectiveness* monitoring is to evaluate the cumulative effects of urban stormwater retrofits and alternative urban BMPs on a subwatershed scale. Monthly event mean concentrations (EMC) and flow measurements from two monitoring stations, in-stream and outfall, should be collected in a headwater watershed to estimate pollutant loadings.

MONITORING GUIDELINES

An acceptable location for this monitoring shall take place in a headwater region (1st or 2nd order on a 1:24,000 scale map) with a comparatively high density of planned restoration BMPs. In addition, watershed size and the number of planned BMPs, years of observation, sampling regularity, and data quality are all critical for detecting changes or trends in analysis. Based on a recent report published by the Interstate Commission on the Potomac River Basin (ICPRB) and Center for Watershed Protection (CWP), on behalf of the Department, to increase the probability of detecting changes in water quality from restoration, ideal monitoring study designs should include the following:

1) one or a few larger BMPs;

2) data from before and after watershed restoration practices are implemented (the longer the period of record for each time period the better); and

3) limited development over time.

In addition, to enhance the probability of detecting changes, data should maximize periods of record with minimal gaps or sample clustering during a portion of the year (Jepsen and Caraco 2019).

More detailed guidance of stormwater monitoring can be found in EPA's manual of *Urban Stormwater BMP Performance Monitoring* (EPA, 2002).

I. CHEMICAL MONITORING

a) Baseflow and Stormflow Monitoring

A minimum of 12 storm events (8 for medium Phase I jurisdictions) and 4 quarterly baseflow samples shall be monitored each year at both an in-stream and an outfall location. The permit requires collecting stormflow and baseflow measurements for total suspended solids (TSS), bacteria (*E. coli* or *Enterococcus* spp.), chloride, discharge, biochemical oxygen demand (BOD_5) or total organic carbon (TOC), orthophosphate, total nitrogen (TN), nitrate & nitrite, total ammonia, and total phosphorus (TP). A qualifying storm is an event that produces enough runoff where the rising, falling, and peak limbs of a storm hydrograph can be identified. Generally, this corresponds to at least 0.25 inches of rainfall. Recommended lab methods and detection limits listed by EPA are shown in Table 1.

Stormwater and Baseflow Representative Samples (Parameters)
Total Suspended Solids (TSS)
Bacteria (*E. coli* or *Enterococcus* spp.)
Chloride
Discharge (flow)
Biochemical Oxygen Demand (BOD_5) or Total Organic Carbon (TOC)
Orthophosphate
Total Nitrogen (TN)
Nitrate + Nitrite
Total ammonia (sewer signal)
Total Phosphorus (TP)

Based on recommendations from Jepsen and Caraco 2019, jurisdictions should attempt to capture storm events throughout all seasons of the year, with at least two occurring per quarter, as required in the permit. This will reduce any bias introduced by seasonal fluctuations in parameters, thereby enhancing future statistical change detection analyses. If extreme weather conditions (e.g., drought) persist, and or in the event of equipment failure or malfunction, these variables should be noted when the data are reported to the Department. On these occasions, a baseflow measurement shall be captured in lieu of a missing storm sample.

While not a permit requirement, jurisdictions are encouraged to employ flow paced sampling during storm events to allow for a more accurate flow weighted EMC calculation. If a jurisdiction employs flow paced sampling, this should be noted in its QAPP. During baseflow sampling, when an outfall does not have flow, it should be recorded that there was no observed flow on the sampling date. There is no need to go back and resample on a date when there is flow. It is of greater importance to have a data point paired with an in-stream baseflow measurement, whether that measurement is zero or greater.

Total ammonia has been added as a new monitoring parameter while requirements for monitoring metals (lead, copper, zinc) have been removed in the new MS4 permits. Total ammonia and pH can be used to estimate NH_3 or NH_4^+. Metals were removed from the monitoring requirements because initial trend analyses indicate that metal concentrations are decreasing among jurisdictions. Furthermore, the State has relatively few water quality impairments due to heavy metal concentrations. Elevated metal concentrations in the water column are generally isolated to specific geographies, i.e., largely those associated with historic industrial activity. The Department consulted with scientists performing restoration research in Maryland, who recommended the removal of metals from permit requirements to offset the cost of some of the new requirements in the updated monitoring programs.

Table 1[1]. The recommended lab methods and detection limits of stormwater monitoring.

Parameter	Method	Recommended Detection Limit (mg/l)
TSS	EPA 160.2	2.45
E. Coli[2]	Colilert	1 org/100 ml
Enterococcus spp.[2]	Enterolert	1 org/100 ml
Chloride	SM4110B	0.08
BOD	EPA 405.1	2
TOC	EPA 415.1	0.16
Phosphate	EPA 365.1	0.0034
TN	EPA 353.2	0.05
Nitrate/Nitrite	EPA 353.2	0.0015
Ammonium (ammonia)	SM 4500	0.009
TP	EPA 365.1	0.0015

[1] (UMCES 2020).
[2] (MDE 2020).

b) Continuous Measurements

Permittees are required to continuously record temperature, pH, discharge (flow) and conductivity at the in-stream monitoring station. The monitoring of conductivity is a new requirement in the MS4 permits. These measurements will allow for better estimates of annual and seasonal pollutant loads and reductions to calibrate watershed assessment models. The recommended interval of continuous monitoring for each parameter is outlined below:

Continuous Measurements (Parameters)	**Recommended Frequency**
Temperature	20 min
pH	hourly
Discharge (flow)	15 min
Conductivity	30 min
Turbidity[1]	2, 5, or 15 min

[1]Frequency depends on device and how a particular location responds to precipitation events

Continuous conductivity monitoring is also recommended as an added parameter by the research community with the goal of using this data to establish a relationship between chloride and conductivity. If a surrogate relationship is developed, permittees may realize a cost savings when performing monitoring in future permits. Chloride is currently identified as a primary stressor to impaired biological communities in many of Maryland's waterways. Performing conductivity monitoring to establish a surrogate relationship with chloride will provide useful data regarding the health of watersheds in the future.

Turbidity monitoring is optional but recommended by scientists because sediment is one of the primary stressors to impaired biological communities in many watersheds. Furthermore, results from continuous turbidity measurements can be used to establish a relationship between turbidity and sediment in urban stormwater. The U.S. Geological Survey's (USGS) *Proceedings of the Federal Interagency Workshop on Turbidity and Other Sediment Surrogates* (Gray & Glysson, 2003) is a useful resource for establishing a sediment and turbidity relationship. Further guidance on turbidity monitoring is forthcoming.

The USGS sediment monitoring procedures typically use a sonde that has a wiper and turbidity sensor. The USGS has estimated "fixed" costs for the operation of sensors at $5,000 per year for operation and maintenance and data QA/QC if a sensor is installed at an existing stream gage. The first year of monitoring will incur installation and upgrade costs of several thousand dollars, depending on the site. Installation of a logger at a gage station may not be feasible for first or second order streams. In these cases, permittees may consider installing a weir to allow continuous flow measurements as a surrogate to having a gage. Jurisdictions are encouraged to contact the Department with any questions regarding monitoring equipment.

II. Biological, Habitat, and Physical Monitoring

Benthic macroinvertebrate and habitat assessment should be conducted in the spring between the outfall and in-stream stations with Maryland Biological Stream Survey (MBSS) sampling protocols. Field personnel conducting the field sampling and lab work should participate in MBSS training and maintain valid certifications for Benthic Macroinvertebrate Sampling, Benthic Macroinvertebrate Laboratory Processing and Subsampling, Benthic Macroinvertebrate Taxonomy, and Physical Habitat Assessment.

Annual geomorphologic stream assessments will include a comparison of permanently monumented stream channel cross-sections and the stream profile at both the outfall and in-stream stations. It is recommended that cross sections be established every 200 - 500 linear feet along the reach where feasible in between the outfall and in-stream stations based on the site-specific conditions in order to obtain a representative dataset (Wood 2020). In addition, a hydrologic and/or hydraulic model (e.g., TR-20, HEC-2, HEC-RAS, HSPF, SWMM, etc.) shall be used in the fourth year of the permit to analyze the effects of rainfall, discharge rates, and stage.

WATERSHED ASSESSMENT AND TRENDS MONITORING

I. BIOLOGICAL MONITORING

OBJECTIVES

A streamlined field survey is required as part of the Phase I MS4 permit monitoring requirements so that the Department can compile results and evaluate the effectiveness of BMP implementation. As part of this effort, permittees are required to use the MBSS methodology to assess the community of benthic macroinvertebrates and their habitats at the watershed level. The results will be compiled with other MS4 monitoring data to allow comprehensive analyses and cross-jurisdiction comparison in the future. The objective is to understand the population dynamics of key macroinvertebrates and their relationships with habitat conditions and water quality. The resulting dataset can be used by the Department to narrow data gaps and inform future State level Integrated Report of Surface Water Quality (IR, MDE & DNR, 2014 & MDE, 2013) and biological stressor identification analyses (BSID; MDE, 2014). Ultimately this data will allow the Department to evaluate the overall water quality and aquatic life conditions of MS4 watersheds, facilitate delisting TMDLs, and inform county and State regulation and management.

SAMPLING DESIGN

To ensure data consistency and enable cross-jurisdiction analysis, a random sampling approach using MBSS protocols is required. The field sampling protocols must be based on the *Maryland Biological Stream Survey: Round Four Field Sampling Manual (Round 4: 2014-2018)* (Stranko et al, 2019). In addition, collecting *in situ* dissolved oxygen, temperature, pH, turbidity, and conductivity data using guidance found in the MBSS Round 3 manual will be required (DNR, 2007). To meet the minimum permit requirements, all permittees must follow the MBSS protocol and utilize random sampling to ensure the collected data could be used in the IR and BSID analyses.

Additional recommendations are detailed below and include choosing the random sampling sites with Generalized Random Tessellation Stratified (GTRS), adopting a “no rotation” sampling

approach (see Table 2), stratifying by at least Maryland 8-digit watershed, and adopting a 1:24,000 scale map. Incorporating these recommendations into the study design will allow the Department to use more advanced statistical analysis across jurisdictional boundaries and link the results with other Statewide restoration efforts. This will significantly enhance the temporal and spatial resolution of the data and its usefulness in data analysis. More specific information on the required field sampling protocols and recommendations are discussed below.

SUMMARY OF SAMPLING DESIGN GUIDELINE:

A. Mandatory:

1. Probability sampling design.

The Department requires random sampling design to ensure unbiased results.

2. Adopt MBSS protocol.

In the field, collect:

a) benthic macroinvertebrates,

b) *in situ* environmental data, including temperature, dissolved oxygen, pH, turbidity, and conductivity with a multi-parameter probe, and

c) habitat information, including bar formation, channel alteration, embeddedness, epifaunal substrate condition, erosion severity, observe channelization, instream habitat condition, pool/glide/eddy quality, riffle/run quality, velocity depth diversity, check presence or absence of concrete/gabion and beaver dam, and shading.

Field personnel conducting the sampling should participate in MBSS training and acquire MBSS Benthic Macroinvertebrate and Physical Habitat Assessment Certification to ensure data quality and consistency (Stranko et al., 2019; DNR, 2017 - for measuring in situ dissolved oxygen).

B. Recommended Study Design Considerations

3. GRTS sampling.

To ensure unbiased and spatially-balanced sampling, the Department recommends using EPA's *Spatially Balanced Sampling of Natural Resources* with the package "spsurvey" in R (Thomas et al., 2011; Stevens and Olsen, 2004). "Oversampling" by five times is recommended to avoid land access issues and other field site issues without losing spatial balance. There is also a graphical user interface available for GRTS sampling ("*SDrawNPS*" in R) developed by the National Park Service (Starcevich et al., 2016). Once installed, a user could easily import their stream map, choose stratification, choose sampling size (either a set number or proportion in the watershed), set up oversampling size, and output a GIS file without any code writing. It is free and user friendly to ensure spatially-balanced sampling, and it decreases the chance of concentrating sampling in one area and leaving others unaddressed, which could be common in regular random sampling procedures with ArcGIS.

4. Non-rotation sampling.

All 8-digit watersheds in each jurisdiction are recommended for sampling at least once every year. This design will address annual variability, which is likely to increase as climate change progresses. A rotational design means different regions are surveyed in different years, whereas non-rotational surveys will allow better compatibility among years and allow greater opportunity for statistical analysis when the same regions are sampled every year. The minimal recommended sample size for each jurisdiction is identified in Table 2. The Table shows that the "no-rotation" sampling design will require the least number of samples to achieve the same precision.

5. Stratified with at least 8-digit watersheds.

Stratifying with at least 8-digit watersheds along with the non-rotational study design will ensure the greatest consistency with updates to the IR, BSID, and TMDLs, which are at the 8-digit scale. However, many jurisdictions have self-defined watersheds that are smaller than a Maryland 8-digit watershed. In this case, the jurisdiction may choose to

stratify by its self-defined watersheds and the Department will aggregate this data back to the 8-digit scale.

6. Use a 1:24,000 map.

USGS's 1:24,000 National Hydrography Dataset (NHD) is the most up-to-date and detailed hydrograph dataset for the nation. Adopting this map scale will increase total stream miles and include smaller streams, closer to most restoration sites, and will be on the same map scale with the other stormwater monitoring. This will allow for more ecosystem study and cross analysis among different types of restorations and monitoring.

7. Additional *in situ* data.

While this is not a permit requirement, datasets can be enhanced by collecting data for chlorophyll, dissolved organic matter, and nitrate. This will allow real-time, highly accurate, measurements in the field with comparatively low cost.

8. Chemical grabs.

If budget allows (~$145 per grab), a chemical grab is recommended when collecting biological data followed by lab analysis for major nutrients including nitrate, nitrite, ammonia, phosphate, total nitrogen, total phosphate, and some anions (particularly chloride).

9. Fixed sites for trend analyses

While not a permit requirement, it is recommended that jurisdictions compliment random biological and habitat monitoring with fixed sites for the purpose of assessing trends over time. Fixed sites can be established by revisiting some of the original, randomly selected stations within a watershed. The Department is currently working on power analyses to determine the ideal revisiting ratio of randomly selected sites within a watershed, and this information will be shared with the jurisdictions once finalized.

10. Continuous trace study.

Collect 5-10 weekly discrete water quality samples beginning in late winter or early spring but no later than March 1 of each year, leading up to the date of biological data collection. Water quality parameters to be collected include temperature, dissolved oxygen, conductivity, major nutrients and anions, and catch data from road-salt applications the previous winter. This data will capture antecedent conditions of a biological community, increase comparability between sites, and significantly help understanding the relationships between the biological community and their surroundings in a watershed. Consider adding this informative benefit to the fixed stations.

D. QA/QC plan

To ensure data usability for further analysis and allow for compilation with other datasets, the MBSS Sampling Manual (p7-11, Stranko et al., 2019) and the Department's Biological Data Quality Guidelines (MDE, 2013) shall be followed to enhance data quality.

Table 2. Sample size per year for biological watershed monitoring to achieve 5% precision with non-rotation sampling design

County/ City	**Minimum sample size**
Anne Arundel	25
Baltimore	33
Baltimore City	20
Carroll	25
Charles	25
Frederick	25
Harford	33
Howard	25
Montgomery	33
Prince George's	25

(Dong et al, 2019. MDE_UMCES Task memo)

II. BACTERIA MONITORING

OBJECTIVES

Permittees are required to monitor monthly bacteria counts at a fixed station in each jurisdictional watershed with a bacteria TMDL. The Department recommends placing trend stations at known resources (e.g., "beach use" areas) rather than TMDL stations to prioritize areas where humans are recreating in the water or where key resources are located. The number of bacteria watersheds for each Phase I jurisdiction is noted in Appendix III, Table 5. The monthly bacteria datasets will enable both time-series analysis and trend analysis, which will help the Department to identify patterns and track the progress of bacteria source controls. If the bacteria counts are consistently high and all known sources have been remediated, permittees may need to consider source tracking and additional management strategies. Therefore, this monitoring can provide long-term records that will contribute to the adaptive management of implementation efforts in bacteria TMDL watersheds. The data will allow both the Department and permittees to determine if the current suite of implementation practices are having any effect on in-stream bacteria concentrations.

SUMMARY OF SAMPLING DESIGN GUIDELINE

A. Mandatory Guidelines:

1. Monitor bacteria TMDL watersheds

Jurisdictions are required to establish a fixed monitoring station in each bacteria TMDL watershed (*E. Coli*, *Enterococcus*, or fecal coliform for freshwater water contact recreation, marine/tidal water contact recreation, and shellfish harvesting, respectively). Stations shall be located on streams identifiable using a 1:24,000 scale map unless otherwise determined via consultation with the Department.

A bacteria monitoring station could also be at the same location where a bacteria TMDL was developed. If the bacteria monitoring site was located on a mainstem segment split between jurisdictions, permittees could either establish stations in their portion of the watershed, or they could work cooperatively and reach a cost-sharing agreement. The

permittee should consult with the Department regarding where these stations should be established.

2. Monthly sampling with EPA approved methods.

Permittees shall collect at least one monthly grab sample at each fixed station at approximately the same day and time of every month (e.g., the first Thursday of every month), regardless of weather conditions. Weather conditions should be noted for future analysis.

Sample collection shall follow the *Standard Methods for the Examination of Water and Wastewater* published by American Public Health Association (Lenore et al, 1989). General rules include using sterile containers, keeping samples in a cooler with ice until analyzed, and adopting dilution methods when samples are taken during or after heavy rains or at sites with chronically high levels of bacteria.

Sample analysis shall follow EPA approved methods (Approved CWA Microbiological Test Methods | US EPA, or listed in p.59 EPA, 2014) and laboratory testing protocols to ensure data quality and comparable results. Bacteria counts shall be expressed in Most Probable Number (MPN) to estimate the number of organisms present per sample.

More detailed methods are in 40 Code of Federal Regulations (CFR) part 136. Both sample collection and analyses shall be consistent and recorded within the jurisdiction.

3. Record flow conditions.

Flow should be recorded at each monitoring location for each sampling event. As a surrogate for recording flow for each event, jurisdictions should look up the observed mean daily flow at the nearest USGS gage in the same watershed or adjacent watershed, normalize the flow to the contributing area, and apply this ratio to the monitoring location for a particular event. Additionally, flow conditions should be recorded as high or low flow based on the nearest USGS gage and a comparison to the threshold flow percentile identified in the applicable Bacteria TMDL for the watershed. If a jurisdiction needs assistance in determining the threshold flow or threshold flow percentile, they should

contact the Department. Alternatively, flow conditions can be assumed baseline 48 hours after a storm in the absence of monitoring data. Flow measurements allow for more advanced trend analyses, and the classification of flow regime allows for analyses during low flow periods only, when water contact recreation is expected (Wymer, 2007). Low flow and high flow trend analysis can also be suggestive of bacteria sources within a watershed.

For each sample, the permittee shall report the observed concentration, flow, and flow regime for the sample date/time.

B. Recommended Guidelines

4. Molecular methods for source tracking

When high bacteria persists at stations where all known sources of bacteria have been eliminated, the Department encourages permittees to adopt microbiological performance-based methods (i.e. qPCR) for source tracking with EPA approved methods, for example EPA Method 1696 and EPA Method 1697 (EPA, 2019a, 2019b). Microbial source tracking with genotypic methods matches probes with genes from specific sources (i.e., human, dog, cow, goose, poultry, etc.); therefore, this method has better accuracy then the traditional antibiotic resistance methods, and could help permittees identify the strategies for bacterial control. More source tracking methods and guides are summarized in Scott (2002) and EPA's *Microbial Source Tracking Guide Document* (Santo-domingo et al., 2004). The Department consulted with two University laboratories that may be available to work with permittees on molecular source tracking. They may be contacted at:

Dr. Rachel T Noble - University of North Carolina at Chapel Hill (rtnoble@email.unc.edu)

Dr. Wolf T. Pecher - University of Baltimore (wpecher@ubalt.edu)

5. Weekly sampling during beach season

The objective of the required monthly bacteria sampling is to establish trends over time and identify/locate sources within a watershed. However, monthly sampling does not meet the data requirements for Integrated Report assessments. This requires a much higher frequency of sampling. Integrated Report assessments will be based on weekly sampling from Memorial Day through Labor Day (beach season). The new Integrated Report bacteria assessment methodology can be found here: Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report. Since the temporal data resolution required under the new permit does not allow for Integrated Report assessment, it is recommended that jurisdictions begin more frequent sampling, once data trends indicate that concentrations are approaching water quality standards.

III. CHLORIDE MONITORING

OBJECTIVES

Elevated chloride concentration is one of the most commonly found chemical stressors to aquatic life in non-tidal streams in Maryland according to the Biological Stressor Identification Analysis (MDE, 2014). Therefore, permittees are required to manage salt application during winter storm events by improving the efficiency of winter weather management activities. To measure the effectiveness of these new requirements, permittees must also perform chloride monitoring. The monitoring data will provide a long-term record of conductivity, which will be used to adaptively manage implementation efforts in watersheds impaired by chloride. At a statewide scale, the data will allow the Department to determine the effects of the current suite of management practices on in-stream chloride concentrations.

SUMMARY OF SAMPLING DESIGN GUIDELINE

Conductivity will be used as a surrogate for measuring in-stream chloride concentration because there is a direct correlation between in-stream conductivity (specific conductance) and chloride concentration during precipitation events where road salt is applied, and it is less expensive and potentially more accurate to monitor continuously. Conductivity measurements taken by a logger can be converted to specific conductance using software such as HOBOware Pro or other method

that uses nonlinear Natural Water Compensation in accordance with method EN 27888 (MDE 2021).

The USGS is currently working to develop surrogate relationships between specific conductance and chloride concentration, which can be applied to predict chloride concentration during non-winter storm events in the future. The latest research details the use of regression models to generate high-frequency [Cl-] time-series datasets using specific conductance as the predictor variable (Moore, Fanelli, Sekellick 2019). Permittees must conduct 30-minute instantaneous, in-stream conductivity monitoring, measured as microsiemens per centimeter (µS/cm). Selection of monitoring locations should be done in consultation with the Department. Monitoring locations should be located in watersheds that:

- Are identified as impaired by chloride on Maryland's Integrated Report of Surface Water Quality,
- Contain a significant mileage of agency jurisdiction's serviced roads (to isolate effects of management actions to the highest degree possible), and
- Is moderately to highly urbanized.

Large Phase I MS4 jurisdictions are required to monitor 2 locations, one in a 1st-order headwater stream of the selected watershed, and one in a 3rd-order, or higher, on the mainstem of the watershed system. Stream order should be determined using a 1:24,000 scale map. Medium Phase I MS4 jurisdictions are required to monitor one location in a 1st-order headwater stream of the selected watershed.

DATA REPORT

Permittees should report the daily, half-hour instantaneous and the daily maximum conductivity values. Permittees should also summarize and report the mean, median, 75th-percentile, 90th-percentile, and maximum conductivity values collected during wintertime (November 1st through March 31st) and non-wintertime (April 1st through October 31st). During frozen precipitation events, a factor of 0.24 measured in microsiemens per centimeter can be used for winter in-stream conductivity values as a rule of thumb to estimate milligrams of chloride per liter (Moore, Fanelli, Sekellick 2019).

EQUIPMENT

Conductivity loggers can be purchased from various water quality instrumentation companies. Jurisdictions are encouraged to contact the Department with any questions regarding monitoring equipment. A logger usually costs approximately $750. Loggers need to be cleaned about once per month to ensure functionality. Additional details on logger installation, maintenance and conductivity monitoring can be found in the Department's Chloride Monitoring Quality Assurance Plan and Logger Instruction Manual (provide on request) or USGS's Guidelines and Standard Procedures for Continuous Water-Quality Monitors (Wagner et al., 2006).

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APPENDIX I. MOU FOR THE BMP EFFECTIVENESS POOL MONITORING

Chesapeake Bay Trust – County/City/Agency X Cooperative Agreement

COOPERATIVE AGREEMENT

THIS COOPERATIVE AGREEMENT ("The Agreement"), entered into this _day of _____, 202_, by and between the

COUNTY/CITY/AGENCY, MARYLAND

XXXXX

XXXXXX

(A Body Corporate and Politic, "the County/ City/ Agency")

and

CHESAPEAKE BAY TRUST

108 Severn Ave

ANNAPOLIS, MARYLAND 21403

("The Trust")

WHEREAS, the County/ City/ Agency and the Trust share a common interest in improvement of water quality in the County/ City/ Agency's tributaries and advancing the community's understanding and improvement of methods by which to do so.

WHEREAS, the County/ City/ Agency has opted into the Pooled Monitoring program as described in the BMP Effectiveness section of the County/ City/ Agency's National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit.

WHEREAS, the Trust administers the Pooled Monitoring Program to answer key restoration questions pertaining to cumulative impacts of watershed restoration activities and the effectiveness of specific restoration practices using robust and rigorous methods.

WHEREAS, the Trust, a nonprofit entity established by the Maryland General Assembly in 1985 to promote public awareness and participation in the restoration and protection of the water quality, aquatic and land resources of the Chesapeake Bay, and other aquatic and land resources of the State, is authorized to contract with other units of government, including the County/ City/ Agency; and

WHEREAS, the Trust has a governance and oversight structure with formal representation from the local government, State natural resource agencies, and the Maryland General Assembly, and uses independent technical review committees to review proposals and recommend awards made through its competitive award programs; and

NOW, THEREFORE, for and in consideration of the mutual covenants contained herein, the parties agree as follows:

ARTICLE I. SCOPE OF WORK

The Trust administers the Pooled Monitoring Program as described in the *Assessment of Controls* section of the County/ City/ Agency's MS4 permit. The goal of the Pooled Monitoring program is to align monitoring and other resources from multiple sources to rigorously and effectively answer key questions about efficacy of watershed restoration projects, impact of

restoration projects, ability to detect water quality signals from restoration projects or suites of projects (at either the project or catchment scale), and other similar questions. The specific questions to be addressed in each program cycle are determined by the Pooled Monitoring Advisory Committee (PMAC), on which the County/ City/ Agency will have one (1) seat as per the PMAC charter (Attachment A to this agreement, which is expressly incorporated herein and made part of this Agreement).

Questions are posed via open, competitive, publicized Requests for Proposals for each program cycle by the Trust, in consultation with the PMAC. The Trust uses an external peer review process to review proposals, and reviews are discussed and proposals recommended for funding to the Trust board by the PMAC. The Trust, in consultation with the PMAC, manages subsequent awards, and works with the PMAC to interpret and present results for and to various stakeholder audiences.

ARTICLE II. CONSIDERATION AND METHOD OF PAYMENT

The County/ City/ Agency has opted to participate in the Pooled Monitoring Program option for MS4 monitoring as described in the *Assessment of Controls* section of the County/ City/ Agency's MS4 permit at a funding level of $_____($x_____) per year for the five-year permit term/ for the remainder of the MS4 permit term as determined by the Maryland Department of the Environment (the Department), the regulatory entity governing compliance with the monitoring section of the MS4 permits.

The County/ City/ Agency may provide additional funds to the Trust upon written agreement by both parties.

The County/ City/ Agency shall provide the annual amount identified above to the Trust in July of each year for the duration of this Agreement. The Trust shall place the award funds in an account to be used solely for administering the Pooled Monitoring Program.

To accomplish the Scope of Work and manage the Program, an amount not to exceed five percent (5%) may be allocated by the Trust to administrative expenses. Copies of financial and programmatic reports prepared by the Trust for the Pooled Monitoring Advisory Committee and

Maryland Department of the Environment will be submitted to the County/ City/ Agency quarterly for quarters ending September 30, December 30, March 31, and July 31 of each year.

The Trust agrees to follow a cost accounting practice, which is in accordance with the standards, principles, and procedures in Code of Maryland Regulation (COMAR) 21.09 and uniform accounting practices of the profession, as acceptable to the County/ City/ Agency.

ARTICLE III. TERM AND RENEWAL

The Agreement Period shall be from XXXXX, 2021, through XXXXX, 2026. The agreement shall be renewable for additional terms of five (5) years upon written agreement by both parties.

ARTICLE IV. AGREEMENT REPRESENTATIVES

The following individuals shall have authority to act under this Agreement for their respective parties:

Jurisdiction/Agency: ***Jurisdiction/Agency X***

_____

XXXXX Division

(XXX) XXX-XXXX

Trust: ***Jana Davis, Ph.D.***
Executive Director
Chesapeake Bay Trust
410-974-2941 x100
jdavis@cbtrust.org

ARTICLE V. KEY PERSONNEL

The parties agree that the following named individuals are considered to be essential to the work being performed hereunder and are designated as key personnel who shall be made available to the full extent required to carry out the work under this Agreement:

County/ City/ Agency ***County/ City/ Agency X***
XXXXX Division
(XXX) XXX-XXXX

Trust: ***Sadie Drescher***
Director, Restoration Programs
Chesapeake Bay Trust
410-974-2941 x105
sdrescher@cbtrust.org

Should these individuals become unavailable during the period of performance, personnel of equivalent capability shall be assigned to complete the work related to this Agreement. Any such substitutions shall require prior written approval by the County/ City/ Agency, which approval may be denied by the County/ City/ Agency at its sole discretion, but shall not be unreasonably denied. Should the Trust be unable to provide substitutes acceptable to the County/ City/ Agency, the County/ City/ Agency may terminate this Agreement, or at its option, negotiate with the Trust for an acceptable modification in the work and/or payment under the Agreement relative to the loss of such key personnel.

ARTICLE VI. MERGER

This Agreement, all exhibits and approved modifications hereto (hereinafter referred to collectively as "Agreement Documents"), embody the entire agreement of the parties. There are no promises, terms, conditions, or obligations referring to the subject matter, other than those contained herein or incorporated herein by reference. The Trust's performance of any work under the Agreement constitutes the Trust's acceptance of all of the Agreement Documents.

ARTICLE VII. AMENDMENT

Only a writing executed by both parties may amend this Agreement.

ARTICLE VIII. GOVERNING LAW

This Agreement shall be governed by and construed under the laws of the State of Maryland.

ARTICLE IX. NO THIRD-PARTY BENEFICIARIES

Nothing in this Agreement shall be construed to: (1) provide a benefit to any third party; (2) operate in any way as a promise, covenant, warranty, or other assurance to any third party; or (3) create any obligation to any third party.

ARTICLE X. INDEMNIFICATION

The Trust shall indemnify, defend, and hold harmless the County/ City/ Agency, its officers, directors, agents and employees (each, including the County/ City/ Agency, a "Covered Person") from and against any and all pending or threatened claims, losses, liabilities, litigation, damage, penalty, expense and demands of every kind and nature whatsoever (any of the foregoing a "Loss"), including, without limitation, the costs as and when incurred of defending any such Loss, and including, without limitation, reasonable attorneys' fees and disbursements therefore, incurred by a Covered Person resulting from or arising in connection with the performance of this Agreement, caused in part or in whole by any negligent or willful act or omission of the Trust, its officers, agents, employees or representatives. The Trust expressly understands and agrees that any performance bond or insurance protection required by this Agreement or otherwise provided shall in no way limit the responsibility to indemnify, keep and save harmless and defend the County/ City/ Agency as herein provided. The County/ City/ Agency does not waive any right or defense, or forebear any action, in connection herewith.

ARTICLE XI. ACCOUNTING

Retention of Records. The Trust shall retain and maintain all records and documents relating to this Agreement for three (3) years after final payment or any applicable statute of limitations, whichever is longer. Records and documents relating to this Agreement shall include, but not be

limited to, the Request for Proposals, received proposals, proposal reviews, documents related to the selection of the proposals to fund, and all documentation prepared by or for the Awardees.

Audit. The Trust shall make available for inspection all records and documents relating to this Agreement upon request of the County/ City/ Agency. All records and documents relating to this Agreement are subject to audit by the County/ City/ Agency or an authorized representative of the County/ City/ Agency. The Trust shall promptly award access to its facilities to authorized County/ City/ Agency representative(s) for review of documents, information and interviews of Trust personnel. The Trust will provide to the County/ City/ Agency upon request copies of any invoices, records, timesheets, work logs, contracts, or any other documents or information needed in order for the County/ City/ Agency to comply with State or federal reporting and audit requirements.

Payment. Payments to the Trust shall be made in accordance with the terms of the Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement by causing the same to be signed by their duly authorized representatives on the day and year first above written.

County/ City/ Agency X, Maryland

Date:

WITNESS

XXXXXX

XXXXXX

XXXXXX

County/ City/ Agency X, Maryland

Approved as to Legal Sufficiency

Date:

Office of Law

CHESAPEAKE BAY TRUST

Date:

WITNESS

Jana Davis, Ph.D.

Executive Director

Chesapeake Bay Trust

ATTACHMENT A

COOPERATIVE AGREEMENT BETWEEN COUNTY/ CITY/ AGENCY X, MARYLAND, AND CHESAPEAKE BAY TRUST

Chesapeake Bay Trust Pooled Monitoring Program (PMP)

DRAFT

INTRODUCTION

The Pooled Monitoring Program (PMP) will focus on answering key questions pertaining to the cumulative impacts of watershed restoration activities and the effectiveness of specific restoration practices posed by the regulatory, regulated, scientific, and practitioner communities using robust and rigorous methods.

Two tenets of the Pooled Monitoring Program are as follows:

All data are collected with a specific question or hypothesis in mind

Research products identify a clear path to integrate the new information into the regulatory process and make it accessible to regulators.

PROCESS

There is a Pooled Monitoring Advisory Committee (PMAC) that includes:

Six members from the regulatory community (U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Oceanic Atmospheric Administration, Maryland Department of the Environment, Maryland Department of Natural Resources)

1 member from the practitioner community

At least 3 members from the MS4 Phase I permittee community. Any MS4 permittee who contributes funds would be a member.

1 member from the environmental community

2 non-voting members of the scientific community who are experts in experimental design and restoration evaluation.

MS4 Permittees who opt into the Pooled Monitoring Program agree with the Department on level of opt-in funding commitment and generate MOUs with the Chesapeake Bay Trust, which manages the Pooled Monitoring Program.

The Chesapeake Bay Trust and PMAC members maintain a list of key questions about certain kinds of restoration projects as well as a minimum research protocol.

The PMAC meets in the fall of each year to review and prioritize key questions.

Questions are compiled into an RFP that lists the prioritized questions and minimum/preferred methodology. The RFP includes an outreach/dissemination requirement in the scope of work. The RFP is bid out to any type of entity that can address one or more questions, and can include bids to conduct new research or to analyze existing data. Bidding entities could include, but are not limited to, academic institutions, consulting firms, scientifically capable watershed organizations. Existing research/monitoring programs would be eligible to bid. As part of the RFP, resources, such as lists of completed restoration projects or permitted projects not yet constructed, would be made available. Bidders would be allowed to use these projects in their research.

Bids/proposals must identify:

- The question being addressed/answered
- The methodology being used to address (including sample size, location, timing, etc.)
- The analysis proposed
- The final product

The interpretation of the results/dissemination plan, i.e. presentation of the results into a form usable by regulatory and practitioner communities.

The Trust, under guidance of PMAC, composes a Technical Review Committee (TRC) that evaluates proposals and recommends projects for funding. The TRC is composed of external technical peer reviewers who have expertise in the topics of the proposals submitted and are not involved in any proposals submitted. The TRC will evaluate proposals using criteria to include:

- Relevance of the project and question posed
- Quality of the methods and analysis proposed
- Qualifications of leads and of the organization
- Communication/dissemination plan

PMAC may recommend that Advisory Groups are established to oversee certain projects.

The research is undertaken and completed; reports are sent to PMAC for review. A subset of projects may be sent for external peer review prior to acceptance of final product or dissemination to the public/community.

Results are disseminated to the practitioner community through, at a minimum:

An annual forum to which regulatory audiences are invited/required by their agencies to attend

Other forums as appropriate.

Results are interpreted for the regulatory audiences, and recommendations are prepared for how regulators can integrate the new information into their processes and policies. Some program funds may be used to develop key tools that facilitate use of the results.

The Trust archives reports, synthesized data, and raw data for public use.

APPENDIX II. MOU FOR THE WATERSHED ASSESSMENT POOL MONITORING

CHESAPEAKE BAY TRUST – COUNTY/CITY/AGENCY X COOPERATIVE AGREEMENT

COOPERATIVE AGREEMENT

THIS COOPERATIVE AGREEMENT ("The Agreement"), entered into this _day of _____, 2021, by and between the

COUNTY/CITY/AGENCY, MARYLAND

XXXXX

XXXXXX

(A Body Corporate and Politic, "the Jurisdiction/ Agency")

And

CHESAPEAKE BAY TRUST

108 Severn Ave

ANNAPOLIS, MARYLAND 21403

("The Trust")

WHEREAS, the Jurisdiction/Agency and the Trust share a common interest in conducting watershed assessments and evaluating long-term water quality trends within the Jurisdiction/Agency's boundaries.

WHEREAS, the Jurisdiction/Agency has opted into the Pooled Monitoring program as described in the *Watershed Assessment* section of the County/ City/ Agency's National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, for the specific _____ requirement.

WHEREAS, the Trust administers the Pooled Monitoring Program to conduct watershed assessments and evaluate long-term water quality trends throughout Maryland.

WHEREAS, the Trust, a nonprofit entity established by the Maryland General Assembly in 1985 to promote public awareness and participation in the restoration and protection of the water quality, aquatic and land resources of the Chesapeake Bay, and other aquatic and land resources of the State, is authorized to contract with other units of government, including the Jurisdiction/Agency; and

WHEREAS, the Trust has a governance and oversight structure with formal representation from the local government, State natural resource agencies, and the Maryland General Assembly, and uses independent technical review committees to review proposals and recommend awards made through its competitive award programs; and

NOW, THEREFORE, for and in consideration of the mutual covenants contained herein, the parties agree as follows:

ARTICLE I. SCOPE OF WORK

The Trust administers the Pooled Monitoring Program as described in the *Assessment of Controls* section of the Jurisdiction/Agency's MS4 permit. The goal of the Pooled Monitoring program is to align monitoring and other resources from multiple sources to rigorously and effectively conduct watershed assessments and evaluate long-term water quality trends, and address other issues pertaining to watershed restoration and watershed assessment.

Solicitation of proposals to conduct watershed assessment monitoring, monitoring to evaluate long-term water quality trends, and address other watershed restoration and assessment are posed via open, competitive, publicized Requests for Proposals for each program cycle by the Trust, in consultation with the Pooled Monitoring Advisory Committee (PMAC). The Trust uses an external peer review process to review proposals, and reviews are discussed and proposals recommended for funding to the Trust board by the PMAC. The Trust, in consultation with the PMAC, manages subsequent awards.

ARTICLE II. CONSIDERATION AND METHOD OF PAYMENT

The Jurisdiction/Agency has opted to participate in the Pooled Monitoring Program option for MS4 permit required Watershed Assessment Monitoring as described in the *Assessment of Controls* section of the Jurisdiction/Agency's MS4 permit at a funding level of $_____($x_____) per year for the five-year permit term/ for the remainder of the MS4 permit term as determined by the Maryland Department of the Environment (the Department), the regulatory entity governing compliance with the monitoring section of the MS4 permits.

The Jurisdiction/Agency shall provide the annual amount identified above to the Trust in July of each year for the duration of this Agreement. The Trust shall place the award funds in an account to be used solely for administering the Pooled Monitoring Program.

To accomplish the Scope of Work and manage the Program, an amount not to exceed five percent (5%) may be allocated by the Trust to administrative expenses. Copies of financial and programmatic reports prepared by the Trust for the Pooled Monitoring Advisory Committee and Maryland Department of the Environment will be submitted to the Jurisdiction/Agency quarterly for quarters ending September 30, December 30, March 31, and July 31 of each year.

The Trust agrees to follow a cost accounting practice, which is in accordance with the standards, principles, and procedures in Code of Maryland Regulation (COMAR) 21.09 and uniform accounting practices of the profession, as acceptable to the Jurisdiction/Agency.

ARTICLE III. TERM AND RENEWAL

The Agreement Period shall be from XXXXX, 2021, through XXXXX, 2026,. The agreement shall be renewable for additional terms of five (5) years upon written agreement by both parties.

ARTICLE IV. AGREEMENT REPRESENTATIVES

The following individuals shall have authority to act under this Agreement for their respective parties:

Jurisdiction/Agency: ***Jurisdiction/Agency X***

_____

XXXXX Division

(XXX) XXX-XXXX

Trust: ***Jana Davis, Ph.D.***
Executive Director
Chesapeake Bay Trust
410-974-2941 x100
jdavis@cbtrust.org

ARTICLE V. KEY PERSONNEL

The parties agree that the following named individuals are considered to be essential to the work being performed hereunder and are designated as key personnel who shall be made available to the full extent required to carry out the work under this Agreement:

Jurisdiction/Agency ***Jurisdiction/Agency X***
XXXXX Division
(XXX) XXX-XXXX

Trust: ***Sadie Drescher***
Director, Restoration Programs
Chesapeake Bay Trust
410-974-2941 x105
sdrescher@cbtrust.org

Should these individuals become unavailable during the period of performance, personnel of equivalent capability shall be assigned to complete the work related to this Agreement. Any such substitutions shall require prior written approval by the County/ City/ Agency, which approval may be denied by the County/ City/ Agency at its sole discretion, but shall not be unreasonably denied. Should the Trust be unable to provide substitutes acceptable to the County/ City/ Agency, the County/ City/ Agency may terminate this Agreement, or at its option, negotiate with the Trust for an acceptable modification in the work and/or payment under the Agreement relative to the loss of such key personnel.

ARTICLE VI. MERGER

This Agreement, all exhibits and approved modifications hereto (hereinafter referred to collectively as "Agreement Documents"), embody the entire agreement of the parties. There are no promises, terms, conditions, or obligations referring to the subject matter, other than those

contained herein or incorporated herein by reference. The Trust's performance of any work under the Agreement constitutes the Trust's acceptance of all of the Agreement Documents.

ARTICLE VII. AMENDMENT

Only a writing executed by both parties may amend this Agreement.

ARTICLE VIII. GOVERNING LAW

This Agreement shall be governed by and construed under the laws of the State of Maryland.

ARTICLE IX. NO THIRD-PARTY BENEFICIARIES

Nothing in this Agreement shall be construed to: (1) provide a benefit to any third party; (2) operate in any way as a promise, covenant, warranty, or other assurance to any third party; or (3) create any obligation to any third party.

ARTICLE X. INDEMNIFICATION

The Trust shall indemnify, defend, and hold harmless the Jurisdiction/Agency, its officers, directors, agents and employees (each, including the Jurisdiction/Agency, a "Covered Person") from and against any and all pending or threatened claims, losses, liabilities, litigation, damage, penalty, expense and demands of every kind and nature whatsoever (any of the foregoing a "Loss"), including, without limitation, the costs as and when incurred of defending any such Loss, and including, without limitation, reasonable attorneys' fees and disbursements therefore, incurred by a Covered Person resulting from or arising in connection with the performance of this Agreement, caused in part or in whole by any negligent or willful act or omission of the Trust, its officers, agents, employees or representatives. The Trust expressly understands and agrees that any performance bond or insurance protection required by this Agreement or otherwise provided shall in no way limit the responsibility to indemnify, keep and save harmless and defend the Jurisdiction/Agency as herein provided. The Jurisdiction/Agency does not waive any right or defense, or forebear any action, in connection herewith.

ARTICLE XI. ACCOUNTING

A. *Retention of Records.* The Trust shall retain and maintain all records and documents relating to this Agreement for three (3) years after final payment or any applicable statute of limitations, whichever is longer. Records and documents relating to this Agreement shall include, but not be limited to, the Request for Proposals, received proposals, proposal reviews, documents related to the selection of the proposals to fund, and all documentation prepared by or for the Awardees.

B. *Audit.* The Trust shall make available for inspection all records and documents relating to this Agreement upon request of the Jurisdiction/Agency. All records and documents relating to this Agreement are subject to audit by the Jurisdiction/Agency or an authorized representative of the Jurisdiction/Agency. The Trust shall promptly award access to its facilities to authorized Jurisdiction/Agency representative(s) for review of documents, information and interviews of Trust personnel. The Trust will provide to the Jurisdiction/Agency upon request copies of any invoices, records, timesheets, work logs, contracts, or any other documents or information needed in order for the Jurisdiction/Agency to comply with State or federal reporting and audit requirements.

C. *Payment.* Payments to the Trust shall be made in accordance with the terms of the Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement by causing the same to be signed by their duly authorized representatives on the day and year first above written.

Jurisdiction/**Agency X, Maryland**

Date:

WITNESS XXXXXX

XXXXXX

XXXXXX

Jurisdiction/Agency X, Maryland

Approved as to Legal Sufficiency

Date:

Office of Law

CHESAPEAKE BAY TRUST

Date:

APPENDIX III. JURISDICTION-SPECIFIC COST BREAKDOWN FOR PARTICIPATING IN THE POOLED WATERSHED MONITORING

Table 3. The minimum sample size* for watershed monitoring pool: biological monitoring

County/ City	sample size
Anne Arundel	25
Baltimore	33
Baltimore City	20
Carroll	25
Charles	25
Frederick	25
Harford	33
Howard	25
Montgomery	33
Prince George's	25

Table 4. The minimum bacteria monitoring sites, which is equal to the numbers of bacteria TMDL watershed

County/ City	Numbers of bacteria TMDL watershed
Anne Arundel	4
Baltimore	7
Baltimore City	4
Carroll	4
Charles	0
Frederick	3
Harford	0
Howard	1
Montgomery	4
Prince George's	3

Table 5. Minimum sample size for watershed monitoring pool: chloride monitoring

County/ City	Large/ Medium	Sample size
Anne Arundel	Large	2
Baltimore	Large	2
Baltimore City	Large	2
Carroll	Medium	1
Charles	Medium	1
Frederick	Medium	1
Harford	Medium	1
Howard	Medium	1
Montgomery	Large	2
Prince George's	Large	2

Table 6. The estimated total price* for participating the watershed monitoring pool

County/ City	Biology	Bacterial	Chloride	Total Cost (Annual)
Anne Arundel	$126,000	$31,768	$15,200	$172,968
Baltimore	$166,000	$54,844	$15,200	$236,044
Baltimore City	$101,000	$31,768	$15,200	$147,968
Carroll	$126,000	$31,768	$8,100	$165,868
Charles	$126,000	0	$8,100	$134,100
Frederick	$126,000	$24,076	$8,100	$158,176
Harford	$166,000	0	$8,100	$174,100
Howard	$126,000	$8,692	$8,100	$142,792
Montgomery	$151,000	$31,768	$15,200	$197,968
Prince George's	$126,000	$24,076	$15,200	$165,276

Note*: These costs represent a higher estimate as well as an upper limit, or price cap, for the Request For Proposal to be advertised by CBT for conducting this monitoring via the pooled option. The final cost will be dictated by the chosen proposal and should be not higher than this estimation. Total costs vary, depending on if a jurisdiction is buying into the pool for all, or only specific, select requirements.

APPENDIX IV: THE DEPARTMENT'S RESPONSE TO MONTGOMERY COUNTY COMMENTS

- Clarify that QAPPs are not required as part of the permit.
    - A QAPP is required as part of the permit. The Department requires a QAPP to use data for regulatory purposes. A QAPP will allow the Department to appropriately analyze and interpret the data.
- Confirm that changes to the chemical monitoring parameters do not apply if the Breewood tributary monitoring is continued.
    - The changes to the permit monitoring requirements still apply even if the Breewood monitoring is continued. The BMP effectiveness monitoring design is the same as the design in the prior permit. This is intentional in order to maintain data consistency for analytical purposes. The primary changes to the BMP effectiveness monitoring are the removal of metals from the list of parameters, the addition of total ammonia, and the addition of continuous monitoring. Local jurisdictions can continue to collect metals, if desired. The continuous monitoring allows for the development of surrogate relationships with the required chemical parameters. These surrogate relationships allow concentration and load estimation at a much higher temporal resolution, which leads to enhanced analytical power in to detect changes in future analyses.
- The surrogate relationship between turbidity and TSS is too variable and inconsistent to accurately predict TSS concentrations from continuous turbidity measurements.
    - USGS has developed protocols for turbidity monitoring that result in accurate surrogate relationships with TSS. However, this is correct. The USGS protocols require real time QAQC of the data in order to develop accurate surrogate relationships. Downscaled and simplified methods for collecting continuous turbidity have not resulted in accurate surrogate relationships. The Department is removing the continuous turbidity monitoring from the BMP effectiveness monitoring, until a more accurate downscaled method for continuous turbidity monitoring is established. The Department is currently working on developing such protocols.
- Confirm that changes to the biological, physical habitat, and geomorphic monitoring do not apply if the Breewood tributary monitoring is continued.
    - Changes to the biological, habitat, and geomorphic monitoring still apply even if the Breewood monitoring is continued. The primary change to the biological and habitat monitoring entails the use of Maryland Biological Stream Survey (MBSS) sampling protocols. Use of these protocols ensure consistency in data collection across jurisdictions and therefore maintain the integrity of analysis across geographies. There are no changes to the geomorphic monitoring requirements.
- Suggest changing language in the watershed assessment monitoring from Benthic megafauna to benthic macroinvertbrates, so as to not confuse with the sampling of salamanders, mussels, fish, etc.
    - The Department has made this change to the monitoring guidelines.

- In the MBSS manual, in-situ data in addition to DO [dissolved oxygen] includes temperature, pH, turbidity, and conductivity with a multi-parameter probe. Are these parameters also required?
    - Yes. These in-situ parameters should be collected as well.
- Watershed assessment monitoring, page 8: "Additional recommendations are included below". Please confirm that these additional recommendations are recommendations and not requirements.
    - Correct, these are recommendations only, not requirements.
- The IBI is currently calibrated to a 1:100K scale map. A standard map scale should be used by all jurisdictions. The 1:24K recommendation should be a requirement, not a recommendation
    - Analyses by Maryland's Department of Natural Resources indicate that the current IBI calculation is applicable to 1:24K streams. However, the Department in conjunction with MD DNR is further investigating the applicability of the current IBI to different stream map scales and stream orders. If future analysis indicates that the current IBI is not applicable to smaller order streams not captured by the 1:100K map, then adjustments will be made for incorporation of data into the Integrated Report. MD DNR is planning to use a modified version of the 1:24K NHD for Round 5 MBSS sampling. As it currently stands, for data to be used in MDE's Integrated report and Biological Stressor Identification analyses, the two primary requirements are use of MBSS protocols and random site selection.
- Bullet 2b, page 9 – should multi-parm prob be changed to "multi-parameter probe"?
    - Yes. This change has been made.
- Page 9, bullet 2c – Does MDE expect only a spring sampling event for habitat? The habitat parameters described are summer habitat. Or, does MDE expect spring sampling for benthics and summer habitat assessment?
    - The Department only expects a spring sampling event. The MBSS summer habitat assessment should be performed while doing benthic sampling in the spring. The Department and MD DNR are currently researching the relationship between these habitat assessments as performed in the spring and summer. If there are significant differences, the Department and MD DNR will make the appropriate adjustments to standardize the assessments with historic assessments so that the data can be seamlessly incorporated into State regulatory analyses, such as the BSID.
- The county could not find the Stranko et al., 2019 and DNR 2017 references for measuring in-situ DO. Please provide a link to this report.
    - See links. Stranko 2019: https://dnr.maryland.gov/streams/Publications/R4Manual.pdf and DNR 2017: https://dnr.maryland.gov/streams/Publications/ea-07-01b_fieldRevMay2007.pdf.
- Page 9 – Please confirm that "B. Recommended study design considerations" are recommended and not required.
    - That is correct. The recommended study design considerations, including using a spatially balanced random sampling site selection method, non-rotation study design, and map scale, are recommendations only and are not a permit requirement. The only requirements for the Watershed Assessment biological monitoring are use of MBSS protocols and random site selection. These are the two primary factors

that ensure use of County data in Maryland's Integrated Report biological assessments.

- Watershed assessment monitoring – Pages 9 and 10. Suggest MDE host a workshop on GRTS to provide spatial balance in sampling design. MDE should provide the stream map and stratification. MDE should define the population of interest.
    - The Department and MD DNR have entered into a Memorandum of Understanding for MD DNR to provide support for the new MS4 Watershed Assessment biological monitoring requirements. One of the specific tasks in this MOU involves outreach to the permittees and hosting workshops, such as the one referenced in this comment. The Department and MD DNR will plan to host a workshop focused on the use of GRTS in a jurisdictions' site selection. Since 1) jurisdictions have been using a variety of map scales in their historic monitoring programs for site selection, and 2) map scale is not a primary factor influencing the incorporation of data into the Department's Integrated Report assessments, the Department is delegating the selection of stream population for sampling to the jurisdictions.
- MDE should provide a streams layer and define the population. The County has 1st thru 5th order streams, and MBSS sampling does not include 5th order. Additionally, there are many NHD and NHD+ layers, and having an MDE source layer would be ideal.
    - Please see prior response.
- Please confirm that the County will pick the bacteria monitoring sites in each TMDL watershed.
    - The County will select its bacteria monitoring sites. The primary requirements for the bacteria monitoring are fixed locations with temporally consistent data collection and subsequent flow characterization. The Department provides recommendations for locating sites at the previous TMDL monitoring stations for jurisdictions that do not have any more informed placement of sites. The Department encourages jurisdictions to target sites where they think data collection will provide them with the most useful information.
- Bacteria monitoring – please consider that weather conditions may make it unsafe to collect samples at approximately the same day and time of every month. We will need flexibility to have an alternative day and time for safety issues, e.g., for extreme weather events.
    - The bacteria monitoring requirement is fixed interval sampling. However, there are outstanding circumstances that make strict fixed interval sampling difficult, and The Department recognizes this. Jurisdictions are provided flexibility in the data collection efforts, but they should attempt to keep those intervals fixed to the maximum extent possible not withstanding safety, health, and other concerns.
- Bacteria monitoring – Record flow conditions. This is a high level of effort for monthly sampling. We would prefer to simply identify storm vs. baseflow based on recent precipitation data.
    - Recording specific flow data rather than generic baseflow vs. stormflow characterizations is important for future statistical modeling of trends. Flow characterization following TMDL methods does not require any additional field effort, and this characterization can be done in aggregate at one time. MDE can work with the jurisdictions to go over these methods and can host a workshop to go over the methodology.

- Please conform that permittees are performing conductivity monitoring as a surrogate for chloride and not conducting chloride monitoring
    - That is correct. Specific conductance monitoring is required and is used to predict chloride concentrations.
- Please confirm that MDE is asking for the instantaneous and not the max conductivity reading over the 30 minute period.
    - That is correct. That instantaneous 30-minute reading should be reported for the specific conductance continuous monitoring.
- Please provide further information on station selection for chloride monitoring. What constitute significant mileage of county owned roads and moderately vs. highly urbanized for site selection?
    - The Department does not have additional guidance at this point on what constitutes significant County-owned roadway and level of urbanization. The intent of the chloride monitoring is to detect if there is an observed decrease in specific conductance from new salt management practices implemented under the County's permit required salt management plan. The County's monitoring should focus on where expected salt management practices will occur, and the monitoring design should attempt to minimize other confounding variables. This is the basis for the referenced recommendations in the monitoring guidelines. For instance, if there are a significant number of privately owned businesses that would be applying salt during winter storm events in the proposed monitoring watershed, the County should consider selecting another watershed to minimize the impacts of non-county DOT salt applications.
- Please provide a copy of the department's Cl- monitoring QAPP
    - The QAPP will be provided to the Phase I MS4s jurisdictions.
- How does the PMAC proceed if one or several of the members become unavailable?
    - It is unclear what is meant by "unavailable". Additional clarification is requested.
- Can a permittee opt into the pool at any point with MDE approval?
    - Yes, a permittee can enter the pool at any point during the permit term. Permittees must inform the Department of their intent to opt into the pool within 4 months of the effective date of the permit. If a permittee chooses not to opt in, a new study design must be submitted in the first-year annual report to address the new monitoring requirements in the permit. However, permittees may submit an alternative plan for meeting the intent of the monitoring provisions in the permit. This can include justification of the continuing of certain local monitoring efforts before transitioning into the pooled program. The Department will work with permittees on this transition; however, once opting into the pool, permittees must continue with that commitment as long as the permit remains in effect.
- The County's sample size in Table 3 (n = 30) does not match the sample size in Table 2 (n = 33). Please confirm which is correct.
    - The correct sample size is 33. The Department will revise Table 2.

APPENDIX V: REVISIONS MADE SINCE AUGUST 2020

The following changes have been made since the August 2020 version of the MS4 Monitoring Guidelines.

Reference	Revision
pg. 4	Required parameter table inserted consistent with parameter table in MS4 permits
pgs. 5-6	Table 1 updated to be consistent with UMCES CBL recommended lab methods and detection limits. TKN parameter replaced with TN. Fecal Coliform removed and replaced with E. Coli and Enterococcus spp. Phosphorus (All Forms) replaced with Phosphate. Chloride, TOC, and Ammonium (ammonia) added.
pg. 6	Specified recommended frequency of continuous monitoring.
pg. 6	Turbidity monitoring made optional because of maintenance and QAQC complications. Language added noting that further guidance is forthcoming.
pg. 9	"Watershed Assessment Monitoring" section renamed to "Watershed Assessment and Trends Monitoring"
pg. 9	"benthic megafauna" changed to "benthic macroinvertebrates" for clarity
pg. 9	temperature, pH, turbidity, and conductivity added to list of mandatory in-situ readings associated with biological monitoring
pg. 10	"multi-parm probe" corrected to "multi-parameter probe"
pg. 14	Table 2 updated to be consistent with Table 3 in Appendix III
pg. 15	Language added to bacteria monitoring section recommending placement of trend stations at known resources ("beach use" areas), rather than TMDL stations, i.e., where humans are recreating in the water or where key resources are located
pg. 16	Bacteria protocols revised so that an accredited lab is no longer required.
pg. 17	Language added to bacteria monitoring section allowing a 48-hour cut-off for flow characterization as an alternative to using the FDC/TMDL method.
pg. 19	Language added to chloride monitoring section recommending a method for converting conductivity to specific conductance
pg. 19	Language added to chloride monitoring section highlighting a resource (Moore, Fanelli, Sekellick 2019) that provides further guidance on developing surrogate relationships between specific conductance and chloride concentration
pg. 20	Chloride coefficient updated consistent with USGS research.
pg. 49	Table 3 corrected to indicate 33 samples for Montgomery County