

## Introduction

By the end of the century, Massachusetts residents are expected to face new challenges including hotter summer days, increased rainfall, and rising sea levels. According to the State Hazard Mitigation and Climate Adaptation Plan, Massachusetts can expect to experience up to 64 days a year over 90 degrees Fahrenheit, a 16% increase in rainfall, and between four and ten and a half feet of sea level rise at the coast. As a result of these pressures from climate change, residents will face longer and hotter summer heat waves, increased likelihood of basement, first floor, or entryway flooding, and possible displacement from their homes during storm surge events. The risks to the residents and LHA staff resulting from climate change are real.

Increased heat will challenge residents with health issues while restricting mobility and outdoor recreation. Flooding could damage critical building systems and limit access. Displacement during climate emergencies could disrupt schooling and employment, routines that form the basis of resident success and growth. Planning for and adapting to these challenges in advance has been the focus of the CHARM project, and the adaptations recommended in this Resilience Toolkit leverage existing assets to adapt in advance of climate change impacts.

Retrofits like community cooling rooms, incorporating cool roofs and pavements, increasing insulation, and elevating mechanical and electrical systems are practical and are achievable over time as retrofits and updates are made to properties. These updates are designed to support residents and streamline the response process for LHA staff. The recommendations in this Resilience Toolkit have come from a comprehensive process of mapping and assessing risks, conducting pilot site building walkthroughs, and creating resilience strategies applicable to the housing typologies that make up the DHCD funded portfolio.

## Risk and Vulnerability Analysis

A Risk and Vulnerability Assessment (RVA) prepared as part of the CHARM project models these future climate change impacts that pose a threat to the approximately 1,430 state-assisted public housing developments and their residents. Understanding these threats will help local housing authorities and the residents they serve prepare for the challenges to come.

The first stage in the RVA process identified the geographical distribution of public housing developments with high exposure to sea level rise/storm surge, extreme heat, and precipitation. The RVA process produced scores measuring the exposure of each housing development to these hazards. Highlights include:

- Coastal housing developments in eastern Massachusetts are at increased risk of flooding due to sea level rise/storm surge (SLR/SS). While only a small fraction - 3.5% - of Massachusetts housing developments are exposed to the SLR/SS, 9 of the top 10 developments with the highest overall exposure face this risk.
- Riverine flooding also poses significant risk to the 2.8% of the portfolio located in FEMA riverine flood zones, with 7 of the top 10 most at-risk developments facing this challenge.
- Heat risk, on the other hand, is expected to be a widespread. By 2070, all developments in the Commonwealth will face an expected 11 days a year above 97°F, a significant increase in extreme heat exposure for residents and staff.

As mapped below, the RVA evaluation enabled an overall exposure score for each public housing development in the Commonwealth. Ranging from 0 to 10, an exposure indicates the risks a development faces now and in the future. A score of 10 indicates that a development faces all possible risks both now and in the future, while an exposure score of 0 indicates no risk to the development now or in the projected future. Exposure scores for each housing development are indicated on the map below, and range from a low of 0.25 to a high of 5.49. This means that no development is exposed to every possible risks now and in the future. And it means that no development is free from every possible risk. Planning and adaptation work is already underway at the housing developments identified as most at risk.

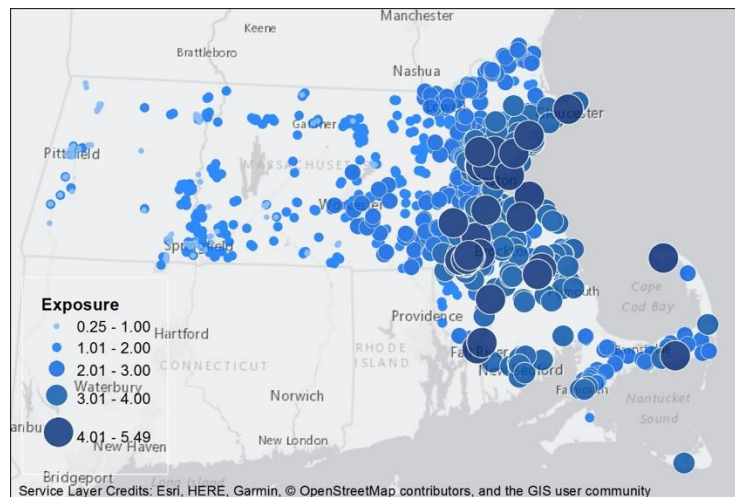


Figure 1: LHA Development Exposure Scores

As DHCD and LHAs take steps to prepare for hazards related to climate change, resilience improvements will also have value during routine weather events and storms. Challenges from summer heat waves, Nor'easter storms, microbursts and tornadoes occur with some regularity in the Commonwealth. Adaptive measures will help residents and staff be ready when these events occur.

High winds, wind driven rain, and flooding from rain and snow fall are seasonal occurrences in Massachusetts and each tests the resiliency of the housing stock and infrastructure. In the fall of 2019, microbursts downed trees and caused extended power outages for LHAs and residents in Salem and other towns on the north shore. Over the past decade, tornadoes have caused damage to the housing stock in the central and western parts of the state. Hurricanes including Sandy and Irene have caused wind damage and flooding. Challenging weather conditions will remain the baseline into the foreseeable future, and resilience improvements will help residents and LHAs be prepared as impacts of events increase.

### Why Climate Resilience Matters

DHCD and LHAs are committed to providing safe and reliable housing in which residents can thrive. Any disruption to a stable housing environment has ripple effects that impact individual lives, employment, and the communities and social networks of residents. Disruptions and dislocations also cause additional work for LHA and DHCD staff, and may come during challenging times like storms or heat waves. In response to this goal, resilience, adaptation, and mitigation of the climate change impacts are

crucial to protecting public housing. Adopting resilience practices can reduce resident stress, smooth LHA workload, and allow continued operation during challenging circumstances.

DHCD's CHARM project has prioritized analyzing the risks facing housing developments so that residents and staff are well prepared now and in the future. Increased resilience to challenges, adapting to changing conditions and mitigating risks are the focal points of this preparation work.

**Resilience** is defined as the ability of a system to prepare for, withstand, and recover quickly from a disaster. Ideally, resilient systems should recover stronger than they were before. By increasing the resilience of housing developments now, future disruptions to the lives of all residents and especially the most vulnerable will be significantly reduced. For LHA communities that may mean withstanding a major storm, recovering quickly, and having increased confidence that the next challenge will be a routine event instead of a crisis.

**Adaptation** will allow residents and staff to be confident in their buildings and in their ability to stay safe during an environmental challenge. Adapting building physical infrastructure and operational planning can help lower risks from climate change hazards. Early preparation, supported by this CHARM resilience toolkit, will help residents and staff across the LHA portfolio adapt to changing conditions ahead of needs, reducing stress and risks for both residents and staff.

**Mitigation** describes efforts to reduce energy use and greenhouse gas emissions that contribute to climate change. Sustainability best practices, including those related to efficiency and emissions reductions, are included through the DHCD Design Guidelines. Some mitigation strategies have co-benefits that also contribute to adaptation to climate hazards, such as insulation to mitigate heating energy use and window shading to mitigate cooling energy use, which both contribute to passive thermal adaptation in response to extreme heat risk.

**Emergency preparedness planning** describes the operating protocols and physical assets, such as generators, resilience hubs, and other emergency equipment that enables an LHA to respond quickly to climate hazard impacts and other emergencies. Emergency preparedness planning in tandem with adaptation is a smart investment to help reduce the impacts of severe weather events associated with climate change. The Resilience Toolkit section on emergency preparedness plans focuses on resident safety, building protection, and continuity of services to sustain operations during extreme weather events (floods, hurricanes, blizzards, and extreme heat, e.g.) as well as associated impacts such as power outages and loss of heating and cooling.

With a portfolio of properties housing approximately 80,000 residents, preparing for climate risks will ensure the safety and health of the resident population. Resilience also includes returning to daily routines as quickly as possible after a disruption, which can be especially important to vulnerable populations including young children and the elderly. With the DHCD portfolio housing children under 5 years old as well as senior residents over 65 years old, minimizing disruptions is a key factor as LHAs develop their resilience plans. These residents will face climate related challenges first, and will benefit from early planning and mitigation action.

#### How the Resilience Toolkit is Organized

The DHCD Resilience Toolkit is organized for ease of use and individual components can be used as stand-alone resources as needed by LHA staff, design professionals, or contractors. The *Resilience*

*Strategies by Building Typologies* graphics are a visual quick reference guide to mitigating risks. *Resilience Best Practices for Housing* is a focused, one-page guide encouraging emergency preparedness and resilience considerations when making updates to properties. The *DHCD Resilience Design Guidelines* is a set of updates to the foundational DHCD Design Guidelines and includes accepted best practices for architects and engineers to include when designing capital improvements. The *Rapid RVA Tool* is a checklist tool for LHA staff to self-assess the resilience of their developments. The same questions in this tool form the backbone of a new component of the 5-year capital inventory process conducted on behalf of DHCD by a third party. The *Guidelines for Emergency Preparedness* is a best practice and instructional guide in establishing an LHA emergency preparedness plan.

***Resilience strategies by building typology:*** Resilience Strategies by building typology provides a graphical overview of retrofits that can be made to mitigate and adapt to hazards. For each type of building, critical systems are identified and potential retrofits are shown. These retrofits are parallel to recommendations in the updated DHCD Resilience Design Guidelines. LHA staff can use this resource to quickly assess what updates might be useful at a given development and can prioritize updates based on their knowledge of their own developments. This quick reference guide can also be used to communicate with residents and staff about updates to be made at a given property.

***Resilience best practices for housing:*** This is a summary of the 20 capital improvements and operational measures that have proven to be successful in improving the resilience and durability of multifamily housing and the improving the safety of residents. It serves as a reminder that many of the existing assets, like community spaces, can be leveraged as locations to shelter in place during power outages and severe weather. It also helps emphasize the importance of keeping a current emergency management plan, and suggests retrofits to building systems when capital improvements are made. Improvements such as raising HVAC systems above flood level, or paying attention to the heat implications during a roof or window replacement can pay off for years into the future. This short reference guide is a good place to start when making building updates or program changes.

***DHCD Resilience Design Guidelines:*** Updates to the DHCD design guidelines are intended to help architects and engineers incorporate resilient design elements when designing capital improvement projects. Organized by CSI index in accordance with DHCD standards, these updates draw from established sources including FEMA resources, Enterprise Green Communities guidance, and others to suggest appropriate strategies to mitigate sea-level rise/storm surge, heat exposure risks, and risks from flooding due to precipitation.

***Rapid RVA tool:*** The rapid RVA tools is designed to allow LHA staff or consultants to quickly evaluate the risks to residents and buildings in a housing development. This short set of 33 questions assesses risk by asking about building condition, resident needs, resilience upgrades in place, backup systems, and the availability of common areas where residents can shelter in place. The tool is written so that a “No” response to a given question will guide the user to useful strategies to mitigate exposure to a given hazard or hazards. For ease of use, the tool is available to LHA staff as a PDF form that can be printed. Developments will be assessed using a version of the rapid RVA tool to be included in the Capital Improvements Management System (CIMS) every five years

***Guidelines for Emergency Preparedness:*** This document provides LHAs with an easy-to-use format for developing Emergency Preparedness Plans focused on extreme weather events (floods, hurricanes, blizzards, and extreme heat, e.g.) as well as associated impacts such as power outages and loss of heating and cooling. The plans address three priorities:

- Resident Safety – Support the preparedness, safety and recovery of residents
- Building Protection – Minimize damage to structure and systems and quickly restore normal building operations, and
- Continuity of Services – Sustain key business operations and resident services during climate-related emergencies or restore services quickly if temporarily discontinued.

This collection of tools will be used differently by different audiences, but will contribute to the common purpose of increasing resilience across housing developments in the DHCD portfolio. Together, the tools listed above will allow LHAs to assess risks under changing circumstances, coordinate capital improvements while incorporating resilience best practices, and manage emergencies effectively.