Climate Resilient
Design Guidelines

City of Chelsea
Massachusetts



Acknowledgments

This project was made possible through funding provided by the Massachusetts Municipal Vulnerability Preparedness (MVP) Program. We are grateful for the Commonwealth's continued investment in helping municipalities prepare for and adapt to the impacts of climate change.

The City of Chelsea's commitment to climate resilience, environmental justice, and community engagement was instrumental in the development of these Design Guidelines. We extend our sincere appreciation to the members of the project Advisory Committee and City staff who dedicated their time, expertise, and thoughtful feedback throughout the planning process.

We would also like to recognize the project team, including Kristen Homeyer, Will Cecio, and Adam Roy, whose technical expertise, collaboration, and leadership helped shape the recommendations contained in this document.

Special thanks are extended to Chelsea residents, industrial stakeholders, property owners, and members of the development community who participated in public engagement activities, stakeholder interviews, and project discussions. Their perspectives and lived experiences provided valuable insight into the opportunities and challenges facing Chelsea as it prepares for future climate conditions.

We are also grateful to the Historical Commission, Conservation Commission, Planning Board, and City Council for their time, engagement, and consideration of the proposed updates and recommendations. Their input helped strengthen this document and align it with Chelsea's broader planning and community goals.

We also acknowledge the contributions of Weston & Sampson and Noble, Wickersham & Heart LLP, whose technical expertise helped inform the development of these Design Guidelines and the associated policy recommendations.



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Glossary of Key Terms

1% ANNUAL CHANCE FLOOD / 100-YEAR FLOOD
A flood event that has a 1% chance of occurring in any given year, commonly used to define flood risk and floodplain boundaries.

ADAPTATION
Actions taken to prepare for and respond to current and future climate impacts, reducing damage and improving resilience.

BASE FLOOD ELEVATION (BFE)
The elevation of floodwaters associated with the FEMA 1% annual chance flood event, used as a reference point for floodplain management and building design.

BIORETENTION
A vegetated system that captures, filters, and infiltrates stormwater runoff.

BLUE ROOF
A roof designed to temporarily store stormwater to reduce runoff and drainage system impacts.

BUILT ENVIRONMENT
Human-made surroundings including buildings, infrastructure, and public spaces.

CHAPTER 91 WATERWAYS REGULATIONS
Massachusetts regulations governing development in tidelands and waterfront areas, including requirements for public access, water-dependent uses, and coastal resilience.

CLIMATE RESILIENCE
The ability of communities, infrastructure, and systems to withstand, adapt to, and recover from climate impacts such as flooding, extreme heat, and severe storms.

COMBINED SEWER OVERFLOW (CSO)
Discharge of untreated wastewater and stormwater when combined sewer systems exceed capacity during heavy rain.

COOL ROOF
A roofing system designed to reflect sunlight and reduce heat absorption.

DESIGNATED PORT AREA (DPA)
A state-designated waterfront area reserved for water-dependent industrial uses and governed by specialized regulations.

DESIGN FLOOD ELEVATION (DFE)
The elevation used to guide the design of buildings and infrastructure to reduce flood risk. DFEs are often established above FEMA's Base Flood Elevation by incorporating freeboard or future flood risk considerations.

DRY FLOODPROOFING
A flood adaptation strategy that makes a building watertight below a specified elevation to prevent floodwaters from entering.

ENVIRONMENTAL JUSTICE (EJ) POPULATION
Communities disproportionately affected by environmental hazards and climate risks due to socioeconomic factors.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)
The federal agency that produces floodplain maps and establishes flood hazard standards used to regulate development in flood-prone areas.

FLOOD INSURANCE RATE MAP (FIRM)
Maps produced by FEMA that show flood risk zones, floodplain boundaries, and base flood elevations.

FLOODPLAIN
Land area subject to flooding, typically defined by FEMA mapping and subject to regulation.

FLOODPLAIN OVERLAY DISTRICT
Local zoning regulations that apply additional requirements within flood-prone areas.

FLOODPROOFING
A combination of design measures intended to reduce flood damage to a structure. Floodproofing may include wet floodproofing, dry floodproofing, elevation of utilities, and flood-resistant materials.

FREEBOARD
Additional height added above a Base Flood Elevation or other flood level to provide an added margin of safety against flooding.

GREEN INFRASTRUCTURE
Systems that use vegetation, soils, and natural processes to manage stormwater, reduce heat, and provide environmental benefits.

GREEN ROOF
A vegetated roof system that absorbs rainwater and reduces heat.

IMPERVIOUS SURFACE
Hard surfaces such as pavement and rooftops that prevent water from infiltrating into the ground, increasing runoff.

LOW IMPACT DEVELOPMENT (LID)
A design approach that manages stormwater at its source using natural processes like infiltration and evapotranspiration.

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (MASSDEP)
The state agency responsible for implementing environmental regulations, including wetlands, stormwater, and water quality standards.

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT (CZM)
The state agency that oversees coastal policy, planning, and programs, including the designation and management of Designated Port Areas.

MASSACHUSETTS STORMWATER MANAGEMENT STANDARDS
State standards that set requirements for managing stormwater runoff, including water quality treatment, recharge, and peak flow control.

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT
A federal program regulating municipal stormwater systems to reduce pollution.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT
A federal permit system regulating pollutant discharges to water bodies.

NATURE-BASED SOLUTIONS
Strategies that use natural systems or processes, such as vegetation, wetlands, and living shorelines, to address climate, environmental, and infrastructure challenges while providing additional ecological and community benefits.

PERMEABLE SURFACE
Materials that allow water to pass through and infiltrate, reducing runoff.

RESILIENT DESIGN
An approach to planning and development that integrates strategies to reduce climate risks while improving long-term sustainability, safety, and performance.

SEA LEVEL RISE (SLR)
The long-term increase in average sea level caused by climate change, resulting from ocean warming and melting land-based ice.

SHADE STRUCTURE
Built or vegetated element that provides shading to reduce heat exposure (e.g., canopies, pergolas).

SITE PLAN REVIEW
Local review process evaluating development design, drainage, and site conditions.

STORM SURGE
An abnormal rise in water levels generated by a coastal storm.

STORMWATER MANAGEMENT
Strategies and infrastructure designed to control runoff, reduce flooding, and improve water quality.

TREE CANOPY
The layer of tree leaves and branches that provides shade, reduces heat, and supports ecological functions.

URBAN HEAT ISLAND EFFECT
The condition in which urban areas are significantly warmer than surrounding areas due to dense development and limited vegetation.

WET FLOODPROOFING
A flood adaptation strategy that allows water to enter enclosed portions of a building while minimizing damage through the use of flood-resistant materials and flood openings.

WETLANDS PROTECTION REGULATIONS (310 CMR 10.00)
State regulations that protect wetlands and related resource areas by establishing permitting requirements and performance standards for development.

Executive Summary

The City of Chelsea faces increasing climate risks from coastal flooding, more intense precipitation, and extreme heat. The Chelsea Resilient Design Guidelines respond by providing guidance to support adaptation to future climate conditions.

Climate Risks and Need for Action

The City of Chelsea faces growing climate risks driven by coastal flooding, more intense precipitation, and extreme heat. These challenges are expected to intensify over time, placing pressure on infrastructure, the built environment, and the health and well-being of residents. In response, the City of Chelsea developed the Chelsea Resilient Design Guidelines as a tool for supporting development and redevelopment projects in adapting to current and future climate conditions.

LOCAL CONTEXT AND VULNERABILITY

Chelsea's dense urban form, extensive impervious surfaces, and low-lying geography along Chelsea Creek, the Mystic River, and Boston Harbor make the city particularly vulnerable to climate impacts. At the same time, social and economic factors, including a high concentration of environmental justice populations, amplify community vulnerability to these risks. As a result, resilient design in Chelsea must consider physical vulnerabilities alongside improving public health, enhancing equity, and advancing long-term community resilience.

Chelsea Resilient Design Guidelines

The Chelsea Resilient Design Guidelines provide a flexible toolkit to support property owners, developers, and project teams in integrating climate resilience into planning and design decisions. They outline practical, implementable strategies that address three core priorities: coastal flood risk, stormwater management, and urban heat. Rather than replacing existing regulatory requirements, the Guidelines supplement state and local policies by translating climate goals into actionable, project-level design approaches tailored to Chelsea's unique context.

How to Use the Guidelines

The Chelsea Resilient Design Guidelines promote a flexible approach that recognizes the diversity of project types across the city. To support this, the Guidelines introduce a set of user types that reflect representative stakeholders in Chelsea:

01. The Small Scale Residential Landlord
02. The Mixed Use Developer
03. The Duplex Owners
04. The Multifamily Courtyard
05. The Industrial/Port Area Property

Case studies illustrate these user types applying resilient design strategies to real-world site conditions in Chelsea. Each case study demonstrates how multiple design strategies can be combined and adapted based on site constraints, development goals, and user needs.

IMPLEMENTING THE GUIDELINES

The case studies serve as a bridge between high-level concepts and implementation, linking to two complementary sets of guidance that support strategy development and application across different contexts: the **Urban Heat & Stormwater Design Guidelines**, which provide citywide design strategies; and the **Coastal Resilience Design Guidelines**, which address coastal flooding and tidally influenced areas.

Advancing a Resilient Chelsea

By translating the City of Chelsea's climate resilience goals into practical, site-specific strategies and demonstrating their application through case studies, the Chelsea Resilient Design Guidelines provide a road map for integrating resilience into planning and development decisions. Over time, consistent application of these strategies will support a more resilient, adaptable, and sustainable Chelsea.



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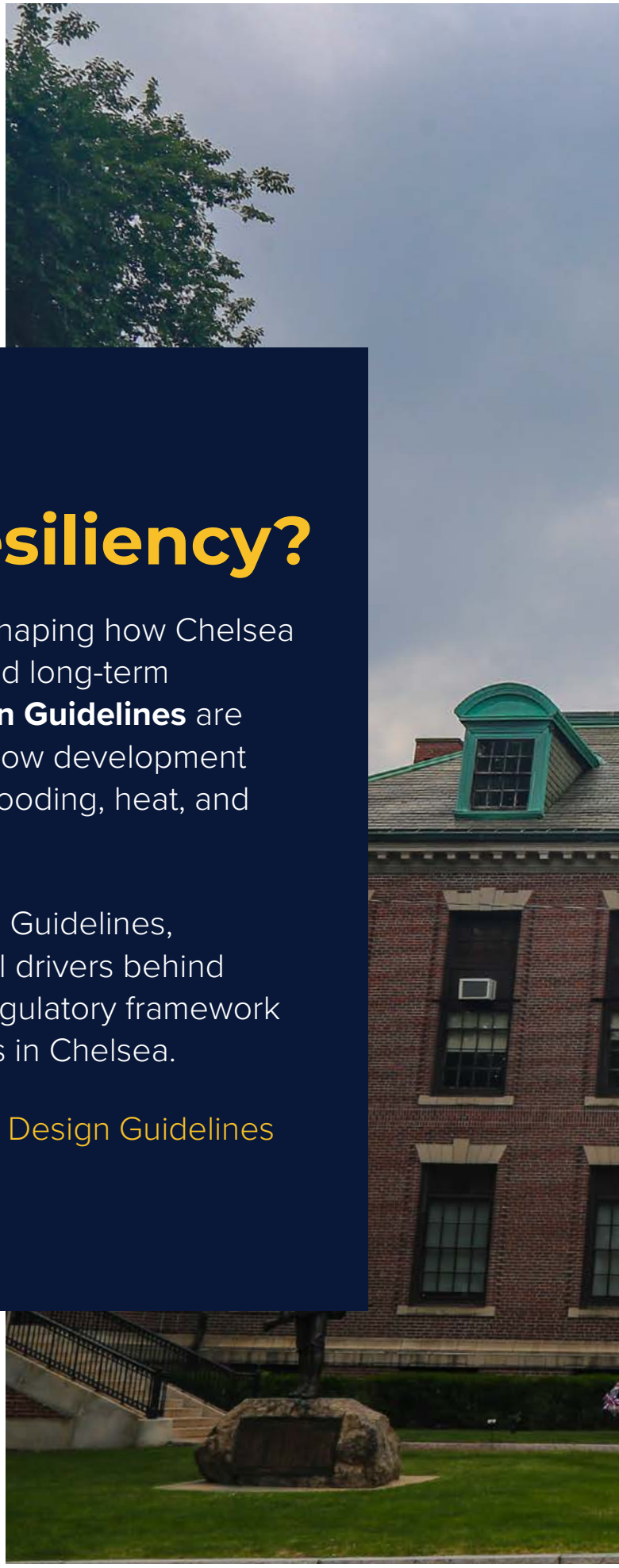
BACKGROUND TO
THE GUIDELINES



Why is Chelsea Planning for Resiliency?

Across the City, climate change is reshaping how Chelsea thinks about design, development, and long-term growth. The **Chelsea Resilient Design Guidelines** are a set of strategies and examples for how development and redevelopment can respond to flooding, heat, and projected climate conditions.

The sections that follow introduce the Guidelines, describe the climate context and local drivers behind them, and outline the planning and regulatory framework governing development requirements in Chelsea.

1. Introduction: Chelsea Resilient Design Guidelines
2. Chelsea Climate Context
3. Policy & Planning Context

Photo Source:
Chelsea City Hall by Matt Frank


CHELSEA
CITY HALL

BACKGROUND TO THE GUIDELINES

Introduction

1

The City of Chelsea created the Chelsea Resilient Design Guidelines to guide developers and property owners in incorporating climate considerations. The guidelines are informed by Chelsea's climate vulnerabilities and resilience priorities.

Project Background

Chelsea is already feeling the impacts of climate change through more frequent street flooding, tidal inundation along its waterfront, and hotter, longer summers that affect residents' health and quality of life.

Changing climate conditions affect public infrastructure, private development, industrial waterfront areas, and the daily experience of people who live and work in the city. The frequency and severity of these impacts is expected to further increase, with the 100-year storm projected to become approximately three times more likely in Chelsea by 2050[1]. As these impacts intensify, they create new challenges for the design, construction, and maintenance of buildings, streetscapes, and public spaces.

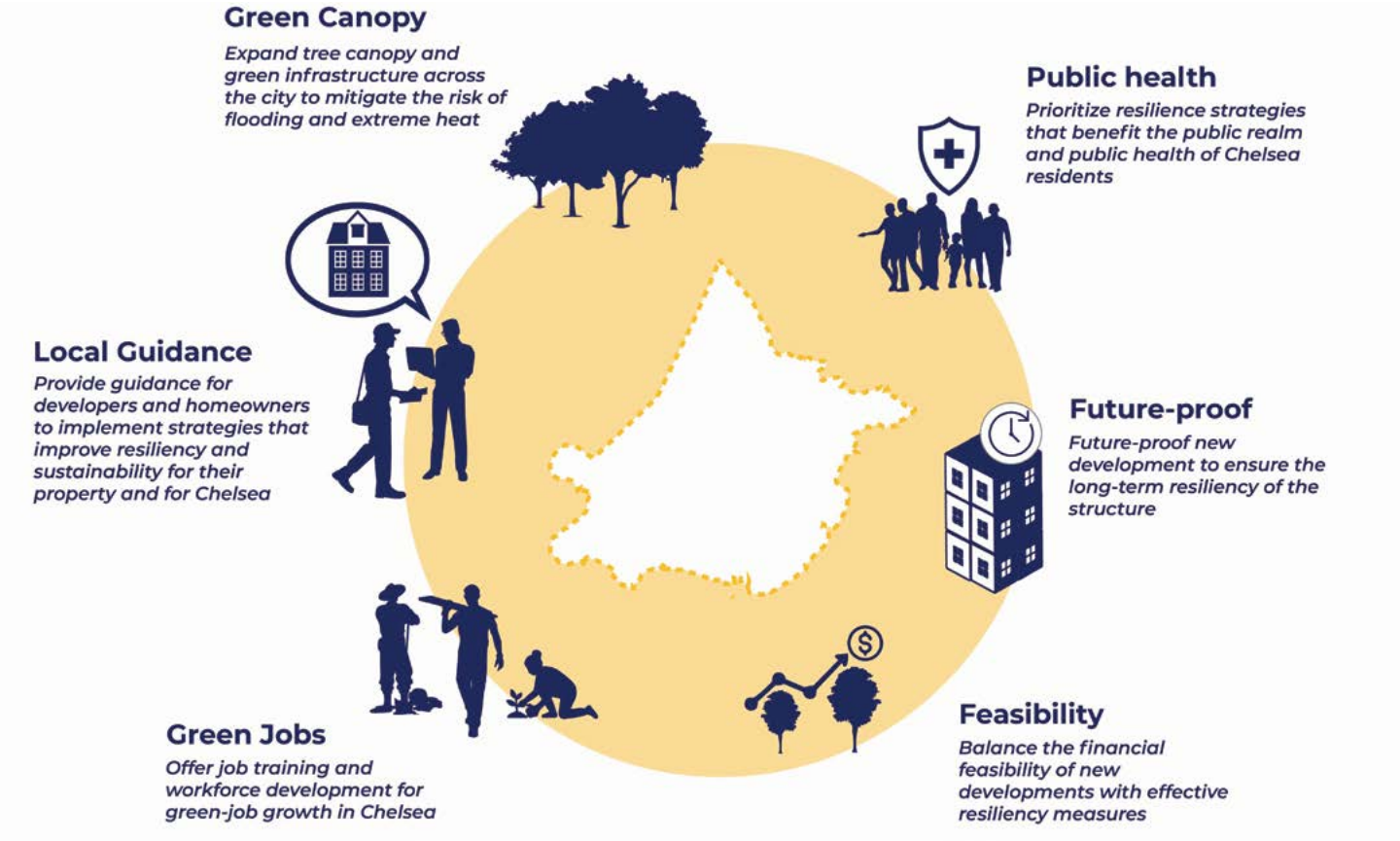
Chelsea's geography and development patterns make resilient design especially important. The City is bordered by Chelsea Creek, Mill Creek, and the Mystic River, and many areas are low-lying, densely developed, and highly impervious. Much of Chelsea's waterfront supports active industrial, maritime, transportation, and utility uses that are important to the regional economy but face increasing exposure to flooding and stormwater. At the same time, inland neighborhoods experience urban heat island effects due to reduced tree canopy, extensive pavement, and limited opportunities for new open space. These conditions require design strategies that are practical, flexible, and responsive to Chelsea's urban context.

Chelsea Resilient Design Guidelines

The Chelsea Resilient Design Guidelines provide recommendations for addressing three primary climate resilience priorities: coastal flooding, urban heat, and stormwater management. The Guidelines are intended to help property owners, developers, and community partners incorporate climate resilience into new development and redevelopment. They are not intended to replace applicable building code or other regulatory requirements. Rather, they are intended to supplement existing requirements by providing practical design guidance that reflects future climate risks and local conditions in Chelsea.

The Guidelines emphasize strategies that can be integrated into a variety of different types of development and redevelopment in Chelsea. The Guidelines recognize that there is no single resilience strategy that will work everywhere. Instead, they are intended to support a flexible approach that allows project teams to identify feasible measures based on site conditions, project type, and community priorities.

1. Woodwell Climate Research Center, 2021.



Chelsea Climate Resilience Framework
Evaluation criteria for climate resilient design

INTEGRATING RESILIENCY INTO DESIGN

Resilient design should not be treated as a separate or optional layer added at the end of a project. It should be considered early and revisited throughout design, construction, and long-term operations and maintenance. When integrated thoughtfully, resilience strategies can protect public and private investments, improve public health and safety, and support a more sustainable and adaptable future for Chelsea.

Since every property and project is different, there is no single approach to resilient design. The most appropriate resilience strategies will vary based on factors such as property type, location, climate risks, site constraints, project goals, and available resources. Resilience planning should be tailored to the unique characteristics and needs of each site.

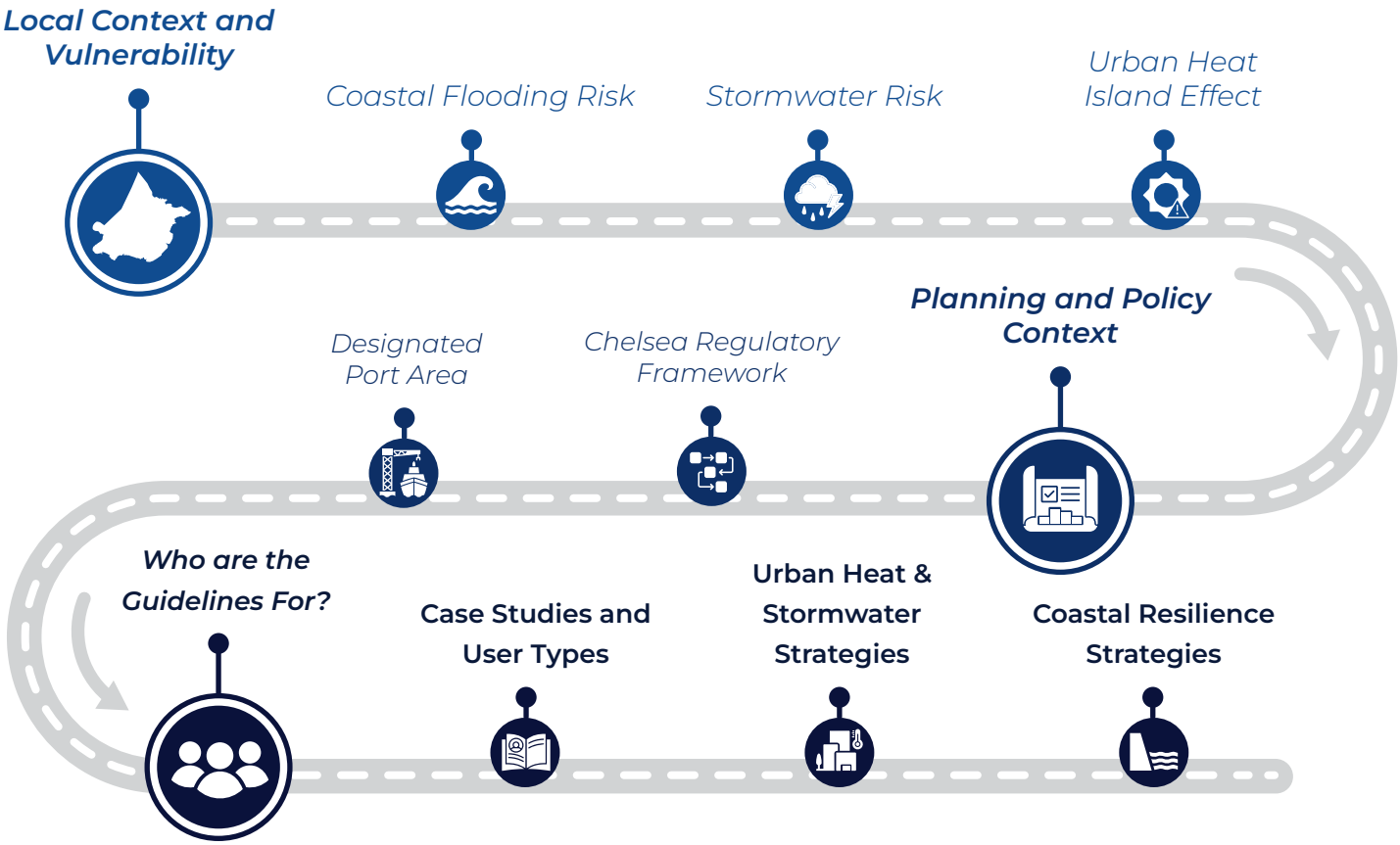
How to Use this Guide

This guide is intended to help property owners, developers, businesses, and institutions, among others, identify opportunities to improve resilience to coastal flooding, stormwater flooding, and extreme heat.

Document Roadmap

The strategies presented throughout the document are designed to provide examples of how resilience can be incorporated into a variety of different types of projects.

The guide is organized around Chelsea's primary climate hazards and the scales at which resilience actions can be implemented. It begins with an overview of Chelsea's climate vulnerabilities and regulatory context, followed by case studies for different project types, such as small landlords, homeowners, larger mixed-use developments, and industrial users in the Designated Port Area (DPA). Subsequent chapters provide more detailed guidance on strategies to address urban heat and stormwater management, and coastal flooding with supporting appendices such as planting and tree species lists. Additional sections highlight considerations for historic properties and industrial facilities. By providing a range of strategies, examples, and resources, the guide is intended to encourage measures that contribute to a more adaptable and resilient Chelsea.





Chelsea Square, Stebbins Fountain
Source: Edwin Barrientos

Limitations

This guide is intended as a planning and design resource to support climate resilience considerations in development, redevelopment, and property improvement projects. The strategies, recommendations, and case studies presented herein are provided for informational purposes only and are intended to help property owners identify opportunities to improve resilience to climate-related hazards.

Implementation of any resilience strategy should be evaluated based on site-specific conditions, project objectives, and applicable local, state, and federal requirements.

Nothing in this guide should be interpreted as superseding or replacing applicable laws, regulations, codes, permit requirements, or agency guidance, including but not limited to building codes, wetlands regulations, Chapter 91 Waterways Regulations, historic preservation requirements, or other permitting programs. Property owners and developers are encouraged to consult the appropriate regulatory agencies and qualified design professionals when evaluating or implementing resilience measures.

Chelsea Climate Context

2

The City of Chelsea is among the most environmentally burdened communities in Massachusetts. At just over two square miles, it is the smallest city in the state and faces out-sized exposure to pollution and other environmental hazards.

Equity and Climate Vulnerability

Nearly half of Chelsea's residents were born outside the United States, and the city's median income is well below the state average. These demographic realities compound physical vulnerability: residents with lower incomes are less able to invest in flood protection, less likely to have air conditioning during heat events, and more likely to live in older buildings in low-lying areas. Climate change does not create these inequities, but it does intensify them[2].

2. Jolicoeur and Mullins,2025.

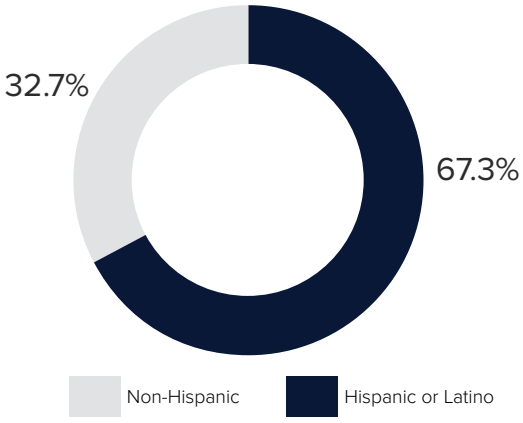
Building on Community Strengths

While Chelsea faces significant climate and environmental challenges, it is also a diverse and resilient community with a strong tradition of civic engagement and environmental leadership. Residents, community organizations, and city staff have helped advance numerous initiatives focused on climate resilience and environmental justice. These efforts provide a foundation for implementing the strategies outlined in these guidelines and helping future development contribute to a more resilient Chelsea.

About **7 in 10 residents (70.6%)** speak a language other than English at home



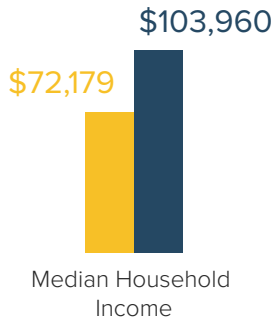
Hispanic and Latino residents make up about **two-thirds** of Chelsea's population

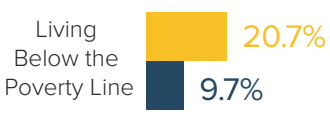


Nearly **half of Chelsea's residents (46.1%)** were born outside the United States



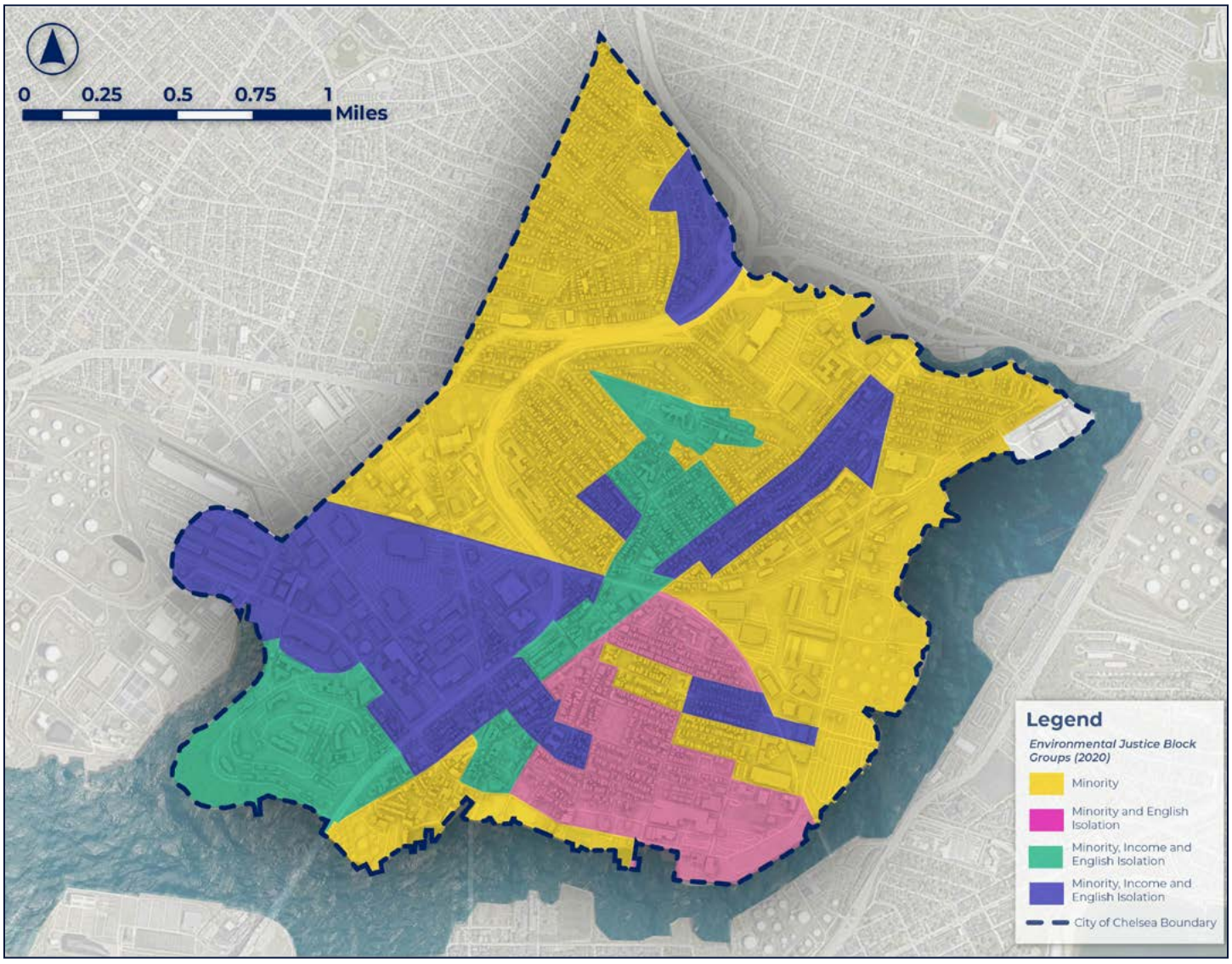
Chelsea's median household income is **lower** than the **Massachusetts** median





The poverty rate in **Chelsea** is about **twice** the **statewide** rate

Source: U.S. Census Bureau 2020-2024 ACS 5-year Estimate



Environmental Justice Neighborhoods
Chelsea, Massachusetts

Coastal Flooding Risk

Chelsea's low-lying location along Chelsea Creek, the Mystic River, and Boston Harbor makes the city highly vulnerable to coastal flooding risks that are projected to intensify with climate change.

Coastal Flooding Vulnerability

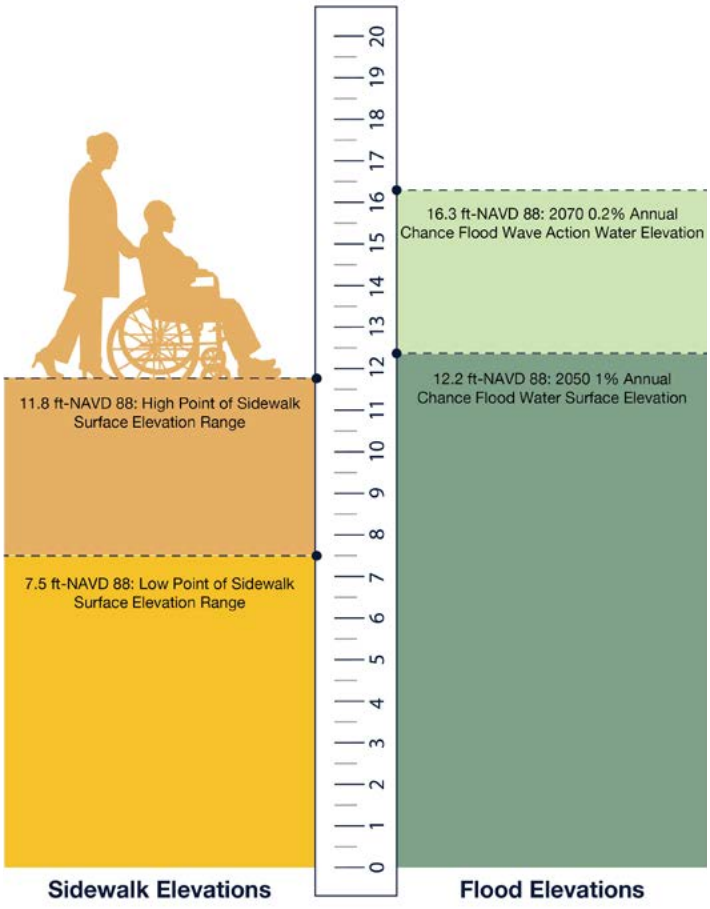
Chelsea's geography makes it acutely vulnerable to coastal flooding. Located where Chelsea Creek merges into the Mystic River and Boston Harbor, Chelsea faces two simultaneous flood threats: storm surge from the harbor and extreme rainfall events, with roughly 15% of the city currently falling within an area of potential flooding[3]. That picture will worsen significantly with climate change. While projections for the historical 1% annual chance flood event indicate it could become approximately three times more likely by mid-century (see page 10), Woodwell Climate Research Center specifically found that the historical 1% annual chance storm surge event could become nearly four times as likely by 2050 and may occur annually by 2080.

Rainfall flooding compounds this: Chelsea's stormwater system is the primary means of conveying stormwater, and with 77% impervious land area in the city, there are limited opportunities for rainfall to infiltrate the ground.[4]

As flood risks increase, property owners may consider elevating buildings, protecting critical systems, or implementing other flood resilience measures. The appropriate elevation for many of these improvements is informed by the Design Flood Elevation (DFE), which serves as a target elevation for reducing flood risk. DFEs are often established above FEMA's Base Flood Elevation (BFE) by incorporating additional freeboard or future flood risk considerations, providing an added margin of safety beyond minimum floodplain management requirements.

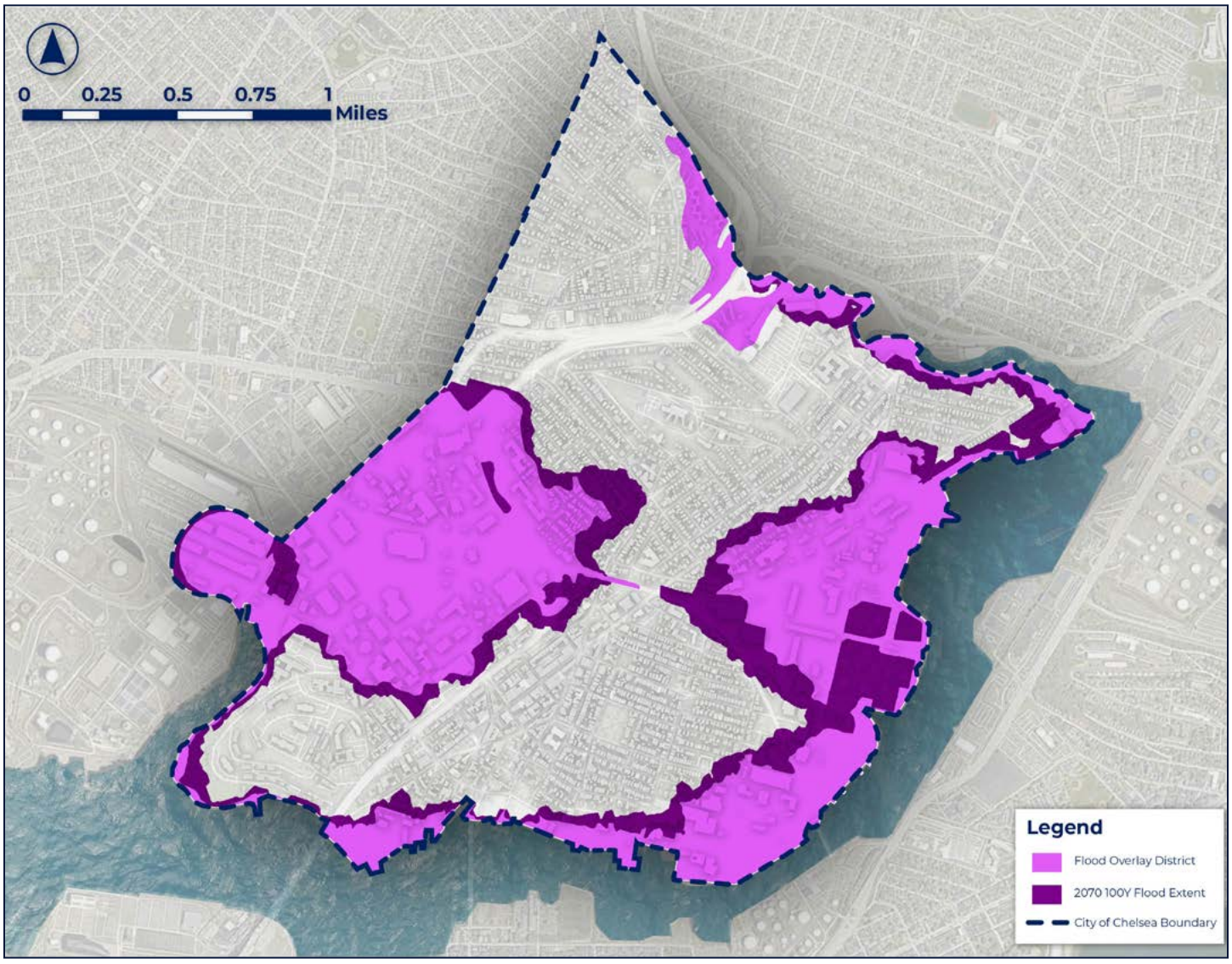
Appropriate DFEs vary based on site conditions, building use, applicable regulations, and project objectives. Guidance on determining Design Flood Elevations and implementing flood-resistant design practices is available through ASCE 24-24, Flood Resistant Design and Construction[5].

5. American Society of Civil Engineers, 2024.



2050 1% Annual Storm
Flood Elevations

3 Woodwell Climate Research Center, 2022.
4 Woodwell Climate Research Center, 2021.



Coastal Flooding Risk Map
Chelsea, Massachusetts

CHELSEA CLIMATE CONTEXT

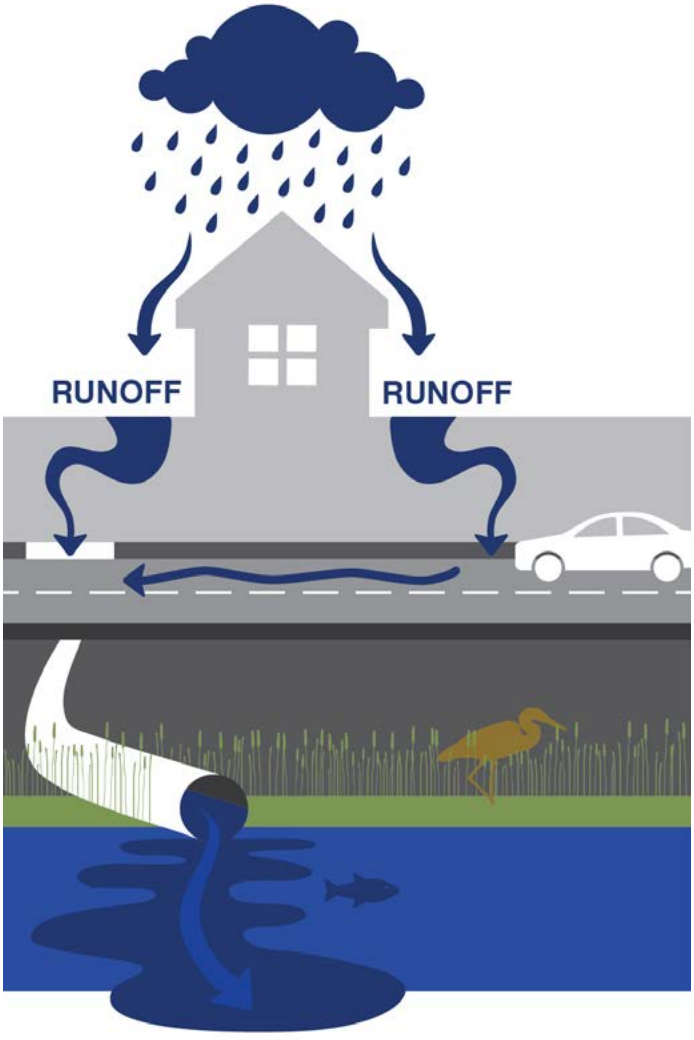
Stormwater Risk

Chelsea's aging combined sewer system and extensive impervious surfaces create persistent stormwater challenges, with heavy rainfall continuing to overwhelm infrastructure and increase the risk of localized flooding and combined sewer overflows.

Stormwater Flooding Vulnerability

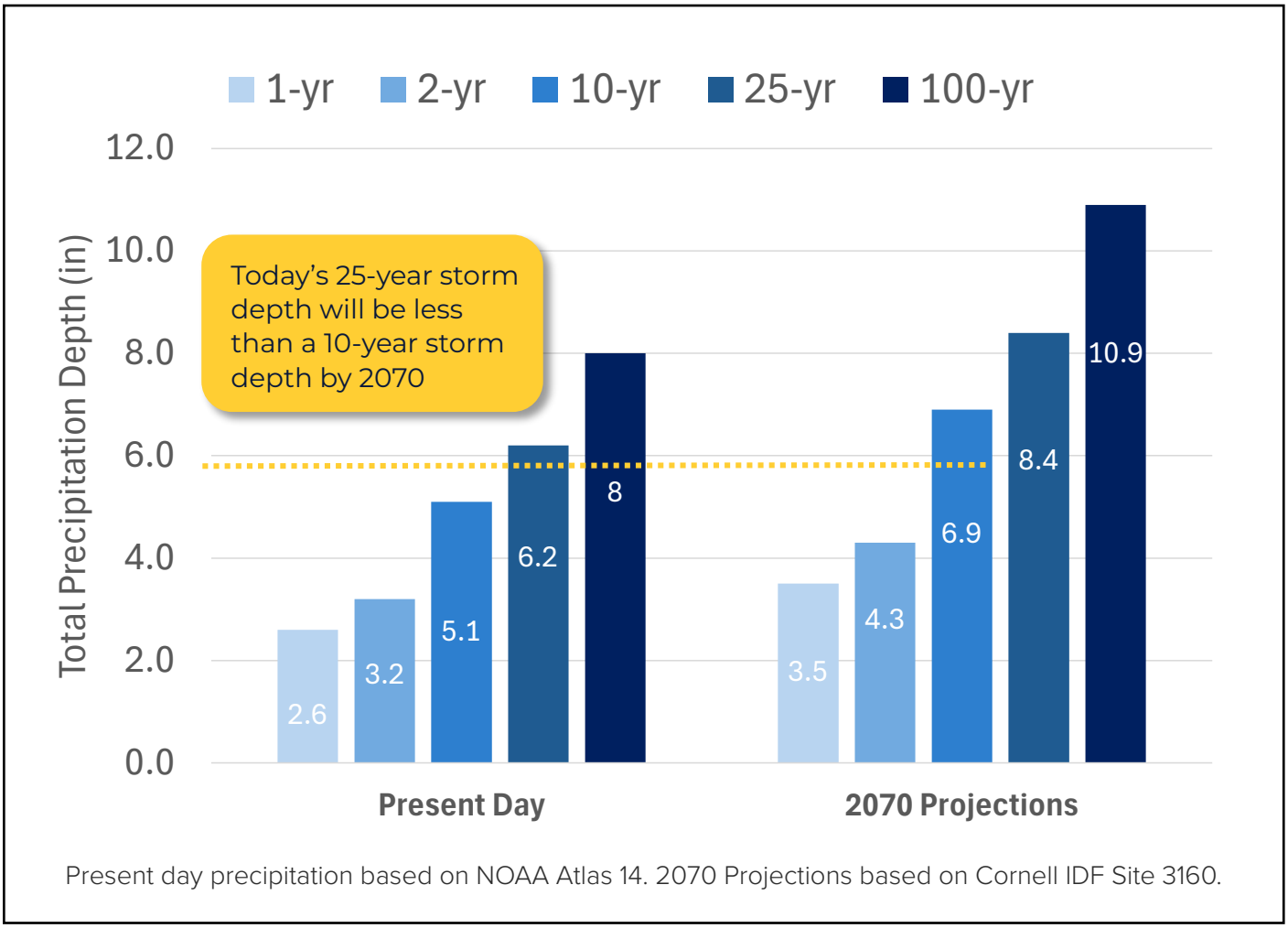
Chelsea's stormwater challenge is inseparable from its aging sewer infrastructure. Combined Sewers are pipes designed to carry both wastewater and stormwater in the same system. A significant portion of the City is served by combined sewers, meaning that during heavy rain events, the combined flow can exceed pipe capacity and discharge untreated sewage directly into nearby waterways.[6]

There are currently 21 combined sewer overflow (CSO) outfalls along the Alewife Brook, Mystic River, and Chelsea River, with annual discharges still measured in the millions of gallons, posing risks to public health, habitat, and wildlife.[7] Chelsea has a long-term sewer separation master plan underway and files annual CSO reports under its National Pollutant Discharge Elimination System (NPDES) permit, but full separation remains a multi-decade infrastructure project. In the interim, green infrastructure that reduces the volume of stormwater entering the combined system, like green roofs, bioretention, or permeable paving, can meaningfully reduce CSO activation frequency.



Stormwater Runoff
Weston & Sampson

6. City of Chelsea Water and Sewer Department, n.d.
7. Mystic River Watershed Association, n.d.



Present day precipitation based on NOAA Atlas 14. 2070 Projections based on Cornell IDF Site 3160.

Stormwater Risk Map
Chelsea, Massachusetts

CHELSEA CLIMATE CONTEXT

Urban Heat Island Effect

Extreme heat is one of the most immediate and widespread climate risks facing Chelsea. Dense development patterns, extensive impervious surfaces, limited tree canopy, and historic industrial land use contribute to elevated temperatures across the city, particularly in densely populated residential neighborhoods.

Extreme Heat Vulnerability

Chelsea's built environment creates intense urban heat conditions. The confluence of dense urbanization, industrialization, historical settlement patterns, and concentrated air pollution has compounded the urban heat island effect in Chelsea, and the city's location within a mapped environmental justice neighborhood means residents are disproportionately vulnerable to extreme heat due to factors including income level, disability, racial inequity, and age.[8]

Heat islands: urban areas that experience higher temperatures than outlying areas.



In urban areas, **daytime temperatures are about 1 to 7° higher** than in outlying areas.

Nighttime temperatures are about 2 to 5° higher than in outlying areas.

Source: US EPA

With minimal tree canopy and nearly 77% impervious surface coverage, the city absorbs and retains heat with little natural relief. Seniors, young children, and people with chronic health conditions, concentrated in Chelsea's dense residential neighborhoods, face the greatest health risk during heat events.

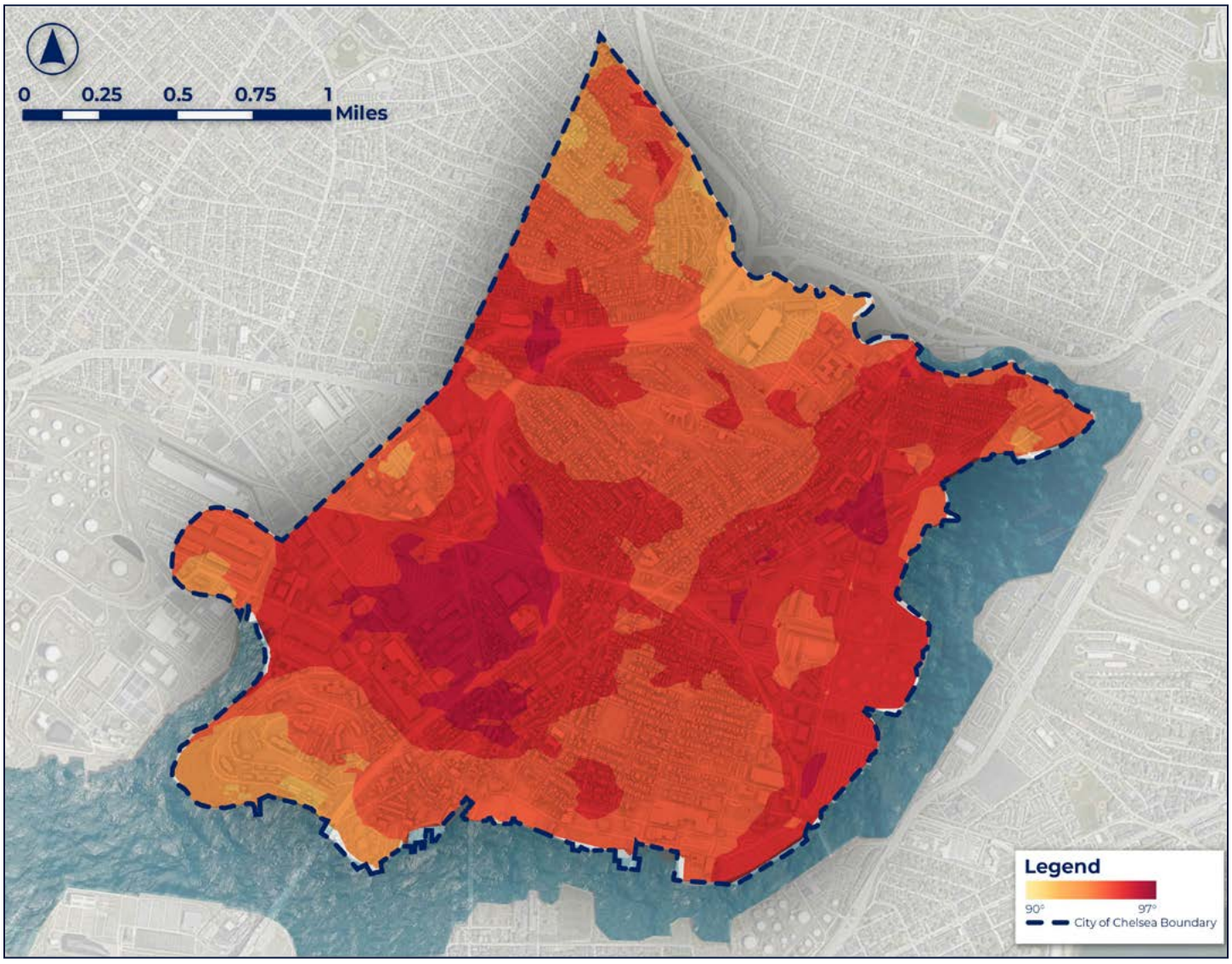
The city implemented targeted heat relief projects, including installation of a solar-reflective cool roof on a public housing complex in 2025, but the scale of the challenge requires systemic responses embedded in development review[9]. The Chelsea Resilient Design Guidelines are designed to build cooling capacity incrementally, project by project, across the whole city.



Urban Heat Mapping
C-HEAT Plan, 2021

8. City of Chelsea Department of Housing and Community Development, n.d.

9. City of Chelsea Department of Housing and Community Development, n.d.



Heat Exposure Risk Map
Chelsea, Massachusetts

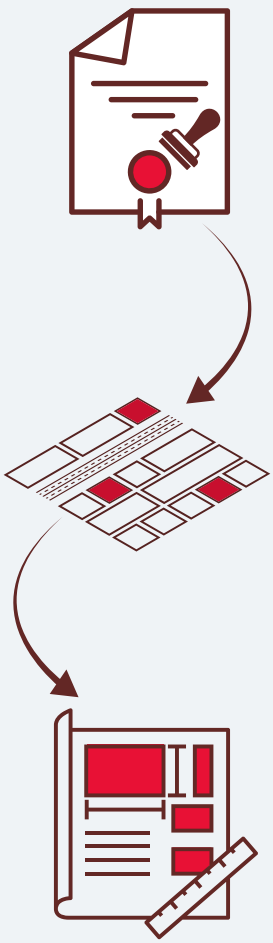
Planning & Policy Context

3

State regulations establish the framework that governs development in Chelsea. In certain areas, including Designated Port Areas and other state-regulated resource areas, additional requirements apply through environmental, coastal, and floodplain regulatory programs.

Layered Approach

Climate resilient design in Chelsea is implemented through a layered system of state regulations, local permitting requirements, and municipal design guidance, including the Chelsea Resilient Design Guidelines, which translate resilience priorities into project-level design strategies.



STATE REGULATIONS

Massachusetts state climate and environmental regulations establish the policy, permitting, and resilience requirements that guide local zoning and land use decisions.

LOCAL ZONING CODE

Chelsea's local zoning code establishes land use, site, and building provisions that can support climate resilience in new construction and redevelopment projects.

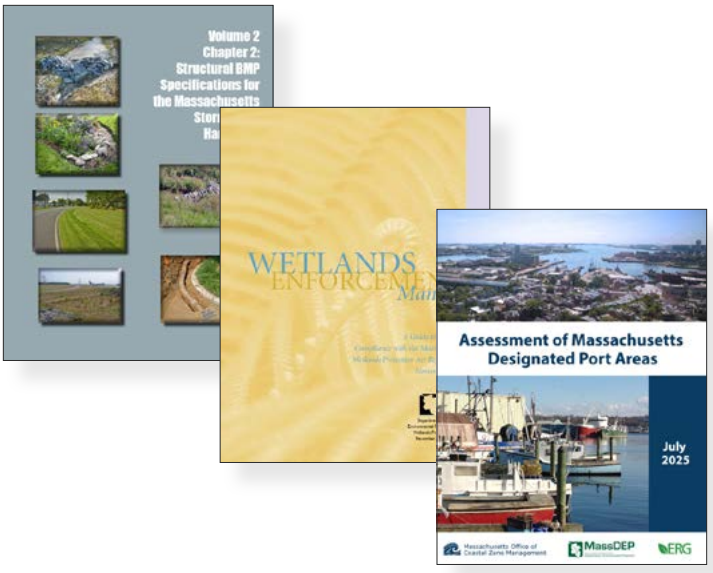
DESIGN GUIDELINES

Design guidelines translate resilience goals and applicable requirements into design guidance for site design, building form, and incorporating climate resilience strategies.

State Regulatory Framework

State statutes, which establish statewide climate, environmental, and coastal protection goals, are implemented by Massachusetts agencies such as the Department of Environmental Protection (DEP) and the Office of Coastal Zone Management (CZM) through permitting programs and technical standards. These regulatory tools establish thresholds for environmental protection, public safety, and climate resilience.

Municipal stormwater management is also shaped by the Environmental Protection Agency (EPA)'s Municipal Separate Storm Sewer System (MS4) permit program, which requires public stormwater systems to reduce pollutant discharges and improve water quality.



Planning & Regulatory Guides & Tools
Commonwealth of Massachusetts

STORMWATER & WETLANDS

Stormwater and wetlands regulation in Massachusetts is established through the Wetlands Protection Regulations (310 CMR 10.00), the Massachusetts Stormwater Management Standards, and the Massachusetts Stormwater Handbook[10]. Municipal stormwater management is also shaped by the EPA's Municipal Separate Storm Sewer System (MS4) permit program, which establishes requirements for public stormwater systems to reduce pollutant discharges and improve water quality. Collectively, these frameworks define requirements for stormwater management, groundwater recharge, water quality treatment, erosion and sediment control, and runoff reduction, while also providing guidance for Low Impact Development (LID) and green infrastructure strategies.

FLOODPLAIN & BUILDING STANDARDS

Floodplain and building standards require compliance with Federal Emergency Management Agency (FEMA) floodplain regulations, implemented through the Massachusetts State Building Code (780 CMR). These standards establish flood-resistant design and construction requirements for development within the FEMA mapped floodplain, with provisions for elevation, structural integrity, and materials to reduce flood risk.

COASTAL & WATERFRONT

Coastal and waterfront development in Massachusetts is regulated through the Chapter 91 Waterways Regulations (310 CMR 9.00), which apply to tidelands, filled tidelands, waterfront areas, and Designated Port Areas. These regulations establish requirements related to coastal flood risk, public access, and the protection of water-dependent and industrial uses along the waterfront.

Chapter 91 plays an important role in shaping how waterfront properties adapt to sea level rise, storm surge, and coastal flooding by regulating development and improvements within jurisdictional areas. Resilience measures such as shoreline stabilization, flood protection infrastructure, utility protection, and other adaptation strategies may require Chapter 91 review and approval depending on the nature and location of the proposed work.

10. Massachusetts Dep't. of Environmental Protection, 2014.

PLANNING & POLICY CONTEXT

Chelsea Regulatory Framework

Chelsea's local zoning and land use regulations guide how development occurs within the city. In certain areas, including overlay districts, additional requirements apply through municipal zoning provisions and site-specific review processes.

LOCAL REGULATORY FRAMEWORK

At the municipal level, the City of Chelsea integrates climate resilience considerations through zoning regulations, site plan review, special permitting, wetlands permitting, and infrastructure planning processes. These mechanisms influence how development addresses stormwater management, flood risk, building design, landscaping, and public realm improvements.

The Chelsea Zoning Ordinance establishes land use controls, dimensional standards, parking requirements, and overlay districts that shape development patterns. Certain projects are subject to Site Plan Review or Special Permit approval, during which the City evaluates drainage, circulation, open space, landscaping, and compatibility with surrounding conditions. At this stage, the City will review applicable climate resilient design strategies such as green infrastructure and permeable surfaces, flooding and heat mitigation measures, and expanded tree canopy.

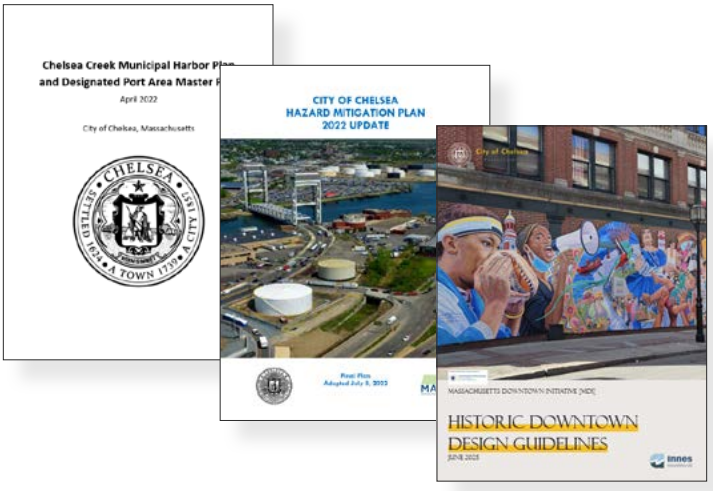
Chelsea's zoning framework includes a series of overlay districts that modify or supplement underlying zoning standards to address specific environmental, infrastructure, housing, and land use objectives.

FLOODPLAIN OVERLAY DISTRICT

The Floodplain Overlay District regulates development within FEMA-designated flood hazard areas and establishes floodplain management requirements consistent with state and federal standards. This includes flood-resistant construction requirements, elevation standards, limits on fill, and restrictions on development that may increase flood risk or reduce flood storage capacity.

RESIDENTIAL PLANNED OVERLAY DISTRICT

The Residential Planned Overlay District (RPOD) promotes coordinated residential development in designated areas of Chelsea by allowing more flexible site planning to improve building layout, pedestrian connectivity, and access to transit and services.



Municipal Plans & Guides
City of Chelsea

CHELSEA CREEK DPA

Chelsea's southern and eastern waterfront along Chelsea Creek is designated as a Designated Port Area (DPA) under Massachusetts Coastal Zone Management policy, which protects land suited for water-dependent industrial uses from conversion to non-maritime purposes. DPAs are intended to preserve and promote water-dependent industrial and maritime uses by protecting waterfront land and facilities necessary to support marine transportation, vessel repair, petroleum distribution, and other industrial activities that require direct access to navigable waters. Development within DPAs is regulated primarily through Chapter 91 licensing, which requires review against standard criteria as well as DPA-specific use restrictions[11].

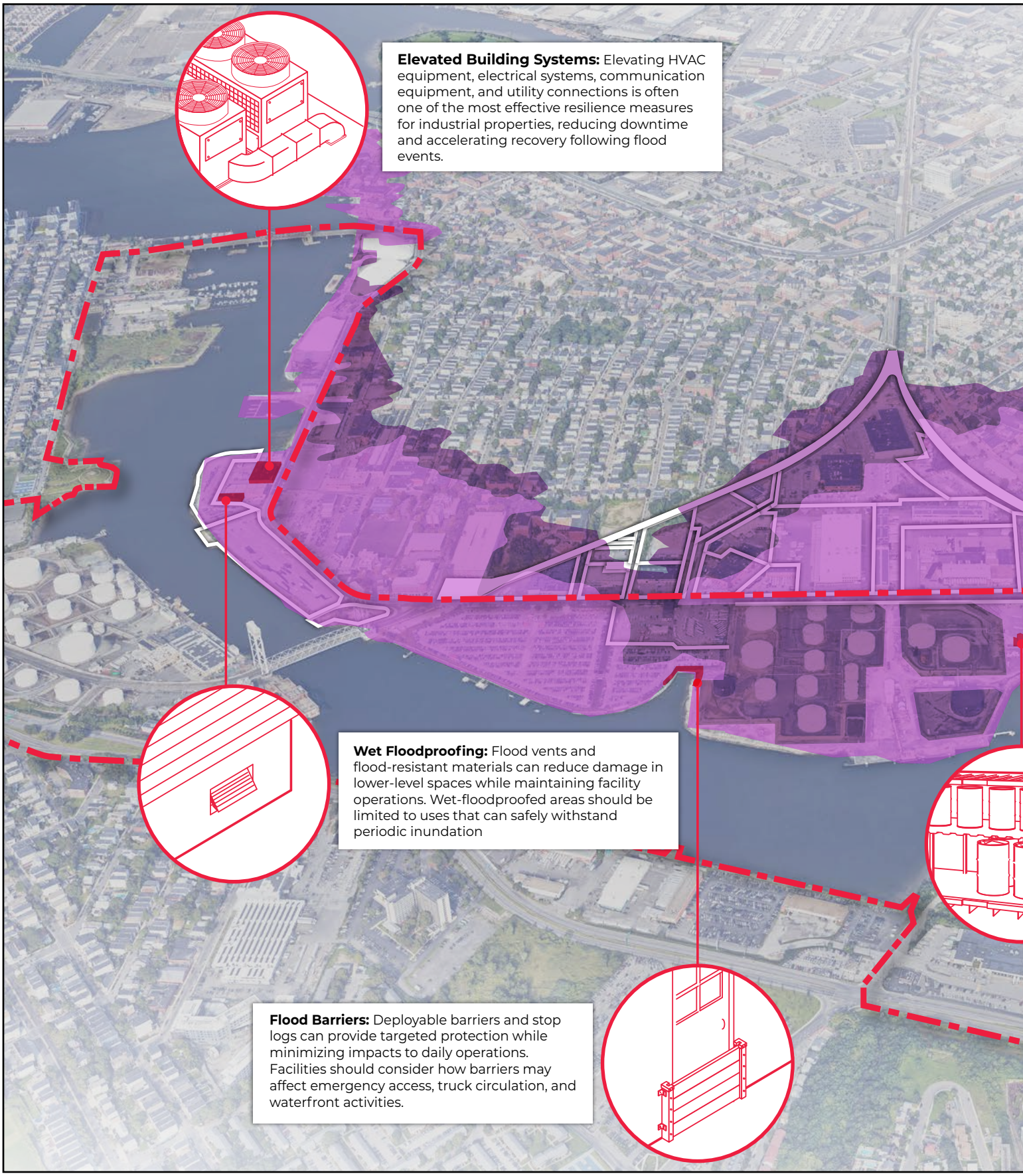
Within a DPA, development is generally limited to water-dependent industrial uses and facilities that directly support such uses. Non-water-dependent uses, including residential, hotel, and most office, retail, and commercial developments, are generally prohibited or significantly restricted because they may displace existing or future maritime industrial activities. Similarly, new structures or fill that would interfere with navigation, reduce waterfront industrial capacity, or limit future water-dependent use opportunities are generally not permitted.

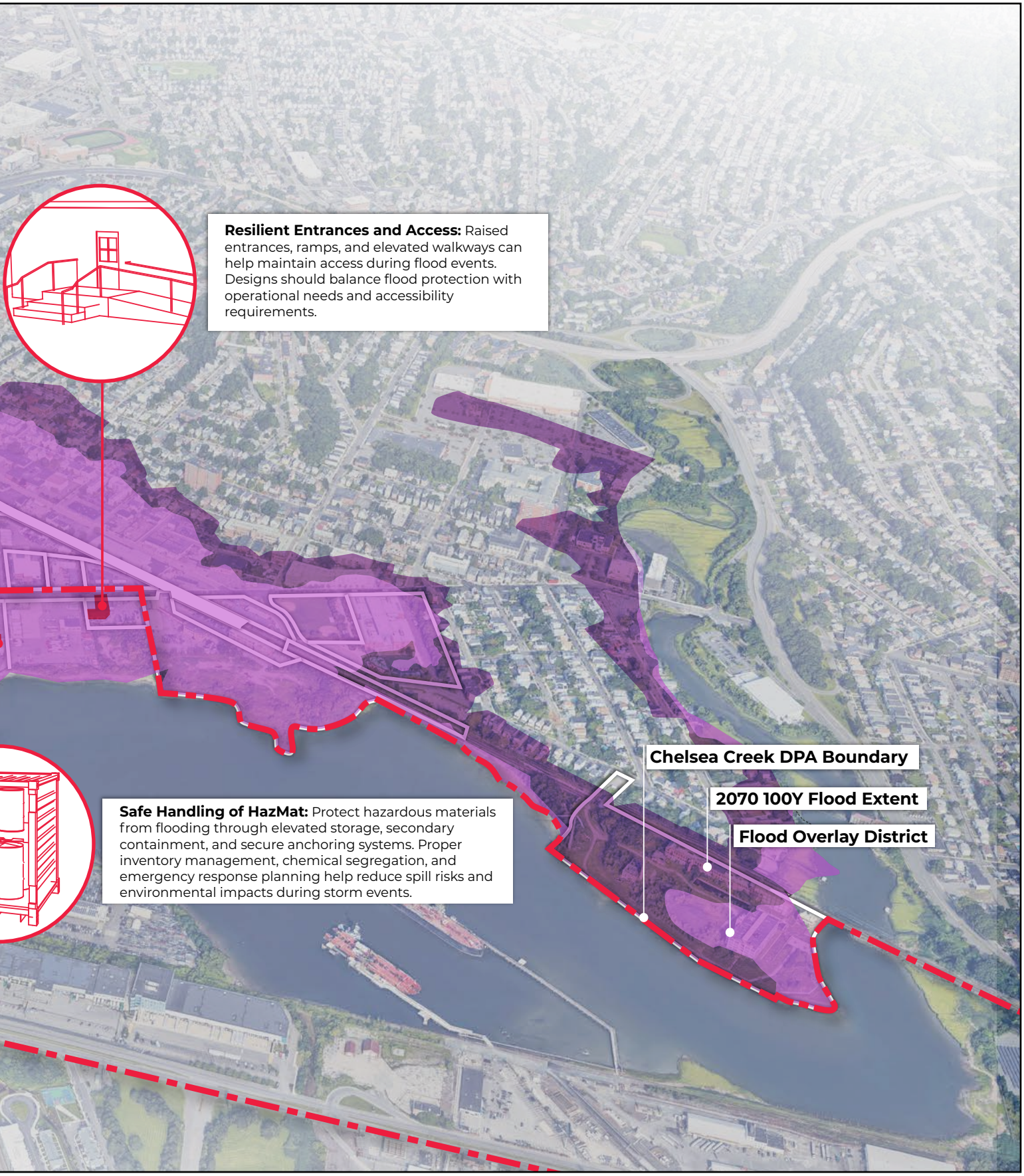
While these restrictions can create challenges for redevelopment, climate resilience improvements are not prohibited within a DPA. Resilience measures should be designed and implemented in a manner that supports and preserves the long-term viability of water-dependent industrial operations. Measures such as shoreline stabilization, seawall and bulkhead improvements, flood protection infrastructure, building elevation, utility protection, and other adaptation strategies may be appropriate where they protect existing facilities from sea level rise, storm surge, and coastal flooding without adversely affecting navigation, maritime operations, or the future industrial use potential of the site.

As a result, resilience strategies within the Chelsea Creek DPA are generally encouraged when they enhance the ability of existing waterfront facilities to withstand climate-related hazards while maintaining the area's function as a working waterfront and supporting the Commonwealth's long-term maritime industrial objectives. As sea levels rise and coastal flooding becomes more frequent, adaptation strategies will play an increasingly important role in protecting waterfront facilities while maintaining the long-term viability of the working waterfront.

11. The Massachusetts Public Waterfront Act, 1866.

Designated Port Area




Resilient Entrances and Access: Raised entrances, ramps, and elevated walkways can help maintain access during flood events. Designs should balance flood protection with operational needs and accessibility requirements.
Safe Handling of HazMat: Protect hazardous materials from flooding through elevated storage, secondary containment, and secure anchoring systems. Proper inventory management, chemical segregation, and emergency response planning help reduce spill risks and environmental impacts during storm events.
Chelsea Creek DPA Boundary
2070 100Y Flood Extent
Flood Overlay District



Who are the Resilient Design Guidelines for?

The Climate Resilience Design Guidelines are intended for property owners, developers, businesses, and institutions undertaking new construction, retrofits, renovations, or site improvements within the City of Chelsea.

The guidelines provide best practices and design strategies that owners, contractors, property managers, and design professionals can apply to projects to address climate-related risks such as flooding, stormwater management, and extreme heat, while supporting long-term building performance and neighborhood resilience.

4. User Types & Case Studies

Photo:
Bassett Square



User Types & Case Studies

4

User types translate the Guidelines into representative stakeholder categories, illustrative of Chelsea's varying property types and project contexts. Case studies provide site-specific examples demonstrating the application of these strategies across the identified user types.

01. SMALL-SCALE RESIDENTIAL LANDLORD

A multifamily landlord in Chelsea is responsible for the ownership, management, and maintenance of residential buildings with multiple units, including upkeep and capital improvements. These properties are subject to local zoning and building code requirements for renovations and major upgrades. Landlords consider flood risk, stormwater management, and extreme heat through building and site strategies such as drainage improvements, landscaping, tree canopy, permeable surfaces, and energy-efficient or cooling upgrades, while balancing cost, tenant needs, and long-term resilience.





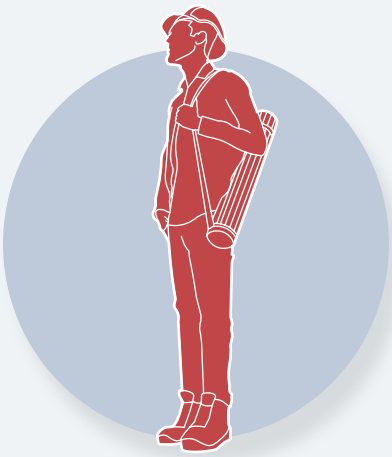
02. MIXED-USE DEVELOPER

A mixed-use developer in Chelsea is responsible for the planning, design, and construction of projects that combine residential, commercial, retail, and/or light industrial uses within a single site. These projects often occur in dense, transit-accessible areas and require coordination across multiple regulatory frameworks, including zoning, site plan review, and environmental permitting. Mixed-use developments are expected to address flood risk, stormwater management, and extreme heat through integrated site design strategies, while balancing resident livability, commercial functions, and long-term asset performance.

03. DUPLEX OWNERS

A duplex property owner in Chelsea is responsible for maintaining and improving a shared residential building, including the building, site, and landscaping. These properties are subject to local zoning and building code requirements, particularly for renovations, additions, and major upgrades, where resilience measures are more likely to be incorporated. Duplex owners address flood risk, stormwater management, and extreme heat through property-scale strategies such as improved drainage, enhanced tree canopy, permeable surfaces, and passive cooling, while balancing affordability and maintenance.





04. MULTIFAMILY COURTYARD

A multifamily courtyard property in Chelsea is managed collectively by owners responsible for maintaining shared building systems, the courtyard, and the surrounding site. These properties are subject to local zoning and building code requirements for renovations and upgrades. Courtyard improvements can address flood risk, stormwater, and heat through strategies such as improved drainage, green infrastructure, expanded tree canopy, permeable surfaces, and passive cooling. These improvements are evaluated based on shared costs, long-term performance, and maintenance.

05. INDUSTRIAL/PORT AREA PROPERTY

An industrial property within a Designated Port Area (DPA) in Chelsea is managed by an owner or operator responsible for maintaining building systems, loading areas, storage yards, and infrastructure that support water-dependent industrial uses. These properties must comply with strict DPA regulations, local zoning, and building codes, and meet all permitting requirements for renovations, upgrades, or site changes. Improvements must also ensure continued support for industrial operations, including the handling and storage of materials. Site improvements may address flood risk, stormwater, and heat impacts, but must be designed to maintain operational functionality and full regulatory compliance.



Case Studies

The case studies on the following pages apply the user types to sites in the City of Chelsea. Each case study represents a scenario in which a user is undertaking site changes such as new construction, redevelopment, renovations, or additions. These scenarios are overlaid on real sites in Chelsea to ground the examples in an urban context where constraints such as density, existing infrastructure, and limited space can make certain resilience strategies more challenging to implement. The intent is to illustrate what is possible in these conditions and how a range of resilience strategies can be applied to support climate-resilient design and property improvements.

The specific strategies depicted in the case studies are further detailed in the Coastal Strategies and Urban Heat & Stormwater Strategy sections, where measures such as green roofs, bioretention, and other resilience approaches are described in greater detail.

Do I need to incorporate all of the strategies shown in the case study?

No. The case studies are intended to illustrate a range of resilience strategies that may be applicable to varying property types. Most projects will incorporate only a subset of these strategies based on site conditions, budget, and project goals.

Even implementing one or two strategies can meaningfully improve the resilience of a property!

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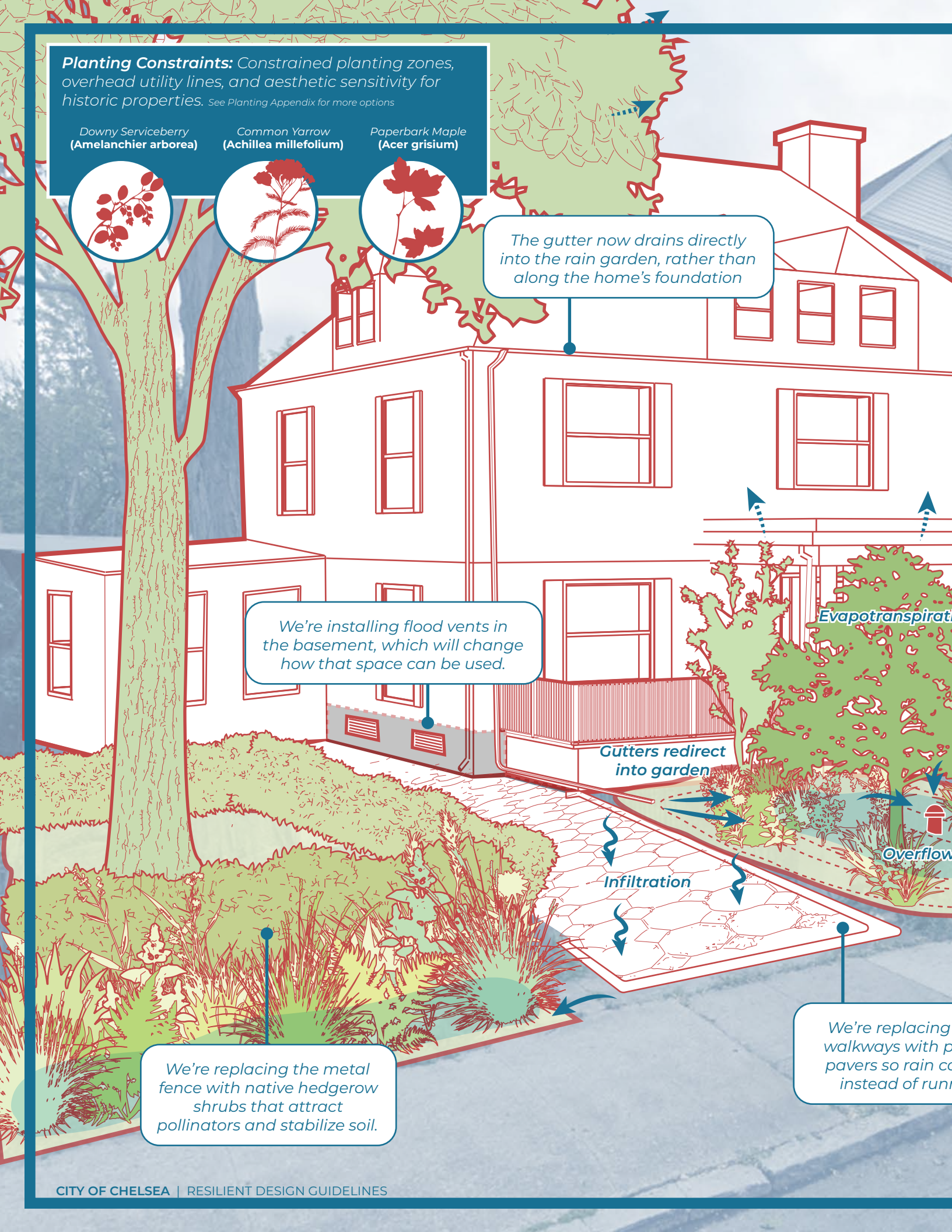
Broadway at Night
Source: Matt Frank


Planting Constraints: Constrained planting zones, overhead utility lines, and aesthetic sensitivity for historic properties. See Planting Appendix for more options
Downy Serviceberry (Amelanchier arborea)
Common Yarrow (Achillea millefolium)
Paperbark Maple (Acer grisium)
The gutter now drains directly into the rain garden, rather than along the home's foundation
We're installing flood vents in the basement, which will change how that space can be used.
Evapotranspirati
Gutters redirect into garden
Overflow
Infiltration
We're replacing the metal fence with native hedgerow shrubs that attract pollinators and stabilize soil.
We're replacing
walkways with p
pavers so rain co
instead of runn

Case Study 01:
Small-Scale Residential Landlord

This was my wife's family home growing up, and her aunt left it to us. It now helps support our retirement, and we're caring for it by making improvements gradually, making sure our tenants can live comfortably while the work is done.

We're adding a front-yard rain garden with native plants to capture stormwater and reduce flooding.

the front
permeable
an soak in
ning off.



Planting Constraints: *Ongoing irrigation and maintenance requirements, limited planting area.*

See Planting Appendix for more options

New York Aster
(Symphyotrichum novi-belgii)



Eastern Redbud
(Cercis canadensis)



Seaside Goldenrod
(Solidago speciosa)



The rooftop is desi
access with integ
and views of th

Infiltration

The lower-level facade is specified with flood-resilient materials.

There are no residentia
on the first floor to kee
spaces above flood

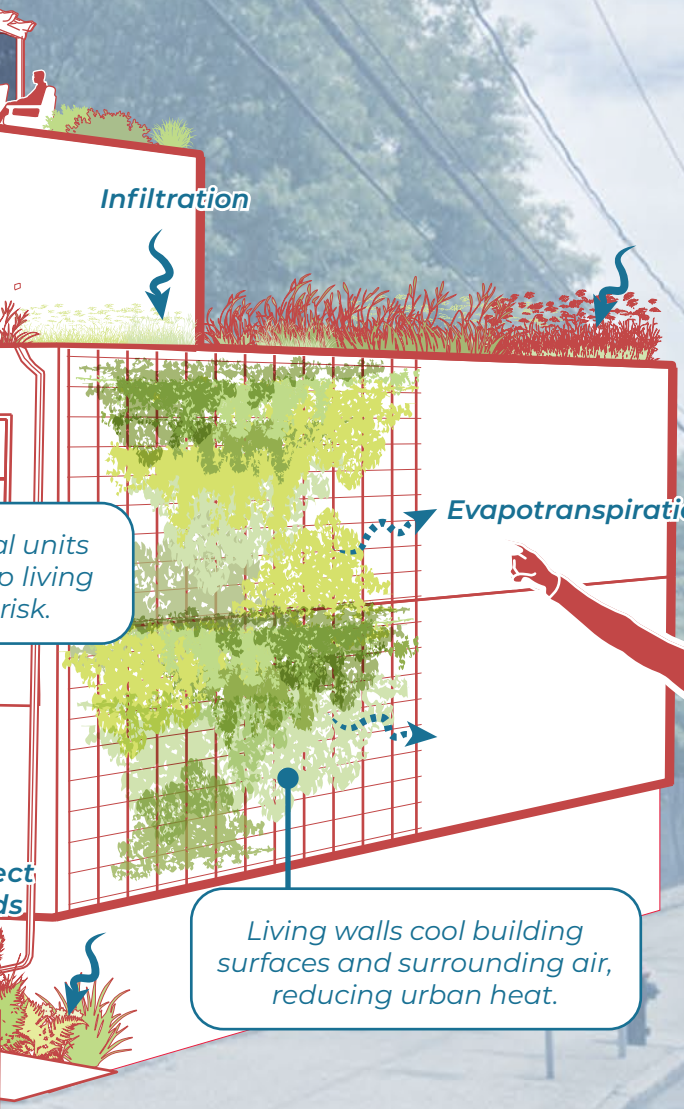
Redirected runoff

Gutters redire
runoff to bed

I love running my plant shop here, because I can plant outside and show what resilient landscaping looks like in practice.

Case Study 02: Mixed Use Developer

igned for shared grated shading e green roofs.

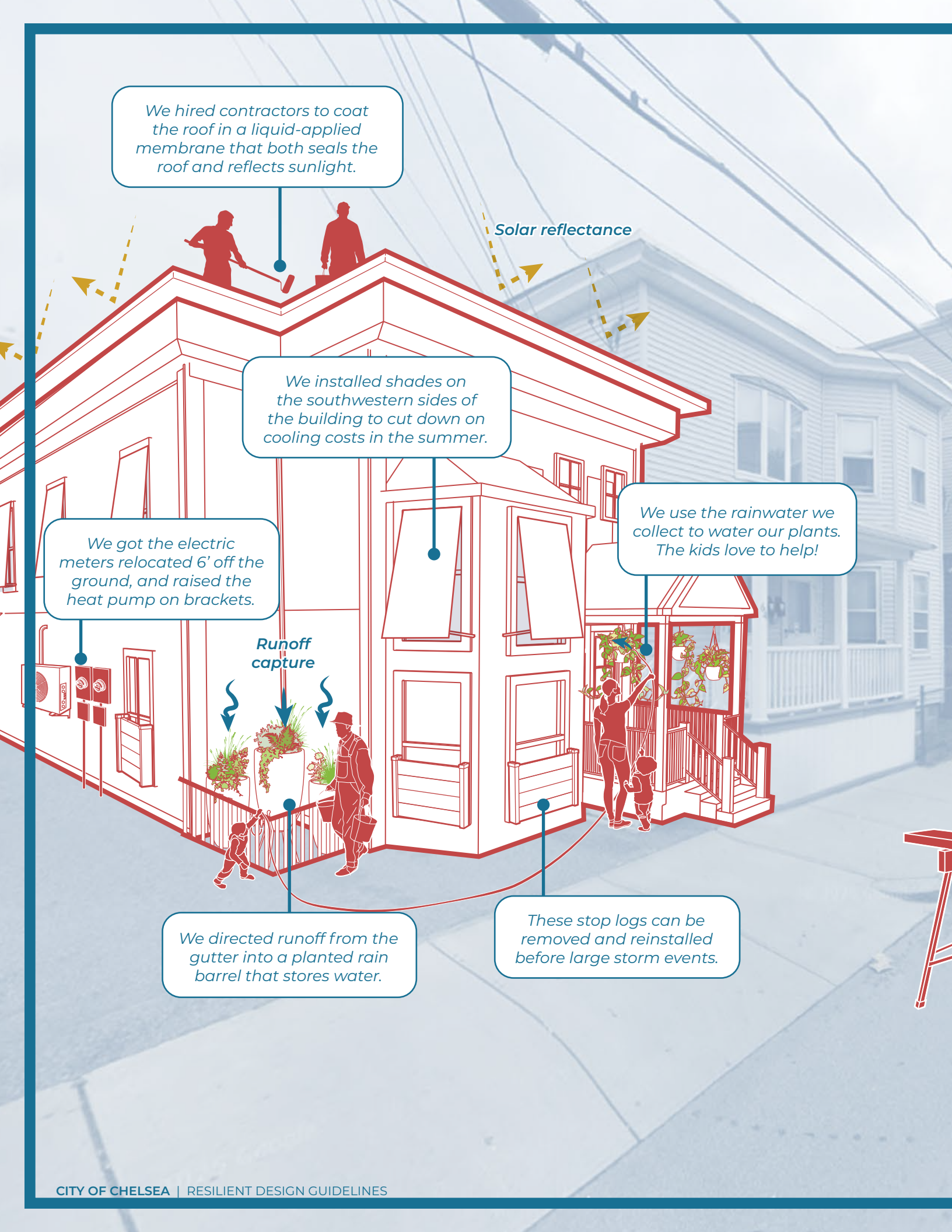


al units p living risk.

Living walls cool building surfaces and surrounding air, reducing urban heat.

This is my third development project, but the first time I worked with a green building consultant. Green roofs and walls cool the building, manage stormwater, and reduce long-term utility and maintenance costs.




We hired contractors to coat the roof in a liquid-applied membrane that both seals the roof and reflects sunlight.
Solar reflectance
We installed shades on the southwestern sides of the building to cut down on cooling costs in the summer.
We got the electric meters relocated 6' off the ground, and raised the heat pump on brackets.
We use the rainwater we collect to water our plants. The kids love to help!
Runoff capture
We directed runoff from the gutter into a planted rain barrel that stores water.
These stop logs can be removed and reinstalled before large storm events.

Case Study 03: Duplex Owners

Planting Constraints: *Compact side yards, clay urban soils, tight property lines, and overhead utility lines.*

See Planting Appendix for more options

Trident Maple
(Acer buergerianum)



Anise Hyssop
(Agastache foeniculum)

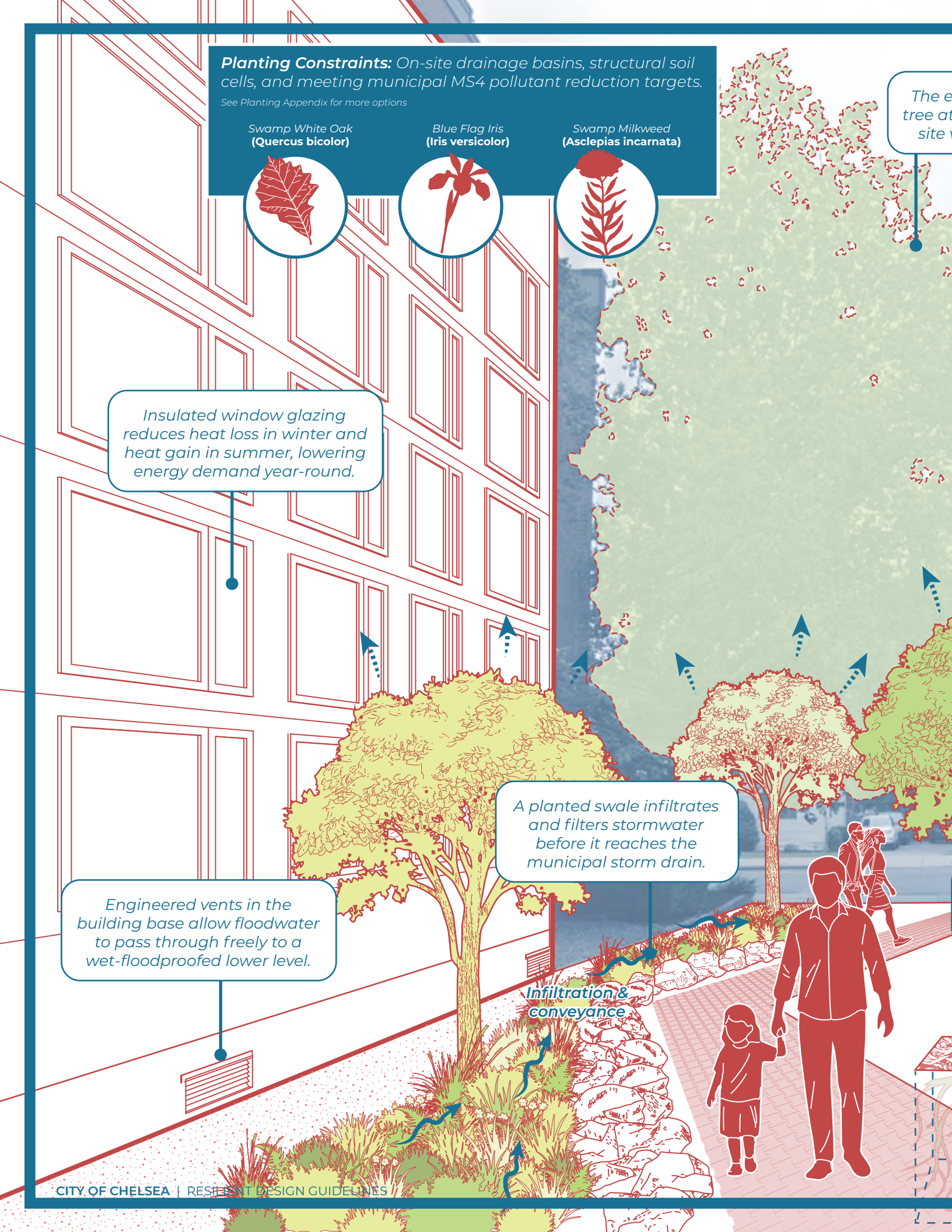


Spotted Bee Balm
(Monarda punctata)

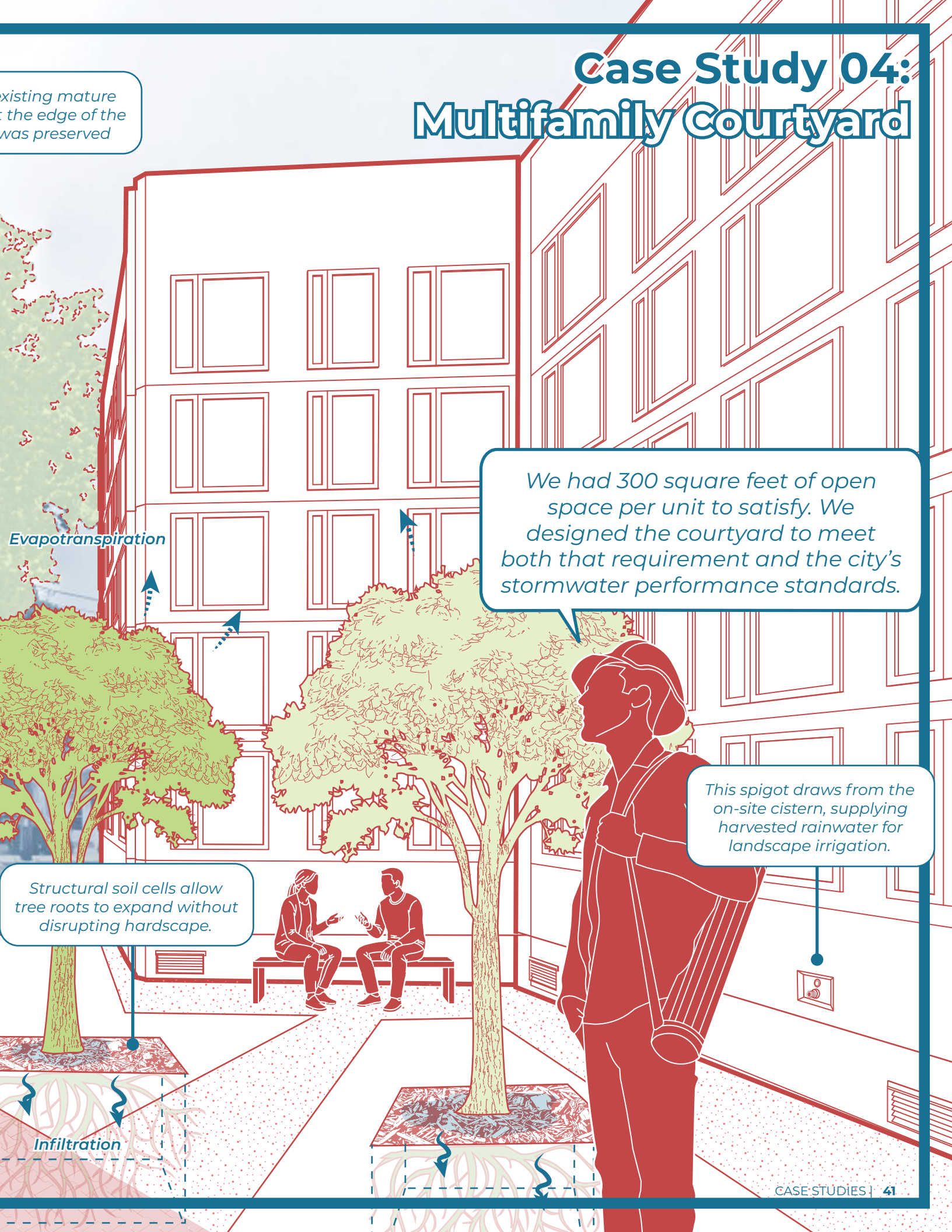


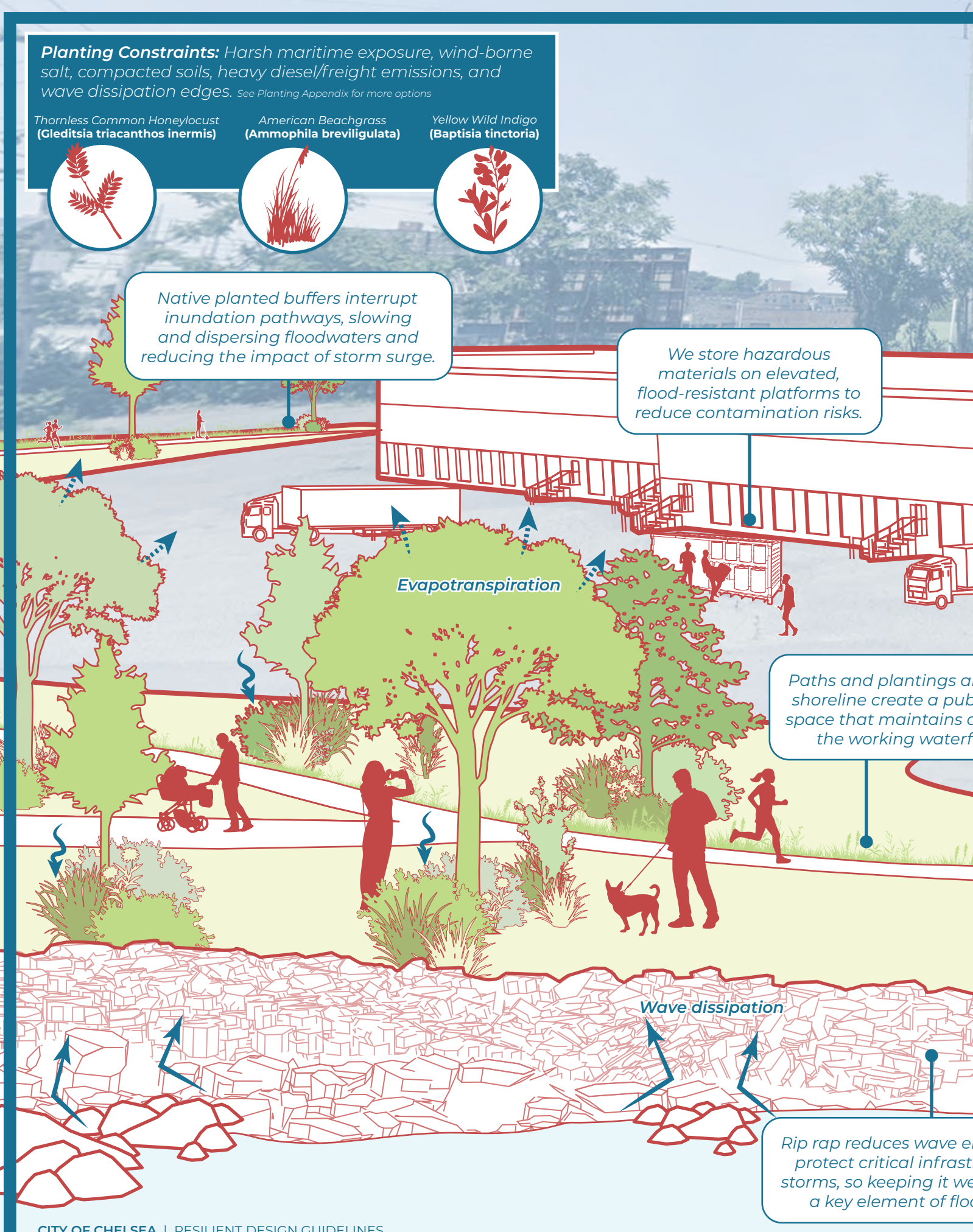
I decided to start tackling some building adaptations with the family in the duplex next door. We coordinated on "cool roof" improvements, and installed flood barriers on the lowest windows around the building.



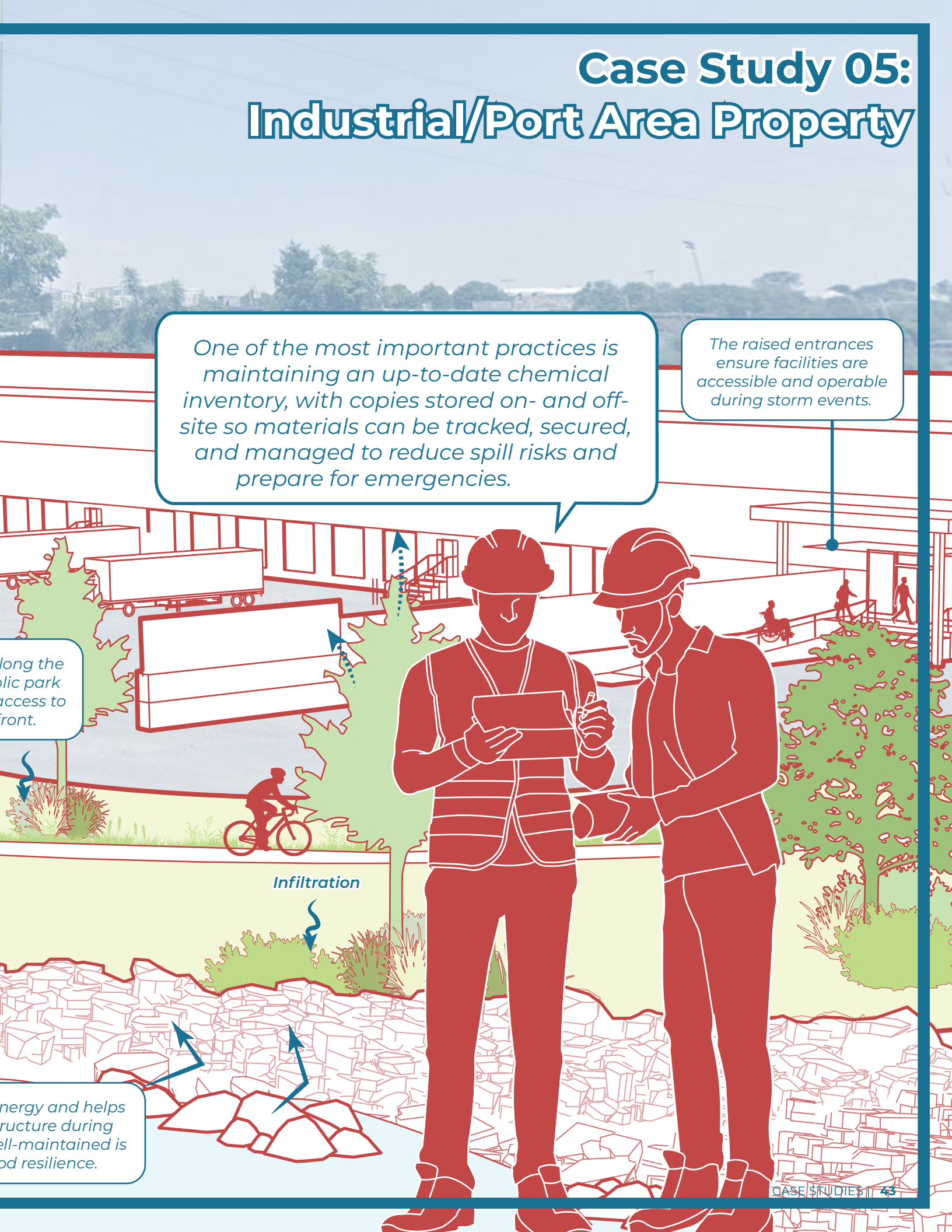

Planting Constraints: *On-site drainage basins, structural soil cells, and meeting municipal MS4 pollutant reduction targets.*
See Planting Appendix for more options
Swamp White Oak **(Quercus bicolor)**
Blue Flag Iris **(Iris versicolor)**
Swamp Milkweed **(Asclepias incarnata)**
The e tree at site
Insulated window glazing reduces heat loss in winter and heat gain in summer, lowering energy demand year-round.
A planted swale infiltrates and filters stormwater before it reaches the municipal storm drain.
Engineered vents in the building base allow floodwater to pass through freely to a wet-floodproofed lower level.
Infiltration & conveyance

Case Study 04: Multifamily Courtyard




Planting Constraints: *Harsh maritime exposure, wind-borne salt, compacted soils, heavy diesel/freight emissions, and wave dissipation edges.* See Planting Appendix for more options
Thornless Common Honeylocust **(Gleditsia triacanthos inermis)**
American Beachgrass **(Ammophila breviligulata)**
Yellow Wild Indigo **(Baptisia tinctoria)**
Native planted buffers interrupt inundation pathways, slowing and dispersing floodwaters and reducing the impact of storm surge.
We store hazardous materials on elevated, flood-resistant platforms to reduce contamination risks.
Evapotranspiration
Paths and plantings a shoreline create a pub space that maintains c the working waterf
Wave dissipation
*Rip rap reduces wave e protect critical infrast storms, so keeping it we a key element of floo

Case Study 05: Industrial/Port Area Property





Urban Heat & Stormwater Resilience Strategies

Photo Source:
Jamie M. Hernandez Park, Weston & Sampson

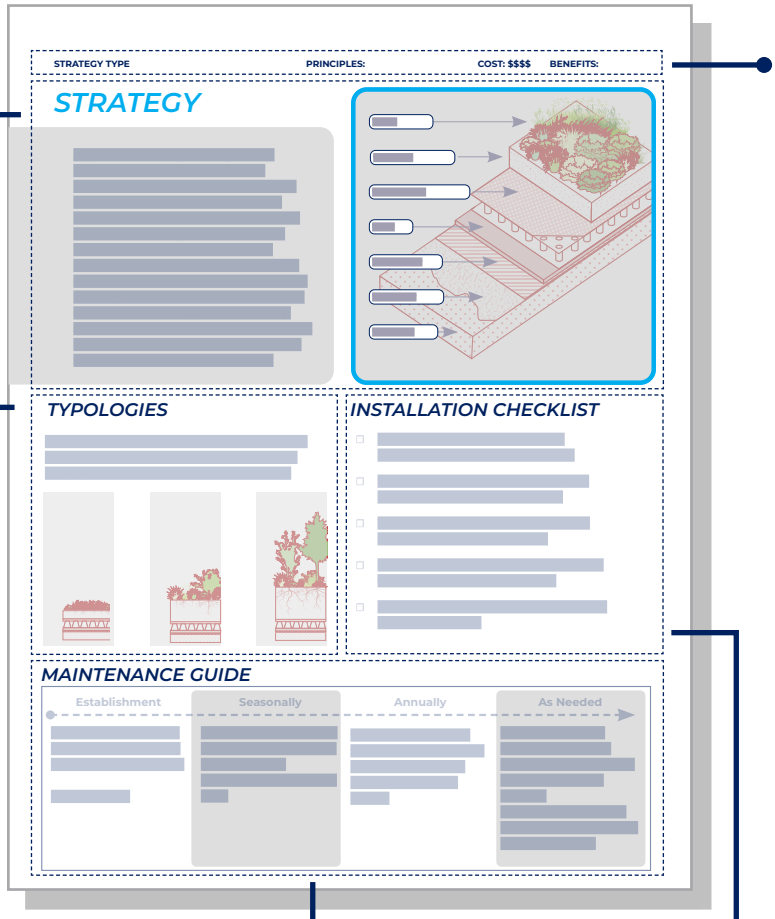


STRATEGIES OVERVIEW

How to Use the Strategies

The Strategies Sheets are intended as starting points for selecting and assembling appropriate resilience interventions. Each sheet presents a single strategy that can be adapted, combined, or scaled depending on site conditions, project goals, and constraints. Taken together, the sheets are meant to function as a modular toolkit. Users are encouraged to consider combining strategies across urban heat, stormwater, and coastal resilience categories to develop site-specific solutions.

Each sheet starts with a brief description and annotated illustration that explain the general functionality of the strategy



Some sheets may include typologies, illustrating common variations or forms of the strategy, where applicable

Summary of short and long-term care considerations, outlining key operational responsibilities

Where included, the checklist provides key steps and conditions to confirm prior to implementation

STRATEGY TYPE:

PLANTED STRATEGIES: Vegetation-based systems for heat, stormwater, and habitat benefits

ROOFTOP & SURFACE STRATEGIES: Roof and ground-plane interventions that manage heat and runoff

SITE FEATURES: Fixed landscape or infrastructural elements that manage drainage, circulation, and on-site environmental comfort

ELEVATED STRATEGIES: Raising buildings or systems above flood levels

ADAPTIVE STRATEGIES: Flexible or deployable measures that respond to flooding or climate change

INDUSTRIAL STRATEGIES: Heavy-duty resilience measures for large-scale operational sites

PRINCIPLES:

Corresponding to resilient design principles on page 11. **Note: All strategies are considered a form of local guidance*

- LOCAL GUIDANCE*
- PUBLIC HEALTH
- FUTURE-PROOF
- FEASIBILITY
- GREEN JOBS
- GREEN CANOPY

COST*:

$	≤$1,000
$$	≤$10,000
$$$	≤$50,000
$$$$	>$50,000

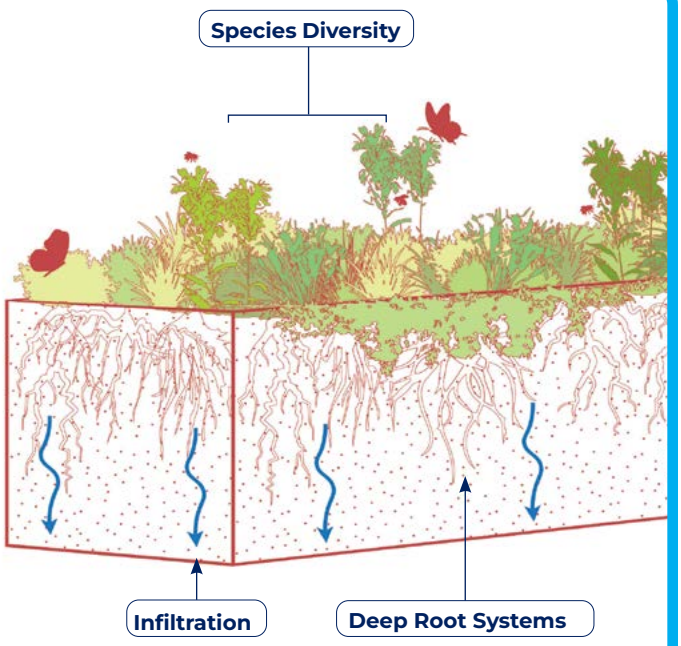
**Costs shown in these Strategy Sheets are for early-stage planning and comparison only. Actual costs will vary based on site conditions, scale, access, materials, regulations, and local labor or permitting requirements.*

BENEFITS:

- STORMWATER
- COASTAL RESILIENCE
- URBAN HEAT MITIGATION

NATIVE PLANTING

Native plants attract pollinators like hummingbirds, bees, and butterflies, which makes a bigger impact than most people realize. Insects are the foundation of the food web: birds, bats, and mammals all depend on them as a food source, and most of our food crops rely on native bees and other insects for pollination.[1,2] Many insects depend on native vegetation as larvae, so choosing plants that support insects helps sustain the broader web of life that we all depend on. With residential yards covering over 40 million acres nationwide, homeowners have real power to protect biodiversity by replacing lawns with native plants and avoiding yard chemicals.[1] Planting native vegetation, typically through seeding, can aid with erosion control, as well as establishing or re-vegetating native plant communities to an area.[3]





SELECT THE RIGHT PLANTS
- Choose native species suited to existing soil and moisture conditions



PROTECT THE SOIL
- Test soil first: urban soils may need decompaction or amendment, or replacement



CREATE HABITAT
- Mix flowers, grasses, shrubs, and trees to support pollinators



LET NATURE WORK
- Leave leaves, stems, and natural cover to support wildlife

The key is matching species to the site's existing soil and hydrology rather than altering the site to fit a species. Working with what's naturally there produces better ecological outcomes and greater biodiversity.[3] If you are adding plants to an existing vegetated area, a good rule of thumb is to aim for at least 70% of your plants to be native species.[4]

SIMPLE, SUPPORTIVE ACTIONS:

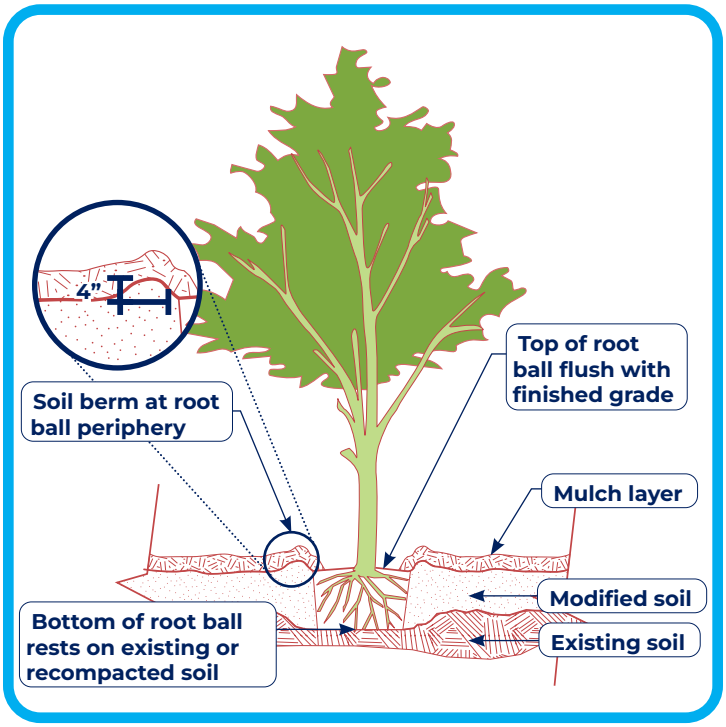
- ☐ Leave leaves as mulch and keep plant stalks standing through winter to protect overwintering insects. This might mean skipping fall cleanup and waiting until mid-spring to cut stems
- ☐ Move leaves out of paths rather than raking or blowing them away. Where safe, leave dead tree trunks standing and tuck fallen branches out of sight, as they act as important insect habitat
- ☐ Adjust mowing habits to mow every 2–3 weeks and let grass reach 3–4" tall
- ☐ Let flowering plants like clover, violets, and native grasses grow in your lawn[4]

MAINTENANCE GUIDE

Establishment	Seasonally	Annually
Water plants during early establishment, monitor for invasive species, and confirm plants are adapting to site conditions	Remove invasive plants, limit mowing, avoid pesticides, and leave leaves and plant stems in place to support pollinators and soil health	Inspect overall plant health, replace failed species if needed, and adjust planting diversity to improve habitat, shade, and resilience over time

TREE PLANTING

Trees provide countless benefits in urban contexts, from improved mental health and property values in tree-lined areas, to stormwater reduction and air quality. Healthy urban forests improves water and air quality, neighborhood stability, and community pride, while also reducing urban heat and energy costs. It is estimated that street trees have an average runoff reduction rate of approximately 6,376 liters per tree per growing season,[5] and urban tree canopy reduces runoff volume by 4–27% depending on canopy density and species. Urban forests have temperatures averaging 2.9°F lower than unforested urban areas.[6] Industry guidance generally recommends a minimum of 2 cubic feet of usable soil for every 1 square foot of mature canopy area, along with decompaction and protection from utility conflicts.[7]



INSTALLATION CHECKLIST

- ☐ Evaluate soil conditions, drainage, sunlight, and available rooting space before selecting tree species*
- ☐ Verify clearance from utilities, sidewalks, buildings, signage, and overhead wires
- ☐ Call 811 at least three working days before digging to locate underground utilities
- ☐ Dig a planting hole 2–3 times wider than the root ball and no deeper than the root flare
- ☐ Confirm that soil volume, pit dimensions, decompaction, drainage, and utility/ compaction protection are adequate for the tree's mature size

See Planting Appendix

In Chelsea, collaboration between local organizations, the City, and the Massachusetts Department of Conservation and Recreation has resulted in the planting of over 2,000 trees on public and private land, increasing the citywide tree canopy. Programs such as Greening the Gateway Cities, launched in Chelsea in 2014, specifically target low canopy, high heat neighborhoods to reduce household heating and cooling demand, and address climate inequities.[8,9,10]

WATCH FOR:

- Leaf discoloration & unusual leaf drop
- Insect damage
- Cracks or wound on the trunk
- Branch dieback
- Fungal growth
- Damage from lawn care or construction equipment

MAINTENANCE GUIDE

Establishment

Install trees at the proper depth with the root flare visible at grade

Provide a mulch ring, watering berm, and staking only where necessary to support establishment

After Storm

Inspect trees for broken, damaged, or hanging branches, trunk wounds, leaning, and erosion around the root zone

Repair protective berms as needed

Seasonally

Monitor tree health for signs of stress, disease, or insect damage

Provide supplemental watering during the first three growing seasons

Replenish mulch as needed to maintain a 2–4 inch depth

Annually

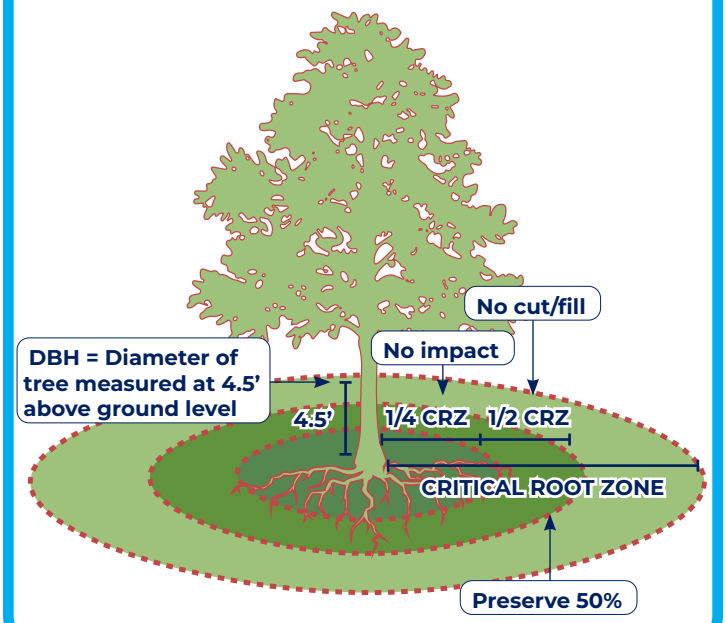
Perform structural pruning to remove dead, damaged, diseased, crossing, or rubbing branches and to encourage strong form

Remove stakes once tree is capable of supporting itself independently

TREE PRESERVATION

Protecting mature trees delivers measurable, multi-benefit outcomes. Preserving mature trees is often more beneficial than planting new ones because established trees already provide decades' worth of environmental, social, and economic value. Large trees offer significantly greater shade, stormwater absorption, air filtration, and carbon storage than young trees, while also supporting more wildlife habitat.[11] Newly planted trees can take decades to deliver the same level of benefits, and some may not survive to maturity. Protecting existing trees helps communities retain these immediate and long-term advantages while avoiding the time and costs required to replace them.

Determining Critical Root Zone (CRZ)



INSTALLATION CHECKLIST[12]

- ☐ Evaluate existing tree health, structure, species suitability, and remaining lifespan before construction begins
- ☐ Identify and clearly mark Tree Protection Zones (TPZ) around trees planned for preservation
- ☐ Install protective fencing around the Critical Root Zone (CRZ) prior to grading, excavation, or equipment access
- ☐ Avoid soil compaction, trenching, material storage, vehicle traffic, and chemical disposal within protected areas
- ☐ Coordinate utility routing, grading, and drainage changes to minimize root disturbance
- ☐ Use hand tools or air spade excavation when work near roots is unavoidable and coordinate with an arborist
- ☐ Develop a long-term tree protection and monitoring plan during and after construction

Construction damage, often not visible right away, is a leading cause of preventable urban tree loss. Existing trees should be protected during construction using industry best practices to minimize impacts to the trees identified to be retained on site. The health of existing trees can also be preserved through regular maintenance strategies, such as organic mulching, and structural pruning, and watering during droughts.

BEST PRACTICES:

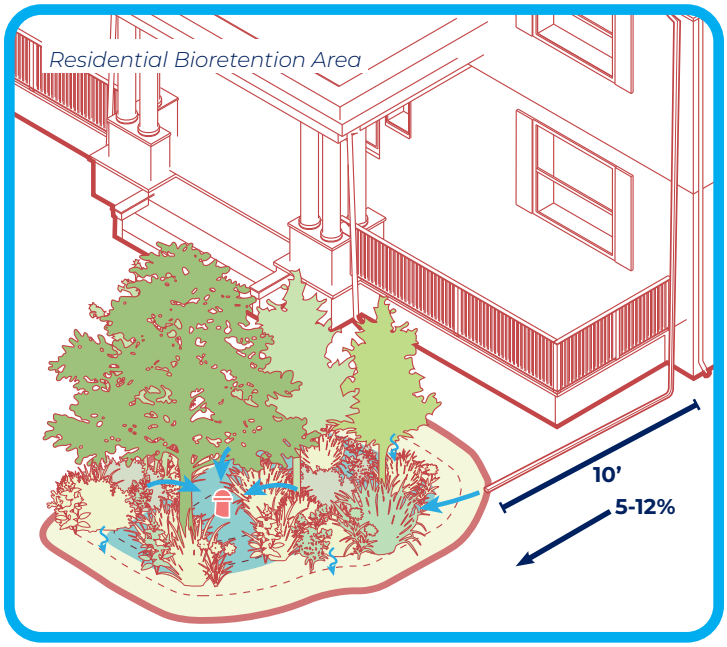
- ☐ Preserve healthy mature trees where feasible to maintain canopy and stormwater benefits
- ☐ Protect CRZ throughout construction activities, using general rule of thumb: 1" DBH = 1' CRZ
- ☐ Avoid topping trees or excessive canopy removal
- ☐ Prioritize planting a diverse mix of native and/or climate-resilient tree species
- ☐ Maintain long-term monitoring and pruning for tree health and storm resilience
- ☐ Include arborist review for construction plans

MAINTENANCE GUIDE

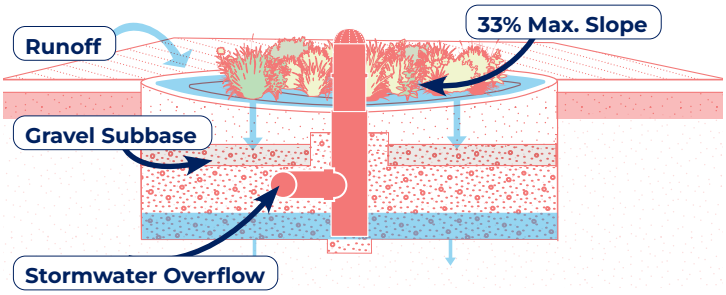
Installation	Seasonally	Annually
Inspect tree protection fencing regularly during construction and monitor trees for stress, canopy decline, or root damage	Maintain mulch 2-4 inches deep, inspect for pests or disease, and avoid soil compaction around root zones	Conduct structural pruning, inspect for dead or hazardous branches, and evaluate overall tree health and stability with a qualified arborist when needed

BIORETENTION

Bioretention features, like rain gardens and bioswales, are gently sloped depressions designed to collect stormwater discharge on-site and filter it through layers of soil media. They can also include optional drainage features, such as beehive drains or perforated pipes installed underground. This process has a range of benefits: recharging the groundwater supply through infiltration, reducing peak flows in sewer systems, supporting vegetation—even cooling urban stormwater before it enters the watershed. A best practice is to plan a footprint of 5-10% of the drainage area.[13]



PROFILE



SITE CONDITIONS [14,15]

- ☐ Avoid siting in forests, wetlands, or floodplains
- ☐ Identify a contributing runoff source (roof, driveway, street, or other pavement)
- ☐ Evaluate site drainage to ensure water infiltrates or drains within 72 hours
- ☐ Select relatives relatively flat or gently sloped areas
- ☐ Maintain a minimum 10 feet from buildings or foundations
- ☐ Confirm utility clearances and coordinate Dig Safe prior to excavation

MAINTENANCE GUIDE

Establishment	Seasonally	Annually	As Needed
Water every day for 2 weeks after planting	Remove trash and built-up sediment to maintain flow and function	Replenish mulch layer 2-3" depth	Replace soil media over time as its pollutant removal capacity declines
Document infiltration rate as a baseline for future comparison	Maintain vegetation through mowing, pruning, and invasive removal	Assess vegetation diversity, interplant new species as needed	Inspect after major storms for debris, erosion, and overall condition
	Inspect periodically to determine whether drainage is functioning properly	Test soil media infiltration rate	Repair eroded or bare areas

FORM AND FUNCTION



BASIN

Bioretention areas are meant to hold water so it can soak into the ground, not to carry flowing water. If water moves through them too quickly, they can erode and won't filter or absorb water effectively.

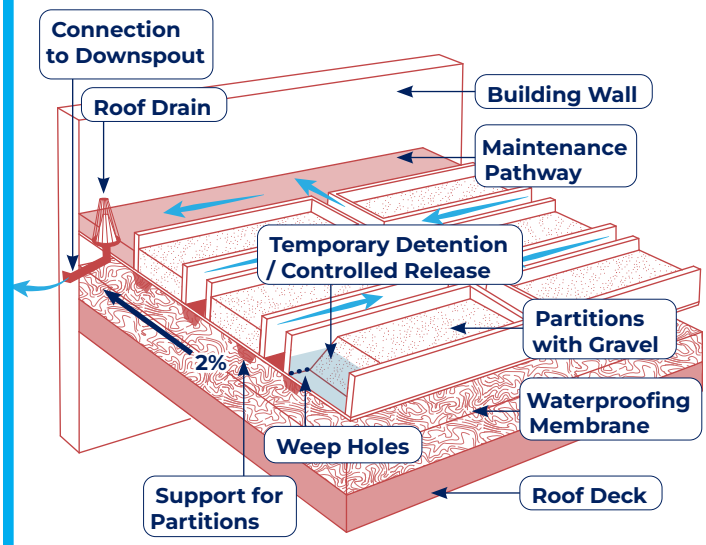


LINEAR

Most guidance recommends placing bioretention (including rain gardens) where water can safely pond, while using systems like **bioswales** or pipes to move water from one place to another.

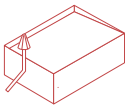
BLUE ROOF

Blue roofs are rooftop stormwater management systems designed to temporarily detain rainfall and slowly release it over time. Rather than directing runoff immediately into the sewer system, blue roofs use controlled flow devices, such as orifices, weirs, check dams, or smart valves, to reduce peak discharge rates during storm events. These systems can decrease downstream flooding, reduce pressure on aging sewer infrastructure, and help cities meet stormwater management goals. Blue roofs are most effective on flat or low-slope roofs with sufficient structural capacity to support temporary water storage loads.[16]

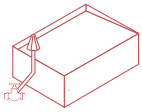


Blue Roof with Partitions

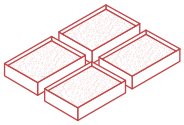
TYPOLOGIES



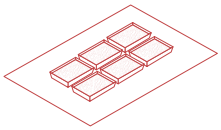
Roof-Integrated: Water is stored directly on membrane-coated roof surface, releasing through roof drains



Actively Controlled: Valves, sensors, and controls manage water release



Partitions: Roof surface is subdivided to form shallow storage zones/detention cells



Modular Tray: Common for retrofits; plastic trays temporarily hold stormwater, draining through internal channels to roof drains

INSTALLATION CHECKLIST

- ☐ Structural capacity requires confirmation from a licensed structural engineer prior to installation
- ☐ Roof slope (less than 2%) and drainage conditions must be verified for detention suitability by qualified professional
- ☐ Plumbing and overflow systems must be validated by qualified professional to ensure safe discharge during storms
- ☐ Provide safe roof access for inspection, maintenance, and debris removal

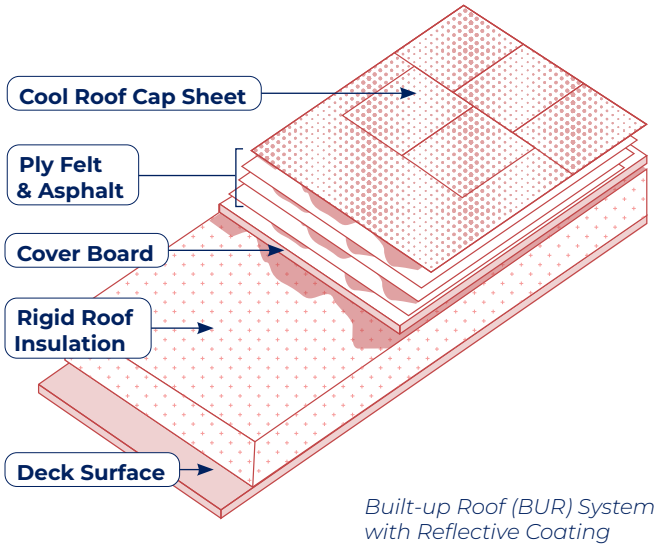
Existing commercial, industrial, institutional, and multifamily buildings in Chelsea may offer strong retrofit opportunities. Approximately 70% of Chelsea is served by combined sewers, where stormwater and wastewater share pipes. During heavy rain, the system can overflow and discharge untreated combined sewer overflow (CSO) into nearby waterways. By delaying rooftop runoff before it enters the sewer network, blue roofs can reduce peak wet-weather flows and contribute to CSO mitigation.[17]

MAINTENANCE GUIDE

Establishment	Monthly	Annually
Inspect waterproofing systems, outlet controls, overflow structures, and drainage performance after installation to confirm proper operation	Remove debris from drains and outlet structures, inspect ponding depth, and verify controlled release devices remain clear and functional	Inspect structural supports, waterproofing membranes, seals, flashing, and outlet controls for wear, leaks, or deterioration

COOL ROOF

Cool roofs are roof surfacing strategies designed to reflect solar radiation and therefore absorb less heat. They can be as simple as applying a specialized coating, such as reflective paint or membrane, or installing new shingles, tiles or sheets, making them an extremely adaptable strategy for retrofits that can be customized for an array of existing conditions. They are especially effective for flat roofs, dark-colored roofs, buildings with poor insulation, or buildings that receive a lot of direct sunlight.[18]



Built-up Roof (BUR) System with Reflective Coating

INSTALLATION CHECKLIST

- ☐ Evaluate existing roof condition, material type, and remaining roof lifespan before installation
- ☐ Identify roof areas with high sun exposure or excessive indoor heat gain
- ☐ Select an appropriate cool roof system based on roof type, slope, and existing materials
- ☐ Verify compatibility between reflective coatings, membranes, or shingles and the existing roof surface
- ☐ Confirm roof penetrations, HVAC equipment, and access paths remain accessible after installation
- ☐ Coordinate permitting requirements, historic district review, and asbestos testing if re-roofing is involved
- ☐ Ensure proper drainage and avoid blocking roof drains or scuppers during installation
- ☐ Document product SRI/solar reflectance values and warranty information for future maintenance

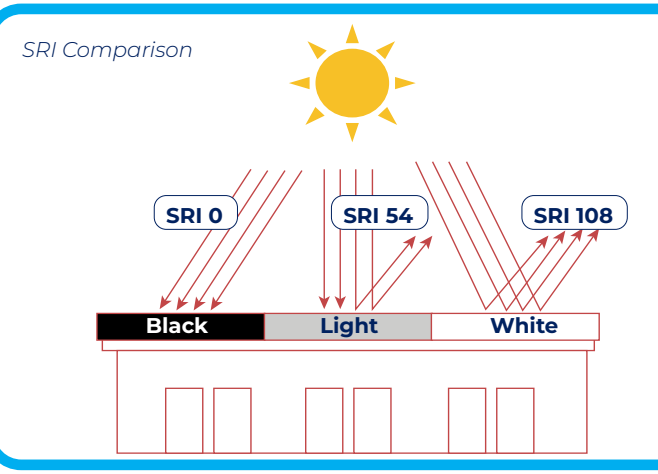
TERMINOLOGY

Albedo: solar reflectance

Emissivity: ability of a material to radiate absorbed heat

High solar reflectance index value (SRI): commonly represented on a scale where higher values indicate a roof's reflectivity and emissivity

High emittance: ability of a material to lower temperature by releasing heat through thermal radiation[19]



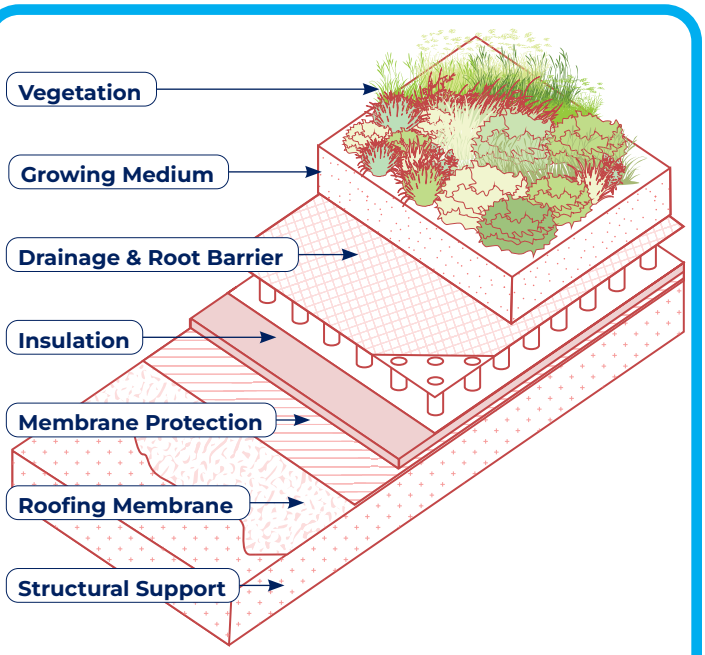
MAINTENANCE GUIDE

Installation	After Storm	Seasonally	Annually
Inspect coating adhesion, seams, flashing, and roof drainage after installation to confirm proper performance and reflectivity	Remove debris, inspect for punctures or coating damage, and clear drains and scuppers as needed	Clean reflective roof surfaces to maintain solar reflectance and inspect rooftop equipment access paths for wear or damage	Inspect coatings, membranes, seams, flashing, and roof penetrations for deterioration or leaks

Maintenance is usually the responsibility of the property owner or building maintenance crew. For multifamily, commercial, or public buildings, maintenance should be included in the property's regular accessibility and safety inspection routine.

GREEN ROOF

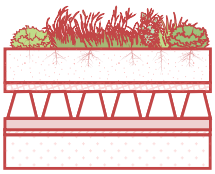
A green roof is a layer of vegetation installed on top of a building roof. Compared to conventional roofs, green roofs can have surface temperatures up to 56°F cooler and may lower nearby air temperatures by as much as 20°F.[20,21] They can also significantly improve building energy performance, reducing cooling demand by up to 70% and lowering indoor temperatures relative to conventional roofing systems.[22,23] Pairing solar panels with green roofs can help the panels work more efficiently by keeping the roof cooler, while also reducing stormwater runoff and helping insulate the building.

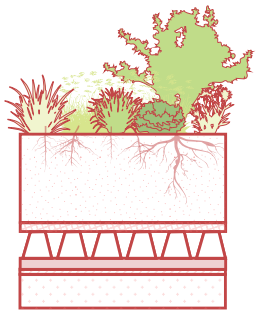


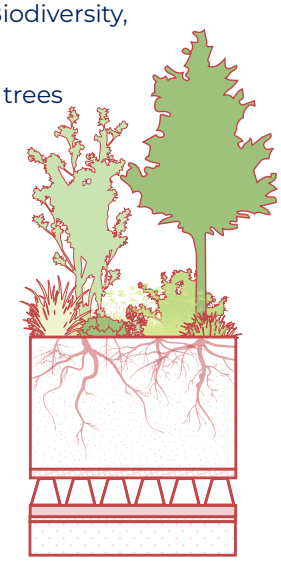
Common Green Roof Layers

TYPOLOGIES

	Extensive	Semi-Intensive	Intensive
Purpose	Stormwater Mitigation	Stormwater Mitigation, Biodiversity	Stormwater, Biodiversity, Open Space
Vegetation	Moss, sedum, herbs, grasses	Herbs, grasses, shrubs	Forbs, shrubs, trees
Depth	4-7”	6-10”	8-30”
Weight	20-40 lb/SF	25-60 lb/SF	45-100 lb/SF
Rain Event	2-4”	3-4.2”	>4.2”
Irrigation	No	Partial	Required







MAINTENANCE GUIDE

Establishment

- Water every day for 2 weeks after planting, then 2x week through summer
- Document drainage/ retention performance
- Confirm roof drains and overflow pathways are functioning

Quarterly

- Hand-weed invasive plants or unwanted vegetation at least every other month
- Inspect soil media for erosion issues

Annually

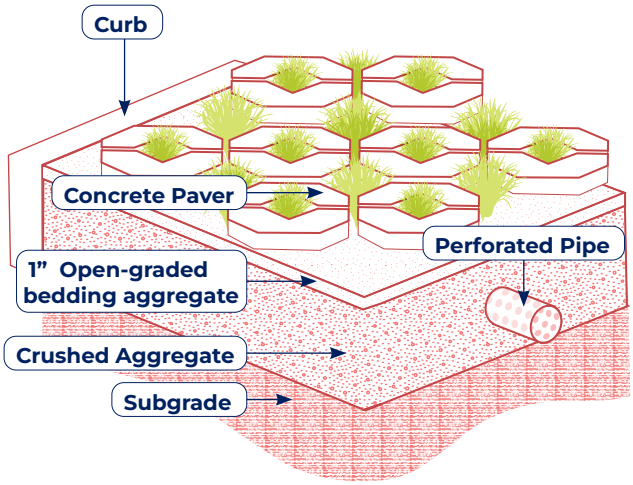
- Cut back dead vegetation from previous season to 4-6”, before new growth starts
- Inspect drain inlet pipe annually

As Needed

- Clear roof drains when clogged by debris or soil
- Optimize irrigation schedule, monitoring for correct frequency
- Repair eroded or bare areas
- Maintain vegetation coverage to be more than 90%

PERVIOUS PAVING

Permeable pavement is a paving system that allows rainwater and snowmelt to pass through the surface and into an underlying stone reservoir where water is temporarily stored, filtered, and infiltrated into the ground. Compared to conventional pavement, permeable pavement reduces stormwater runoff, improves water quality, promotes groundwater recharge, and can reduce localized flooding. EPA and USGS research indicates that permeable pavements can significantly reduce runoff volumes and peak flows while filtering pollutants before they reach waterways.[24,25,26]



Pervious Pavers System

TRADE-OFFS

- Higher upfront costs than conventional pavement in some applications
- Performance declines if sediment accumulates and maintenance is neglected
- Not ideal for all high-speed or heavily loaded roadways



Pervious Pavers in Residential Driveway

SITE CONSIDERATIONS

- ☐ Requires suitable subsurface conditions and adequate infiltration rates
- ☐ Infiltration through contaminated soils should be evaluated by qualified environmental professionals and may require liners, underdrains, or alternative BMPs
- ☐ Utility conflicts, easements, and ADA requirements should be evaluated during design

TYPOLOGIES



Porous Asphalt Asphalt mix with interconnected voids that allow water to infiltrate



Pervious Concrete Concrete with little or no sand, creating a porous structure that allows water to pass through



Permeable Interlocking Pavers (PICP) Individual pavers separated by stone-filled joints that allow stormwater infiltration

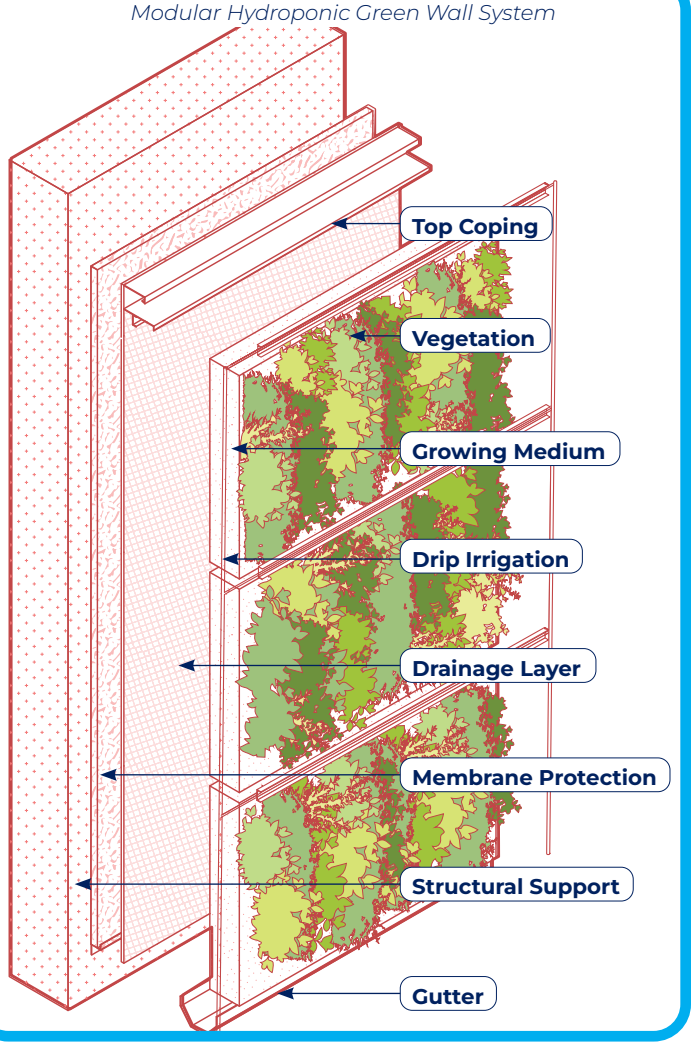
MAINTENANCE GUIDE

Installation	Periodic	Seasonally	Annually
Prevent sediment deposition during construction	Vacuum sweeping to maintain infiltration, never using high-pressure systems to clean Remove accumulated debris and sediment	In winter, avoid sanding pavers as it can clog system	Inspect surface condition and drainage performance Replace joint aggregate as needed

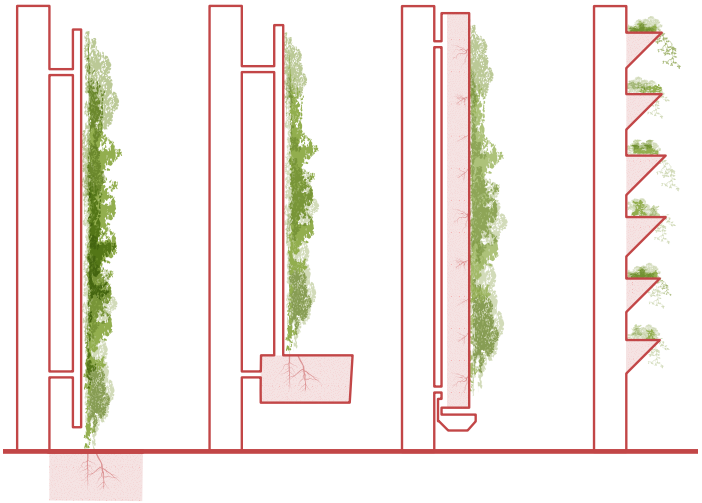
GREEN WALLS

A “green wall” is a broad term used to describe vegetated wall systems that add plants to vertical building surfaces. Vegetated walls can reduce wall surface temperatures by up to 36°F through shading and evapotranspiration, meaning it reduces both direct solar gain and heat released from building surfaces.[27,28] Green walls provide additional co-benefits including lowering ambient temperatures, reduced building energy demand for air conditioning and improved insulation performance.[29]

Modular Hydroponic Green Wall System



TYPOLOGIES



In-ground Planter

Green façades use climbing plants rooted in the ground or planters and supported by trellises, cables, or screens.

Modular Tray System

Living walls generally use modular planting panels attached directly to the building wall, incorporating soil or hydroponic growing systems.

INSTALLATION CHECKLIST

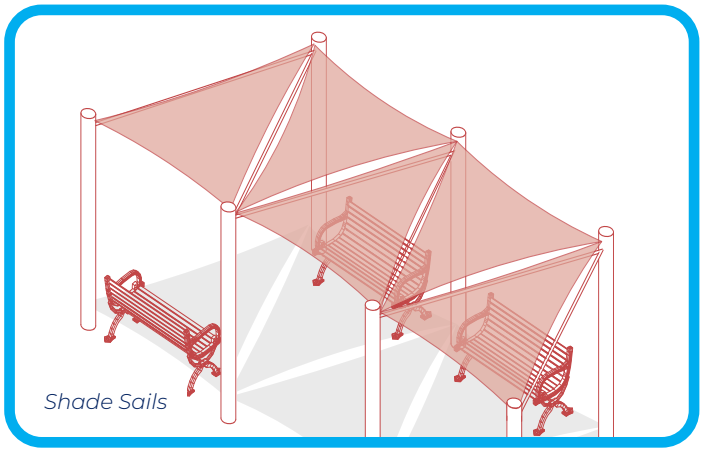
- ☐ Evaluate waterproofing and drainage protection of existing wall assembly
- ☐ Use qualified professional to review structural attachment capacity and overall system support conditions
- ☐ Confirm water supply, drainage, and backflow prevention requirements are met for irrigation system
- ☐ Plan for long-term maintenance, including ongoing maintenance access

MAINTENANCE GUIDE

Establishment	After Storm	Seasonally	Annually
Inspect irrigation, anchors, drainage, and plant establishment after installation to confirm healthy growth and proper water flow	Inspect irrigation lines, drainage systems, wall attachments, and plant health for signs of clogging, leaks, deterioration, or structural stress	Water plants as needed, prune overgrowth, replace damaged plants, and clear drainage or irrigation components of debris	Inspect structural supports, waterproofing systems, irrigation lines, and overall plant health for long-term performance and wall protection

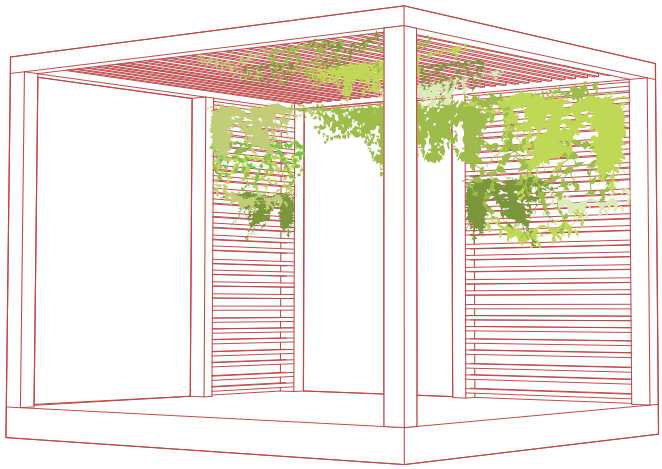
SHADE STRUCTURES

Shade structures are built features designed to reduce direct sun exposure and lower surface and air temperatures in outdoor spaces. These structures may include canopies, pergolas, awnings, covered walkways, shade sails, or solar canopies. High-SRI (Solar Reflectance Index) materials are often used on roofs or canopy surfaces to reflect more sunlight and absorb less heat than conventional materials. EPA guidance explains that reflective materials and shaded surfaces can help reduce urban heat island impacts, improve outdoor comfort, and lower surrounding surface temperatures. Shade structures can improve comfort and safety along sidewalks, playgrounds, public spaces, parking lots, transit stops, and building entrances, especially during extreme heat events. In Chelsea, shade structures may also support cooling access routes and improve thermal comfort in dense urban areas with limited tree canopy.[30]



Shade Sails

Planted Trellis



INSTALLATION CHECKLIST

- ☐ Determine the location, use, and amount of shade coverage needed
- ☐ Select the appropriate structure type based on site conditions and sun exposure
- ☐ Verify setbacks, pedestrian clearance, and ADA access requirements
- ☐ Install footings, anchors, and framing to withstand wind and snow loads
- ☐ Use durable, UV-resistant, and corrosion-resistant materials
- ☐ Coordinate electrical and utility connections for lighting or solar canopies if applicable
- ☐ Inspect structural connections, shading surfaces, and drainage conditions after installation

MAINTENANCE GUIDE

Installation	Seasonally	After Storm	Annually
Inspect anchors, fasteners, and structural connections	Clean surfaces and inspect for corrosion, tearing, or damage	Inspect for wind damage or loose components	Inspect structural supports, coatings, lighting, and solar systems if applicable

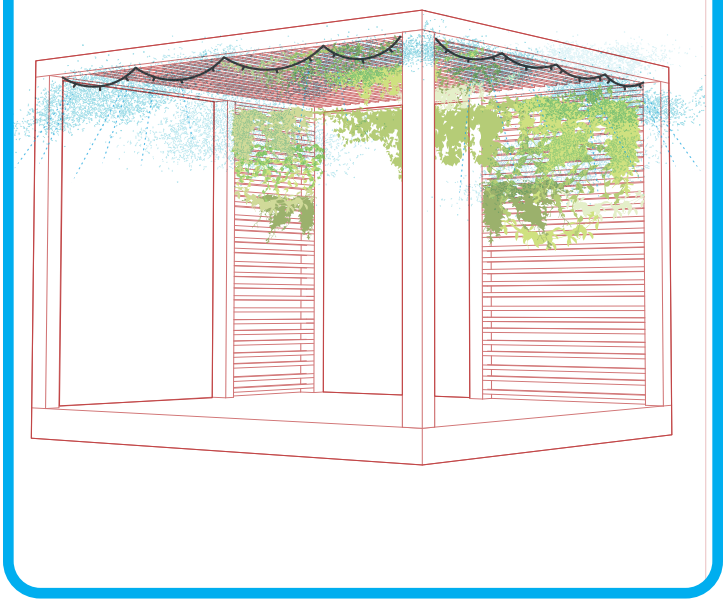
Maintenance is usually the responsibility of the property owner or building maintenance crew. For multifamily, commercial, or public buildings, maintenance should be included in the property's regular accessibility and safety inspection routine.

PRINCIPLES: COST: $$$$ BENEFITS:

INSTALL A WATER FEATURE

Water features can help provide comfort during hot weather by cooling nearby areas through evaporation and by reducing surrounding surface temperatures.[29] Misting systems, splash pads, fountains, spray features, interactive water elements, or shaded water installations, are all types of water features that help activate public spaces while supporting heat resilience and public health goals. These benefits depend on proper water quality management: features must be designed and operated to control microbial growth, including Legionella, and to address slip hazards from wet surfaces. A winterization plan should be established for seasonal shutdown, and clear long-term operations and maintenance responsibility should be assigned to ensure the feature continues to function safely and reliably.

Planted Trellis with Misting System

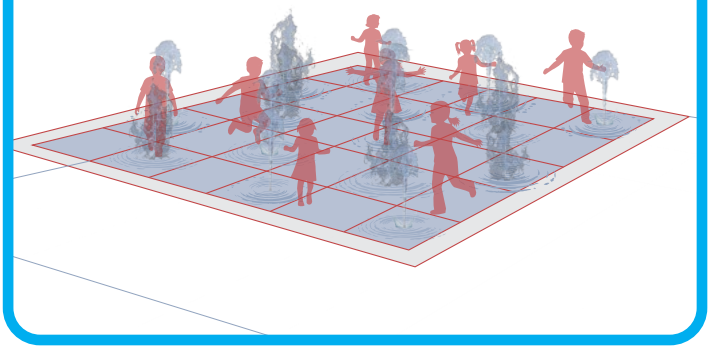


INSTALLATION CHECKLIST

- ☐ Select an appropriate water feature type based on available space, maintenance needs, and intended public use
- ☐ Verify access to water supply, drainage, electrical connections, and underground utilities before installation
- ☐ Install proper drainage systems to prevent standing water, overspray, or slip hazards near sidewalks and entrances
- ☐ Coordinate pumps, plumbing, filtration, and backflow prevention systems during installation
- ☐ Include nearby shade, seating, or permeable surfaces to improve thermal comfort and usability
- ☐ Plan for long-term operations and maintenance responsibility, including maintaining access routes for cleaning and winterization
- ☐ Establish a water quality monitoring and disinfection plan to control microbial growth

PRINCIPLES: COST: $$$$ BENEFITS:

Splash Pad

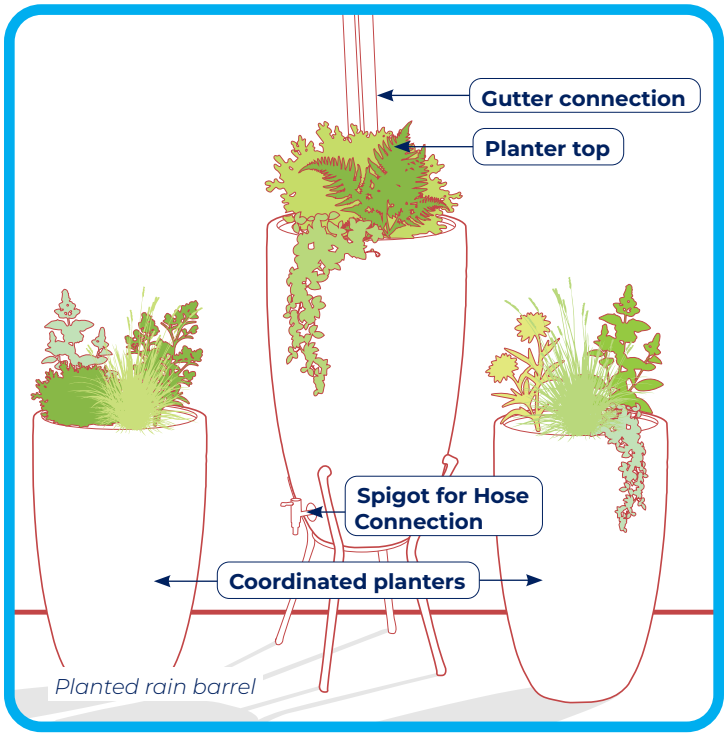


MAINTENANCE GUIDE

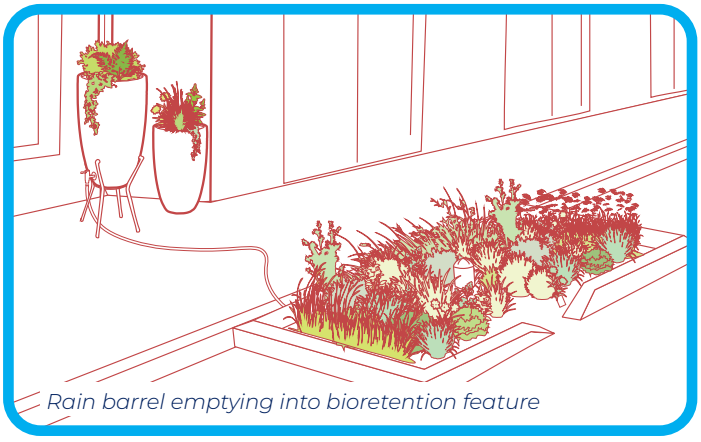
Installation	After Storm	Seasonally	Annually
Test pumps, plumbing, spray systems, drainage, and controls after installation to confirm proper operation and water flow	Remove debris, inspect pumps and drainage systems, and verify water features remain functional and safe from public use	Clean nozzles, filters, drains, and water basins and inspect for debris, algae buildup, leaks, or standing water	Inspect plumbing, electrical system, pumps, waterproofing, and winterization components before and after seasonal operation

RAIN BARRELS

Rain barrels can meaningfully reduce household water use, especially in summer when demand peaks. Rain barrels connect to individual downspouts and hold modest volumes (50–100 gallons), releasing water by gravity for uses like irrigation. While easy to install, their limited capacity means they provide only modest reductions in stormwater runoff unless they are frequently emptied between rainfall events. Rain barrels can contribute to stormwater management benefits when properly designed, including overflow routing to infiltration features like rain gardens or dry wells. Their effectiveness depends on adequate sizing, year-round operation considerations (such as freezing protection), and ensuring timely drawdown to maintain storage capacity and reduce peak runoff.[15] Rain barrels can be routed to empty into bioretention features, to recharge overflow capacity.



Planted rain barrel


Rain barrel emptying into bioretention feature

INSTALLATION CHECKLIST

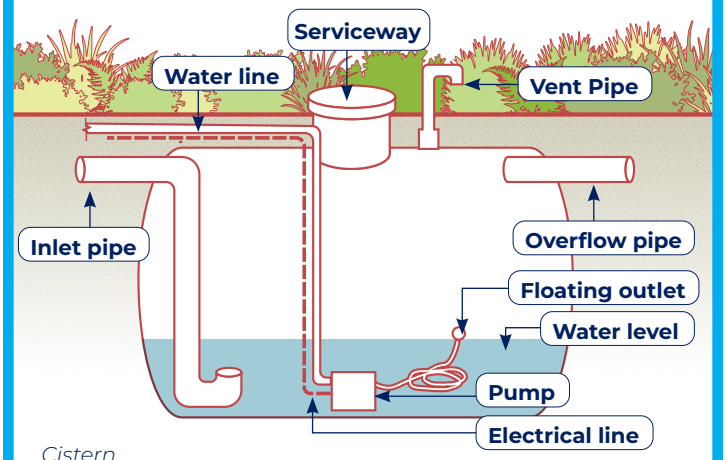
- ☐ Select a location directly beneath or near an existing roof downspout
- ☐ Elevate the barrel slightly on blocks or a stand to improve water pressure and hose access
- ☐ Install an inlet screen or filter to prevent leaves, debris, and mosquitoes from entering the system
- ☐ Verify overflow outlets direct excess water away from foundations, sidewalks, neighboring properties, or building entrances
- ☐ Secure the barrel and connections to prevent tipping, leaking, or disconnection during storms

MAINTENANCE GUIDE

Installation	After Storm	Seasonally	Annually
Inspect barrel connections, downspouts, inlet screens, and overflow outlets after installations to confirm water flows properly and does not leak	Remove leaves or debris from inlet screens, check overflow pathways, and verify the barrel remains stable and securely connected after heavy rainfall or wind events	Clean gutters, downspouts, screens, and filters regularly to prevent clogging and mosquito buildup	Drain and disconnect the system before winter to prevent freezing damage Inspect the barrel structure, supports, overflow routing, and surrounding infiltration for long-term wear or damage

CISTERNS

Cistern systems capture roof runoff and store it in above- or below-ground tanks for delayed release or non-potable reuse such as irrigation, toilet flushing, or cooling support. Compared to rain barrels, cisterns provide significantly larger storage capacity and can be integrated into building-scale or site-scale stormwater management strategies. Systems are typically paired with filtration, pumps, and controlled overflow to connect storage to landscape or stormwater infrastructure.



Cistern

INSTALLATION CHECKLIST

- ☐ Select location with direct connection to roof leaders or stormwater conveyance system
- ☐ Confirm available space and subsurface conditions for above- or below-ground installation
- ☐ Use a qualified professional to provide stable foundation or excavation base appropriate to cistern type and load conditions
- ☐ Route overflow safely away from buildings, pedestrian areas, and adjacent properties
- ☐ Coordinate utility clearances prior to excavation and installation
- ☐ Secure all fittings and access points to prevent leakage and system failure during storm events

Cisterns are most effective where roof area is substantial, seasonal rainfall patterns create peak runoff events, and there is a consistent on-site demand for non-potable water. Cisterns use pumps for pressurized distribution and can be configured for slow, continuous release to infiltration systems, preserving storage capacity for the next storm. They can be used as standalone systems or integrated into broader stormwater networks including infiltration areas, bioswales, or detention systems. The Massachusetts Stormwater Handbook handbook emphasizes that cisterns should be designed to allow timely drainage, in order to maintain storage capacity for subsequent storm events.[15]

MAINTENANCE GUIDE

Installation	After Storm	Seasonally	Annually
Install inlet filtration, such as leaf screens, debris filters, and/or first-flush diversion, to reduce sediment and organic buildup	Check cistern stability, check overflow pathways, and ensure no erosion or pooling occurs around discharge points	Clean filters and pretreatment devices. Inspect pump systems and controls Confirm freeze protection systems are operational before winter.	Drain and inspect cistern interior for sediment buildup Test pump and distribution system Inspect structural integrity, seals, and connections

HEAT & STORMWATER STRATEGIES

Industrial Sites



Industrial properties often have unique characteristics that influence stormwater management and urban heat, including large roof areas, extensive paved surfaces, outdoor storage yards, and transportation infrastructure. These site features can generate significant volumes of runoff during storm events while also contributing to elevated surface temperatures and heat exposure for workers. At the same time, these sites can support strategies that reduce runoff, improve water quality, and mitigate urban heat. Site constraints such as active operations, heavy vehicle traffic, and contaminated soils may influence the design and placement of these measures, but do not preclude the implementation of effective resilience strategies. However, infiltration, excavation, and planting in potentially contaminated areas may require environmental review and should avoid mobilizing contaminants.

Many industrial properties along Chelsea Creek are located within the Designated Port Area (DPA) and may be subject to additional waterfront regulations and permitting requirements. The strategies presented in this section are intended to support resilience while maintaining existing industrial operations and compatible waterfront uses. They are not intended to facilitate changes in land use or DPA-supported uses. Additional information on the DPA, Chapter 91, and waterfront regulatory considerations is provided in Chapter 3. ***For more information, visit:***

Massachusetts Waterways Regulation (Chapter 91):

310 CMR 9.00: Massachusetts Waterways Regulation

Massachusetts Designated Port Areas Program:

Massachusetts Designated Port Areas

The following highlights stormwater and heat mitigation strategies that may be particularly applicable to industrial properties while remaining compatible with ongoing industrial operations and the working waterfront character of Chelsea Creek.

PLANTED STRATEGIES

Existing operations, vehicle circulation, underground utilities, contaminated soils, and material storage needs may influence the location and design of planted areas.

Consider strategies that can be integrated into site edges, buffers, setbacks, enhanced tree pits, or underutilized portions of the site while maintaining operational access.

POTENTIAL APPLICATIONS:

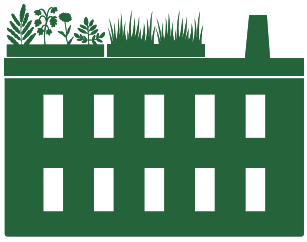
- Landscape buffers along site edges
- Enhanced tree pits near parking areas
- Perimeter tree plantings
- Planted stormwater features in underutilized portions of the site

RESOURCES:

U.S. EPA, Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites

U.S. EPA, Design Principles for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas

MA CZM, Landscaping to Protect Your Coastal Property from Storm Damage and Flooding



ROOFTOP STRATEGIES

Large industrial rooftops often represent one of the greatest opportunities for resilience improvements. Cool roofs, blue roofs, and green roofs can reduce runoff, lower roof temperatures, and improve building performance without affecting ground-level operations.

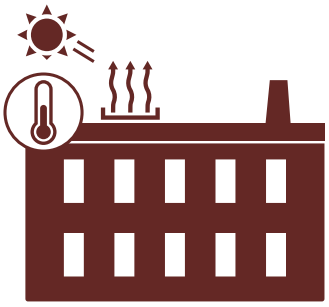
Structural capacity, rooftop equipment, maintenance access, and operational continuity should be evaluated in selecting rooftop strategies.

POTENTIAL APPLICATIONS:

- Cool roofs on warehouses
- Blue roofs on large industrial buildings
- Green roofs on office or administrative portions of industrial facilities.

RESOURCES:

Massachusetts Clean Water Toolkit, Rooftop Detention (Blue Roofs)



SURFACE STRATEGIES

Surface strategies should be designed to accommodate heavy vehicle loads, freight movement, fueling areas, and industrial operations.

Permeable pavement may be most appropriate in parking areas, pedestrian zones, or other low traffic areas and should generally be avoided in fueling, loading, hazardous material storage, or high-spill-risk areas unless specifically designed with environmental controls.

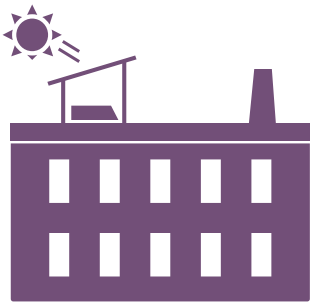
POTENTIAL APPLICATIONS:

- Employee parking areas
- Pedestrian walkways
- Overflow parking areas
- Other low-traffic locations

RESOURCES:

U.S. EPA, Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites

Massachusetts Clean Water Toolkit, Porous Pavement



SHADING STRATEGIES

Shade strategies can improve worker comfort and reduce heat exposure in loading areas, parking lots, outdoor workspaces, pedestrian routes, and employee gathering areas.

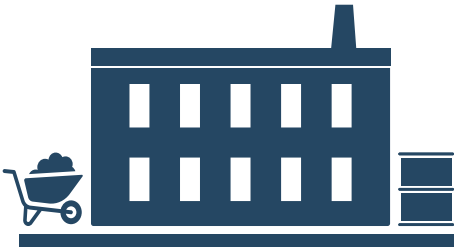
Shade structures should maintain adequate clearances for vehicles and equipment and may provide additional benefits when combined with solar canopies.

POTENTIAL APPLICATIONS

- Solar canopies over employee parking lots
- Shaded break areas
- Shaded pedestrian connections
- Shaded employee gathering spaces

RESOURCES:

City of Scottsdale, AZ, Shade Structure Guidelines



SITE FEATURES

Site features such as rainwater harvesting systems, stormwater storage tanks, and living walls, among others, can provide multiple resilience benefits while supporting site operations.

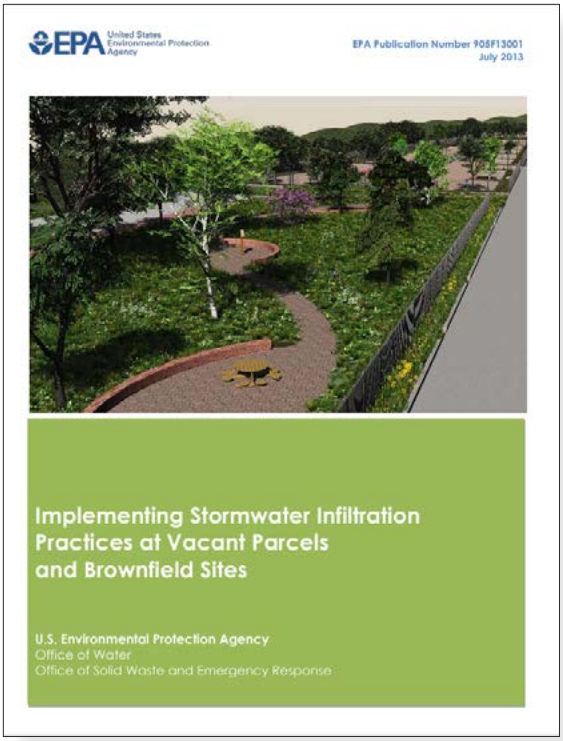
Facilities should consider maintenance requirements, utility conflicts, available space, and compatibility with industrial activities when selecting site features.

POTENTIAL APPLICATIONS:

- Rainwater harvesting systems that provide water for irrigation, equipment washing, or other non-potable uses
- Underground stormwater storage located beneath parking lots
- Cisterns integrated into building or site infrastructure
- Living walls on office or administrative portions of industrial facilities

RESOURCES:

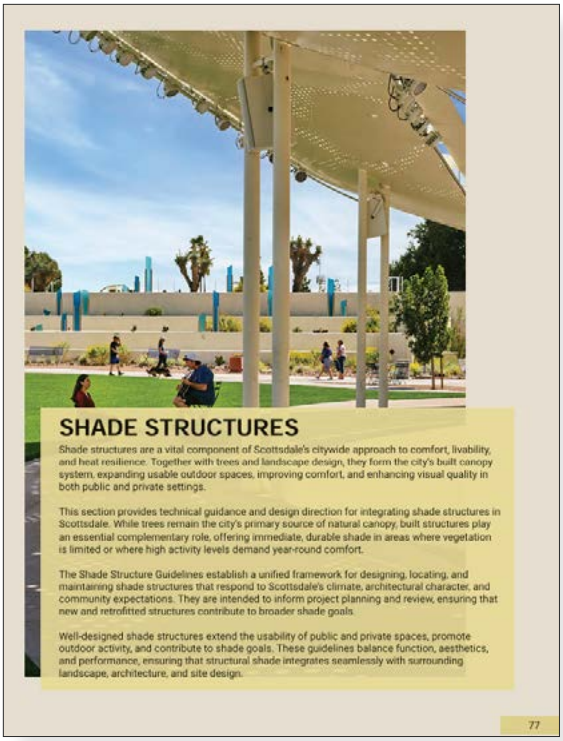
NYC Planning, Resilient Industry Mitigation and Preparedness in the City's Industrial Floodplain



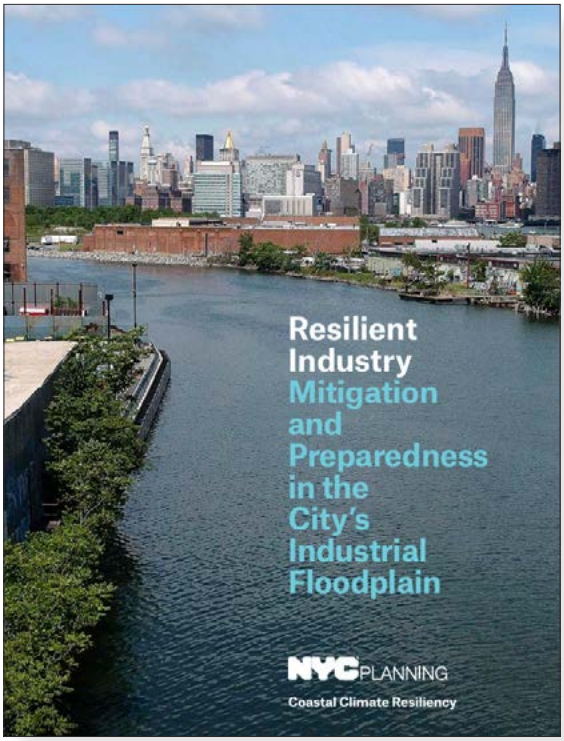
US EPA
Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites



US EPA
Design Principles for Stormwater Mg'mt on Compacted, Contaminated Soils in Dense Urban Areas



City of Scottsdale, Arizona
Shade Structure Guidelines



NYCPlanning
Resilient Industry: Mitigation and Preparedness in the City's Industrial Floodplain

HEAT & STORMWATER STRATEGIES

Historic Buildings



Historic properties often contain architectural features, mature landscapes, and site characteristics that contribute to both their historic significance and their resilience. At the same time, older buildings and sites may be more vulnerable to extreme heat, flooding, and changing climate conditions due to aging infrastructure or development patterns established before modern stormwater management practices.

Climate adaptation and historic preservation should be viewed as complementary goals. Thoughtfully designed stormwater and heat mitigation strategies can help extend the lifespan of historic buildings and landscapes and support the long-term stewardship of historic resources. Many resilience measures can be incorporated in ways that preserve character-defining features, maintain historic site relationships, and remain compatible with the architectural character of the property.

When evaluating stormwater and heat mitigation measures, property owners should consider both the resilience benefits of a strategy and its potential effects on historic buildings and cultural resources.

The following considerations highlight approaches that can help improve resilience while respecting the character and significance of Chelsea's historic buildings and neighborhoods.

PLANTED STRATEGIES

Tree preservation should generally be prioritized where feasible, as mature trees often contribute to both historic character and heat mitigation. New planting areas, rain gardens, and bioretention features should be integrated into existing landscape areas whenever possible and designed to avoid impacts to significant trees, historic walkways, stone walls, fences, courtyards, and other character-defining site features.

POTENTIAL APPLICATIONS:

- Preservation of mature trees
- Restoration of historic landscape features
- Landscape improvements that reinforce historic site patterns

RESOURCES:

National Park Service, Climate Change and Cultural Landscapes

Resilient Guidelines for Charleston, South Carolina: Landscaping Improvements



ROOFTOP STRATEGIES

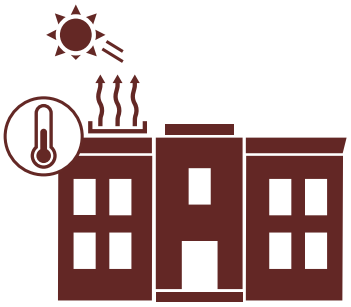
Cool roofs, green roofs, and blue roofs may be appropriate where they have limited visibility from public streets and do not alter significant roof forms, materials, cornices, chimneys, dormers, or other character-defining architectural features. For highly visible roofs, property owners should consider whether alternative materials or less visible resilience measures may achieve similar benefits while preserving historic character. These may be most appropriate on rooftops of additions to historic buildings or rear roof areas where visibility is limited and historic architectural features can be preserved.

POTENTIAL APPLICATIONS:

- Cool roofs, green roofs, and blue roofs on portions of buildings or new additions with limited visibility from public streets
- Rooftop resilience measures incorporated without altering significant roof forms or architectural features

RESOURCES:

National Park Service, Green Roofs on Historic Buildings



SURFACE STRATEGIES

Permeable paving should be designed to respect the historic character of existing site surfaces. Where historic paving materials are present, property owners should consider opportunities to preserve, repair, or reuse the same materials, or select permeable alternatives that are compatible in appearance, scale, color, texture, and pattern. New paving should complement the historic character of courtyards, walkways, driveways, and other site features while improving drainage and reducing runoff.

POTENTIAL APPLICATIONS:

- Permeable walkways, courtyards, and driveways that maintain the appearance of historic paving through the use of compatible materials, colors, textures, and patterns.

RESOURCES:

National Park Service, Climate Change and Cultural Landscapes

Nantucket Resilient Design Guidelines for Natural Features

Resilient Guidelines for Charleston, South Carolina: Landscaping Improvements



SHADING STRATEGIES

Shade structures, awnings, trellises, pergolas, and other cooling features should complement the architectural style, scale, materials, and detailing of historic buildings. New shade features should be compatible with the character of the property and integrated into overall building design, rather than appearing as standalone additions. Where feasible, shade structures should draw from historic architectural precedents and avoid obscuring significant façades, entrances, storefronts, windows, or decorative architectural features.

POTENTIAL APPLICATIONS

- Awnings, pergolas or trellises in gardens and courtyards that match the historic appearance of the building façade.

RESOURCES:

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings



SITE FEATURES

Rain barrels, stormwater storage systems, and other site features should be thoughtfully integrated into the property to minimize impacts on character-defining features. Where feasible, stormwater storage infrastructure should be located below grade or in less prominent areas, such as side yards or rear yards, among others. New site features should be designed to preserve the historic appearance of the site while providing resilience benefits.

POTENTIAL APPLICATIONS:

- Rain barrels located in rear yards
- Underground stormwater storage beneath courtyards or parking areas
- Living walls or other green infrastructure located in areas with limited visibility from public streets

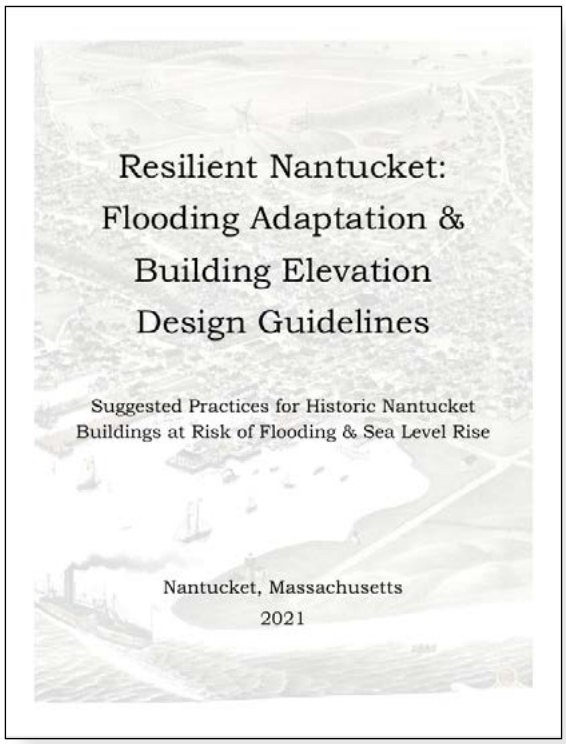
RESOURCES:

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings

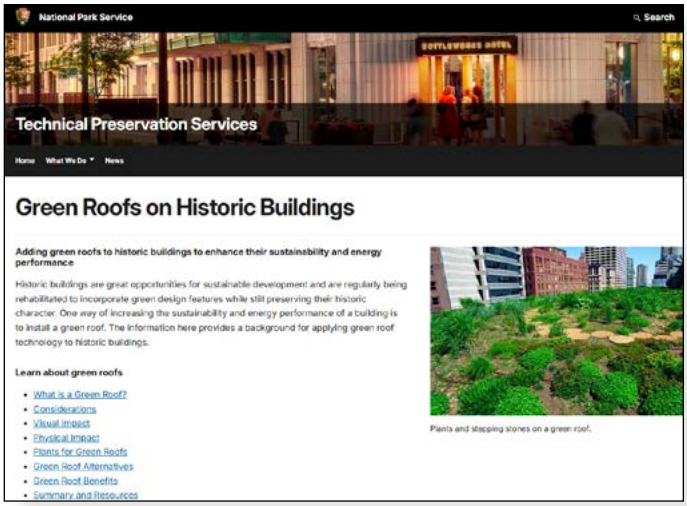
Resilient Guidelines for Charleston, South Carolina: Landscaping Improvements



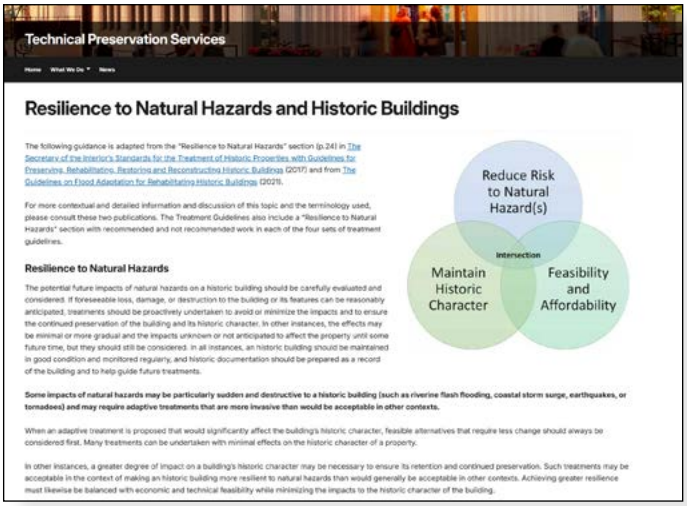
US Secretary of the Interior
Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings



Nantucket, Massachusetts
Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines



National Park Service
Green Roofs on Historic Buildings



National Park Service
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Coastal Resilience Strategies



Photo Source:
From Chelsea to Boston by Isaac Subillaga



ELEVATED BUILDINGS

Elevating structures is one of the most effective ways to reduce flood risk and protect buildings from repetitive flood damage. FEMA identifies several elevation approaches depending on a building's foundation type, structural system, flood zone, and desired level of protection. Required elevation is typically determined by the Base Flood Elevation (BFE) and local floodplain regulations, incorporating locally required or project-specific freeboard.[1]

Looking for more guidance?

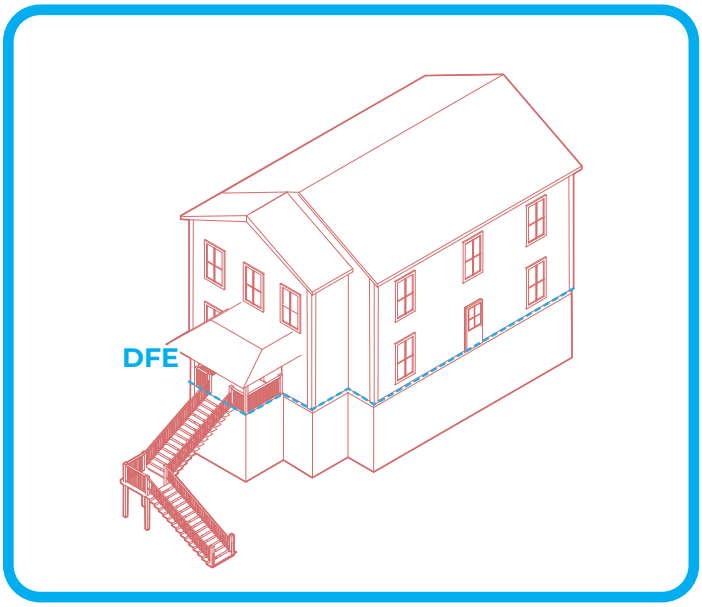
ASCE 24-24, Flood Resistant Design and Construction, provides guidance on elevating new and existing buildings in flood-prone areas to reduce future flood risk and damage

KEY CONSIDERATIONS

- ☐ Use applicable future sea level rise projections, flood data, code requirements, and local freeboard standards when setting elevations
- ☐ Coordinate with access, utilities, and operations
- ☐ Manage impacts to adjacent properties and flood storage
- ☐ Integrate with stormwater and hazardous material containment

COST: $$$$ **BENEFITS:**

Extended Foundation Walls: The existing structure if lifted using hydraulic jacks and extends the foundation walls upward beneath the home



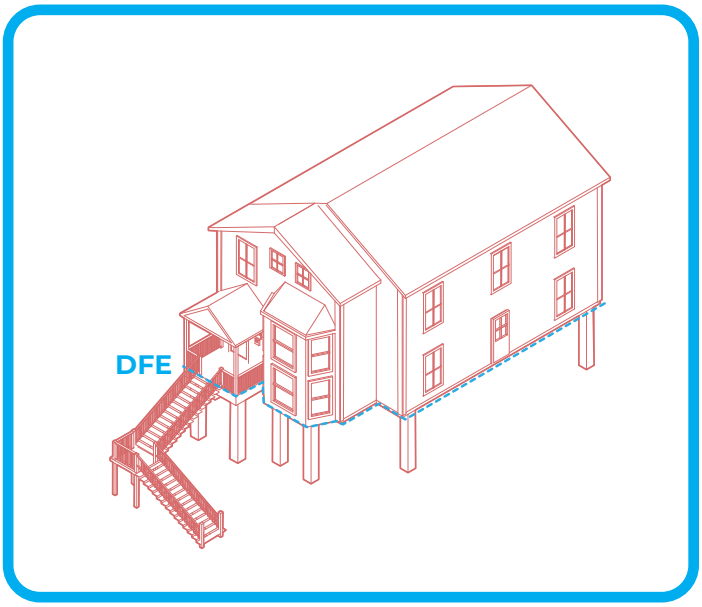
Best suited for: Woodframe or masonry homes, basement and crawlspace foundations, and sites with moderate elevation increases.

Considerations:

- ☐ Existing foundations may need reinforcement
- ☐ Flood openings are typically required to equalize water pressure
- ☐ Basements below flood elevation may need to be filled or abandoned

COST: $$$$ **BENEFITS:**

Open Foundations: Homes can also be elevated on piers, posts, columns, or pilings that allow floodwaters to pass beneath the structure

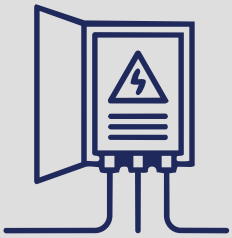


Best suited for: Coastal flood zones, high-risk flood and wave action areas, or sites with larger elevation increases.

Considerations:

- ☐ Open foundations reduce obstruction to floodwaters
- ☐ Structural connections must resist lateral flood and wind forces
- ☐ Elevated access, parking, and utilities require careful integration

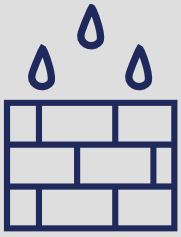
COMMON ELEMENTS FOR ALL ELEVATION STRATEGIES[2]



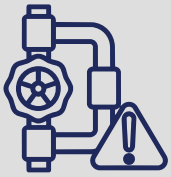
Elevate critical systems above the DFE



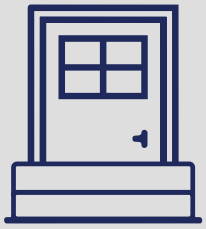
Design drainage to prevent floodwater intrusion



Use flood-resistant materials at lower levels



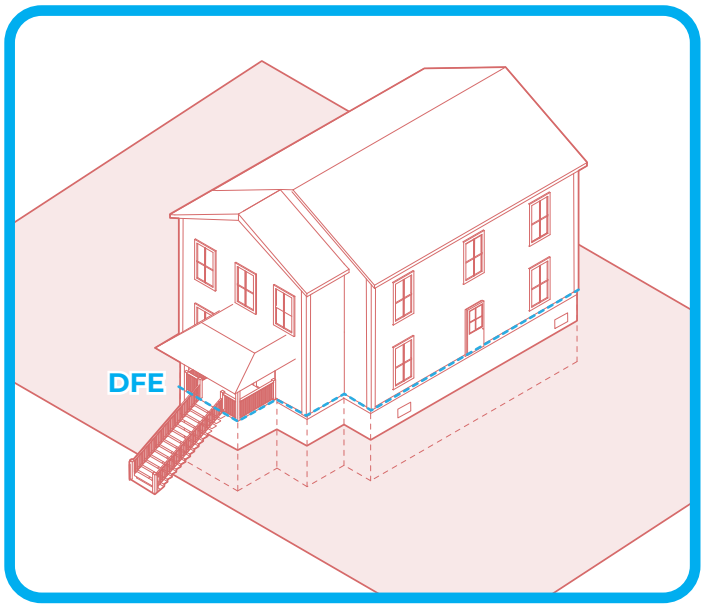
Install backflow preventers and seal utility penetrations



Provide deployable or permanent flood barriers where needed

COST: $$$$ **BENEFITS:**

Abandoning the Lower Level: The lowest enclosed area remains below flood elevation and is converted to storage or access space, adapted to withstand periodic flooding, while occupiable areas are relocated above.



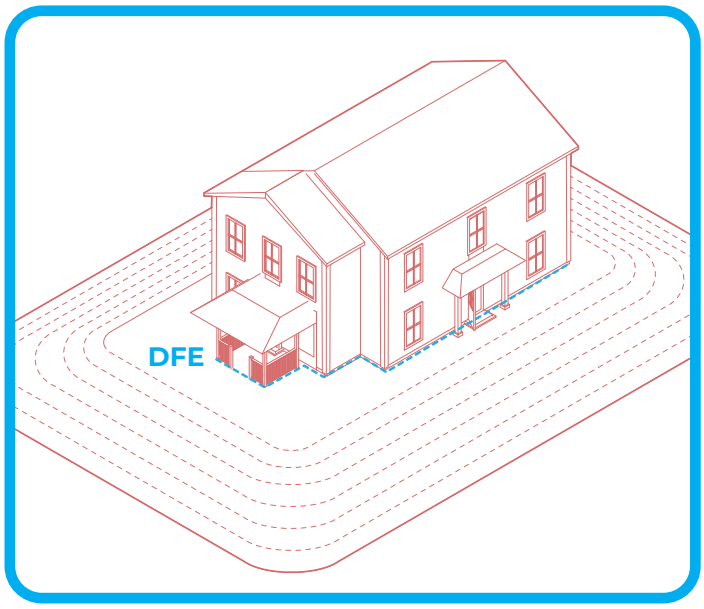
Best suited for: Masonry structures with existing upper floors, or homes where full elevation is impractical

Considerations:

- ☐ Lower levels cannot remain habitable under floodplain regulations
- ☐ Remove vulnerable finishes and relocate utilities above flood levels
- ☐ Typically paired with wet floodproofing strategies to minimize damage when floodwaters enter the space

COST: $$$$ **BENEFITS:**

Engineered Fill (Raised Grade): The building pad or surrounding site grade is raised using engineered fill. Compacted soil is placed around and beneath the structure to elevate the lowest floor above the DFE.



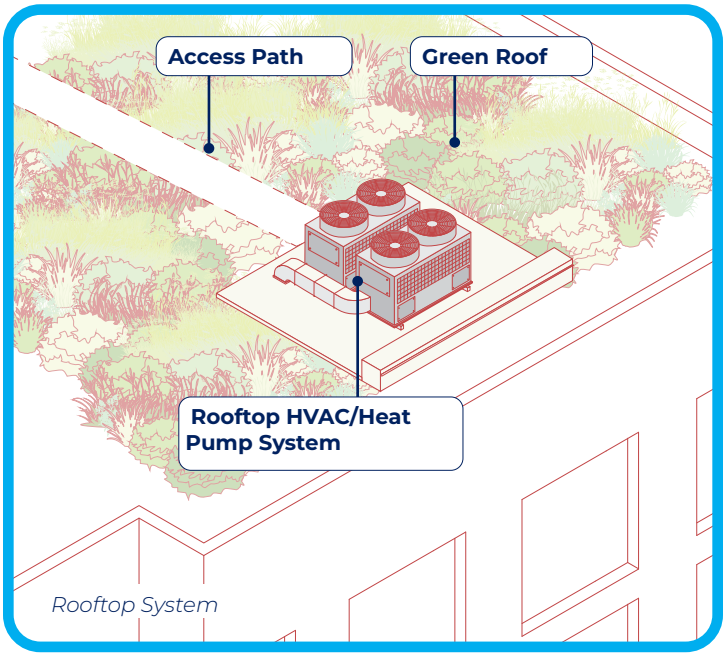
Best suited for: Shallow flood conditions, sites with adequate space for grading and side slopes, and homes requiring modest elevation increases.

Considerations:

- ☐ Raising grade can alter drainage patterns and potentially increase flooding impacts on adjacent properties
- ☐ In many floodways and coastal high hazard areas, the placement of fill is restricted or prohibited

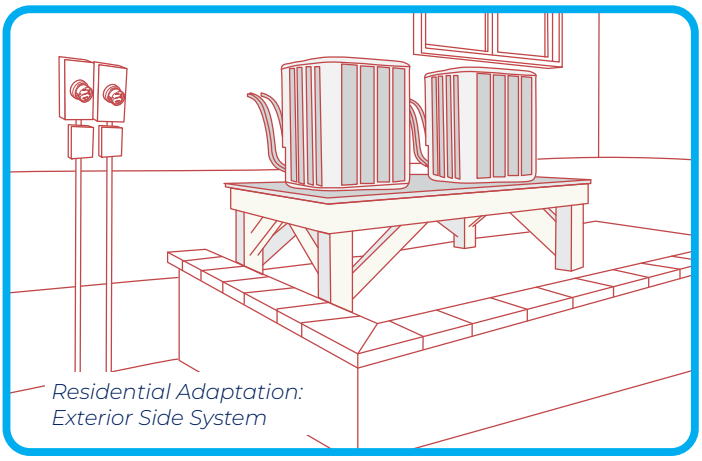
ELEVATED UTILITIES

In coastal and high-risk flood zones, mechanical utility systems should be designed to remain secure and operational during flooding and high winds. Because many secondary electrical components are not designed for submersion, even shallow flooding can lead to system-wide damage, requiring extensive inspection, replacement, and delaying safe reoccupation of the building. This typically involves elevating equipment above expected flood levels, anchoring it to the building structure, and ensuring it can withstand storm surge, wave action, and wind forces.[3] Exterior elevated equipment must comply with manufacturer requirements, utility company requirements, wind anchorage, service access, noise/setback, fire, electrical, and mechanical code requirements.



Rooftop System

COST: $$$$ BENEFITS:


Residential Adaptation: Exterior Side System

INSTALLATION CHECKLIST

- ☐ Use corrosion-resistant materials, connectors, and fasteners for exterior or exposed components
- ☐ Anchor platforms and pedestals securely to the main structure
- ☐ Anchor HVAC equipment to resist storm surge, wave, and wind forces
- ☐ Provide flexible connections (conduit, cables, piping, ductwork) where permitted
- ☐ Elevate equipment above the flood protection level where possible
- ☐ Consider suspending systems from elevated framing or raising structural elements[2]
- ☐ Relocate equipment to higher floors if elevation in place is not feasible
- ☐ Provide safe and continuous egress for maintenance access

MAINTENANCE GUIDE

Periodic

- Inspect elevated equipment for stability, corrosion and anchorage
- Verify access to meters remains unobstructed for utility service
- Confirm platforms or wall mounts remain fastened

Seasonal

- Clear drainage pathways around exterior platforms
- Inspect venting and exhaust systems for obstruction
- Protect and seal electrical wiring within conduit

After Storm

- Inspect for damage, water intrusion, or debris
- Replace any ductwork, wiring, or components inundated by floodwater
- Determine integrity of fuel tanks, shutoff valves, and connections before restoring service

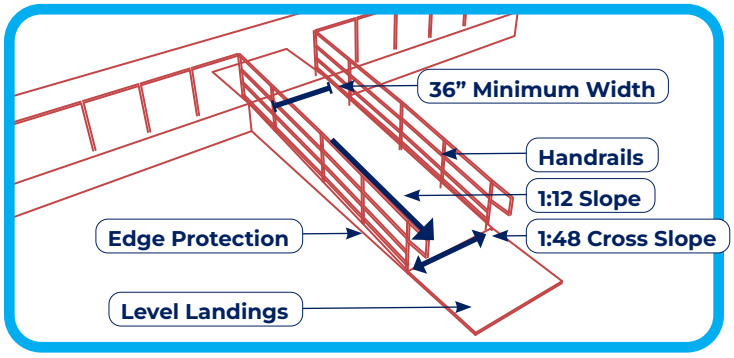
Annually

- Conduct professional inspection of HVAC and boiler systems
- Update or replace worn fittings or valves to maintain rapid disconnect capability

ACCESSIBLE EGRESS

An access ramp provides a sloped route into a building, often used when stairs, raised entries, or elevated first floors limit access. In flood-prone areas, ramps can help maintain accessible entry and egress when buildings are elevated, retrofitted, or redesigned to reduce flood damage. FEMA identifies elevation as a common flood retrofit approach, and elevated buildings still need safe access routes for residents, visitors, and emergency use.[2] Accessible ramp design should follow federal accessibility standards, including limits on slope, landing requirements, handrails, and stable walking surfaces. The U.S. Access Board notes that ramps are used where accessible routes have changes in level greater than allowed for walking surfaces.[5]





INSTALLATION CHECKLIST

- ☐ Verify adequate space for required slopes and landings
- ☐ Use slip-resistant, durable, and flood-resistant materials
- ☐ For slope and handrails, maintain ADA- and Massachusetts Architectural Access Board requirements where applicable
- ☐ Anchor ramps, railings, and elevated landings securely to the structure
- ☐ Avoid water ponding near ramp entries
- ☐ Avoid blocking sidewalks, emergency access, or required egress paths

TYPES TO CONSIDER:

- Straight Ramp
- Switchback Ramp
- Side-Yard Ramp
- Integrated Elevated Entry System
- Modular Aluminum Ramp

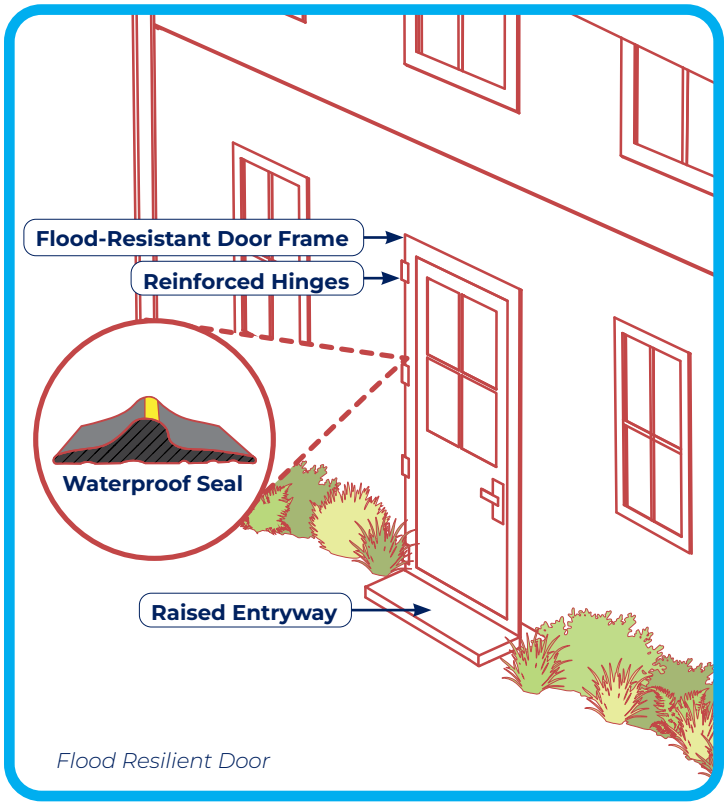
MAINTENANCE GUIDE

Installation	Monthly	Annually
Confirm ramp surface is stable, firm, and slip resistant Check that handrails, landings, and transitions are secure and clear	Remove leaves, debris, snow, ice Check for ponding water at the base of the ramp	Inspect for settlement, rot, corrosion, cracking, or loose connections Check drainage around ramp and entrance

Maintenance is usually the responsibility of the property owner or building maintenance crew. For multifamily, commercial, or public buildings, maintenance should be included in the property’s regular accessibility and safety inspection routine.

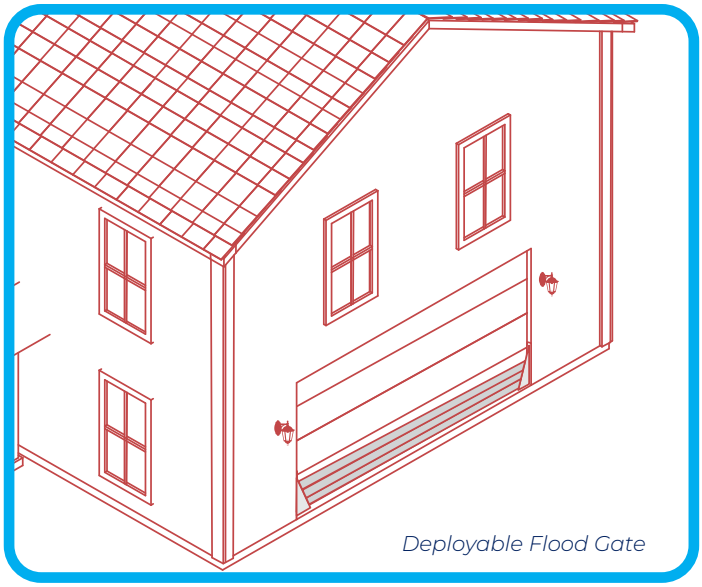
RESILIENT ENTRANCES

Resilient entrances are building entry systems designed to better withstand flooding, storm surge, and water intrusion during extreme weather events. These may include elevated entries, flood-resistant doors, reinforced frames, flood barriers, waterproof seals, raised thresholds, and durable flood-resistant materials. FEMA recommends protecting vulnerable building openings because doors and entry points are common locations for floodwater intrusion and structural damage during storms.[2] Resilient entrances are often paired with wet or dry floodproofing strategies, which may include deployable flood shields, elevated landings, flood-resistant materials, and accessible egress routes that maintain safe building access during flood events.[2]



Flood Resilient Door

COST: $$$$ BENEFITS:


Deployable Flood Gate

INSTALLATION CHECKLIST

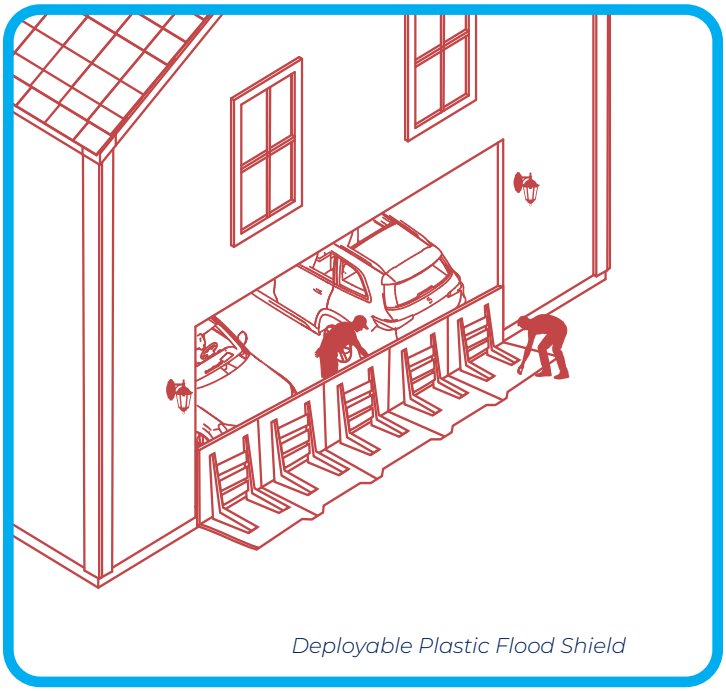
- ☐ Evaluate existing doorway elevations, flood exposure, drainage conditions, and accessibility needs before retrofit
- ☐ Verify ADA accessibility, emergency egress, and sidewalk clearance requirements are maintained[5]
- ☐ Install flood-resistant materials, corrosion-resistant hardware, and waterproof seal systems at vulnerable openings
- ☐ Coordinate grading, drainage improvements, and threshold elevations to reduce water intrusion near entrances
- ☐ Test deployable barriers, seals, and door systems before storm events to confirm proper operation

MAINTENANCE GUIDE

Installation	Before Storm	Annually
Inspect thresholds, seals, hinges, barriers, and drainage systems after installation to confirm watertight connections and proper operation	Deploy temporary flood barriers, inspect seals and hardware, and clear nearby drains or entry areas of debris	Inspect entrances for corrosion, water damage, seal deterioration, or structural movement and replace damage components as needed

DRY FLOODPROOFING

Dry floodproofing is a flood protection strategy that prevents floodwater from entering a building by sealing walls, doors, windows, and other openings. FEMA explains that dry floodproofing systems may include flood shields, flood barriers, reinforced walls, waterproof coatings, sealants, pumps, backflow preventers, and deployable barriers designed to resist flood forces and keep water out of enclosed spaces.[2]

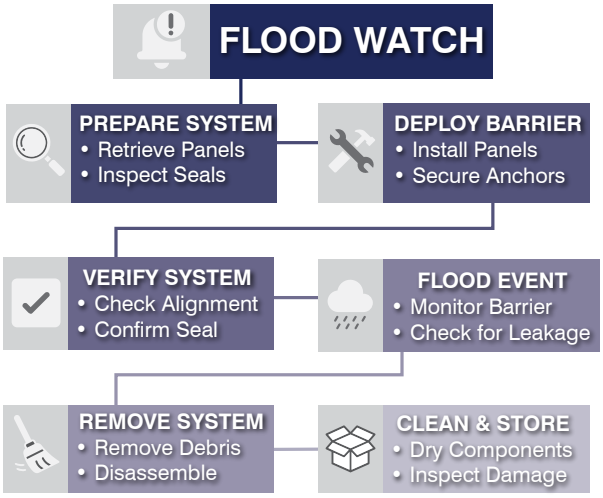


Deployable Plastic Flood Shield

INSTALLATION CHECKLIST

- ☐ Evaluate flood depth, building condition, and expected flood duration before selecting dry floodproofing systems
- ☐ Have a qualified professional determine that walls and foundations can withstand hydrostatic flood pressure or identify areas needing reinforcement[6]
- ☐ Identify vulnerable openings including doors, windows, utility penetrations, vents, and garage entrances
- ☐ Install flood shields, waterproof coatings, sealants, pumps, or deployable barriers at critical entry points
- ☐ Coordinate backflow preventers, drainage systems, and sump pumps to reduce internal flooding risks
- ☐ Maintain ADA access, emergency egress, and required building access during floodproofing installation
- ☐ Test deployable systems, pumps, seals, and alarms before flood events to confirm proper operation

Dry floodproofing is most commonly used for commercial buildings, mixed-use buildings, utility spaces, and critical infrastructure. Dry floodproofing is generally not an acceptable compliance strategy for new or substantially improved residential buildings in Special Flood Hazard Areas.[7]

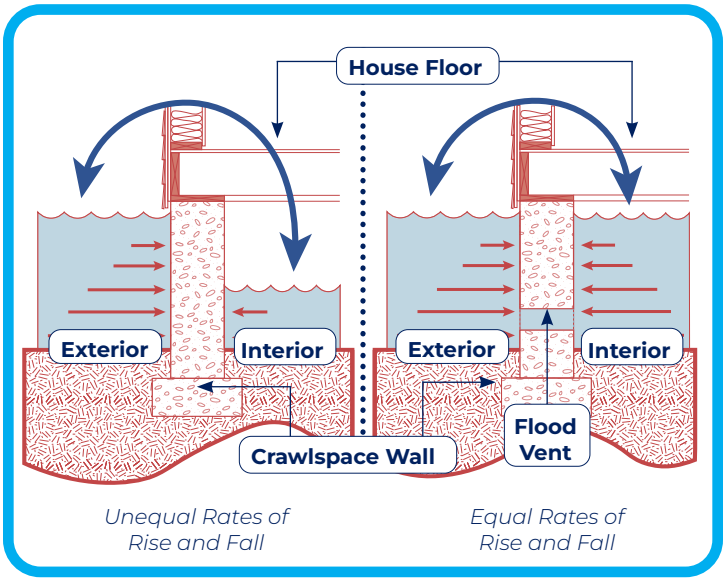


MAINTENANCE GUIDE

Installation	Before Storm	After Storm	Annually
Inspect waterproofing systems, anchors, pumps, seals, and deployable barriers after installation to confirm watertight performance	Deploy flood barriers, inspect seals and closures, and test pumps, alarms, and backflow systems before anticipated flooding	Inspect for leaks, structural damage, corrosion, or water intrusion, cleaning/ repairing as needed Store components, when appropriate	Test deployable barriers, service pumps and backflow preventers, and inspect coatings, structural supports, and waterproofing systems

WET FLOODPROOFING

Wet floodproofing is a retrofit strategy that intentionally allows floodwater to enter enclosed portions of a building to reduce pressure on walls, floors, and foundations during flooding. Wet-floodproofed areas below flood elevation are generally limited to parking, access, storage, and similar low-damage uses—not habitable space. FEMA explains that wet floodproofing relies on using flood-resistant materials, relocating utilities, and installing flood openings or vents that allow water to automatically enter and exit enclosed spaces. This strategy is commonly used in crawlspaces, garages, and enclosed lower levels below elevated buildings.[2]



SUITABLE FOR:

- Basements, crawlspaces, garages, and enclosed lower levels below flood elevation
- Buildings where enclosed lower areas are used for parking, storage, or access rather than living space
- Buildings with flood vents/ openings that can remain unobstructed during flooding

FEMA Definition:

"The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a building, which is intentionally allowed to flood. Usually, only enclosed areas used for parking, building access, or storage are wet floodproofed."[2]

INSTALLATION CHECKLIST

- ☐ Confirm enclosed lower levels are appropriate for wet floodproofing (not finished living space)
- ☐ Install flood openings/vents on multiple walls where required
- ☐ Use flood-resistant materials and finishes below flood elevation
- ☐ Elevate utilities and mechanical systems above flood elevation
- ☐ Improve drainage and grading around the building perimeter
- ☐ Inspect foundation walls and lower-level structural conditions
- ☐ Coordinate retrofit work with local permitting and FEMA/NFIP requirements[8]

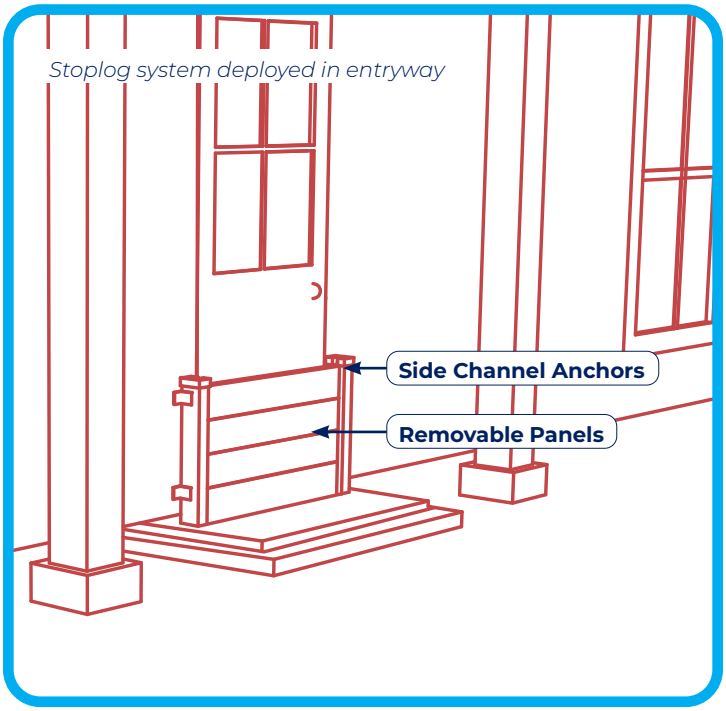
MAINTENANCE GUIDE

Installation	After Storm	Seasonally	Annually
Confirm flood vents remain unobstructed	Remove Debris	Inspect vents, coatings, and seals	Review floodproofing systems
Inspect flood-resistant materials and finishes	Inspect for water damage	Check utilities and connections for corrosion	Inspect for mold, cracking, or material degradation
	Check vents and drainage pathways		

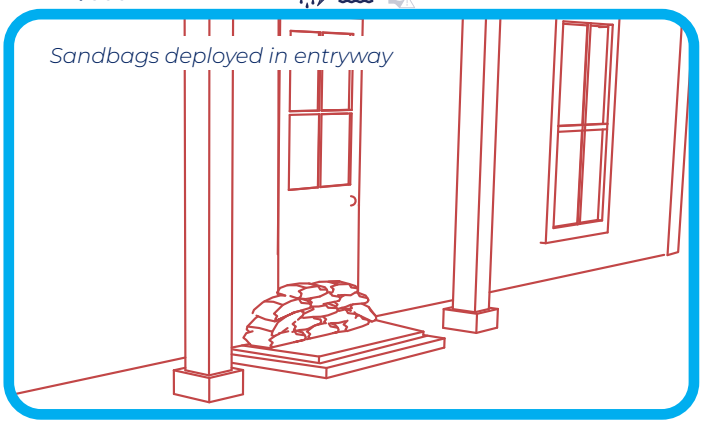
Maintenance is usually the responsibility of the property owner or building maintenance crew. For multifamily, commercial, or public buildings, maintenance should be included in the property's regular accessibility and safety inspection routine.

FLOOD BARRIERS

Flood barriers are temporary or permanent systems designed to prevent or reduce floodwater from entering buildings, streets, infrastructure, or sites during storm events. These systems may include stop logs, deployable flood panels, flood shields, inflatable barriers, water-filled barriers, or temporary sandbag systems. FEMA identifies flood barriers as a dry floodproofing strategy commonly used to protect building openings such as doors, loading docks, garage entrances, and utility penetrations.[2] deployable barriers require a written O&M/deployment plan, responsible personnel, storage location, triggers, training, inspection, and post-storm cleaning



COST: $$$$ BENEFITS:



TYPES TO CONSIDER:

- Stop Logs
- Inflatable Barriers
- Plastic Barriers
- Sandbags

INSTALLATION CHECKLIST

- ☐ Identify doors, garage openings, utility penetrations, and low-entry points needing protection
- ☐ Select the appropriate barrier type based on flood depth, space, and deployment needs[8]
- ☐ Install side channels, anchors, or mounting hardware securely to walls or foundations
- ☐ Verify seals, gaskets, and panels create a watertight connection
- ☐ Maintain ADA access, emergency egress, and sidewalk clearance where required
- ☐ Provide accessible storage space for removable barriers, stop logs, or panels
- ☐ Test deployment procedures and inspect systems before flood events

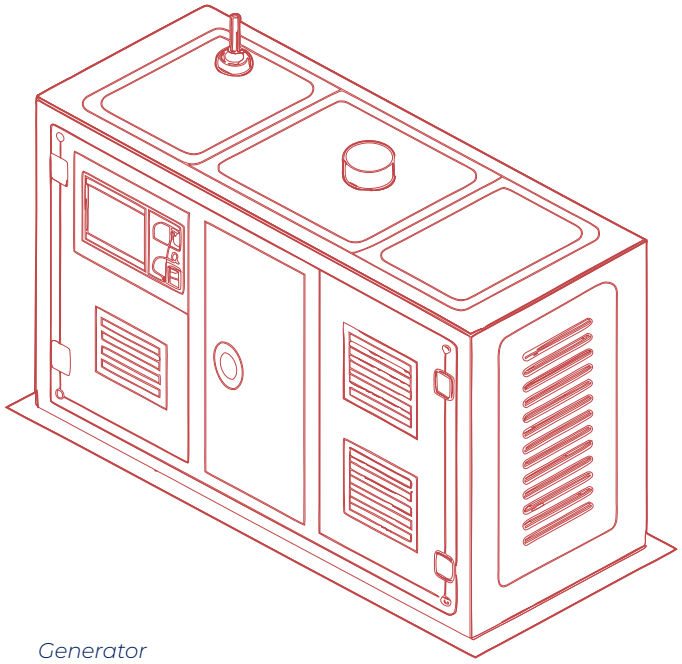
MAINTENANCE GUIDE

Installation	Before Storm	After Storm	Annually
Confirm barriers fit properly and seals are functional	Deploy temporary barriers and inspect components	Remove debris, inspect for leaks or damage, and clean barrier systems	Test deployable systems and review emergency procedures

Maintenance is usually the responsibility of the property owner or building maintenance crew. For multifamily, commercial, or public buildings, maintenance should be included in the property's regular inspection and emergency preparedness routine.

GENERATOR/ BACKUP POWER

Backup power systems provide temporary electricity during power outages caused by storms, flooding, extreme heat, or grid failures, and may include portable generators, permanently installed standby generators, battery backup systems, or larger emergency power systems for multifamily and commercial buildings. FEMA guidance explains that backup power systems are important for maintaining critical building functions during emergencies, including lighting, refrigeration, sump pumps, elevators, communications, heating and cooling systems, and medical equipment.[9]



Generator

INSTALLATION CHECKLIST

- ☐ Follow applicable building, electrical, and fire codes, including carbon monoxide safety, ventilation, fuel storage, flood elevation, licensed electrical installation, transfer switches, and fire code compliance
- ☐ Identify critical systems or equipment that require backup power
- ☐ Select an appropriate system type based on building size, fuel availability, and emergency power needs
- ☐ Coordinate fuel storage, gas connections, exhaust routing, and fire safety requirements before installation
- ☐ Meet ventilation, clearance, and flood protection requirements

In flood-prone areas, FEMA recommends elevating generators, electrical panels, fuel systems, and associated equipment above flood elevation to reduce flood damage and maintain operation during storm events.[9] Emergency power systems are commonly paired with elevated utilities, floodproofing, and resilient building system strategies.

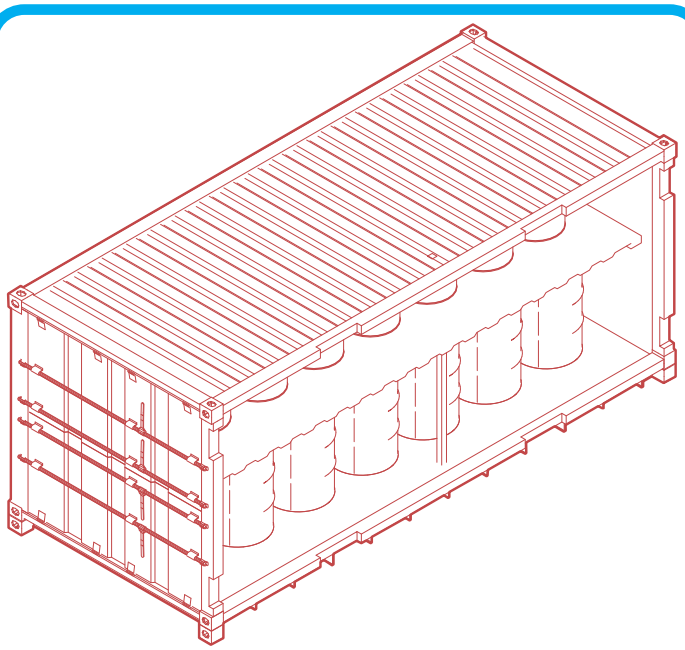
- ☐ Elevate generators, fuel tanks, and electrical equipment above flood elevation where feasible
- ☐ Install transfer switches and electrical connections through licensed electricians and qualified contractors
- ☐ Test startup systems, transfer switches, and emergency operation protocols

MAINTENANCE GUIDE

Installation	Monthly	After Storm	Annually
Test generator startup, transfer switches, fuel systems, and emergency power connections after installation to confirm proper operation	Run generator test cycles, inspect fuel systems and battery connections, and verify ventilation and exhaust systems remain clear	Inspect for flood damage, debris, fuel leaks, or electrical issues and confirm systems remain operational	Perform full inspection and servicing of generators, transfer switches, fuel systems, and electrical connections through a licensed contractor

SAFE HANDLING OF HAZARDOUS MATERIAL

Coastal industrial facilities face significant risk from hurricanes, flooding, and storm surge, a category referred to as natural hazard-triggered technological disasters, or "natech." These events can damage storage vessels and pipes, wash chemicals into floodwaters, cause power outages that disrupt temperature and pressure controls, and ignite flammable materials via lightning. Since many chemical facilities are already located in low-lying coastal zones, climate change-driven sea level rise and storm surge increase the need for these users to adopt preventative measures.[10] Waterfront and industrial users should store chemicals away from floodplains and sensitive areas like streams, and keep storage buildings downwind from waterways. Buildings should be designed to resist high winds, and sites should provide proper drainage to manage floodwaters.[10]



Elevated storage of hazardous material

HAZMAT CONSIDERATIONS:

- ☐ Relocate hazardous materials away from flood-prone areas, drains, and sensitive waterways where feasible
- ☐ Store chemicals in flood-resistant, ventilated, and secure storage areas above expected flood elevation
- ☐ Install secondary containment systems, spill protection, and secure anchoring for tanks, shelving, and storage cabinets
- ☐ Develop emergency response procedures for spills, flooding, power outages, and storm preparation before severe weather events

INVENTORY
- Maintain current chemical inventory and separate incompatible materials

STORAGE
- Use approved storage cabinets and keep chemicals off the floor

CONTAINMENT
- Provide secondary containment and remove spills within 24 hours

STORM PREP
- Move chemicals to higher ground, plug drains, and notify authorities

MAINTENANCE GUIDE

Installation	Regularly	Before Storm	After Storm
Confirm hazardous materials are properly labeled, segregated, secured, and protected from flooding or storm damage after installation or relocation	Inspect storage cabinets, containment systems, anchors, drains, and chemical inventories for leaks, corrosion, or improper storage conditions	Move hazardous materials to higher ground where possible, secure containers and shelving, plug floor drains, and notify local authorities of your storage locations[11]	Inspect containers for leaks or damage, ventilate affected areas, remove contaminated materials safely, and restrict access to impacted spaces until conditions are stabilized[12]

COASTAL RESILIENCE STRATEGIES

Industrial Sites

Industrial properties, particularly those located within the Chelsea Creek Designated Port Area (DPA), play a critical role in the regional economy and supply chain. These facilities support fuel storage and distribution, maritime commerce, transportation, and other industrial operations that serve Chelsea and the broader Commonwealth.

Industrial Site Considerations

As sea levels rise and coastal flooding becomes more frequent, industrial properties face increasing risks from storm surge and tidal flooding. Resilience planning within the DPA must balance flood protection with the operation of water-dependent industrial facilities. Resilience measures should reduce flood risk while preserving industrial access and supply chain activities.

Many of the coastal resilience strategies described in this guide are applicable to industrial properties, as noted in the graphic below. Facilities within the DPA may also wish to consider broader operational and organizational measures that improve preparedness, reduce environmental risks, and support coordinated resilience planning across the waterfront.

Similar to the urban heat and stormwater strategies described previously, the coastal resilience strategies presented in this section are intended to support resilience while maintaining existing industrial operations and compatible waterfront uses. They are not intended to encourage or facilitate changes in land use, DPA-supported uses, or waterfront activities. Proposed projects involving changes in use, redevelopment, or substantial modifications to waterfront facilities may require additional site-specific review and approvals from local and state regulatory agencies. Additional information on the DPA, Chapter 91, and waterfront regulatory considerations is provided in Chapter 3.

PREVENTION AS A RESILIENCY MEASURE

Infrastructure failure prevention, along with proper maintenance, are key aspects of a resilient waterfront. Shoreline protection infrastructure such as riprap, seawalls, and bulkheads can deteriorate over time if not maintained properly, increasing the risk of failure as coastal flooding and storm events become more frequent and severe. The upkeep of these systems is crucial for mitigating the impacts of future flood events, along with advance planning, and integration into regional emergency systems.

Prevention may also include pre-planning actions such as frequent weather monitoring, participation in emergency alert systems, and relocating commercial vehicles in advance of forecasted flood events.

02. BUILDING ENVELOPE & ACCESS

Flood resilience measures that affect building entrances, exterior walls, doors, windows, and access routes should be designed to minimize impacts on significant façades and architectural features. Temporary or deployable measures may provide opportunities to improve resilience while limiting permanent alterations to historic materials.

PREVENTION AS A RESILIENCY MEASURE | Ports Resilience Index (Climate Resilience Toolkit)

The **Ports Resilience Index (PRI)** is a qualitative self assessment tool designed to help port authorities evaluate how prepared their organization is to continue operations during and after disasters. It uses a structured checklist of yes/no indicator questions that focus on management practices rather than simply physical infrastructure, allowing ports to identify strengths, gaps, and priority actions.

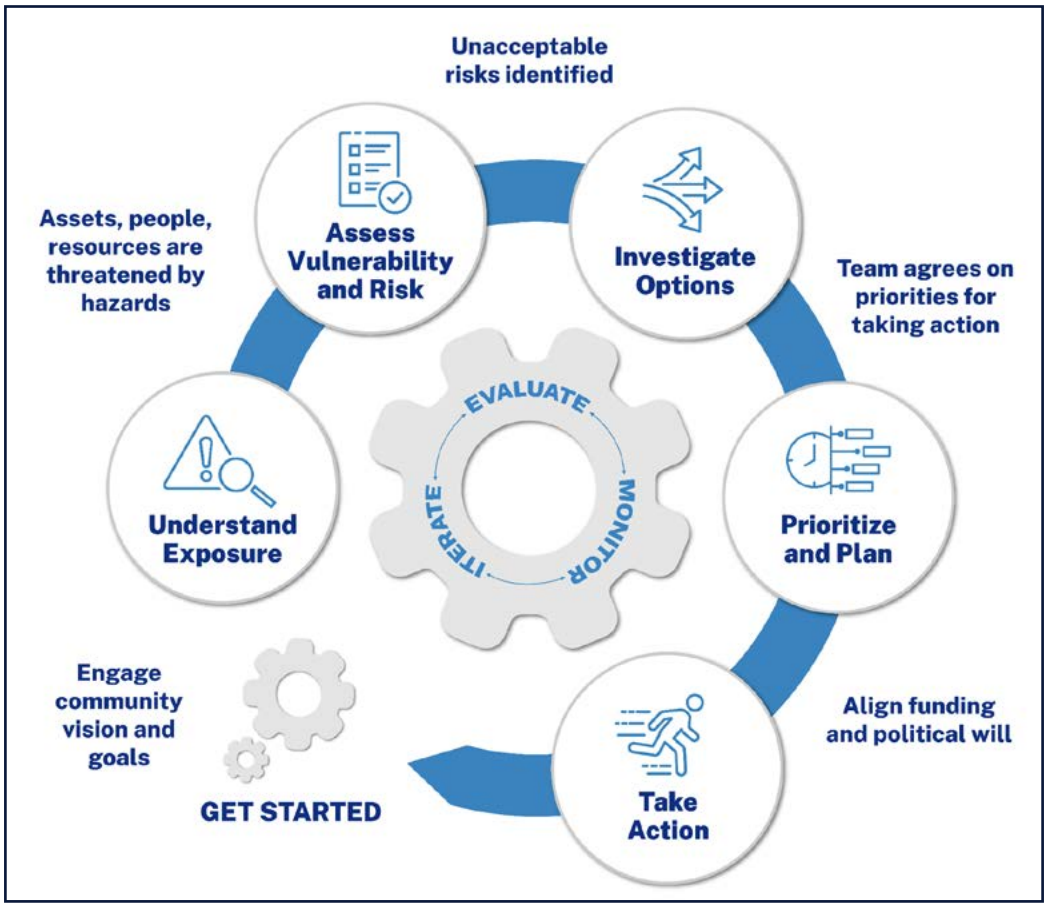
The index addresses multiple operational areas, including hazard assessment, infrastructure and asset management, insurance and risk management, continuity of operations, and internal coordination. The PRI encourages ports to involve interdepartmental staff in discussions that reveal institutional vulnerabilities and promote shared understanding of risk.

The PRI does not produce a regulatory score. Instead, it generates a baseline resilience profile and a set of recommended short- , medium- , and long-term actions.

The tool is intended as a starting point for resilience planning and can be repeated over time to track progress and support continuous improvement.

U.S. Department of Homeland Security
Ports Resilience Index:

[Ports Resilience Index, U.S. Climate Resilience Toolkit]



NOAA Climate Program Office
U.S. Climate Resilience Toolkit

COASTAL RESILIENCE STRATEGIES

Industrial Sites Cont'd

SAFE HANDLING OF HAZARDOUS MATERIALS

Hazardous materials may involve oversight or permitting requirements from local fire departments, MassDEP, EPA, the Occupational Safety and Health Administration (OSHA), the U.S. Coast Guard, applicable fire code requirements, Spill Prevention, Control, and Countermeasure (SPCC) regulations, Emergency Planning and Community Right-to-Know Act (EPCRA) Tier II reporting requirements, and facility-specific permits. Hazardous materials regulations and permit requirements vary by facility and are designed to address a range of operational, safety, spill prevention, and response considerations. Beyond maintaining regulatory compliance, flood-prone industrial properties should treat hazardous materials management as a proactive resilience measure by evaluating flood exposure and minimizing the potential for chemical releases during extreme weather events.

INCREASED TRANSPARENCY

As it stands, no single organization directly oversees whether DPA businesses have adequate plans in place to handle flooding events, leaving the city without a reliable mechanism for ensuring baseline preparedness across the waterfront. This lack of transparency creates blind spots in regional resilience planning, as one unprepared site can undermine the investments of neighboring properties and compromise citywide emergency response. For this reason, considering a legally reviewed process for requesting or encouraging non-sensitive preparedness information and integrating that information into municipal hazard mitigation and harbor planning, is a foundational step toward coordinated, effective flood resilience along the waterfront.

CASE STUDY

INCREASED TRANSPARENCY | The Port of New Bedford (Resilient Design Guidelines)

The Port of New Bedford's **Resilient Design Guidelines** organizes strategies along a hierarchy of Avoidance, Protection, and Recovery, prioritizing elimination of risk where possible, minimizing vulnerability where it cannot be avoided, and designing for rapid recovery when full protection is not feasible.

The accompanying **Maritime Business Resilience Toolkit** encourages businesses to develop emergency response and recovery plans, and stresses that these materials must be accessible to all employees, including translating plans into multiple languages for non-English speakers and finding ways to disseminate information that does not rely on internet access.

The Port of New Bedford
Resilient Design Guidelines

Port of New Bedford, Resilient Design Guidelines

Maritime Business Resilience Toolkit

Port of New Bedford, Maritime Resilience Toolkit

ADDITIONAL RESOURCES

Chelsea Creek Municipal Harbor Plan and Designated Port Area Master Plan

Provides guidance on waterfront development, public access, industrial land use, and climate resilience within the Chelsea Creek waterfront. The plan includes recommendations for maintaining water-dependent industrial uses while addressing future flood risks and improving waterfront infrastructure.

Chelsea Creek MHP and DPA Master Plan

Massachusetts Office of Coastal Zone Management (CZM) Publications & Resources

The Massachusetts Office of Coastal Zone Management (CZM) provides a wide range of guidance documents, technical reports, planning resources, and adaptation tools related to coastal resilience, waterfront planning, flood risk management, nature-based solutions, and working waterfronts. These resources can help property owners, municipalities, and waterfront businesses evaluate climate risks and identify appropriate resilience strategies.

Building Resilience in Massachusetts Designated Port Areas

Resilient Industry: Mitigation and Preparedness in the City's Industrial Floodplain

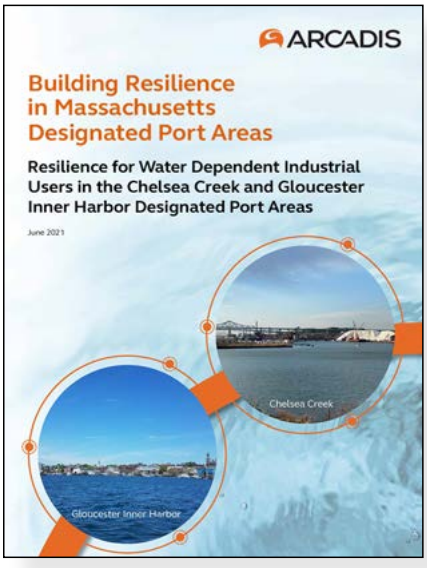
Developed by the NYC Department of City Planning, this guide provides practical recommendations for industrial businesses operating in flood-prone areas, including strategies for hazardous material management, emergency preparedness, business continuity planning, facility retrofits, and flood risk reduction. The plan includes actions businesses can implement before, during, and after flood events to improve resilience and reduce operational disruptions.

NYC Planning, Resilient Industry Mitigation and Preparedness in the City's Industrial Floodplain

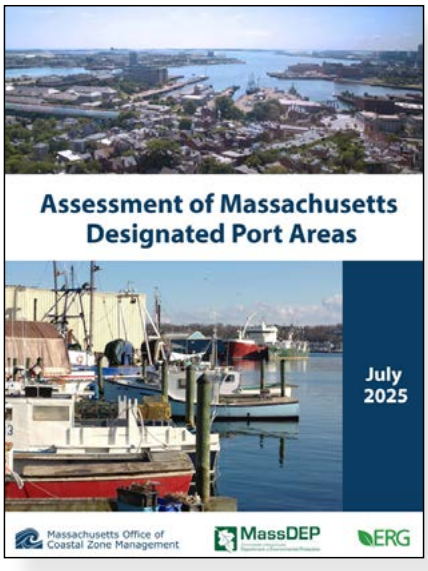
Nature-Based Solutions for Ports: Opportunities and Challenges (World Bank)

This guide explores how ports and industrial waterfronts can integrate nature-based solutions with traditional infrastructure to improve resilience, reduce maintenance costs, limit operational disruptions, extend asset lifespans, and support long-term adaptation.

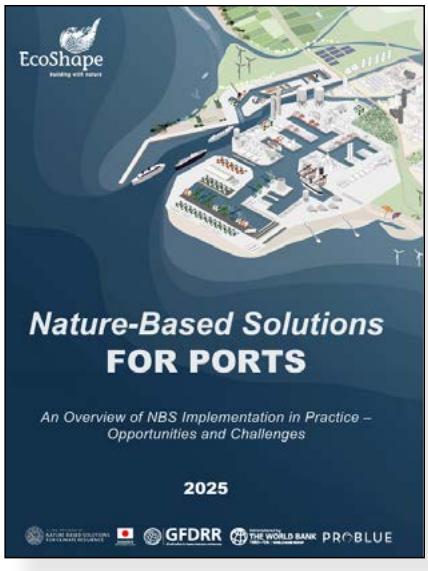
Nature-Based Solutions for Ports



MA CZM
Building Resilience in Massachusetts Designated Port Areas



MA CZM
Assessment of Massachusetts Designated Port Areas



World Bank
Nature-Based Solutions for Ports: Opportunities and Challenges

COASTAL RESILIENCE STRATEGIES

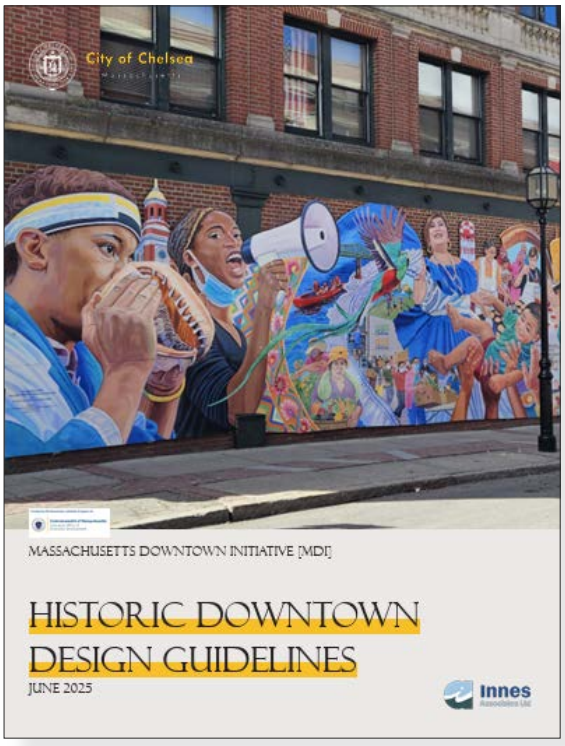
Historic Buildings

Many of Chelsea's historic buildings were constructed before floodplain regulations and face increasing exposure to coastal flooding, storm surge, and heavy precipitation. Climate adaptation measures can reduce future flood damage and help preserve important historic resources for future generations.

Historic Building Considerations

Resilience interventions should be designed to preserve the architectural features, materials, and landscapes that contribute to a property's historic character. Adaptation strategies should seek to retain character-defining features wherever feasible and carefully consider how proposed improvements may affect a building's appearance, setting, and relationship to the surrounding streetscape. Where applicable, adaptation measures should also consider a building's relationship to adjacent historic structures and the broader neighborhood context.

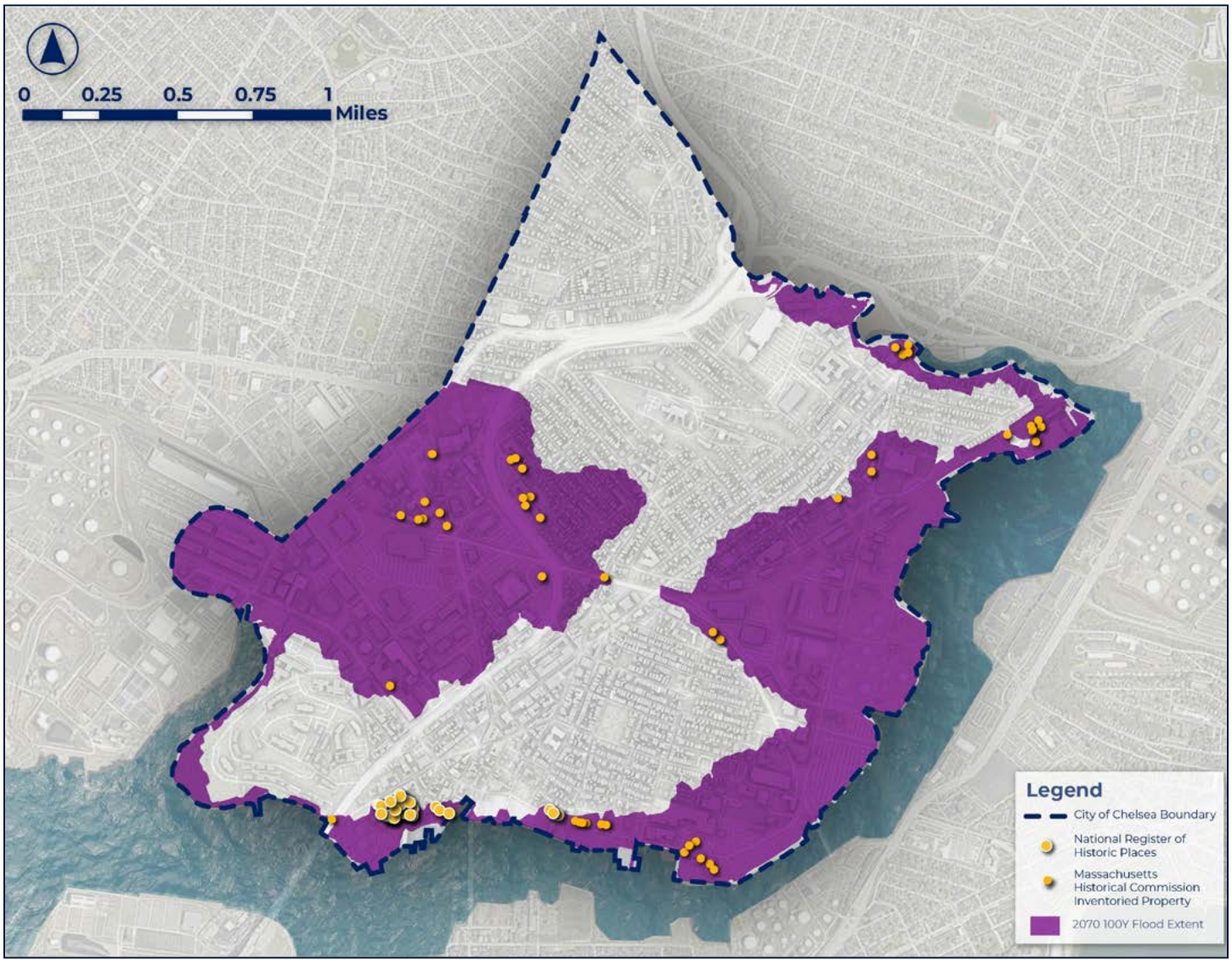
The National Park Service recommends evaluating adaptation measures along a spectrum of interventions, beginning with strategies that have limited impacts on historic character and progressing to more substantial modifications only where necessary to address long-term flood risk. The following considerations highlight opportunities to improve flood resilience while supporting the long-term preservation of Chelsea's historic buildings and neighborhoods.



City of Chelsea
Historic Downtown Design Guidelines

CITY OF CHELSEA - HISTORIC DOWNTOWN DESIGN GUIDELINES

For additional guidance, refer to the City of Chelsea's Historic Downtown Design Guidelines, which outline local considerations for preserving historic character and maintaining compatibility within the downtown context. ***To view the Guidelines, visit:*** Historic Downtown Design Guidelines, Chelsea, MA



Historic Properties within the 2070 100-Year Flood Extent
Chelsea, Massachusetts

Historic Buildings Cont'd

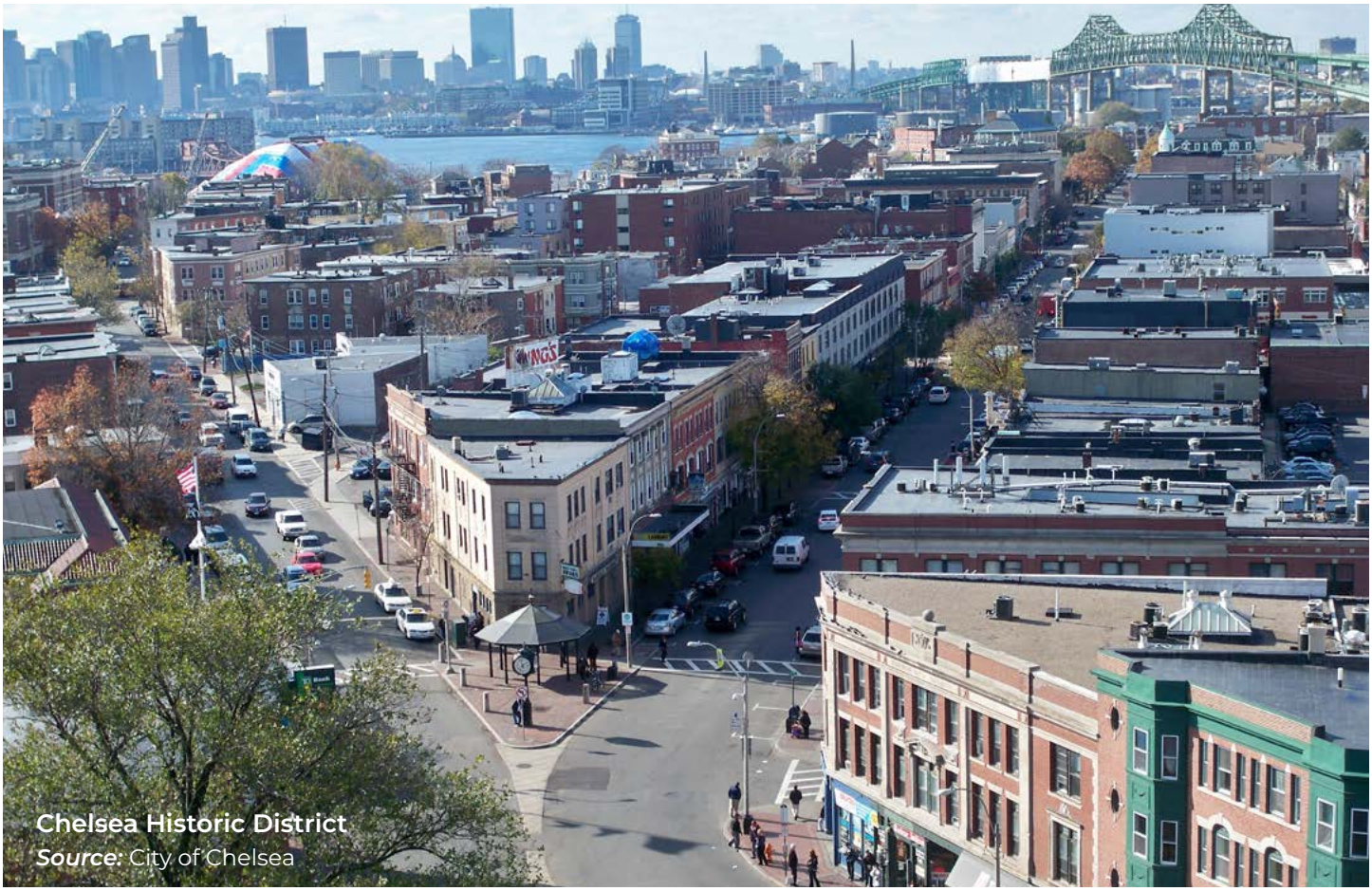
01. BUILDING FORM

Strategies that alter a building's form, including elevation, floodproofing, and foundation modifications, can provide some of the most effective protection against long-term flood risk but may also have the greatest potential to affect historic character. Property owners and developers should carefully consider how resilience measures may alter a building's height, foundation, and significant architectural features such as porches, stoops, storefronts, and entrances.

Where modifications are necessary, resilience improvements should seek to preserve or replicate character-defining features and integrate new foundations, stairs, ramps, and other elements into the overall architectural design. Property owners should also consider whether less invasive measures may provide interim protection while preserving future adaptation options. Where buildings are elevated, new foundation elements, flood vents, access stairs, ramps, and screening should be designed to complement the historic character of the building.

02. BUILDING ENVELOPE & ACCESS

Flood resilience measures that affect building entrances, exterior walls, doors, windows, and access routes should be designed to minimize impacts on significant façades and architectural features. Temporary or deployable measures may provide opportunities to improve resilience while limiting permanent alterations to historic materials.



Chelsea Historic District
Source: City of Chelsea

03. BUILDING SYSTEMS

Building system upgrades are often among the least visible resilience improvements and can provide substantial flood protection with limited impacts on historic character. Elevating mechanical equipment, electrical systems, utility connections, and backup power systems can significantly reduce flood-related damage while preserving historic façades and building form.

Whenever feasible, new equipment should be located in secondary or less prominent areas and integrated into existing building infrastructure. Property owners should consider coordinating resilience upgrades with ongoing rehabilitation, maintenance, and building improvement projects to reduce costs and minimize impacts on historic materials.

04. INCREMENTAL ADAPTATION PATHWAYS

For many historic properties, resilience improvements are most effective when implemented as part of a long-term adaptation strategy rather than a single project. Property owners may wish to begin with lower-impact measures, such as building system upgrades or deployable flood protection, while evaluating more substantial interventions over time.

A phased approach can allow resilience investments to be coordinated with routine maintenance, rehabilitation projects, and changing flood risks. This approach may also provide opportunities to monitor the effectiveness of adaptation measures, preserve future flexibility, and balance resilience objectives with the long-term stewardship of historic resources.

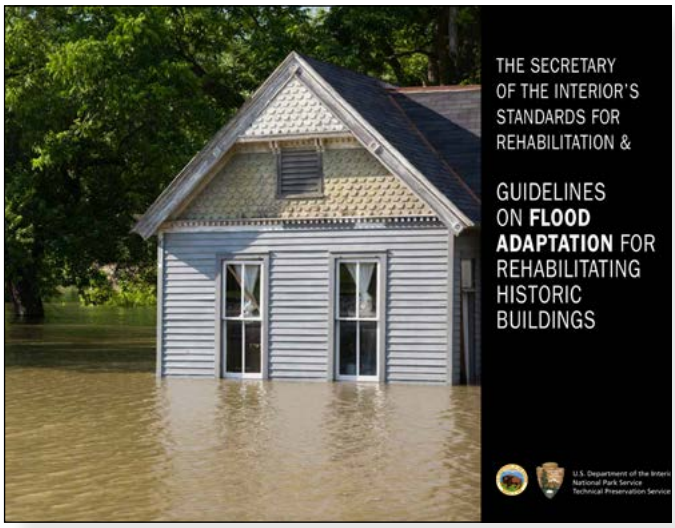
ADDITIONAL RESOURCES

Property owners interested in implementing adaptation projects are encouraged to consult the National Park Service's Flood Adaptation Guidelines for Rehabilitating Historic Buildings, which provides detailed guidance on building elevation, floodproofing, building systems, site design, and adaptation planning for historic structures.

Property owners pursuing rehabilitation of historic structures may also wish to explore historic rehabilitation tax credit programs. Certain resilience-related improvements may qualify as eligible rehabilitation expenditures when incorporated into a certified rehabilitation project and designed in accordance with applicable preservation standards. *For information, visit:* IRS, Rehabilitation Credit

National Park Service
Flood Adaptation Guidelines:

NPS, Flood Adaptation Guidelines



National Park Service
Flood Adaptation Guidelines

End Notes

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Chelsea Creek
Source: Weston & Sampson

Conclusion



Photo Source:
City of Chelsea, Chick Corea Mural



Conclusion

Chelsea's history, economy, and identity have long been shaped by its waterfront, neighborhoods, and diverse built environment. As climate change increases the frequency and severity of coastal flooding, stormwater flooding, and extreme heat, resilience planning will become increasingly important to protecting the people, places, infrastructure, and economic assets that make the city unique.

While no single strategy can eliminate climate risk, thoughtful planning and incremental improvements can reduce vulnerabilities and improve the ability of buildings, sites, and communities to withstand future challenges.

The strategies presented in this guide are intended to help property owners, businesses, institutions, and community members identify practical opportunities to enhance resilience while supporting Chelsea's broader goals for economic vitality, environmental stewardship, public health, and historic preservation. By integrating resilience into planning decisions, Chelsea can continue to adapt to a changing climate while preserving the qualities that define the city and its waterfront.



Park Opening at 88 Clinton St.
Source: Weston & Sampson

Appendix



Photo Source:
Creekside Commons by Matt Frank



Planting Appendix

Small Trees Planting List
Chelsea, Massachusetts

Common Name	Scientific Name	Height (Ft)	Width (Ft)	Street Tree?	Native?	Utility Line Compatible?
Trident maple	*Acer buergerianum*	20-30	15-25	Y	N	Y
Hedge maple	*Acer campestre*	25-35	25-35	Y	N	Y
Paperbark maple	*Acer griseum*	20-30	20-30	N	N	Y
Purpleblow maple	*Acer truncatum*	25-30	25-30	Y	N	Y
Downy serviceberry	*Amelanchier arborea*	35	20	Y	Y	N
Shadblow serviceberry	*Amelanchier canadensis*	12-30	10-20	Y	Y	Y
Allegheny serviceberry	*Amelanchier laevis*	15-25	15-30	Y	Y	Y
Apple serviceberry	*Amelanchier x grandiflora*	20-30	15-25	Y	N	Y
American hornbeam	*Carpinus caroliniana*	20-30	20-30	Y	Y	Y
Smoketree	*Cotinus obovatus*	20-30	15-30	N	Y	Y
Eastern redbud	*Cercis canadensis*	20-30	25-35	Y	Y	Y
White fringetree	*Chionanthus virginicus*	15-25	10-25	Y	Y	Y
Korean dogwood	*Cornus kousa*	15-30	15-30	N	N	Y
Cornelian cherry dogwood	*Cornus mas*	15-25	15-20	N	N	Y
Thornless cockspur	*Crataegus crusgalli var. inermis*	20-30	20-35	Y	Y	Y
Witchhazel	*Hamamelis virginiana*	10-30	15-20	N	Y	Y
Amur maackia	*Maackia amurensis*	20-30	20-30	Y	N	Y
Star magnolia	*Magnolia stellata*	10-25	15	N	N	Y
Sargent crabapple	*Malus sargentii*	15	12	Y	N	Y
Crabapple cultivars	*Malus spp. (many cultivars)*	10-25	10-25	Y	N	Y
Persian parrotia	*Parrotia persica*	20-30	15-30	Y	N	Y
Amur chokecherry	*Prunus maackii*	35	35	Y	N	N
Sargent cherry	*Prunus sargentii*	35	15	Y	N	N
Accolade flowering cherry	*Prunus sargentii x P. subhirtella*	20-30	15-25	Y	N	Y
Japanese tree lilac	*Syringa reticulata*	20-30	15-25	Y	N	Y
Blackhaw viburnum	*Viburnum prunifolium*	30	15	N	N	Y

Medium Trees Planting List
Chelsea, Massachusetts

Common Name	*Scientific Name*	*Height (Ft)*	*Width (Ft)*	*Street Tree?*	*Native?*	*Utility Line Compatible?*
Miyabe maple	*Acer miyabei*	30-45	30-40	Y	N	N
Red horsechestnut	*Aesculus x carnea*	30-50	30	N	N	N
Europen hornbeam	*Carpinus betulus*	35-60	30-40	Y	N	N
Yellowwood	*Cladrastis kentukea*	30-50	40-55	N	Y	N
Turkish filbert	*Corylus colurna*	40-50	15-35	Y	N	N
Carolina silverbell	*Halesia carolina*	20-40	20-35	N	Y	N
Eastern red cedar	*Juniperus virginiana*	40-50	8-20	N	Y	N
American hophornbeam	*Ostrya virginiana*	25-40	20-40	Y	Y	N
White cedar	*Thuja occidentalis*	40-60	10-15	N	Y	N
Japanese zelkova	*Zelkova serrata*	50-80	40-60	Y	N	N

Large Trees Planting List
Chelsea, Massachusetts

Common Name	Scientific Name	Height (Ft)	Width (Ft)	Street Tree?	Native?	Utility Line Compatible?
White fir	*Abies concolor*	30-50	15-30	N	N	N
Red maple	*Acer rubrum*	40-60	30-70	Y	Y	N
Freeman maple	*Acer x freemanii*	40-75	Varies	Y	Y	N
Horsechestnut	*Aesculus hippocastanum*	75	70	N	N	N
River birch	*Betula nigra*	40-70	40-60	N	Y	N
Pignut hickory	*Carya glabra*	65	40	N	Y	N
Northern catalpa	*Catalpa speciosa*	40-60	20-40	Y	Y	N
Sugar hackberry	*Celtis laevigata*	60-80	50	Y	Y	N
Common hackberry	*Celtis occidentalis*	40-60	40-60	Y	Y	N
Katsuratree	*Cercidphyllum japonicum*	40-60	25-60	Y	N	N
Ginkgo	*Ginkgo biloba*	50-80	30-40	Y	N	N
Thornless honeylocust	*Gleditsia triacanthos var. inermis*	40-60	30-70	Y	Y	N
Kentucky coffeetree	*Gymnocladus dioicus*	50-75	40-50	Y	Y	N
Larch	*Larix decidua*	75	30	N	N	N
American sweetgum	*Liquidambar styraciflua*	50-75	40-65	Y	Y	N
Tuliptree	*Liriodendron tulipfera*	70-90	35-50	Y	Y	N
Dawn redwood	*Metasequoia glyptostroboides*	70-100	25-50	N	N	N
Black tupelo	*Nyssa sylvatica*	30-60	20-40	Y	Y	N
Norway Spruce	*Picea abies*	60	30	N	N	N
White spruce	*Picea glauca*	60	20	N	Y	N
Serbian spruce	*Picea omorika*	50-60	20-25	N	N	N
Oriental spruce	*Picea orientalis*	60	25	N	N	N
Swiss stone pine	*Pinus cembra*	30-40	15-25	N	N	N
Austrian pine	*Pinus nigra*	60	30	N	N	N
London planetree	*Platanus x acerifolia*	70-100	65-80	Y	N	N
American sycamore	*Platanus occidentalis*	100	80	Y	Y	N
White oak	*Quercus alba*	45-80	45-80	Y	Y	N
Swamp white oak	*Quercus bicolor*	45-70	45-60	Y	Y	N
Scarlet oak	*Quercus coccinea*	60-75	40-50	Y	Y	N
Shingle oak	*Quercus imbricaria*	40-60	40-65	Y	Y	N
Chinkapin oak	*Quercus muehlenbergii*	35-50	35-60	Y	Y	N

Large Trees Planting List (continued)
Chelsea, Massachusetts

Common Name	Scientific Name	Height (Ft)	Width (Ft)	Street Tree?	Native?	Utility Line Compatible?
Pin oak	*Quercus palustrus*	50-70	25-40	Y	Y	N
Willow oak	*Quercus phellos*	40-60	40-60	Y	Y	N
English oak	*Quercus robur*	40-60	40-60	Y	N	N
Northern red oak	*Quercus rubra*	60-75	60-75	Y	Y	N
Sassafras	*Sassafras albidum*	30-60	25-40	N	Y	N
Japanese pagoda tree	*Styphnolobium japonicum*	50-70	35-55	Y	N	N
Baldcypress	*Taxodium distichum*	50-70	20-40	N	Y	N
American linden	*Tilia americana*	60-80	20-40	N	Y	N
Littleleaf linden	*Tilia cordata*	50-70	30-50	Y	N	N
Silver linden	*Tilia tomentosa*	50-70	25-55	Y	N	N
American elm (cultivars with various degrees of resistance to Dutch Elm Disease)	*Ulmus americana*	60-80	30-60	Y	Y	N
Lacebark elm	*Ulmus parvifolia*	40-75	30-75	Y	N	N
Elm hybrid	*Ulmus x spp.*	15-20	10-15	Y	N	N

Non-Tree Species Planting List
Chelsea, Massachusetts

Common Name	Scientific Name	Type	Height	Spacing	Growth Habit	Resistant To	Salt Tolerant	Drought Tolerant	Pollinator Powerhouse
Common yarrow	*Achillea millefolium*	Perennial	1-3'	2-3'	Spreading	Deer Rabbit	yes	yes	yes
Black cohosh	*Actaea (Cimifuga) racemosa*	Perennial	3-7'	2-3'		Deer Rabbit			
Thread-leaf bluestar	*Amsonia hubrichtii*	Perennial	2-3'	2'	clumping	Deer Rabbit		yes	
Wild columbine	*Aquilegia canadensis*	Perennial	2'	10-16"		Deer	yes		
Goat's beard	*Aruncus dioicus*	Perennial	4-6'	3-4'					
Common milkweed	*Asclepias syriaca*	Perennial	3 - 5'	2-3'		Deer Rabbit	yes		
Butterflyweed	*Asclepias tuberosa*	Perennial	2'	1-2'		Deer Rabbit	yes	yes	
Blue false wild indigo	*Baptisia australis*	Perennial	4'	2-3'	clumping			yes	
Pennsylvania sedge	*Carex pensylvanica*	Sedge	.5-1'	.5-1'					
Buttonbush	*Cephalanthus occidentalis*	Shrub	5-12'	4-8'					
White turtlehead	*Chelone glabra*	Perennial	1.5 - 2.5'	1.5-2'		Deer Rabbit			
Sweet pepperbush	*Clethra alnifolia*	Shrub	3-8'	4-6'					
Lanceleaf coreopsis	*Coreopsis lanceolata*	Perennial	2'	1-2'	spreading	Deer Rabbit	yes		
Purple coneflower	*Echinacea purpurea*	Perennial	2-4'	1.5-2'	clumping	Deer Rabbit		yes	
Purple love grass	*Eragrostis spectabilis*	Grass	1-2'	1-2'				yes	
Hollow Joe-pye weed	*Eupatorium fistulosum*	Perennial	6'	3-4'		Deer Rabbit			
Joe pye weed	*Eupatorium maculatum*	Perennial	5-8'	4-5'					
Joe Pye weed	*Eutrochium maculatum*	Perennial	3-7'	3-4'	spreading	Deer Rabbit			

Non-Tree Species Planting List (continued)
Chelsea, Massachusetts

Common Name	Scientific Name	Type	Height	Spacing	Growth Habit	Resistant To	Salt Tolerant	Drought Tolerant	Pollinator Powerhouse
Wild strawberry	*Fragaria virginiana*	Perennial	.5'	1-2'	aggressive	Deer Rabbit		yes	yes
Wild geranium	*Geranium maculatum*	Perennial	1-1.5'	.75 - 1'	clumping	Deer Rabbit			yes
Swamp sunflower	*Helianthus angustifolius*	Perennial	8'	3-Feb			yes		
Oxeye sunflower	*Heliopsis helianthoides*	Perennial	3-6'	2-4'		Deer Rabbit		yes	yes
American alumroot	*Heuchera americana*	Perennial	2""	1-1.5'	clumping		yes	yes	
Inkberry	*Ilex glabra*	Shrub	5-10'	5-8'					
Winterberry	*Ilex verticillata*	Shrub	6-12'	6-12'					
Blue flag iris	*Iris versicolor*	Perennial	1-3'	2-3'		Deer Rabbit			
Virginia sweetspire	*Itea virginica*	Shrub	3-5'	3-5'					
Mountain laurel	*Kalmia latifolia*	Shrub	5-15'	5-15'		Deer Rabbit			
Blazing star	*Liatris spicata*	Perennial	2-5'	1-2'		Deer			
Spicebush	*Lindera benzoin*	Shrub	6-12'	6-12'		Deer		yes	
Cardinal flower	*Lobelia cardinalis*	Perennial	4'	.5 - 1.5'		Deer Rabbit			
Scarlet bee balm	*Monarda didyama*	Perennial	2-4'	2-3'	meanders	Deer Rabbit			
Wild bee-balm	*Monarda fistulosa*	Perennial	4'	2-3'	spreading	Deer Rabbit			
Allegheny spurge	*Pachysandra procumbens*	Perennial	.5 - 1'	1-2'	spreading	Deer Rabbit			
Switch grass	*Panicum virgatum*	Grass	3-6'	2-3'				yes	
Foxglove beardtongue	*Penstemon digitalis*	Perennial	3 - 4'	1.5-2'		Deer Rabbit		yes	

Non-Tree Species Planting List (continued)
Chelsea, Massachusetts

Common Name	Scientific Name	Type	Height	Spacing	Growth Habit	Resistant To	Salt Tolerant	Drought Tolerant	Pollinator Powerhouse
May apple	*Podophyllum peltatum*	Perennial	1'	2'	spreading	Deer Rabbit			
Solomon's seal	*Polygonatum biflorum*	Perennial	4'	1.5 - 2'		Deer Rabbit	yes	yes	yes
Broad leaf mountain mint	*Pycnanthemum muticum*	Perennial	2-4'	1-3'	spreading	Deer Rabbit			
Fragnant sumac	*Rhus aromatica*	Shrub	2-6'	6-10'		Rabbit		yes	
Winged sumac	*Rhus copallinum*	Shrub	7-15'	10-20'		Rabbit		yes	
Green coneflower	*Rudbeckia laciniata*	Perennial	3-4'	2 - 3.5'		Deer Rabbit			
Seaside goldenrod	*Solidago sempervirens*	Perennial	2 - 3.5'	1.5-2.5'	clumping	Deer Rabbit	yes	yes	yes
Showy goldenrod	*Solidago speciosa*	Perennial	5'	2-3'	clumping				yes
Smooth blue aster	*Symphyotrichum laeve*	Perennial	1-3'	1-1.5'				yes	yes
New England aster	*Symphyotrichum novae-angliae*	Perennial	2-4'	2-3'		Deer Rabbit		yes	yes
New York aster	*Symphyotrichum novi-belgii*	Perennial	1-3'	1-2'			yes	yes	yes
Lowbush blueberry	*Vaccinium angustifolium*	Shrub	.5-2'	.5-2'					
Highbush blueberry	*Vaccinium corymbosum*	Shrub	6-12'	8-12'					
Blue vervain	*Verbena hastata*	Perennial	5 ft	18-24"					
Arrowwood viburnum	*Viburnum dentatum*	Shrub	6-10'	6-10'					
Golden Alexander	*Zizia aurea*	Perennial	2-3'	1-2'		Deer Rabbit			



Mill Creek
Source: Weston & Sampson

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