# Climate Resilience Guidance for Local Jurisdictions

## Background and Purpose

BMC's Climate Change Resource Guide assists local departments of public works (DPWs) and departments of transportation (DOTs) to prepare for climate change impacts by providing historical and projected climate data; expected impacts on infrastructure service areas;[1] and information on relevant regulations, funding/financing opportunities, and potential adaptation strategies. The associated Toolkit is a worksheet that helps users navigate each chapter of the Climate Change Resource Guide.

The purpose of this Climate Resilience Guidance is to further assist DPWs and DOTs in implementing climate change resilience activities. The guidance is intended for any DPW or DOT in the Baltimore metropolitan region, recognizing that processes are different across jurisdictions, although comparable at a high level. While this guidance is geared towards the needs and processes of local government DPWs and DOTs, any department or agency may use it as it applies to their work.

Throughout this document, the icons shown in the table to the right indicate when a recommended action or resource is tailored to a specific service area. Most recommendations and resources are meant to be applicable across service areas and are represented by the "all" icon. However, the Steering Committee and workshop participants who helped develop this Guidance provided some suggestions and resources that are service-area specific, which are tagged with the appropriate icon in the margin.

| Icon | Service Area |
|---|---|
| | Transportation |
| | Stormwater |
| | Water |
| | All |

Before using this Climate Resilience Guidance document, we recommend first reviewing the Climate Change Resource Guide and Toolkit to become familiar with the more general information. This will help you assess the more specific actions presented in this Guidance and decide what is most relevant for your department.

[1] The infrastructure service areas discussed in the Climate Change Resource Guide include transportation, stormwater, water, wastewater, facilities, and solid waste.

# Checklist

## Navigating Use of Regional Resilience Resources

BMC has developed three key resources to support regional resilience efforts: (1) Climate Change Resource Guide and accompanying Toolkit, (2) Climate Resilience Guidance for Local Jurisdictions (this document), and (3) Recommendations for Interjurisdictional Coordination.

This checklist is a high-level guide to navigate these three regional resilience resources, providing steps for how local governments and associated departments can use these resources to understand and create an approach to increase resilience within their jurisdiction and across other jurisdictions. Each checklist item addresses different aspects of this process. You can refer back to the checklist regularly to track progress and identify next steps.

| | Step | Who? |
|---|---|---|
| ✓ | **Get the Big Picture** | |
| | Read the **Climate Change Resource Guide** (or read this presentation providing an overview) | Staff involved in DPW/DOT planning and design |
| | Answer the **Toolkit** questions | Point person(s) coordinating across DPW/DOT planners and designers |
| ✓ | **Take Action** | |
| | Read this document, **Climate Guidance for Local Jurisdictions** | Staff involved in DPW/DOT planning, design, project management, and maintenance |
| | Create an approach to documenting climate risk and identifying recommended projects, policies, and procedures that will increase resilience across DPW/DOT infrastructure<br>• Your local Climate Action Plan, Hazard Mitigation Plan, capital improvement plan, stormwater management plan, etc. can provide insight on climate risks and ideas for projects or policies | Point person(s) coordinating across DPW/DOT planning, design, project management, and maintenance staff |
| | Identify one or more strategies from this **Climate Guidance for Local Jurisdictions** to pursue | Leadership and staff teams (planning, project management, maintenance) |
| | Identify relevant stakeholders for each selected strategy and associated recommendations (more details in strategies below) | Planning teams |
| | Create a timeline for implementation | Project teams |
| | Identify resources necessary for implementation | Leadership and staff teams |
| | Meet with decision-makers/department heads/elected officials to make the case for needed changes | Leadership and staff teams |

| ✓ | Coordinate Regionally | |
|---|---|---|
| | Read the **Recommendations for Interjurisdictional Coordination** document | Staff involved in DPW/DOT climate-related efforts |
| | Identify the most relevant actions for implementation | Staff involved in DPW/DOT climate-related efforts |
| | Participate in regional coordination discussions | Point person(s) for DPW/DOT staff involved in climate-related efforts |
| | Maintain regular communication with other jurisdictions to share information and lessons learned, and build regional resilience | Point person(s) for DPW/DOT staff involved in climate-related efforts |
| | Work with others to create regional dashboard and achievable, meaningful performance measures to track progress on climate initiatives | Point person(s) for DPW/DOT staff involved in climate-related efforts |

# Introduction

This Climate Resilience Guidance focuses on implementation of priority resilience strategies identified during meetings with the project Steering Committee and workshops with transportation, water, and stormwater practitioners across the region (though note there are other adaptation strategies in the Climate Change Resource Guide that may also be considered). Specifically, this Guidance provides information on the following recommended resilience strategies:

1. Develop and adopt climate change resilience design standards and codes, updating existing or creating new standards and codes as needed
2. Screen new and existing capital projects for climate change risk and opportunities
3. Identify and obtain dedicated funding and financing for resilience infrastructure and activities
4. Monitor, maintain, harden, and retrofit assets to promote resilience and prevent damage

Each strategy includes a description of **what** it is, **why** it is relevant for local DOTs and/or DPWs, **how** a department might implement the strategy, and **resources** to help with implementation. Additionally, the following apply to all four strategies:

- The **timeline for implementing** these recommendations is largely context-specific to the local jurisdictions, and is dependent on interjurisdictional coordination and other factors, including staff capacity, funding, and political will.
- **Relevant stakeholders** for implementing these recommendations include but are not limited to state and local DOTs and planning departments, local DPWs and sustainability offices, Maryland Department of the Environment, elected officials, FHWA, EPA, FEMA, community-based organizations, nonprofits, contractors, and engineering consulting firms. Note that project considerations for resilience will likely involve a more varied group of stakeholders than traditional DPW/DOT projects.

# Strategies

## Strategy #1: Develop and adopt climate change resilience design standards and codes, updating existing or creating new standards and codes as needed

**What:** Develop and adopt design standards for infrastructure under your department's management/jurisdiction that account for changes in climate conditions over time and incorporate approaches to increase resilience to a variable climate.

**Why:** Local DPWs and DOTs typically use local codes and design standards to inform infrastructure planning, design, and other decisions, many of which assume that future climate conditions will remain the same as historical conditions. This means that infrastructure designed to these standards may not be prepared to withstand changes in climate. To ensure that infrastructure and other investments are resilient to climate change, local codes and standards should be updated to reflect expected future climate conditions. This is particularly relevant for long-lived infrastructure, which can expect to see a lot of change in conditions before the end of its useful life.

**How:** To develop and adopt accurate and effective resilience design standards and codes, you must first understand what constitutes an effective climate resilience design standard by looking to other successful examples. From this knowledge, you should then examine your jurisdiction's existing codes to identify where action is appropriate and/or necessary, and then identify relevant climate risk inputs and associated design thresholds to apply to design standards and codes. The American Society of Civil Engineers (ASCE) and Maryland Coast Smart Construction Program both provide strong examples of resilient design codes and guidance:

- The ASCE 2014 update of Flood Resistant Design and Construction provides minimum requirements and performance standards for construction in flood hazard areas. These standards include designing for flood loads, foundation performance, material selection, placement of utilities, and determining risk levels based on use.
- ASCE/SEI 7-22, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, is an essential part of buildings codes and includes a variety of climate hazards, including flood, snow, rain, atmospheric ice, and wind loads.
- The Maryland Coast Smart Construction Program, developed by the Maryland Department of Natural Resources, provides guidance for state and local capital projects that include construction or reconstruction of a structure. The guidance includes information on siting, elevation, material choice, buffers, and on-site mitigation. This guidance is mainly focused on flood prone areas determined by the Coast Smart Climate Ready Action Boundary (CS-CRAB).

To maximize potential for success, it is important to have the support of the agency leaders (e.g., Director of Planning and Zoning, legislative officials, chief engineers) to help drive the

process. Developing and/or updating codes and standards to be climate resilient can be a lengthy process that requires buy-in both from those responsible for writing the codes and from those responsible for implementing them. Having top-down direction from agency leadership can help ensure that updating codes and standards is a priority, has a clear timeline, roles are defined, and interagency coordination is facilitated.

You also need to decide whether the following preliminary steps are needed to secure support from your top legislative and/or executive officials: (a) updating a local comprehensive plan or other plan (e.g., local hazard mitigation plan) to integrate climate change, which can result in recommendations and strategies that the local government can implement, such as revising climate resilience design standards; (b) obtaining approval to conduct a study to implement the Recommended Actions listed as part of this strategy, and, if funding for a consultant is needed, to secure approval of that funding for an RFP and contract.

**Recommended Action #1: Review example climate resilience design standards.** Several state and local governments have adopted climate resilience design standards. These existing standards can serve as a model or inspiration for language that jurisdictions in the BMC region could use to establish their own resilience design standards. For example:

- New York City's Climate Resiliency Design Guidelines: These guidelines apply to capital projects and focus on resilience to more intense and frequent extreme heat and precipitation, and sea level rise. They provide detailed guidance for how to use future-looking climate change data to inform the design of City facilities. For example, they provide a straightforward formula for adjusting the design flood elevation to account for sea level rise based on the end of the project's useful life and whether the project is a critical facility (Figure 1).

**Table 4 - Determine the sea level rise-adjusted design flood elevation (DFE)[53]**

| End of Useful Life | Base Flood Elevation (BFE)[54] in NAVD 88 | + Freeboard[55] | + Sea Level Rise Adjustment[56] | = Design Flood Elevation (DFE) in NAVD 88 |
|---|---|---|---|---|
| **Critical* Facilities** | | | | |
| **2020s** (through to 2039) | FEMA 1% (PFIRM) | 24" | 6" | = FEMA 1% + 30" |
| **2050s** (2040-2069) | FEMA 1% (PFIRM) | 24" | 16" | = FEMA 1% + 40" |
| **2080s** (2070-2099) | FEMA 1% (PFIRM) | 24" | 28" | = FEMA 1% + 52" |
| **2100+** | FEMA 1% (PFIRM) | 24" | 36" | = FEMA 1% + 60" |
| **Non-critical Facilities** | | | | |
| **2020s** (through to 2039) | FEMA 1% (PFIRM) | 12" | 6" | = FEMA 1% + 18" |
| **2050s** (2040-2069) | FEMA 1% (PFIRM) | 12" | 16" | = FEMA 1% + 28" |
| **2080s** (2070-2099) | FEMA 1% (PFIRM) | 12" | 28" | = FEMA 1% + 40" |
| **2100+** | FEMA 1% (PFIRM) | 12" | 36" | = FEMA 1% + 48" |

*Figure 1. NYC Resiliency Design Guidelines provide a formula for adjusting the DFE for sea level rise.*

- Boston's Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way: These guidelines provide design, operations and maintenance, and cost considerations that are needed to advance conceptual flood barrier ideas to implementation. They also present climate design adjustments to account for SLR and storm surge, extreme precipitation, and extreme heat (see Figure 2 for their table on precipitation design adjustments).

**Table 2. Extreme Precipitation Design Adjustments**

| Peak Hourly Intensity Rainfall (inch/hour) | | | |
|---|---|---|---|
| End of useful life | 10% annual design storm (in/hr) (BWSC 2015 (A1FI)) | 2% annual design storm (in/hr) | 1% annual design storm (in/hr) |
| Baseline (NOAA 14) | 1.66 | 2.33 | 2.62 |
| 2035 | 1.78 | *Data not available* | *Data not available* |
| 2060 | 1.91 | *Data not available* | *Data not available* |
| 2100 | 2.11 | *Data not available* | *Data not available* |
| **Total Storm Depth (inches/24 hour)** | | | |
| End of useful life | 10% annual design storm (in) (BWSC 2015 (A1FI)) | 2% annual design storm (in) | 1% annual design storm (in) (City of Cambridge 2015) |
| Baseline (NOAA 14) | 5.25 | 7.18 | 8.08 |
| 2035 | 5.60 | *Data not available* | 10.2 |
| 2060 | 6.03 | *Data not available* | *Data not available* |
| 2100 | 6.65 | *Data not available* | 11.7 |

*Figure 2. Boston's Climate Resilient Design Standards and Guidelines provides guidance for adjusting design based on future rainfall intensity.*

**Recommended Action #2: Identify which design standards and codes can and should be updated, and if new standards and codes need to be developed and adopted to help ensure new infrastructure is designed to be resilient to climate change.**

- Review existing design standards and codes to identify which include climate conditions to inform design or other planning considerations.
  - For these standards and codes, assess whether the current climate inputs capture expected conditions or if they need to be updated.
  - If updates are required, use climate projections from the design inputs listed below under Recommended Action #3.
- Identify if new standards and codes need to be developed and adopted.
  - If relevant, develop standards for infrastructure that is critical, sensitive to climate, or otherwise a priority for resilience efforts.
  - Use the climate projections from the design inputs listed below under Recommended Action #3, as well as the sensitivities and risk tolerance of the infrastructure in question, to identify appropriate inputs for the new standards and codes.

**Recommended Action #3: Identify relevant design inputs for your jurisdiction.**

- First, review BMC Climate Change Resource Guide Chapter 2 for regional data to identify projected future temperature and precipitation data for your jurisdiction, followed by Appendix A for local data.
- If needed, use the US Climate Explorer tool for regularly updated data for a variety of climate variables. This is considered the authoritative resource for climate science in the United States.
- Create a table or timeline of future climate conditions to plan capital projects and design standards accordingly.
    - For example, identify the projected maximum temperatures in the region (and/or your local jurisdiction) in 2030, 2050, and 2080.

Additional resources for specific hazards are listed below.

- ***Sea levels and coastal flooding:***
    - Table 4 of the BMC Climate Change Resource Guide provides projected relative sea level rise at local tide gauges (Figure 3).

| Tide Gauge | Projected Relative Sea Level Rise (ft) | | |
|---|---|---|---|
| | Near-Term (2030) | Mid-century (2050) | End-of-Century (2080) |
| Baltimore | 0.6 (0.4 – 0.9) | 1.2 (0.8 – 1.6) | 2.3 (1.6 – 3.1) |
| Annapolis | 0.6 | 1.2 | 2.4 |

* Values shown are the state of Maryland's projected sea level rise values above 2000 levels. The projected value represents a central estimate, or the 50% probability that sea level rise is projected to meet or exceed. Values in parentheses indicate the likely range of projected sea level rise; sea level rise has a projected 67% probability of being between these values (not specified in the data source for the Annapolis tide gauge). The 2030 and 2050 projections for sea level rise are for RCP 4.5, though there is very little difference between RCP 4.5 and RCP 8.5 over the next 30 years. The 2080 projections are for RCP 8.5. Source: Sea-level rise: Projections for Maryland 2018.

*Figure 3. The BMC Climate Change Resource Guide presents sea level rise increments across future time horizons for Baltimore and Annapolis.*

    - The Maryland Coast Smart Construction Guidelines provide requirements (that are voluntary at the local level) on siting and designing the construction of a structure or highway facility within an area that is vulnerable to sea level rise, as defined by the Coast Smart Climate Ready Action Boundary (CS-CRAB). The CS-CRAB represents the floodplain created by a 3-foot vertical extent above the 100-year FEMA floodplain elevation (aka Base Flood Elevation) to account for a Category 2 storm surge and 2 feet of sea level rise.
    - NASA's Interagency Sea Level Rise Scenario Tool provides the latest projections for tide gages around the country.
- ***Rainfall:***
    - The Maryland Department of the Environment is currently in the process of updating stormwater quantity control standards for watersheds, which may include stormwater quantity management standards for flood control, through their A-StoRM project.

- In addition, MDOT SHA's forthcoming Highway Drainage Manual update will include drainage design standards for incorporating forward-looking climate projections.
- Pending these updates, review and incorporate into local standards as appropriate.

- ***Temperature:***
  - As applicable, review any temperature inputs to your current design guidelines.
  - Consult the BMC Climate Change Resource Guide for a range of projected temperature values for your jurisdiction.

**Relevant Resources**

- BMC Climate Change Resource Guide: An excellent starting place to obtain climate change information, including hazards and adaptation options
- US EPA Climate Resilience Evaluation and Awareness Tool (CREAT) Risk Assessment Application for Water Utilities: An interactive tool created by the EPA to assist utilities in understanding and planning for climate risk, including cost-benefit analyses
- Example climate resilience design guidelines (Recommended Action #1)
  - Maryland Coast Smart Construction Program Guidelines
  - NYC Climate Resiliency Design Guidelines
  - Climate Ready DC Resilient Design Guidelines
  - Boston Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way (for guidance on design, operations and maintenance, and cost considerations for SLR and storm surge)
  - Philadelphia Water Department Climate-Resilient Planning and Design Guidance
  - **MDOT SHA**'s forthcoming **Highway Drainage Manual** update
  - National Cooperative Highway Research Program (NCHRP) 15-61**:** The project, Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure, provides hydraulic engineers with the tools needed to amend practice to account for climate change
  - **NCHRP 15-80**: Design Guide and Standards for Infrastructure Resilience, once released for publication, will provide examples of climate change design guidelines and standards at the local, state, federal, and international level, as well as guiding principles for addressing climate change in design
- Identifying design inputs (Recommended Action #3)
  - First, review BMC Climate Change Resource Guide Chapter 2 for regional data to identify projected future temperature and precipitation data for your jurisdiction, followed by Appendix A for local data
  - If needed, use the US Climate Explorer tool for regularly updated data for a variety of climate variables. This is considered the authoritative resource for climate science in the United States
- Integrating equity into climate design and planning
  - MD Climate Solutions Now Act of 2022 provides a definition of "underserved" or "overburdened" communities. **Local jurisdictions can use this definition to integrate equity into climate planning and design standards**, such as requiring that projects within/upstream of such communities include community engagement and that the project does not exacerbate climate risks to the community. **Overburdened** communities refer to census tracts with at least three environmental health indicators above 75$^{th}$ percentile statewide (e.g., air pollution, traffic, lead paint, superfund sites, animal feeding operations). Also included are areas lacking broadband coverage or experiencing higher levels of certain health conditions. **Underserved** communities refer to census tracts with residents qualifying as low-income, nonwhite population, or having low English proficiency.
- Relevant industry research includes
  - **Transportation:** forthcoming NCHRP research findings on Design Guide and Standards for Infrastructure Resilience, FHWA's Boosting Pavement Resilience, and a study considering state DOT design manuals and stormwater standards
  - **Stormwater:** Maryland Stormwater Design Manual and research from UMD's Stormwater Infrastructure Resilience and Justice (SIRJ) Lab can serve as a foundation and space for innovation on stormwater infrastructure design
  - **Water:** The Water Research Foundation's ongoing project to create a Practical Framework for Water Infrastructure Resilience

## Strategy #2: Screen new and existing capital projects for climate change risk and opportunities

**What:** Apply a process to screen or otherwise review capital projects to identify climate risks and resilience opportunities. Ideally, this would be integrated as a step in existing capital planning processes.

**Why:** Identifying opportunities for new projects to be proactively designed for climate resilience can save money and effort in the long run. Additionally, by considering how and when existing assets may be affected by climate change, local governments can plan and budget for rehabilitation, relocation, and/or replacement.

**How:** Local governments can implement the following recommended actions to give transportation, stormwater, and water sector planners discrete considerations for assessing climate risks and resilience opportunities during capital planning and design (e.g., how a project may be impacted by climate hazards like flooding, heat, and storms). Note that if state funding is being used for a local capital project, there is a screening process that the Maryland Department of Budget and Management (DBM) coordinates to identify projects within the CS-CRAB boundary as mapped on the state's Growth and Conservation Area map. DBM works with the Maryland Department of Natural Resources to provide resilience guidance for consideration to incorporate into the project.

**Recommended Action #1: Incorporate climate considerations into the project development and selection process.**

- The purpose of this action is to help identify and communicate the climate risks and resilience opportunities for new projects. Doing so will help ensure that climate considerations are "baked in" to the overall capital planning process, which can give local governments more confidence that their investments in capital projects have accounted for potential risks and built resilience to these risks as appropriate.
- Developing a process for incorporating climate considerations into the project development and selection process will also create coordination, documentation, and structure around resilience efforts.
- **Local governments can include a climate impact statement as part of any existing forms used to submit project proposals.** This impact statement can ask project teams to answer (1) What are the climate change impacts that may affect the project? (E.g., is the project sited in the 500-year floodplain, which is expected to see more frequent flooding in the future?) and (2) How are these risks being addressed? This could include physical (e.g., installing a backup generator at a critical facility on a raised platform to reduce its risk to flooding) as well as operations and maintenance measures (e.g., more frequent cleaning for storm drains in anticipation of more frequent and intense rainfall).
    - For example, MDOT SHA includes an impact statement on their Programmatic Categorical Exclusion (PCE) form. In addition, MDOT MTA is currently evaluating climatic review as part of the NEPA process.

- **Local governments can create and use a metric for evaluating climate risk and resilience of projects.** This metric could be incorporated into existing evaluation processes, such as by adding a criterion for assessing the climate risk faced by the project and how well such risks are mitigated, and if the project contributes to the overall resilience of the jurisdiction. Resilience scoring could influence how much funding a project gets, or its scope.
    - Local governments can review examples of resilience scoring for lessons learned and best practices. These include Anne Arundel's CIP Resiliency Criteria and Howard County's DPW Bureau of Engineering Transportation and Special Projects Division Checklists (see Relevant Resources box below for further details and additional resources).
- Review existing climate-related considerations used during site selection and project design (e.g., stormwater conveyance). As appropriate**, add to this list to include climate risks that are expected in the region**, such as severe winter weather.
    - See BMC Climate Change Resource Guide Chapter 2 for regional data to identify projected future temperature and precipitation data for your jurisdiction, followed by Appendix A for local data.
    - Any experimentation with changing these considerations should be well documented and shared with other jurisdictions in the region.
- When submitting projects for the long range transportation plan, **evaluate and share information on potential climate impacts** as requested on the project submittal form.

**Recommended Action #2: Improve documentation of internal discussions and knowledge of risks.**

- The purpose of this action is to help break down existing silos and facilitate the capture and transfer of information on climate-related discussions and decisions (e.g., from county staff to commission, and between various departments and agencies).
    - An example of current documentation of conversations regarding climate risk in the region is The Maryland Department of Planning's training resources page. This page includes recorded conversations from Anne Arundel County staff, Maryland DEP, and climate change experts on climate change risks and best practices for protecting critical infrastructure. These recordings serve as one formatting strategy for documenting local dialogue and best practices.
    - This example indicates a best practice but also indicates the unique ways that different departments and agencies document internal discussions and knowledge of risks. Using BMC's **Recommendations for Interjurisdictional Coordination** guidance document, departments and agencies can coordinate to decide on a unified documentation practice.
- **Local governments can develop a standard format for documenting the discussions and decisions made by DPW and DOT staff who are implementing the recommendations in this Climate Resilience Guidance, and other staff involved in climate risk and resilience work.** The documentation does not have to be a brand-new process—local jurisdictions can add a section on documenting climate-related narratives

and decisions into existing processes, such as adding a statement about climate impacts to projects within the capital budget description (as discussed in Recommended Action #1 above). However, documentation does not need to be limited to just the capital planning process—any decision-making process that may be impacted by climate change is a candidate for this recommendation.

- Such documentation not only ensures that information that supported decision-making can be readily referenced, but also helps integrate climate discussions across departments and staff, increasing familiarity with and uptake of such information. A widespread audience should understand the impact of climate change, and their own role/responsibility for building climate resilience.
- Such documentation also helps to formalize risk and resilience concerns within existing government processes, which can help make the case for decision-makers to support climate resilience efforts.

**Recommended Action #3: Identify climate resilience projects outside the traditional CIP development process based on vulnerability of infrastructure and communities as well as available funding.**

- The purpose of this action is to widen the net for potential climate resilience actions. While Recommended Action #1 above focuses on the CIP process and other existing project development processes, this action focuses on developing and implementing resilience measures that are not tied to specific projects within the CIP.
- **Local governments can use a variety of resources to better understand how climate change might impact their region.** The BMC Climate Change Resource Guide describes future climate trends in the region in Chapter 2, and potential impacts to local public works and transportation departments in Chapter 3. For additional high-resolution climate projections, consult the US Climate Explorer tool.
  - Your local Hazard Mitigation Plan can be an excellent resource. Not only does this plan already identify risks and potential risk-reduction measures, but it is also required for applying to certain types of non-emergency disaster assistance from FEMA. Connecting resilience projects to the Hazard Mitigation Plan can therefore help to better position you for federal funding.
  - Maintain open and regular communication with other jurisdictions in the region to understand the innovative data sources and adaptation strategies they are implementing. Sharing lessons learned will help the region to build upon successful initiatives.
- **Once you have identified key climate concerns for your jurisdiction, you can identify potential adaptation strategies to mitigate those climate risks.** There are a variety of federal and state resources to help you understand which adaptation strategies are right for you. Start with Chapter 5 of the BMC Climate Change Resource Guide.

**Relevant Resources**

- Resilience scoring and screening (Recommended Action #1)
  - Anne Arundel's CIP Resiliency Criteria provide an example of how local governments can score (1) project resilience to flooding and (2) resilience of buildings, as applicable
  - Resilience 2050 Project Submittal Form to screen capital projects submitted for inclusion in the regional long-range plan
  - **Howard County DPW Bureau of Engineering, Transportation and Special Projects Division Checklists** (e.g., Roadway, Sidewalk, and Storm drain Checklists) of project requirements for being accepted. These Checklists (and the example template and language) may be an opportunity to add climate resilience considerations in the project development process
  - MD DNR green infrastructure efforts have already been used as a template that some at the local level are following, including the assessment of areas with SLR and shoreline mapping
  - NYC Climate Resiliency Design Guidelines: **Exposure Screening Tool**, which can be used to assess climate hazards before the finalization of a project scope, and **Resilient Design Submittal Checklist** as design checklist guidance across project stages (included in Appendix 6 of the Guidelines)
- Identifying climate risks (Recommended Action #3)
  - BMC Climate Change Resource Guide Chapters 2 and 3 for regional climate trends and potential impacts to local DOTs and DPWs
  - US Climate Explorer tool for high-resolution climate projections
  - Use the interactive MDOT SHA Climate Change Vulnerability Viewer for visualization of potential sea level rise and coastal storm surge in your jurisdiction
  - CS-CRAB **(Coast Smart Climate Ready Action Boundary)** to characterize potential areas of flooding by determining minimum elevation requirements and other flood-related siting and design standards
  - MD EJScreen Mapper to identify environmental justice concerns across the state
  - US EPA Climate Resilience Evaluation and Awareness Tool (CREAT) Risk Assessment Application for Water Utilities to better understand and plan for climate risk
- Sources for resilience measures (Recommended Action #3)
  - BMC Climate Change Resource Guide Chapter 5
  - Required documents to identify opportunities for resilience, such as **Local Hazard Mitigation Plans** which identify infrastructure at risk, **Nuisance Flood Plans** which provide information on infrastructure at risk to flooding, and **Local Comprehensive Plans**, which provide an opportunity to integrate climate change adaptation for all types of long-term community needs (transportation, water resources, public facilities, etc.)
  - Maryland Department of Planning Best Practices for Integrating Climate Change, Identifying Suitable Receiving Waters to inform Local Comprehensive Plans
  - US EPA Resilient Strategies Guide for Water Utilities presents a combination of best practices/potential projects, as well as funding opportunities that are state-specific
- **MDOT MTA Resilience and Adaptation Toolkit** includes multiple resources on addressing resilience and equity. These include the USDOT 2022 Equity Action Plan, the USDOT 2021 Climate Action Plan Revitalizing Efforts to Bolster Adaptation and Increase Resilience, the Justice40 Initiative, the Maryland Environmental Justice Screening Tool, and the Transit Station Area Profile Tool (TSAPT)
- UMD Environmental Finance Center and MD Department of Natural Resources Ready for Resilience: Embedding Climate Action into Local Government Operations provides guidance to facilitate implementation of resilience, including for hazard and vulnerability assessments, policies and codes, and infrastructure and asset management

## Strategy #3: Identify and obtain dedicated funding and financing for resilience infrastructure and activities

**What:** This strategy aims to assist local governments in identifying relevant funding and financing opportunities for resilience initiatives and equip them with the resources and strategies needed to successfully obtain the funds. This includes addressing issues of staffing/capacity, quantifying the costs and benefits of resilience, and identifying appropriate funding streams and grant opportunities. It also seeks to address the related need for more consistent and life-cycle oriented analysis of projects.

**Why:** Often, the additional staffing resources and technical expertise that are needed to identify and obtain sufficient funding and financing for resilience efforts pose a burden to local governments. Additionally, climate change will impact local budgets and shape the availability of financing sources for local governments, and current financing does not always incorporate a life-cycle cost view of projects, nor a consideration of extended future maintenance needs.

**How:** Local governments can utilize the below recommendations to address the issues described above. Specifically, the recommended actions are meant to help local governments better understand and identify resilience financing opportunities that are relevant to their jurisdiction, develop strategies to overcome barriers of technical and staffing capacity in applying to funding opportunities, and better understand and develop lifecycle costs and benefits of resilience actions. Analyzing the lifecycle costs and benefits of resilience helps make the business case for implementation, as it more clearly demonstrates the long-term cost savings of resilience investments to both the public and elected officials, rather than focusing on the immediate up-front costs of implementation.

**Recommended Action #1: Identify relevant opportunities to fund and finance resilience.**

- There are a variety of funding and support resources for local climate resilience efforts, including:
  - Chapter 6 of the BMC Climate Change Resource Guide, which provides information on funding and financing sources.
  - MD Resiliency Partnership, which has multiple resources, including guidance on grants, technical assistance tools to help local governments assess their climate vulnerability, and more.
  - Federal funds, including the 2021 Infrastructure Investment and Jobs Act (IIJA) and 2022 Inflation Reduction Act (IRA), which have earmarked billions of federal dollars across a variety of sectors and departments to support resilience projects.
- State and local governments have increasingly pursued new financing mechanisms for resilience efforts, including Green Bonds. Some of these new financing strategies are outlined by the Center for Climate and Energy Solutions.

**Recommended Action #2: Develop strategies to overcome barriers of technical and staffing capacity in seeking resilience financing and funding.**

- Counties and municipalities often cite the lack of staffing and/or technical capacity as a barrier to seeking financing or funding for resilience projects, even if there is a clearly demonstrated need and other eligibility requirements are met. To overcome these obstacles, local governments can:
  - **Pool resources and apply for grant funding to support projects across multiple jurisdictions**. This is particularly useful for resilience projects, as climate change impacts will be felt across jurisdictional boundaries.
    - It may be most efficient for partner jurisdictions to first collaboratively define the resilience effort they are seeking to fund, but then have one jurisdiction lead the grant application process, as coordinating the application across multiple entities may actually increase the effort involved in applying.
    - Discuss with BMC how they might be able to provide support in managing this sort of collaborative process or in identifying grants that allow cross-jurisdictional applicants.
  - **Develop template language to streamline the grant writing process** and shorten lead time of preparing applications. Work with your government's communications and grant writing-related staff as needed to help develop this language.
    - This may entail general language on the climate risks your government has identified, as well as any other boilerplate text that would be broadly relevant across grants (e.g., size of the jurisdiction and brief description of the population and/or government, how you've come to identify the priority climate risks, what efforts—if any—are underway to address these risks, and what risks remain that need this grant to be addressed).
    - It could also take a "fill in the blanks" approach to allow grant writers to quickly tailor an introduction/statement of need for each specific grant.

**This template might say something along the lines of**:

"____ (City/County/Department) has identified ____ (climate hazard) as a priority hazard through _____ (approach – GIS analysis; community survey; reviewing the BMC Climate Change Resource Guide; observation of current impacts). Historically, this has affected our (City/County/Department/population) through _____ (description of past impacts), including to infrastructure (specific stormwater, water/sewer, transportation, etc. structures and facilities in specific geographic locations). However, we expect that _____ (future impacts due to climate change). With that in mind, we are seeking to _____ (description of proposed resilience solution; bonus if you tie in grant theme/purpose/requirements). We expect this will _____ (list of outcomes), based on _____ (any sort of research, case studies, examples of successful implementation elsewhere that can support your decision to choose the proposed solution)."

  - **Account for financing and funding responsibilities/obligations in workforce planning**. Ensure that this type of work is explicitly included in staff roles so that it can be a priority action for the team. Identify who/which position is best suited for

these responsibilities, and if additional staff need to be brought on board to ensure your government has the staffing and technical capacity to confidently pursue funding and financing opportunities.

**Recommended Action #3: Evaluate and communicate lifecycle costs and benefits of resilience to help with financing.**

- The purpose of this strategy is to better understand and communicate costs and benefits associated with resilience, and thereby help make the business case for investing in resilience.
- **Local governments should consider the entire project lifecycle when identifying the costs of projects**, rather than the current focus on costs associated with implementation and about a year of maintenance.
  - Doing so can help shed light on the costs of inaction (i.e., not implementing resilience measures), since climate change may cause costly wear-and-tear, damage, or increased maintenance needs over the life of the project.
  - Resilience measures are not always politically popular because they can carry higher upfront costs than the same project minus any resilience measures. Taking on a lifecycle view of costs can help demonstrate that near-term investments in resilience can lead to cost savings over time, as costs from climate impacts are avoided. For example, the United Nations has estimated that every $1 invested in climate resilient infrastructure saves $6.
  - It is critically important to convey the cost savings associated with resilience investments to agency executives, elected officials, and the public. Resilience must be seen as not only a risk prevention tool, but also a cost-savings mechanism. The use of co-benefits in evaluating the costs of projects can increase the business case value of a project and its appeal.
  - Additionally, the insurance industry is increasingly promoting or requiring reporting climate risks and use of resilience measures to offset risks of insured assets and communities. Actively building your local jurisdiction's resilience can help boost its credit bond rating.
- For this strategy to be effective, the **lifecycle costs and benefits must be communicated to a wider audience beyond the project team** (i.e., finance department staff and decision-makers should also understand the project purpose, intent, and benefits in order to ensure sufficient funding).
  - Developing a communications strategy to create financial support for resilience strategies can pull inspiration and expertise from many different industries. The use of strategic case-making principles can assist in building public and political will to support the operations and maintenance of the jurisdiction's infrastructure.
  - Efforts to bolster climate literacy, specifically around resilience, among the general public and elected officials will also support these efforts.
    - Attend Maryland Climate Leadership Academy, which supports the continued climate-related education and training for staff in state and local governments.

- Local governments may choose to do a Life Cycle Assessment (LCA) made up of three steps: Environmental LCA, Life Cycle Cost Assessment, and Social LCA.
  - The US General Services Administration provides information and resources to better understand Life Cycle Assessments and how to conduct them.
  - The University of California Institute of Transportation Studies developed a tool for local governments to assess the life cycle of pavement. This tool presents a valuable transportation specific life cycle assessment methodology, as well as serves as an excellent case study for other local government-conducted life cycle assessments.

**Relevant Resources**

- Funding and financing opportunities (Recommended Action #1)
  - BMC Climate Change Resource Guide Chapter 6
  - MD Resiliency Partnership has multiple resources, including guidance on grants
  - **Federal funds**, including the 2021 Infrastructure Investment and Jobs Act (IIJA) and 2022 Inflation Reduction Act (IRA)
  - FEMA Recovery and Resilience Resource Library, an extensive database of FEMA recovery and resilience programs, including funding opportunities
  - Inspiration and research on innovative climate financing mechanisms can be found at the Center for Climate and Energy Solutions
  - NOAA's Funding and Financing Options and Considerations for Coastal Resilience Projects
  - UMD Environmental Finance Center and MD Department of Natural Resources Ready for Resilience: Embedding Climate Action into Local Government Operations provides guidance to facilitate implementation of resilience, including for finance and budgeting
- Identifying costs of resilience (Recommended Action #3)
  - **Howard County Eco Works**. Review as a model for built green infrastructure, considering maintenance needs of resilience projects
  - CNT Green Infrastructure Benefits section on Transportation Benefits which help quantify and value the transportation benefits of green stormwater infrastructure
  - Kirkland, WA DPW case study of quantitative ranking of costs and benefits for integration of Low Impact Development and Green Infrastructure Programs into design of CIPs
- Benefit-Cost Analysis and Life Cycle Analysis (LCA) guidance (Recommended Action #3)
  - **US GSA** information and resources to better understand LCAs and how to conduct them
  - UC Institute of Transportation Studies tool for local governments to assess the life cycle of pavement
  - FEMA BCA Guidance and Supplement BCA Guidance and USDOT BCA Guidance for Grant Programs for guidance on how to conduct benefit-cost analysis for grant applications
  - The Institute for Sustainable Infrastructure provides the infrastructure scheme Envision to evaluate the sustainability of multiple infrastructure types
  - BREEAM Infrastructure (formerly CEEQUAL) is a sustainability assessment framework for civil engineering, infrastructure, landscaping, and public realm projects. The BREEAM framework evaluates projects across criteria of Management, Resilience, Community and Stakeholders, Land use and Ecology, Landscape and Historic Environment, Pollution, Resources, and Transport
  - EPA Climate Resilience Evaluation and Awareness Tool (CREAT) is a climate-related risk assessment tool for water utilities. CREAT compares risk over time to the cost of several different adaptation measures.
- Boosting local climate literacy (Recommended Action #3)
  - Maryland Climate Leadership Academy supports the continued climate-related education and training of staff in state and local governments

## Strategy #4: Monitor, maintain, harden, and retrofit assets to promote resilience and prevent damage

**What:** In addition to ensuring new infrastructure is resilient, local jurisdictions should also monitor their existing infrastructure to identify vulnerabilities to climate hazards and address any associated potential damage through ongoing maintenance and retrofits.

**Why:** Building resilience is an ongoing process and often takes time to implement across infrastructure systems. During this process, it is important to not only construct new resilient infrastructure, but also monitor existing assets that may be more vulnerable for damage, make repairs where necessary, and implement hardening mechanisms and retrofits when possible. Increasing the resilience of existing infrastructure helps to ensure its longevity and usefulness in the face of climate impacts—which is good for both the government's investment in the infrastructure as well as the people who rely on/use the infrastructure. Increasing infrastructure resilience can even protect the safety of the facility occupants, such as against extreme heat or flooding events.

**How:** Local governments should build resilience into their existing maintenance and operations procedures by prioritizing climate risk as an issue to be addressed, and increasing resources for monitoring/repair/retrofit efforts to protect against the increased potential damage associated with climate change. Sometimes the least-cost option will be to move a facility. Other times, "soft" options such as adding natural and nature-based features can protect a facility.

**Recommended Action #1: Include climate change in maintenance prioritization frameworks.**

- Many DOTs and DPWs have frameworks to prioritize and address maintenance needs. Climate change could be incorporated into these frameworks to ensure vulnerabilities and climate-related damage are being prioritized and addressed expediently.
- Utilization of maintenance request tracking technology can greatly aid these efforts by both allowing for more efficient responses to maintenance needs and, if programmed to do so, automate prioritization of climate-related requests. Additionally, tracking maintenance requests can help identify areas that are more prone to climate-related issues and therefore might be a priority for building resilience.

**Recommended Action #2: Increase frequency of monitoring of infrastructure for potential damage.**

- Conduct targeted studies on assets that may be vulnerable to climate hazards to look for existing or potential damage. This can inform prioritization of repair and maintenance work.
- Explicitly consider a wide range of potential climate impacts and hazards (i.e., water table levels during drought periods, asphalt damage during prolonged extreme heat, etc.) when monitoring for potential impacts.
- Use technology when available to accurately assess risk and/or monitor conditions in real time (i.e., SCADA systems, GIS mapping).

- The data collected from this monitoring can help identify which facilities or geographic areas are experiencing more climate-related impacts, which can help prioritize where to implement resilience efforts.
- On the flip side, it would also be useful to continue monitoring climate-related trends and impacts once resilience measures are implemented—this could in part track the performance and efficacy of the resilience measure (e.g., in avoided flood damages to the facility during heavy storms; in reducing building energy usage during extreme heat events).

**Recommended Action #3: Prioritize retrofits, repairs, and hardening based on level of risk and criticality.**

- Characterizing the vulnerability and criticality of infrastructure is essential given long useful lives of infrastructure, costs of maintenance and replacement, and the reliance on critical infrastructure features being available and fully operational. Understanding current and expected future vulnerability to climate change will help prioritize limited resources and help identify and prioritize the most essential components of our regional infrastructure for resilience investments.
- To best allocate resources, vulnerability to climate risk and criticality can be used as prioritization factors for where to implement resilience measures such as repairs and retrofits.
    - Equity should also be a consideration when deciding how best to allocate resources for resilience efforts. It is important that resilience benefits are felt by historically underserved and overburdened communities and those who face socioeconomic risks as well as climate risks.
- To understand vulnerability, you should evaluate a combination of sensitivity (how susceptible the asset/infrastructure is to being damaged), exposure (how likely the asset/infrastructure is going to experience a climate hazard based on physical location), and criticality (how severe the impact would be if an asset was damaged).
    - Recommended Action #2 above can help inform both exposure (e.g., where hazards are frequently occurring) and sensitivity (e.g., which assets/infrastructure are experiencing more severe impacts from climate hazards).

**Relevant Resources**

- BMC Climate Change Resource Guide Chapter 5 for a menu of adaptation strategies
- UMD Environmental Finance Center and MD Department of Natural Resources Ready for Resilience: Embedding Climate Action into Local Government Operations provides guidance to facilitate implementation of resilience, including for infrastructure and asset management
- Examples of effective monitoring systems and protocols that consider climate change (Recommended Action #2)
    - **Baltimore County's Asset Management System** incorporates climate change into its preventative maintenance decision making framework
    - **Harford County** utilizes a robust GIS database to inform their emergency and adaptation planning efforts
    - **MDOT SHA** has started tracking frequently flooded structures to build out a Climate Change Vulnerability viewer. They are also developing an emergency relief data tool to capture real time emergency events, impacts, costs, and areas of concerns to better inform preventative maintenance and retrofits