Methodologies and Tools to Support Climate-Resilient Stormwater Best Management Practices

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RAND | Community Health and Environmental Policy Program

Project Overview

- **Objective:** Create an integrated toolkit of guidance materials, web-based tools, and references for integrating climate considerations into stormwater planning, management and/or design, as well as enhancements to Chesapeake Bay modeling. Including:
  - i) a two-part vulnerability assessment tool,
  - ii) a decision-support tool and framework for integrating the information from a widely-used future precipitation tool,
  - iii) guidance on resilient design adaptations for stormwater infrastructure and restoration, and
  - iv) modeling enhancements to characterize the sensitivity of BMPs to climate change.

- **Timeline:** Early 2024 – 12/31/2028

- **Funder:** U.S. EPA

Project Team

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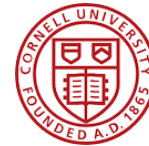
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Activity 1. Vulnerability Assessment Tool

- **Objective:**
  - Develop a vulnerability assessment tool for local communities in the Chesapeake Bay watershed. The tool will provide step-by-step guidance on implementing vulnerability assessment approaches appropriate and practical for the stormwater management community in the Chesapeake Bay watershed.
- **Research Steps:**
  - Carry out literature review to identify and evaluate vulnerability assessment approaches and relevant datasets
  - Summarize vulnerability assessment approaches
  - Develop pilot vulnerability assessment tool
  - Present tool framework for feedback and carry out pilot of vulnerability assessment tool
  - Finalize and publish tool
- **Output:**
  - Vulnerability assessment tool to help local jurisdictions and residential communities review and understand vulnerabilities of their existing and planned infrastructure to climate change by Sept 2025

Activity 2. Climate Resilience Decision Support Tool

- Objectives:
  - Develop interactive online guidance to accompany the existing climate-projected IDF curve tool, initially conceptualized as a decision tree that illustrates the process needed extract information from the tool to directly address key stormwater design and policy questions. This will include guidance on how to select future time periods, climate scenarios, and how to take a risk-based approach when choosing values in the uncertainty range in the IDF curves.
  - Develop a scope of work to update the IDF curve tool with the latest climate model projections and at an improved resolution.
- Research Steps:
  - Solicit feedback from interested parties across the watershed to build out decision support needs
  - Develop decision support tool leveraging prior work and feedback from region
  - Finalize scope of work for updated climate-Informed IDF curves (funding TBD and separately)
- Output:
  - One interactive web-based decision tree (decision support tool) by 12/19/2025
  - One technical report to accompany the tool by 12/19/2025
  - Two to three illustrative case studies by 6/19/2026

Activity 3. Resilient Design Guidance Manual

- Objectives:
  - Develop a guidance manual that includes resilient design adaptations and implementation options for stormwater infrastructure and restoration practices. The manual will be similar in scope and function to a typical design manual in which users can navigate based on infrastructure type. We will also include a mapping of vulnerabilities to adaptation options in the manual, so users will be able to identify which options might help address vulnerabilities identified in their infrastructure system.
- Research Steps:
  - Identify priority BMPs and climate adaptation strategies through literature, expert elicitations, leveraging the findings from the literature review in Activity 1.
  - Carry out a code review to identify which aspects of design make performance sensitive to climate change.
  - Consolidate design adaptations for each priority BMP into a set of feasible options for the region and summarize them in a guidance manual.
- Output:
  - One guidance manual design for use by stormwater managers and developers by 9/25/2026

Activity 4. BMP Climate Sensitivity Modeling

- Objectives:
  - Estimate the impact of future hydrology on a range of widely used BMPs in the Chesapeake Bay watershed.
  - Produce model simulations that provide the pollutant removal efficiencies for different BMPs and uncertainties associated with future hydrological conditions.
- Research Steps:
  - Develop two types of rainfall-runoff hydrologic models to evaluate different urban and agricultural water quality BMPs.
  - SWMM (urban) and SWAT (agriculture) will be used to quantify the nutrient and sediment removal efficiencies for a range of BMPs on representative sites, under a broad set of climate futures.
  - Each individual BMP will be evaluated under an ensemble of downscaled climate projections using a subset of global climate models.
- Output:
  - One technical report that contains: literature review of existing urban and agricultural BMPs; synthesis of model simulations that provide pollutant removal efficiencies for BMPs; look up tables for pollutant removal efficiencies under a range of conditions by 12/17/2026
  - One to two peer reviewed journal articles submitted by 12/31/2026

Activity 4. Stormwater BMPs

- Bioretention cells
- Infiltration trenches
- Permeable pavement
- Filter strips
- Green roofs
- Wet swales
- Detention ponds

Should other BMPs be of key interest to stakeholders, we will determine suitable modeling approaches to evaluate those BMPs.

Activity 4. Agricultural BMPs

- Land retirement/conversion
- Alternative crops and/or cover crops
- Wetland management (including restoration, enhancement, and creation)
- Dry detention pond development
- Conservation tillage
- Application rates of fertilizer and/or manure
- Pasture and grazing management practices
- Forest or grass buffers
- Runoff control in barnyard areas
- Tree planting in erodible areas
- Agricultural drainage (e.g., tile drainage, ditches)

Should other BMPs be of key interest to stakeholders, we will determine suitable modeling approaches to evaluate those BMPs.

Activity 5. Outreach, Dissemination and Training

- Objectives:
  - Engage interested parties and obtain feedback on interim and final products in Activities 1-4
  - Deliver dissemination presentations within the watershed and nationally
  - Develop and implement Climate and Stormwater Training Program
- Outputs:
  - Regular engagement over the course of the project with members (or the full workgroups) the Urban Stormwater Workgroup, Modeling Workgroup, Climate Resiliency Workgroup, Water Quality Goal Implementation Team, Management Board, and others, as requested or relevant to gain feedback and disseminate outputs, all engagement completed by 12/31/2028
  - Three on-site or virtual training presentations to state and local government agencies on the new tools once the tools are completed by 12/31/2028
  - Three presentations to disseminate results to a broader audience at national or regional conferences to share lessons learned and provide examples of future work for other EPA regions by 12/31/2028
  - Development and implementation of climate and stormwater training program by 12/31/2028

Thank you.

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