Maryland
Department of
the Environment

Wes Moore, Governor
Aruna Miller, Lt. Governor

Serena McIlwain, Secretary
Suzanne E. Dorsey, Deputy Secretary

Proposed Stormwater Management Regulatory Requirements

for

New Development and Redevelopment

in

Maryland

July 26, 2023

Contents

1. INTRODUCTION

Urban and riverine flooding is a growing issue in Maryland. Climate change is impacting Maryland's rainfall patterns and stormwater runoff. To begin to address these impacts of climate change, Maryland's stormwater management law was updated in 2020 to require the Maryland Department of the Environment (Department) to regularly review and update its stormwater management standards, incorporating information on the most recent precipitation data available and the results from investigations into flooding events that have occurred in Maryland since 2000. After a year of reviewing available flooding events data, meeting with local jurisdictions, coordinating with other state agencies, and participating in group discussions related to rainfall patterns and stormwater management design, the Department proposes a first phase of changes to the current standards for stormwater management for new and redevelopment.

The Department presented the initial first phase of changes to the Advancing Stormwater Resiliency in Maryland (A-StoRM) Stakeholder Group in October of 2022. The Stakeholder Group was asked to review the proposal and submit comments to the Department by February 2023. The comments received by the Department have been posted for public review on the Department's A-StoRM project website at the following link:

https://sb-227-maryland.hub.arcgis.com/

After review of the comments and further discussions, the Department proposes additional recommendations for this first phase of changes to the state stormwater design requirements. Many of the comments received from the stakeholder group members have helped shape these additional recommendations. The following describes the proposed design criteria changes including new criteria developed since February 2023. The Department plans to publish in the Maryland Register in August these proposed changes for public comment as a first step prior to moving forward with the proposed regulation change process.

2. PROPOSED SWM REQUIREMENTS

Maryland's Environment Article 4-201 and the Code of Maryland Regulations (COMAR) 26.17.01 set the minimum criteria for stormwater management for land disturbances greater than 5,000 square feet. The current requirements were developed in 2000 and updated in 2010. Maryland's rainfall patterns have and continue to change. Maryland designers need to use updated design storms based on more recent precipitation information. The average annual rainfall amount in Maryland has increased and will continue to increase due to climate change resulting in the need to manage more volume for water quality treatment.

As rainfall patterns change, the landscape that is the result of development has also changed. Soil compaction during the land development process impacts the hydrologic characteristics of soil properties, in particular infiltration. In addition, the runoff from high intensity short duration storms is not adequately conveyed to and attenuated in Maryland's current environmental site design (ESD) practices. As noted by comments received by Stakeholder Group members (Graf, et.al. 2022; Sevens, 2022) adequate stream channel protection will not likely be achieved in these

ESD practices and additional protections will be needed. As these short duration high intensity rain events become more prevalent and begin to represent Maryland's frequent events, the state stormwater practice design standards must adapt. Maryland also must ensure the safe conveyance of stormwater runoff from design storms to stormwater management practices intended to manage the runoff.

a. Stormwater Management Rainfall Data Must be Updated to Incorporate Current Rainfall Patterns

Maryland uses average rainfall depths associated with a 24-hour duration storm event as the basis for stormwater management requirements and best management practice design. Current minimum design standards use the county average rainfall depths shown in Table 2.2 in the 2000 Maryland Stormwater Design Manual (Design Manual) (MDE, 2000). These values were taken from the United States Department of Commerce, Weather Bureau's 1961 publication *Technical Paper or "TP" 40 "Rainfall Frequency Atlas of the United States* (USCD, 1961). Most of the rainfall data used to develop TP 40 was gathered from 1938 to 1957.

More recent precipitation data were incorporated into *National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 2 Precipitation-Frequency Atlas of the United States, Ohio River Basin and Surrounding States*, published by the U.S. Department of Commerce, NOAA in 2004 and updated in 2006 (NOAA, 2006). NOAA Atlas 14 uses a much larger period of record, is based on a more robust statistical analysis method, and includes more rain stations and gauges - 93 in Maryland. NOAA Atlas 14 includes point-specific information and statistically robust mean values for each of Maryland's counties. Therefore, Maryland will require new design storm rainfall depths for each county, based on county mean values from the 2006 NOAA Atlas 14.

b. The Appropriate Design Storms to Provide Water Quality Treatment, Provide Channel Protection, and Prevent Flooding Must be Based on Updated Rainfall Data

Rainfall frequency, intensity, and associated peak discharge are increasing as our climate changes. The design standards and volumes that are used to size environmental site design practices and flood control practices will increase as well to maintain resiliency.

i. Water Quality Treatment Design Storm

In Maryland, the water quality design storm is based on the 90% capture rule introduced in *Design of Stormwater Wetland Systems* (Schueler, 1992). This rule required that BMPs be designed to capture and treat 90% of the average annual rainfall thereby capturing and treating the runoff from the majority of the storms in Maryland. Rainfall frequency spectrums for seven Maryland locations were compiled in 1996 as part of the *Technical Support Document for the State of Maryland Stormwater Design Manual* (Schueler and Claytor, 1996). An analysis of that information recommended that 1 inch of rainfall should be used to meet this requirement for most of Maryland.

More recent analysis of rainfall data from selected weather stations (available from the National Oceanic and Atmospheric Administration's National Center for Environmental Information (NOAA/NCEI) here: Climate Data Online) has shown that as much as 1.4 inches of rainfall now represents 90% of the average annual rainfall in Maryland. Additionally, since the publication of the 2000 Manual, the federal government has adopted a 95% capture rule for the design of stormwater features on federal properties. In Maryland, it is estimated that 2.0 inches of rainfall would need to be captured to meet this 95% capture standard.

ii. Channel Protection Design Storm

The Design Manual requires that 24-hour extended detention of the one-year, 24-hour storm event as described in "*Design Procedures for Stormwater Management Extended Detention Structures*" (MDE, 1987) be used to protect stream channels from erosion. Rainfall depths for the one-year, 24-hour storm event are provided in Table 2.2 (see p. 2.11 of the Design Manual). This table was originally published in October 2000 and provides the rainfall depths for each county in Maryland as found in TP-40.

Recently a consortium of universities and the RAND Corporation published future projected IDF curves for the Chesapeake Bay Watershed based on the current NOAA Atlas 14 precipitation data with a range of predictions for future climate change. The data are presented in an online application tool developed by the **Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA)** for three emissions scenarios with four confidence intervals and two time periods (2020-2070 and 2050-2100). The tool can be found here:

https://midatlantic-idf.rcc-acis.org/

MDE has evaluated the online tool to determine how it could be used to inform regulations and design standards for controlling stormwater runoff in Maryland. For a high emissions scenario projecting to the year 2100, the MARISA tool predicts that due to the impacts of climate change, Maryland will see an average increase for the two-year 24-hour design storm rainfall of 13%. The average 1 year 24-hour design storm for Maryland will likely also increase by 13%. Therefore, Maryland will raise the 1 year 24-hour design storm rainfall from 2.7 inches to 3.0 inches.

iii. ESDv Design Storm

Environmental Site Design uses small scale stormwater management practices, non structural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources. The Design Manual requires that the ESDv is managed to the Maximum Extent Practicable (MEP) in an approved ESD practice. The ESDv is intended to manage both the 90% average annual rainfall (water quality) up to the 1 year 24-hour storm (channel protection). Predicted changes to the design storms used for water quality treatment and channel protection result in the need to modify the required ESDv.

c. Soil Compaction During Land Development Changes the Characteristics Of Runoff

Current development methods typically include removing topsoil and compacting subsoils as part of site grading operations. These stripped and compacted soils have greatly reduced infiltration capacities thereby limiting plant growth and water retention (Schwartz, 2021) and (Day, 2016). This loss of hydrologic function and the associated increase in runoff is not considered in the development of hydrologic studies used for stormwater management design. This results in undersized stormwater management practices and increased local runoff and flooding. For this reason, stormwater management designs will be required to consider all disturbed soils as having the properties and characteristics of hydrologic soil group D as described in Part 630, Chapter 7 (NEH630.07) of the National Engineering Handbook (USDA, 2009).

d. ESD Practices No Longer Provide Channel Protection Due to High Intensity Storms

ESD practices were originally intended to provide water quality treatment and channel protection for small drainage areas. These practices infiltrate and/or slowly release these common, lower intensity storms. These design characteristics of ESD practices were originally intended to provide the attenuation needed for channel protection. Changes in the precipitation patterns have resulted in ESD practices that do not provide the flow attenuation needed to address downstream channel erosion.

ESD practices are often located online and used to reduce the runoff volume and discharge rate requirements for quantity management or flood control. These online ESD practices are not resilient to high intensity storms, as they become flooded, are not able to adequately infiltrate, or simply bypass these larger intensity runoff events. The Department must ensure that ESD practices are designed to manage water quality by ensuring they remain as offline practices that bypass higher intensity events.

As climate change continues to produce more short duration high intensity storms that generate high runoff flows, *the* Department must look to larger, standard extended detention practices that are resilient to higher intensity events, to adequately protect downstream receiving streams from erosion, for these larger standard extended detention practices, the Department must require the 24-hour extended detention of the 1-year storm event method (MDE, 1987). When using this method, the Cpv is stored and released in such a gradual manner that critical erosive velocities in receiving channels for bankfull and near-bankfull events will seldom be exceeded.

e. ESD Practices Should Not be Used to Manage Larger or More Intense Storms

Reports of monitoring of existing ESD practices have shown that while they may reduce the peak discharge rate from smaller storm events they are not appropriate for managing peak discharge rates for extreme events (Thompson, et.al., 2023; Hopkins, et. al.2022). To ensure our stormwater designs remain resilient in the face of climate change, Maryland must balance the need to provide adequate water quality treatment through ESD practices with the need to provide channel protection and flood control. This will require refocusing stormwater management from relying solely on ESD practices to requiring a combination of ESD and larger practices that address a wider spectrum of rainfall events.

f. Ensure the Conveyance of Design Storms to Management Practices

Maryland stormwater design criteria must ensure that stormwater runoff is adequately and safely conveyed to the practices required to manage the runoff. Maryland's current stormwater management design standards do not include conveyance standards. At a minimum the concept of adequate conveyance to stormwater facilities should be a fundamental stormwater management requirement. Site designs must ensure that the design volume of stormwater runoff is safely directed into the stormwater practices for treatment. Similarly, any outflow or bypassed runoff must be conveyed in a safe and non-erosive manner to downstream practices, storm drain systems, or other acceptable outfalls.

g. Ensure That No Flooding or Erosion Related Deleterious Impacts are Created from Stormwater Runoff to Existing Downstream Properties

Maryland stormwater regulations must require that approved stormwater management plans for stormwater runoff from new development will not create flooding or erosion related deleterious impacts to existing downstream properties or public road infrastructure under design storm conditions. The approval authority has a responsibility to require verification from the applicant that the stormwater runoff from a development site will not change from pre-development conditions in flow rate, velocity, and location of discharge for the design storm.

The reviewer should also verify that stormwater runoff from a site will maintain the capacity and stability of the downstream conveyance system to an adequate outfall. An adequate outfall must have the capacity to convey the stormwater runoff from a site to a public drainage channel, public stormwater conveyance system, stable watercourse, or a FEMA or locally mapped and regulated 100-year floodplain. As part of the stormwater plan approval process, any change in design storm runoff rate, velocity, or location characteristics from pre-development conditions shall require a downstream offsite drainage easement to be recorded in the land records of the proper local jurisdiction.

The design storm should be determined by the local jurisdiction but should at a minimum be the 1-year 24-hour storm. If the local jurisdiction approval authority requires quantity management, the design storm shall be both the 1-year 24-hour storm and the quantity management storm. For projects located in a known flooding problem area, the design storm should be, at a minimum, the 1-year 24-hour storm, the local quantity management storm, and the 100-year 24-hour storm, unless a watershed study approved by the local approval authority and the Department has identified a watershed-based alternative design storm.

In addition to these requirements, the state regulations and local stormwater management ordinances will continue to indicate the following:

"If a stormwater management plan involves direction of some or all runoff off of the site, it is the responsibility of the developer to obtain from adjacent property owners any easements or other necessary property interests concerning flowage of water. Approval of a stormwater management plan does not create or affect any right to direct runoff onto adjacent property without that property owner's permission."

h. Ensure Historically Overburdened and Underserved Communities are Adequately Protected from Unmanaged Stormwater Runoff

It is Department policy to implement environmental laws and programs wherever possible in a manner that reduces existing inequities and avoids the creation of additional inequities in overburdened and underserved communities. National studies show that overburdened and underserved communities bear a disproportionate share of the negative environmental consequences resulting from industrial activities, land-use planning and zoning, municipal and commercial operations, or the execution of federal, state, or local programs and policies.

Current state stormwater management regulations allow for reduced management levels for the reconstruction of existing impervious areas for redevelopment. COMAR 26.17.01.02.B. defines redevelopment as "any construction, alteration, or improvement performed on sites where existing land use is commercial, industrial, institutional, or multifamily residential and the existing site impervious area exceeds 40 percent." Less stringent stormwater criteria for redevelopment were program incentives to promote Smart Growth and reduce urban sprawl by encouraging redevelopment in areas already served by public infrastructure such as drinking water, sanitary sewers, and roads.

Many sites that meet the redevelopment definition are in areas that are also considered overburdened and underserved. To ensure that full water quality and quantity treatment are provided in these communities, the Department will modify the definition of redevelopment areas to exclude those that are identified as overburdened or underserved. The Department shall require the use of the MDE EJ Screening Tool to identify those areas with a combined socioeconomic score of 75 or greater. Any land development within these communities will be required to follow the new development stormwater management criteria. Below is a link to the MDE EJ Screening Tool:

https://mdewin64.mde.state.md.us/EJ/

3. NEW DEVELOPMENT REQUIREMENT

The Department will require that new development projects must provide management of the ESDv and the channel protection volume (CPv) for the entire area within a limit of disturbance (LOD) of a project. The project ESDv must be calculated based on the volume of runoff from 3 inches of rainfall for the entire LOD. The ESD design storm or amount of rainfall to be managed will be increased from 2.7 inches to 3.0 inches to account for climate change.

The Department will require that at a minimum all of the ESDv for the impervious area within the project LOD must be managed in an ESD practice. The remaining ESDv for the pervious area within the LOD must be managed to the MEP in an ESD practice. All remaining ESDv for the pervious area not managed in an ESD practice must be managed on-site within a water quality best management practice identified in Chapter 3 of the Design Manual.

MDE will require that Cpv management means providing 24-hour extended detention of a portion of the volume of runoff from the 1-year storm for the entire LOD area. ESDv and CPv are to be calculated separately and provided in mutually exclusive volumes. Over-management of the CPv within a different point of discharge from the LOD is not allowed. The Department proposes to update Table 2.2 in the Design Manual based on Atlas 14 with a climate change factor of 13%.

The Department will require that the design storm runoff is adequately conveyed to the stormwater management practices required to manage the runoff. The ESDv design storm runoff from all impervious areas and from pervious area to the MEP within the LOD must be conveyed to the ESD practice designed to manage the runoff. The remaining ESDv design storm runoff must be conveyed to a water quality BMP from Chapter 3 of the Design Manual. The full CPv design storm runoff must be conveyed to a structural practice providing extended detention.

To ensure ESD practices remain resilient to climate change, ESD practices cannot be used to manage storms larger than the ESDv design storm. ESD practices shall be designed as offline structures. There shall be no accounting for managed volume and no routing of storms greater than the ESDv design storm through an ESD practice. There shall be no reduced CN method credit for quantity management for any storm that passes through an ESD practice.

a. New Development Calculations

i. Calculating ESDv:

ESDv shall be calculated for the entire LOD and for the drainage area to each ESD practice. The impervious area for the LOD must be treated in an ESD practice for 2.77 inches of runoff and the pervious area for the LOD must be treated in an ESD practice for 1.25 inches of runoff. All pervious surfaces are assumed to be compacted and are therefore calculated as open space in good condition with D soils (CN of 80)

Eq. 1: $$ESDv = 2.77\ (in) \times (A_i / 12\ (in/ft)) + 1.25\ (in) \times (A_p / 12\ (in/ft))$$

Where,

A_i = total impervious area within the LOD (square feet)
A_p = total pervious area within the LOD
2.77 inches is the runoff from 3 inches of rainfall for a RCN of 98
1.25 inches is the runoff from 3 inches of rainfall for a RCN of 80 (Open Space in Good Condition - HSG D)

The ESD practice shall only manage the ESDv required for the area draining to it, and all other runoff shall bypass the ESD practice. The required ESDv shall be calculated for each area draining to each ESD practice. The total ESDv provided by each ESD practice shall equal the ESDv required to be managed for the site LOD.

ii. Calculating CPv:

The entire CPv for the entire LOD must be managed in a CPv practice.Use Appendix D.11 of the Design Manual to determine the required CPv.

https://mde.maryland.gov/programs/water/StormwaterManagementProgram/Pages/stormwater_design.aspx

The CPv shall be held and discharged over 36 hours (or 24-hours for cold water resources watersheds). The CPv control structure shall be sized using the method described in Appendix D.11 of the Design Manual. The detention time for the CPv is provided when the time between the centroid of the design storm inflow hydrograph and the centroid of the design storm outflow hydrograph of the extended detention practice is a minimum 24-hours (or 12 hours for cold water resources watersheds). This must be verified through review of TR-20 modeling reports.

Because the centroid of the design storm inflow hydrograph occurs at 12 hours for a 24-hour design storm, this will ensure the 36 hour (or 24-hour in coldwater resources) discharge requirement. Cold water resources watersheds are identified on the Department of Natural Resources Cold Water Resources Mapping Tool as Maryland Trout Watersheds, Put and Grow Trout Watersheds, and Benthic Coldwater Macroinvertebrates.

https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=dc5100c0266d4ce89df813f34678944a

4. REDEVELOPMENT REQUIREMENT

The Department will require that for all redevelopment areas, excluding those with combined socioeconomic scores greater than 75 as shown on the MDE EJ Screening Tool (https://mdewin64.mde.state.md.us/EJ/),

the minimum stormwater management is provided when one of the following is met:

- The runoff from at least 50% of existing impervious area within the LOD is conveyed to and treated in an on-site ESD practice.
- Reduce existing impervious area within the LOD by at least 50%; or
- A combination thereof.

The ESDv for redevelopment shall be calculated using the following equation:

Eq. 2. *ESDv = 2.77(in)/12(in/ft) x (0.5Ai)*

Where,

Ai = area of existing impervious surface within the LOD (square feet)
2.77 inches is the runoff 3 inches of rainfall for a RCN of 98

All redevelopment areas that are located within areas with combined socioeconomic scores greater than 75 as shown on the MDE EJ Screening Tool shall follow the New Development stormwater management criteria.

5. TRANSITION PERIOD

The Department plans to move forward with proposing regulation changes in December 2023. Barring no significant comments, Maryland's proposed stormwater regulations would go into effect on January 1, 2027. Local municipal and county ordinances would need to be updated with the new regulations. The Department will provide a Model Ordinance and updated Design Manual, and design examples to help local governments in updating their ordinances. All municipal and county ordinances would be required to be approved by the Department by January 1, 2026, and approved by the local governing body by January 1, 2027.

Development projects that are already in the approval process as of January 1, 2027 could be approved and constructed under the previous regulations that were adopted on May 4, 2009, but would also be required to meet every step of the following schedule:

- Concept Plans must be approved by June 30, 2028
- Site Development Plans must be approved by June 30, 2029
- Final Plans must be approved by June 30, 2030
- Construction under the Final Plans must be started by June 30, 2032; and
- Construction under the Final Plans must be substantially completed by June 30, 2035.

6. CONCLUSION

Maryland must meet the impacts of climate change head on and protect its citizens from flooding by implementing bold solutions now and in the future that challenge the status quo. The Department proposes to take immediate action by proposing significant changes to the state's stormwater management regulations. These include using the latest precipitation data and climate change projections to make the design of Maryland's stormwater management practices more resilient to increasing stormwater runoff thereby minimizing the impacts of land development on downstream areas. More detailed information is also being gathered on the capacity of existing stormwater conveyance systems to handle increasing stormwater runoff.

The Department will use this information to propose additional quantity management regulations soon to protect Maryland's most vulnerable communities from flooding.

The Department has also begun taking the next steps to develop a comprehensive approach for mitigating flooding in both new and already-developed communities. With federal flood mitigation grant funds, the Department will invest in watershed studies that can model flood risk based on existing and future development scenarios. These modeled results can be used by local communities to develop watershed-specific quantity management policies and practices for new development, redevelopment, and capital improvement projects to safely convey runoff from larger storm events, meet downstream conveyance capacity requirements, and mitigate flooding.

Finally, the Department, in collaboration with local, State, and federal agencies charged with reducing flood risk, must expand what it means to comprehensively manage a watershed for flooding. Only when stormwater, floodplain, and coastal flood managers; land use, resource, and agricultural planners; and scientists, emergency management professionals, environmental advocates, community organizers and others come together at a watershed level, can the root causes of flooding be determined, and the most effective mitigation practices be developed. By implementing bold and progressive management measures now and in the future, and in coordination with other agencies and the State's inaugural Chief Resilience Officer, Maryland can prepare for and minimize the flooding effects of climate change.

7. REFERENCES

Butcher, J. et al. (2023, June 21) *Climate Impacts to Restoration Practices* [Conference presentation]. Chesapeake Bay Trust 2023 Pooled Monitoring Forum: Restoration Research to Make Science and Regulatory Connections, Baltimore, MD.

Day, S.D. 2016. Soil Profile Rebuilding: An Alternative to Soil Replacement. City Trees. Sept/Oct 2016.

Eshleman, K. (2023, June 21) *A Paired-Watershed Study to Assess the Aggregated Effectiveness of Green Stormwater Infrastructure in Suburban Residential Development* [Conference presentation]. Chesapeake Bay Trust 2023 Pooled Monitoring Forum: Restoration Research to Make Science and Regulatory Connections, Baltimore, MD.

Hopkins, K, et. al., 2022. Lessons learned from 20 y of monitoring suburban development with distributed stormwater management in Clarksburg, Maryland, USA. Freshwater Science. Volume 41(3):459-476.

MDE. 1987. Design Procedures for Stormwater Management Extended Detention Structures. Maryland Department of the Environment.

MDE. 2000. 2000 Maryland Stormwater Design Manual, Vol I & II. Maryland Department of the Environment.

NOAA. 2006. National Oceanic and Atmospheric Administration,d Atlas 14, Volume 2 Precipitation-Frequency Atlas of the United States, Ohio River Basin and Surrounding States. U.S. Department of Commerce.

Graf, Lori, et.al. (December 7, 2022). [Letter to Mr. Raymond Bahr. A-StoRM Stakeholder Group Feedback].

Schueler, T. 1992. Design of Stormwater Wetland Systems. Metropolitan Washington Council of Governments.

Schueler, T. and Claytor, R. 1996. Technical Support Document for the State of Maryland Stormwater Design Manual. Center for Watershed Protection.

Schwartz, S. 2021. The Effectiveness of Soil Decompaction for Stormwater Management. MDOT-SHA, July 2021.

Stevens, Amy. (February 15, 2023). [Letter to Mr. Raymond Bahr. Stakeholder Consultation Group Comments].

Thompson, T. et al. (2023, June 21) *Effectiveness of Stormwater Management Practices in Protecting Stream Channel Stability* [Conference presentation]. Chesapeake Bay Trust 2023 Pooled Monitoring Forum: Restoration Research to Make Science and Regulatory Connections, Baltimore, MD.

USDA. 2009. Part 630, Chapter 7 (NEH630.07) of the National Engineering Handbook. United States Department of Agriculture, Natural Resources Conservation Service. January.

USDC. 1961. Technical Paper 40, Rainfall Frequency Atlas of the United States. United States Department of Commerce, Weather Bureau.