BALTIMORE METROPOLITAN COUNCIL

BRTB
Baltimore Regional Transportation Board

Climate Change Resource Guide: Planning, Designing, Operating, and Maintaining Local Infrastructure in a Changing Climate

An Overview

Agenda

- Introduction to the Resource Guide & Toolkit
- Overview of each chapter, with toolkit questions for each

KEY TERMS

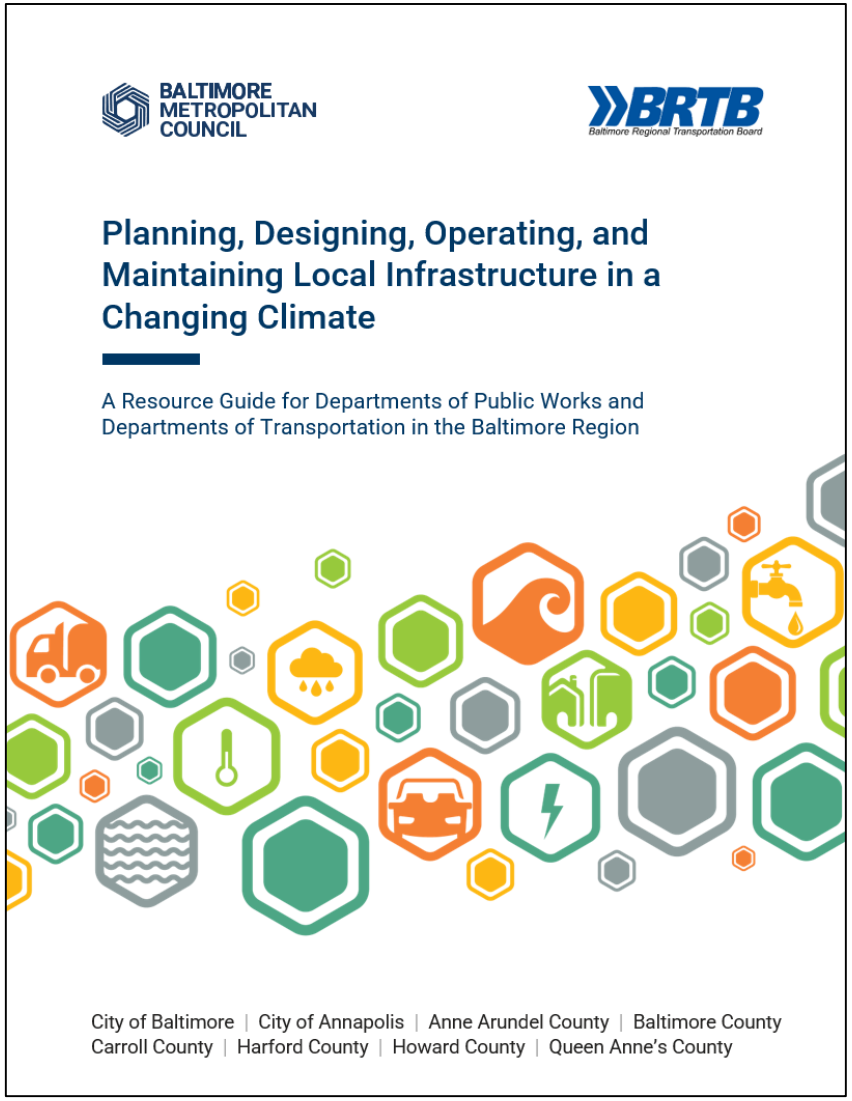
There are two ways to take action on climate change:

- **Adaptation**: Measures to proactively adjust to a changing environment.

  Examples include ensuring sufficient building cooling systems given rising temperatures or siting assets outside future flood zones.
- **Mitigation**: Measures to reduce greenhouse gas emissions to slow or stop the impacts of climate change.

  Examples include transition to clean energy sources or electrification of building heating systems.

This Resource Guide and Toolkit focus on adaptation.



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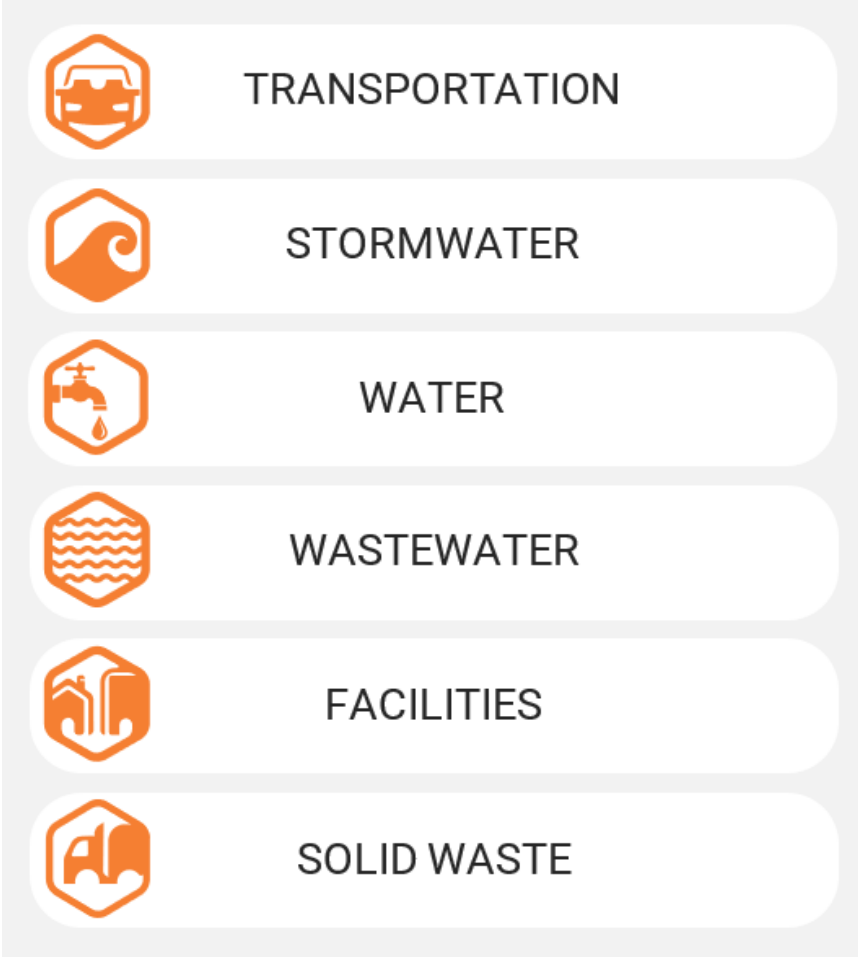
Introduction

- Resource Guide and Toolkit support local DPWs and DOTs to prepare for climate change
- Covers 6 infrastructure service areas



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Resource Guide Overview

- **The Resource Guide consists of six chapters to support climate resilience planning:**
  - Ch1: Introduction and Toolkit
  - Ch2: The Changing Climate
  - Ch3: Climate Change Impacts
  - Ch4: Policies
  - Ch5: Adaptation Options
  - Ch6: Funding and Financing

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Toolkit Overview

- The Toolkit, within the Resource Guide, is a worksheet that makes the content from each chapter actionable for users, by including questions to consider for your work

Toolkit Questions	Enter Your Responses
Climate science: Chapter 2 and Appendix A	
1. What climate hazards are relevant to your work or project? Use the information about current and future climate change in Chapter 2 (regional summary) and Appendix A (jurisdictional data) to determine relevant climate hazards. For each climate hazard, certain variables may be highly relevant to your service area or project (e.g., number of days above 90°F for worker safety; heating/cooling degree days for facilities; freeze/thaw days for transportation). Review the list of climate variables in Appendix A to identify variables particularly relevant to your work.	**Climate hazards** ☐ Temperature ☐ Precipitation ☐ Sea level rise and storm surge ☐ Other extreme weather **Climate variables**
2. For each of the climate hazards: What are the historical climate conditions? How are the climate conditions changing in your jurisdiction? Use the information about current and future climate change in Chapter 2 (regional summary) and Appendix A (jurisdictional data) to evaluate how the climate hazards are changing. Consider your planning timeframe or asset's useful life when reviewing the projected climate conditions. For example, decisions about maintenance or replacement of facility mechanical components should consider medium-term projections (centered around 2050), while decisions about construction of new long-lived infrastructure should consider long-term projections (end of century and beyond).	**Historical climate conditions** **Projected climate conditions**

Toolkit Questions	Enter Your Responses
Climate impacts: Chapter 3	
3. Given changing climate conditions, what are anticipated impacts to your service area or project? Consider impacts that your service area or project has recently experienced, and use the climate projections from Question 2 along with the information and examples from Chapter 3 to determine projected climate impacts. Which anticipated impacts are priorities to address? Consider prioritizing impacts based on potential damage, disruption of public services, and cost of repair.	**Projected climate impacts**
4. Have climate impacts to your service area or project disproportionally affected vulnerable populations? Review the a) BMC Vulnerable Populations Index, b) Maryland Commission on Climate Change Adaptation and Resiliency Work Group's Justice, Equity, Diversity, and Inclusion Strategic Framework, and c) information on climate impacts from Chapter 3 to consider the uneven impacts to vulnerable populations who may face elevated climate risks. Are there areas where infrastructure investments could both reduce climate impacts and enhance social equity?	
Policies: Chapter 4	
5. Are there state and local policies on climate impacts that affect your work or project? Use the information from Chapter 4 to determine relevant climate policies. Are there policies that would help facilitate climate adaptation measures if approached from a climate perspective? For example, environmental justice policies may help show progress or build support when addressing climate. On the flipside, are there policy or planning barriers that limit your ability to address climate impacts?	
Adaptation options: Chapter 5	
6. Given the projected climate impacts, what are potential adaptation strategies within your service area or for your project, across relevant functions (e.g., design, maintenance)? Use the information and examples from Chapter 5 to begin to identify potential adaptation strategies. What adaptation options are no-regrets (i.e., generate benefits regardless of future climate) and/or could be implemented in the near-term? What adaptation options are no or low cost?	
Funding and financing: Chapter 6	
7. What funding and financing sources are available to help implement the adaptation options? Use the information and examples from Chapter 6 to begin to identify potential funding and financing strategies for adaptation.	
Next steps	
8. What are your next steps to address these climate impacts and plan for these adaptation options? For the selected adaptation strategies, would there be implications to other service areas? Are there other agencies or departments (inside or outside your jurisdiction) your DPW or DOT should coordinate with?	

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Ch2: The Changing Climate in the Baltimore Region

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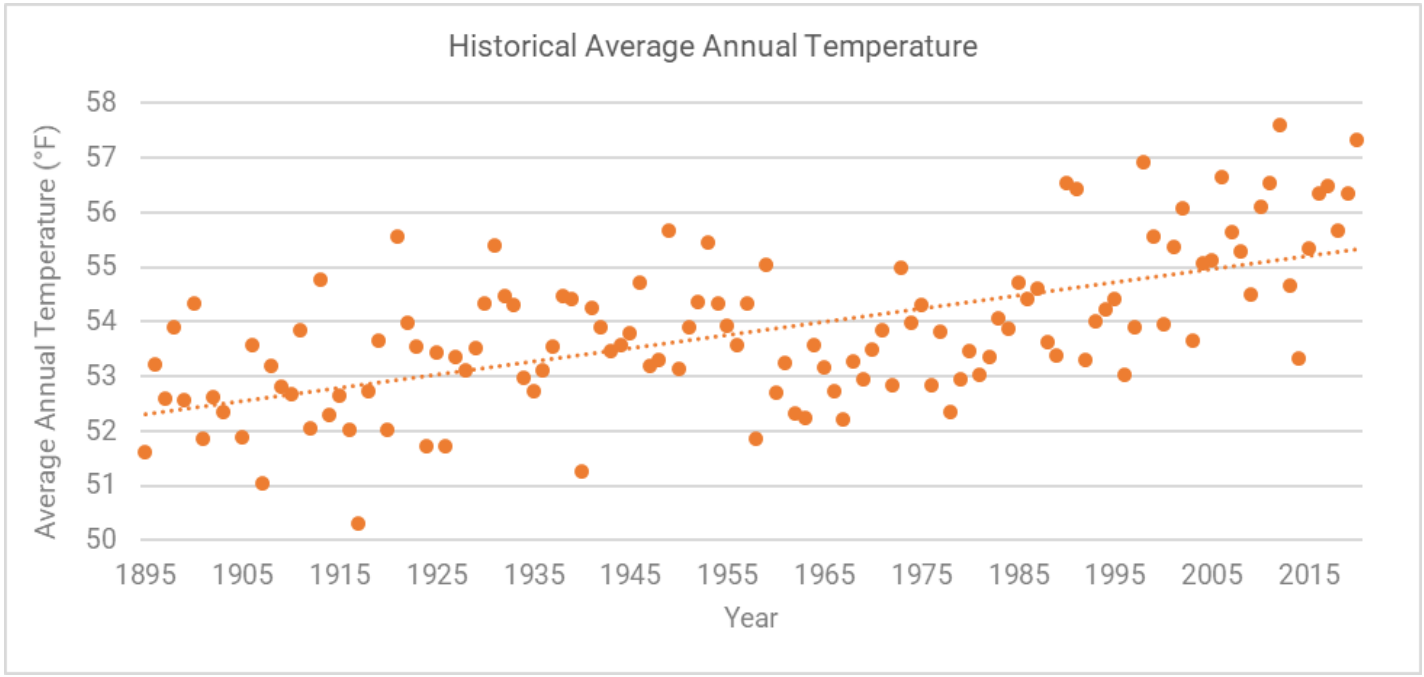
Ch2: The Changing Climate in the Baltimore Region

- **Climate has been changing in the Baltimore region over the past century**
  - Upward trend in annual temperature (+0.2°F per decade)
  - Slight increase in annual precipitation, particularly falling in intense storms
  - Sea level rise in the Chesapeake Bay and tributaries (+1.22 ft since 1928) and increase in nuisance flooding



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Ch2: The Changing Climate in the Baltimore Region

- **Climate in Maryland will continue to change**
  - The Baltimore region is expected to experience changes with temperatures, rainfall patterns, sea levels, and extreme weather events, mostly due to an increase in greenhouse gases
- **Resource Guide provides regional and jurisdictional climate projections**
  - Across three time horizons: near-term (2030s), medium-term (2050s), and long-term (2090s)
  - Uses scenario that projects high greenhouse gas emissions with little reduction (RCP 8.5); this scenario is recommended by FHWA
  - Climate variables that may be useful for infrastructure planning and design. For example:
    - Number of days above 90°F for worker safety
    - Heating/cooling degree days for facilities
    - Daily freeze/thaw cycle for transportation

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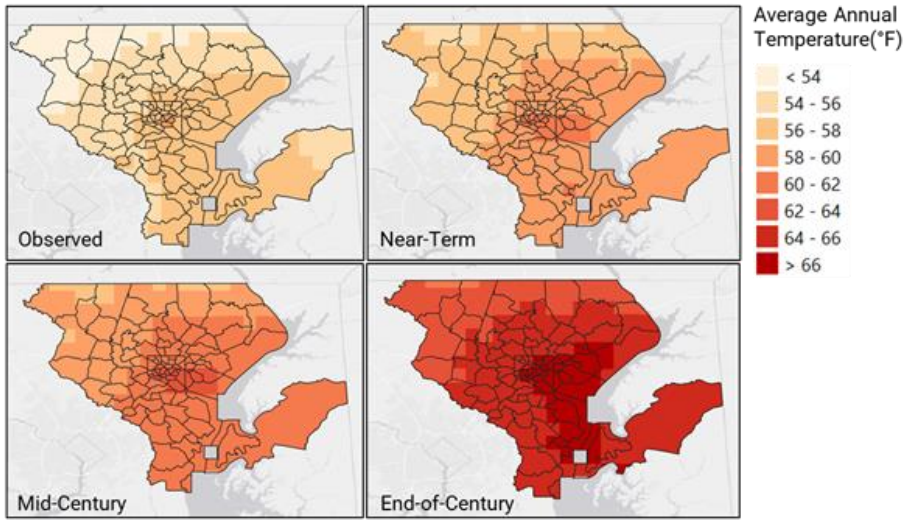
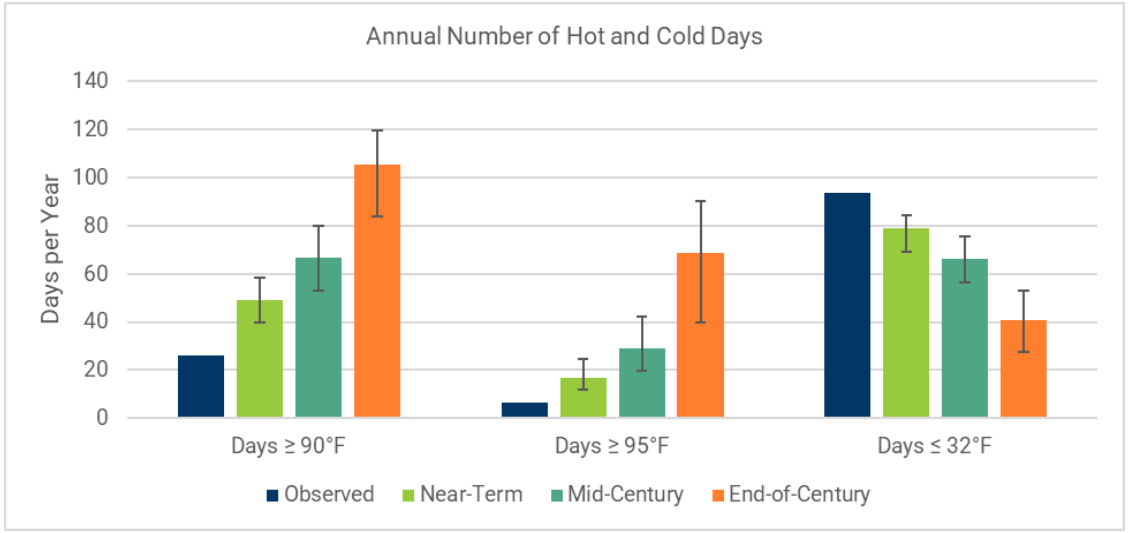
Ch2: The Changing Climate in the Baltimore Region: Temperature

- **Temperatures will dramatically increase**
  - Increase in average temperatures
    - Historical annual average temperature of 56°F across the region is projected to reach 65°F by 2090s
  - Increase in number of extreme heat days (above 90°F, 95°F) and number of heatwaves





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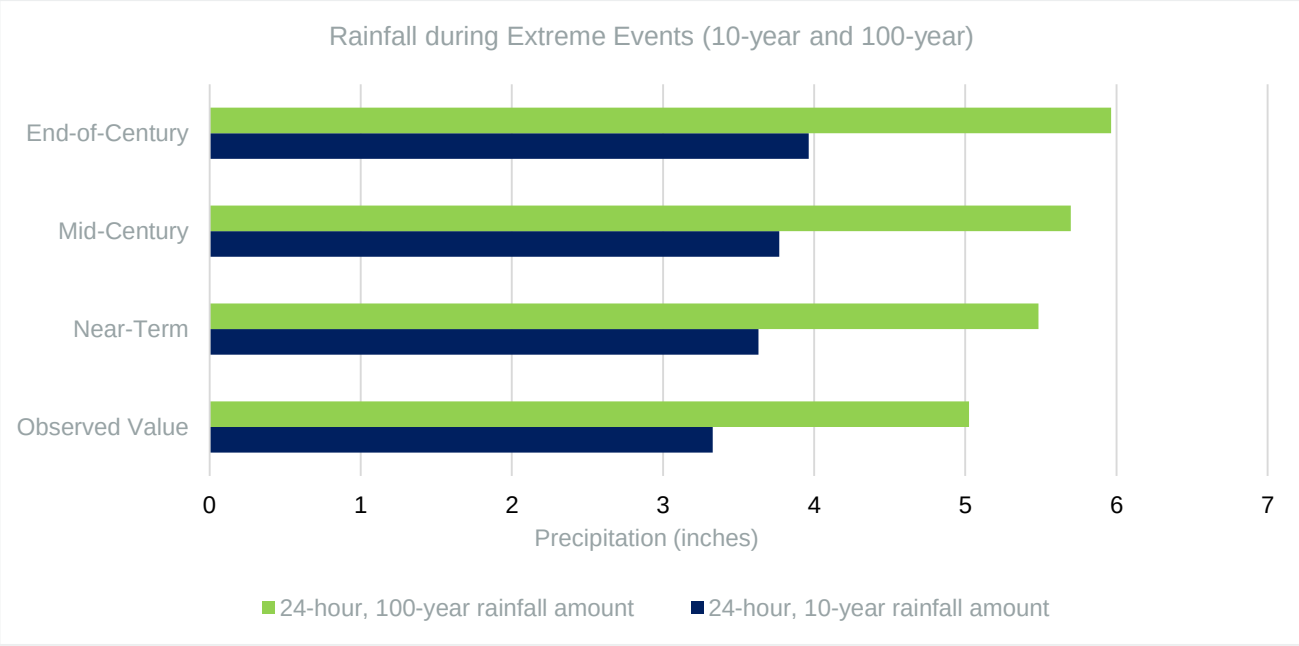
Ch2: The Changing Climate in the Baltimore Region: Precipitation

- **Precipitation will fall in heavier events**
  - Increase in rainfall during extreme events
    - Increase in the amount of precipitation in 24-hour, 10-year and 100-year rainfall events
  - Average annual precipitation is not projected to increase notably



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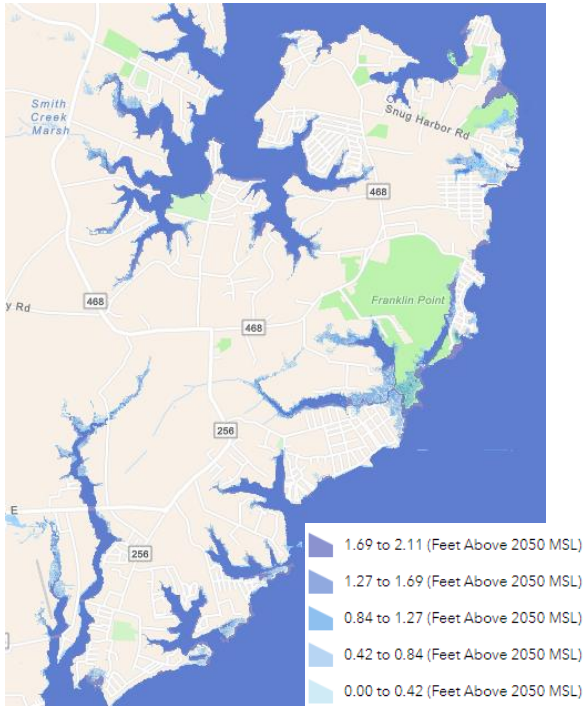
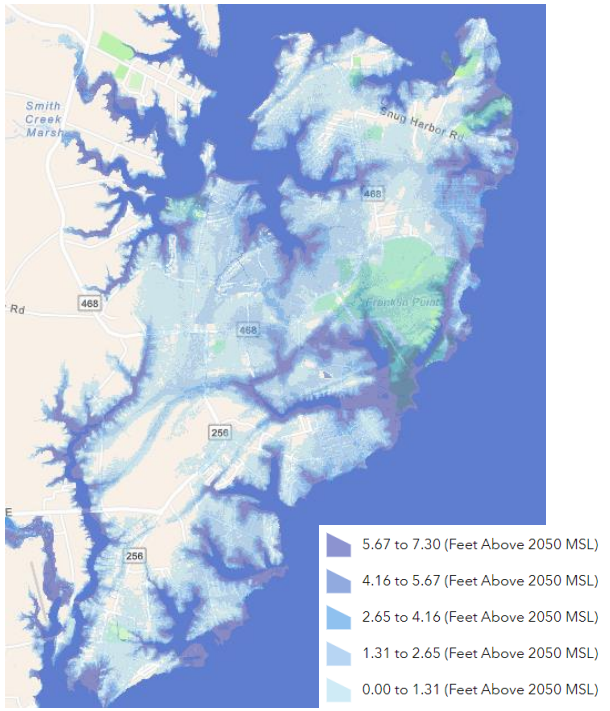
Ch2: The Changing Climate in the Baltimore Region: Sea level rise and coastal storm surge

- **The Baltimore region shoreline will experience increases in coastal flooding from sea level rise and storm surge**
  - Sea level is projected to rise over 1ft by 2050 and over 2ft by 2100
  - Storm surges will become more severe, due to sea level rise and more intense storms
  - Use: Interactive MDOT SHA Climate Change Vulnerability Viewer

Sea level rise inundation depths by 2050 in Anne Arundel



Flood depths during a 1% annual chance flood by 2050 in Anne Arundel



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Ch2: The Changing Climate in the Baltimore Region: Extreme weather

- **Extreme weather events will increase in both frequency and intensity**
  - Increase in the strength and volume of thunderstorms and derechos, due to warming atmospheric temperatures
  - Increase in the number of hurricanes identified as Category 3 or stronger through 2050
- **Extreme cold snaps due to weakened “polar vortex” events**
  - This could lead to more frequent cold weather outbreaks in the northern and northeastern US
- **Although currently no quantitative estimates for these changes in extremes, a shift towards more extreme weather should be expected**

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Toolkit Questions: The Changing Climate

1) What climate hazards are relevant to your work or project?

- For each climate hazard, certain variables may be highly relevant to your service area or project (e.g., number of days above 90°F for worker safety; heating/cooling degree days for facilities; freeze/thaw days for transportation).

2) For each of the climate hazards: What are the historical climate conditions? How are the climate conditions changing in your jurisdiction?

- Consider your planning timeframe or asset's useful life when reviewing the projected climate conditions (e.g., maintenance decisions or replacement of facility mechanical components should consider medium-term projections (centered around 2050); construction of new long-lived infrastructure should consider long-term projections (end of century and beyond)).

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Ch3: Climate Change Impacts to Local Public Works and Transportation Departments

Ch3: Climate Change Impacts

- **Jurisdictions are already seeing impacts from hazards across infrastructure service areas**
  - Impacts include infrastructure damage, increased maintenance and costs, and operational impacts
  - Impacts can be felt disproportionately by vulnerable populations, including people of color, those who are low-income or have disabilities, children, and the elderly
  - Across the region, heavy rain has been perceived are the most impactful hazard

	Climate Impacts			
Service Area	Heavy Precipitation and Inland Flooding	Sea Level Rise and Coastal Flooding	Extreme Heat	Other Extreme Weather
Transportation	Erosion, washouts, and heavy precipitation affect the integrity of pavement by reducing strength of pavement, leading to further deterioration. Inundation and erosion affect the structural integrity of bridges and rail infrastructure. Flooded roadways can cause detours or delays. Heavy precipitation and flooding can result in transit/rail service delays.	Coastal roads already experiencing nuisance flooding will flood more frequently and potentially permanently. Low-lying coastal roads that are further inland may flood. Flooded roadways can cause detours or delays. Sea level rise with storm surge will decrease clearance levels and damage bridges. Flooding and erosion along coastal routes will affect the ability to safely continue transit service. Waterfront facilities supporting ports and other transportation services may be impacted by sea level rise, flooding, and strong storms.	Extreme heat can cause buckling or softening of surface pavement materials. Road crews are impacted by extreme temperatures, thus affecting worker safety. Public health impacts can result as transit riders wait for the bus/train during extreme heat days. Extreme heat can cause buckling and damage to rail lines and runways, and can stress bridge integrity.	Downed trees or power lines from storms can cause roadway closures. Extreme weather compounds damage to aging transportation infrastructure. Wide temperature swings can damage roadways and transportation infrastructure when ice expands in cracks during freeze/thaw days. High winds can result in bridge closures.
Stormwater	More frequent and intense storms can increase flooding, stormwater runoff, and erosion. Heavy rainfall can overwhelm stormwater capacity.	Gravity-fed systems may no longer function as designed if outfalls are submerged. Coastal flooding at outfalls could drive backflow into the system. Groundwater levels may increase, reducing the soil's ability to absorb stormwater and increasing runoff.	Limited documented impacts exist for this service area.	Storms could introduce debris that can clog storm drains, pipes, and outfalls.

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Ch3: Climate Change Impacts

- **Climate change will also impact the availability of financing sources for local governments**
  - Credit rating agencies are now considering potential impacts of the changing climate (which could affect local governments' ability to repay)
- **Climate adaptation can help:**
  - Ensure credit ratings are not downgraded
  - Maintain/improve a bond rating
  - Save $ for taxpayers
  - Increase financing source availability for local infrastructure projects

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Toolkit Questions: Climate Change Impacts

3) Given changing climate conditions, what are anticipated impacts to your service area or project? Consider impacts that your service area or project has recently experienced.

- Which anticipated impacts are priorities to address? Consider prioritizing impacts based on potential damage, disruption of public services, and cost of repair.

4) Have climate impacts to your service area or project disproportionally affected vulnerable populations? Review the BMC Vulnerable Populations Index.

- Are there areas where infrastructure investments could both reduce climate impacts and enhance social equity?

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Ch4: Relevant Policies

Ch4: Relevant Policies

State-level policies

- Existing environmental regulations administered by the state should be adhered to, though note they are based on historical climate data
  - Such as: Maryland Department of the Environment's (1) dam safety regulations and (2) stormwater management regulations

- Local governments are authorized to establish a Resilience Authority to fund large-scale infrastructure projects
  - (Senate Bill 457, 2020)
  - E.g., Anne Arundel County and the City of Annapolis partnered to establish a Resilience Authority

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Ch4: Relevant Policies

State-level policies, for coastal jurisdictions

- The State updates sea level rise projections every 5 years
  - (House Bill 0514/Senate Bill 0258, 2015)
  - Most recent report, *Sea-level rise: Projections for Maryland 2018*, available to support jurisdictions
- Coast Smart Construction Program, providing guidance on siting and design of capital projects based on sea level rise and coastal flooding
  - (House Bill 615, 2014; House Bill 1350/Senate Bill 1006, 2018; House Bill 1427, 2019)
  - Defines a new coastal flooding planning areas, called the Coast Smart Climate Ready Action Boundary (CS-CRAB)
- Develop a local nuisance flood plan and update every 5 years
  - (House Bill 1350/Senate Bill 1006, 2018; House Bill 1427, 2019)
- Require the use of living shorelines in tidal wetlands to address shore erosion impacts from sea level rise
  - (House Bill 973)

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Ch4: Relevant Policies

Local-level policies

- Jurisdictions in Baltimore region have already been taking action to address climate impacts, such as by developing climate adaptation plans
- Though climate adaptation has not been represented in local policies in a codified way
  - Local codes and standards should be updated to ensure that infrastructure is able to withstand these changing conditions; could use information from climate projections
  - These updates may apply to include local codes and standards such as:
    - Local design standards and specifications
    - Local development or floodplain regulations
    - Worker safety protocols

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Toolkit Questions: Policies

5) Are there state and local policies on climate impacts that affect your work or project?

- Are there policies that would help facilitate climate adaptation measures if approached from a climate perspective (e.g., environmental justice policies may help show progress or build support when addressing climate)? On the flipside, are there policy or planning barriers that limit your ability to address climate impacts?

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Ch5: Climate Adaptation Options for Local Public Works and Transportation Departments

Ch5: Climate Adaptation Options

- Menu of climate adaptation options by hazard and across service areas
- A multi-faceted approach to adaptation spans functions:
  - Planning
  - Design/Construction
  - Maintenance/Operations/Worker Safety

Changes in Temperature Strategies

Adaptation Strategy	Service Areas	Function	Examples
Adjust and expand worker safety plans		Planning Design/Construction ✓ Maintenance/ Operations/Worker Safety	In Austin, TX, the Climate Resilience Action Plan suggested expanding staff safety plans to adjust work schedules and safety policies for fieldworkers during extreme heat days, poor air-quality days, and other climate-related health risk days.
Plant more trees and vegetation to provide shading and lower ambient temperatures		✓ Planning ✓ Design/Construction Maintenance/ Operations/Worker Safety	**Baltimore County's** Climate Action Plan calls to increase the urban tree canopy, targeting areas with urban heat island impacts. Philadelphia, PA, is developing an Urban Forest Strategic Plan, prioritizing equity and environmental justice in service delivery, so that that the most vulnerable and underserved communities can benefit from healthy tree canopy.
Incorporate **shading into street and building code standards**		✓ Planning ✓ Design/Construction Maintenance/ Operations/Worker Safety	Phoenix, AZ, incorporated shade standards, such as requiring a minimum of 75% of public sidewalks be shaded, into the municipal code
Incorporate bus shelters, shading, and seating for transit riders and workers		✓ Planning ✓ Design/Construction ✓ Maintenance/ Operations/Worker Safety	Tacoma Park, MD, committed by resolution to develop a bus shelter prioritization plan and identified the need to make improvements to bus stops as a means of enhancing alternative transportation options. In Los Angeles, CA, *StreetsLA* is expanding street furniture and administering a program to install new bus shelters to thousands of bus stops in the region to protect riders from heat and maintain ridership.
Use cooler pavement mixes (e.g., light-colored aggregate) to reduce surface temperatures		Planning ✓ Design/Construction Maintenance/ Operations/Worker Safety	Chicago, IL's Green Alley program is repaving alleys in the city with permeable, high-albedo pavement, a lighter-colored surface that reflects sunlight instead of absorbing it. Chula Vista, CA's Climate Action Plan adaptation strategies include installation of cooler paving products, intended to incorporate reflective paving into all municipal projects (parking lots and streets).

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Toolkit Questions: Climate Adaptation Options

6) Given the projected climate impacts, what are potential adaptation strategies within your service areas or for your project, across relevant functions (e.g., design, maintenance)?

- What adaptation options are no-regrets (i.e., generate benefits regardless of future climate) and/or could be implemented in the near-term? What adaptation options are no or low cost?

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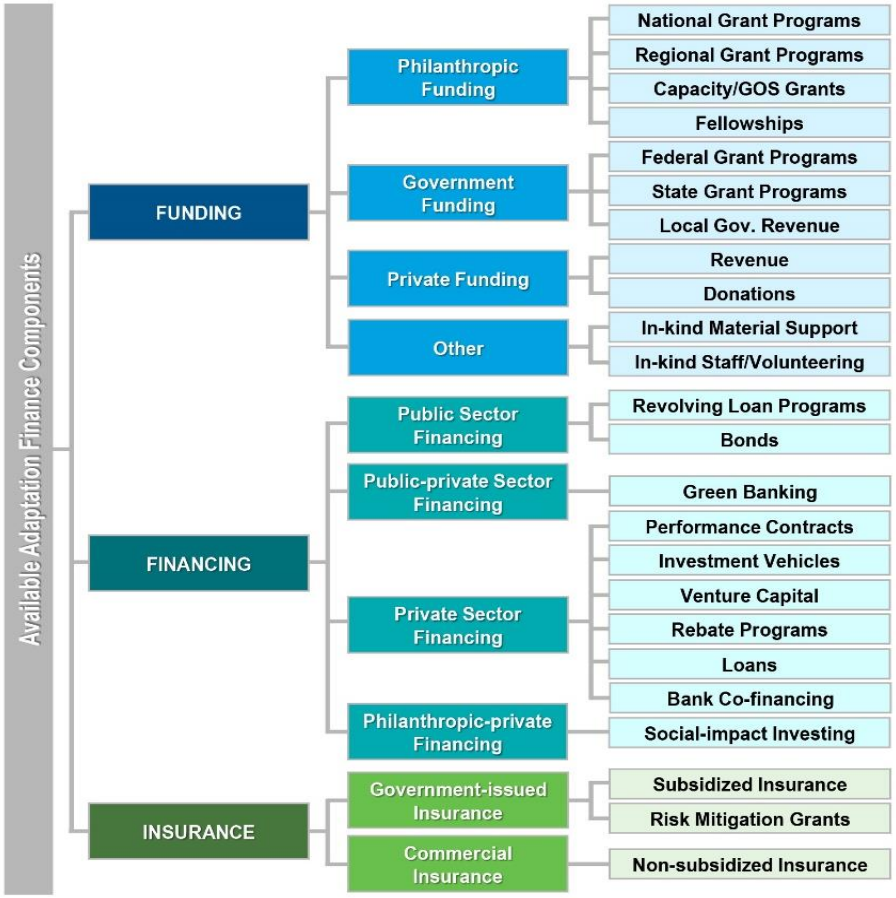
Ch6: Funding and Financing Sources

Ch6: Funding and Financing Sources

- Potential sources of funding and financing can be found in chapter

Service Area	Agency and Program	Purpose of Funds	Amount of Available Funds	Eligible Applicants	Application Frequency
Crosscutting	National Oceanic and Atmospheric Administration (NOAA), Effects of Sea Level Rise Program (ESLR)	Provides a suite of science products to inform coastal managers of local coastal vulnerability and solutions to mitigate flood risk given sea level rise. Supports resilience planning for coastal ecosystems, communities, infrastructure, and surface transportation.	In FY2021, the program awarded $4.6 million to five new and eight continuing projects.	Past awards went to partnerships between universities, metropolitan planning organizations (MPOs), state agencies, Federal agencies, and nonprofit organizations	Once every few years
Transportation	U.S. Department of Transportation (USDOT), Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant program[47]	Funding for planning, preparation, design, or construction of transportation capital projects. Priority projects include those that demonstrate reductions of climate change impacts.	Maximum award of $25 million. Minimum award of $5 million in urban areas and $1 million in rural areas. Cost share: Minimum 50% Federal/50% non-Federal	Local governments, states, tribes, territories, MPOs, transit agencies, port authorities, and other political subdivisions of State or local governments.	Annual
Transportation	USDOT, Infrastructure for Rebuilding America (INFRA) Program	Funding for nationally or regionally significant highway and freight projects. For the first time in 2021, USDOT began prioritizing projects that address climate change and environmental justice and promote racial equity.	Minimum award of $5 million to a small project and $25 million to a large project. 25% of total funding is reserved for projects in rural areas, and 10% is reserved for small projects. In FY2021, $889 million was available. Cost share: INFRA grants may be used for up to 60% of project costs.	Local governments, MPOs that serve a population of > 200,000 individuals, states, special purpose district or public authority with a transportation function, and tribes	Annual



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Toolkit Questions: Funding and Financing Sources

7) What funding and financing sources are available to help implement the adaptation options?

Toolkit Questions: Next Steps

8) What are your next steps to address these climate impacts and plan for these adaptation options?

- For the selected adaptation strategies, would there be implications to other service areas? Are there other agencies or departments (inside or outside your jurisdiction) your DPW or DOT should coordinate with?

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For More Information

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