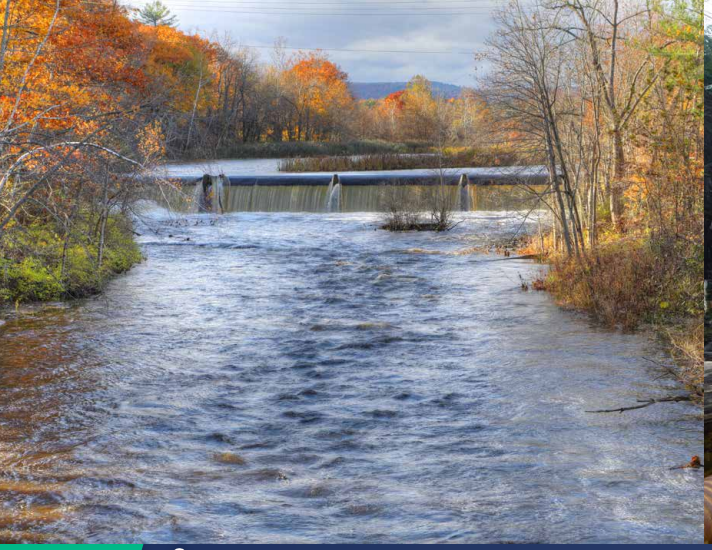


ResilientMass Finance Strategy Full Report

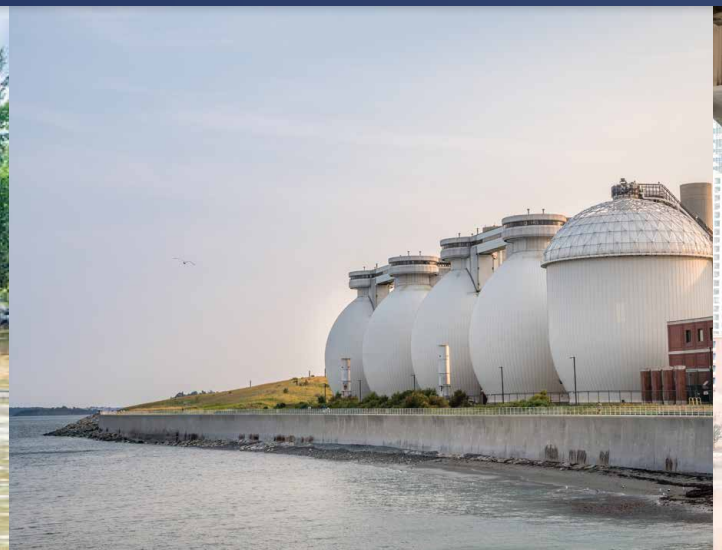
August 2025

EXECUTIVE OFFICE of ENERGY & ENVIRONMENTAL AFFAIRS

massDOT
Massachusetts Department of Transportation

ResilientMass



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Springfield, MA
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Deerfield, MA

Introduction

As detailed in the 2022 Massachusetts Climate Change Assessment[1] and the 2023 ResilientMass Plan,[2] the Commonwealth of Massachusetts faces increasing risks from climate change, aging infrastructure, and economic disruptions that threaten the long-term resilience of its communities and its economic growth potential throughout the remainder of the century. The Commonwealth has already developed comprehensive plans and policy frameworks to address impacts and build long-term resilience. However, continued adaptation to both a changing climate and an evolving funding landscape will require a whole-of-government approach to finance and deliver resilience at scale.

While the investment needs to strengthen infrastructure and natural systems to withstand the impacts of climate hazards are significant, the value of these investments and consequences of inaction are even higher. Over the past 30 years, each one degree Fahrenheit increase in average temperature has resulted in a 3.2% increase in local government services spending, as well as increased spending by the Commonwealth.[3] Homeowners of coastal homes in Massachusetts lost over $273 million in relative appreciation between 2005 and 2017 due to sea level rise.[4] Depending on the level of response during this century, the total cost of storm damages in Boston alone could be between $5 and $100 billion (B).[5] The costs of these impacts will not be distributed evenly. For example, Massachusetts ranks second in the nation for the percentage of federally subsidized affordable housing units vulnerable to coastal flooding.[6]

Global projections of climate change damages estimate that even with significant action today, the world economy is already committed to a 19% income reduction through 2050, due to losses in labor productivity, reduced agricultural yields, and damage to physical infrastructure. The cost of these damages is estimated to be $38 trillion annually by 2050.[7]

Action now provides the Commonwealth with quantifiable avoided economic losses. In the United States (US), a retrospective study of mitigation activities funded by federal grants finds that over a period of around 20 years, each dollar invested in natural hazard mitigation resulted in $6 of savings in avoided damages.[8] A study from the US Chamber of Commerce of 25 modeled natural disaster scenarios adds to this finding, estimating $7 in reduced economic costs after an event (e.g., production and income losses from people leaving the labor force) from each $1 in resilience investment. When adding the benefits from avoided damage and cleanup costs, benefits outweighed costs 13:1.[9] Based on analysis of prototypical projects that fall within the key resilience measures, the benefits consistently outweigh costs on an order of a least 2:1. The benefits for these prototypical projects are likely to be higher given not all benefits are readily monetizable, and the analysis focuses on direct benefits, rather than avoided cascading economic losses to the regional economy.

The ResilientMass Finance Strategy responds directly to a 2023 ResilientMass Plan action and Climate Chief recommendation to develop a comprehensive strategy for investing in climate resilience. It addresses three essential questions:

- What are important infrastructure-related resilience measures in the Commonwealth?
- What will they cost, and what is the value of these investments?
- How can Massachusetts build a long-term system to fund, finance, and scale the pace of implementation?

The result is a two-part strategy. First, an **Investment Assessment** estimates the investment need and resilience value of seven key resilience measures—high-impact capital interventions across infrastructure, ecosystems, and public services. The Investment Assessment focuses primarily on resilience investments through 2050 for publicly owned assets, though the methodology varies by key resilience measure. For the seven key resilience measures, the estimated rough order of magnitude need is between $90B and $130B.

Understanding Investment Need

Massachusetts is not unique in grappling with understanding the investment needed to advance climate resilience. In New York, Legislation S.2129-B/A.3351-B creates a 'Climate Superfund' and notes that the cost of statewide climate adaptation investments will easily exceed $150B through 2050. Earlier proposals for text for a Climate Change Superfund Act noted that the cost of statewide climate adaptation investments will "easily reach several hundred billion dollars" based on key known investment needs including $100B to handle large rain events in New York City, an estimated $52B to protect New York City from storm-driven flooding from a US Army Corps of Engineers study, and a study estimating $75B to $100B in costs to protect Long Island from extreme weather.[10] A study for Los Angeles County by the Center for Climate Integrity estimated it would cost municipal, county, state, and federal governments $12.5B to protect communities through 2040.[11]

The **Resilience Finance Roadmap: Building Capacity for Action** outlines a phased approach to building the financial, institutional, and technical capacity needed to deliver those measures over time. It describes the necessary structure and capacities required to meet Massachusetts' resilience investment needs; assesses current system performance; and presents a three-phased plan to evolve into a mature, adaptive, and high-performing investment framework aligned with the Commonwealth's priorities.

Four strategic priorities drive progress across all phases. These priorities inform decision-making, investments, and system design to ensure scalable, consistent, and equitable resilience investment. The priorities include:

- Make projects easier to implement;
- Streamline and expand access to funding;
- Implement financing mechanisms; and
- Build regional and organizational capacity.

The phased strategy recognizes that system transformation must occur alongside continued investment. Adaptive learning is applied throughout to evaluate progress and adjust as needed as the system evolves. The three phases are described below.

PHASE 1

Piloting and Aligning focuses on establishing foundational system functions using existing tools and programs.

PHASE 2

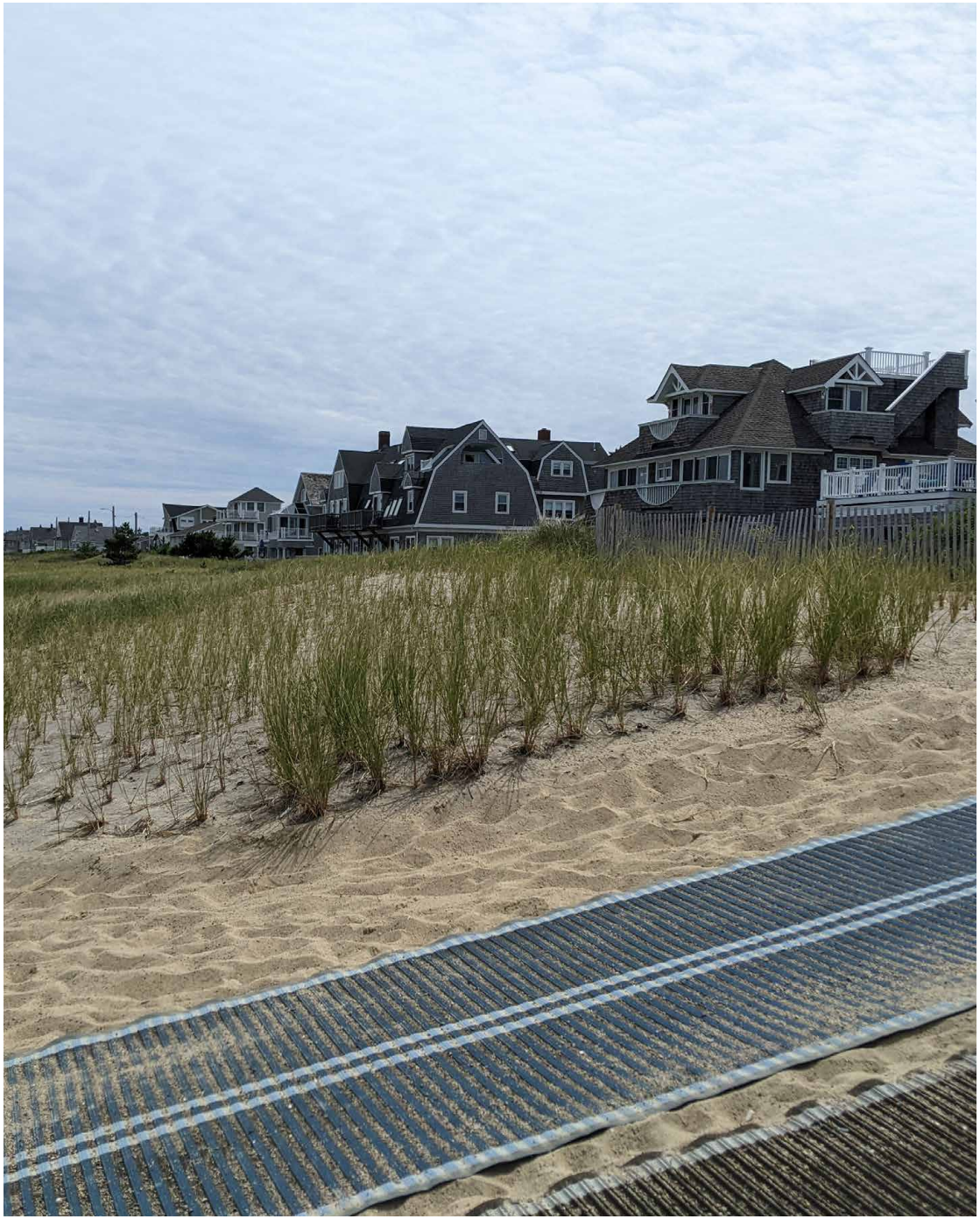
Scaling Implementation-Advancing Resilience in Everything focuses on actions to expand institutional and financial infrastructure.

PHASE 3

Institutionalizing and Integrating for Systemwide Resilience, in which resilience becomes a core part of how the Commonwealth plans, funds, and manages capital projects.

The Investment Assessment and the Roadmap were both informed by a ResilientMass Finance Advisory Committee. The Committee included representatives from municipal government, regional planning agencies, community-based organizations, academic institutions, and advocacy groups across Massachusetts, with a focus on including voices from organizations representing Environmental Justice populations (see Appendix A). The engagement process helped ensure the final product not only reflects technical and economic feasibility but also advances climate equity, community resilience, and long-term stakeholder alignment.

Together, the Investment Assessment and the Roadmap provide a set of key resilience measures that offer clear public value and a phased strategy for financing, delivering and scaling those measures over time. The Roadmap enables smarter investment, stronger coordination, and more equitable outcomes—ensuring that the Commonwealth's most important resilience priorities are not only identified, but also delivered.



Nantasket Beach, MA

Nantucket, MA

Investment Assessment of Key Resilience Measures

This chapter presents the investment need and resilience value associated with seven key resilience measures—high-impact capital interventions across infrastructure, ecosystems, and public services defined specifically for the purposes of this study. These seven key resilience measures focus specifically on projects that require upfront capital investment and do not represent the universe of *all* resilience investments, such as programs that support preparedness or community capacity building.

The analysis identified seven key resilience measures through an iterative process. Starting from an extensive list of potential measures developed based on agency data and literature review, state and local agency representatives and subject matter experts applied the following selection criteria: the capital/physical asset nature of projects, alignment with Massachusetts' existing resilience policy frameworks, risk reduction potential, availability of cost and project information, and geographic considerations. The ResilientMass Finance Advisory Committee, a group of representatives from municipal government, regional planning agencies, community-based organizations, academic institutions, and advocacy groups across Massachusetts (see Appendix A), provided additional consultation to refine the final seven key resilience measures.

The Investment Assessment relies on state and local agency data and studies. The investment need presented is an estimated rough order of magnitude (ROM) upfront capital cost for a subset of strategies within each key resilience measure based on data and methodology availability.

The investment need analysis does not include operations and maintenance or financing costs. The investment need analysis focuses primarily on resilience investments through 2050 for publicly owned assets, though this focus varies by key resilience measure methodology.[12]

The value that could be realized from investing in the key resilience measures, referred to herein as the resilience value, is summarized based on literature review and case studies. For a subset of key resilience measures, benefit-cost analysis was conducted to demonstrate the avoided costs and co-benefits of prototypical projects. The resilience value information presented here is meant to demonstrate potential avoided costs and benefits that could be realized from investments in the key resilience measures. However, resilience value is highly variable and context dependent and not all avoided costs or benefits may be applicable or realized for all investments.

Table 1 shows the total ROM investment need estimated for the seven key resilience measures with additional information provided in the following pages. Overall, the Investment Assessment does not capture all resilience investment needs or resilience value. It is not a capital improvement plan and does not identify specific assets for prioritization or investment.[13] See Appendix B for additional information on data, methodology, and analysis limitations.

Resilience Measure

As defined by this project, a capital project or program, or portfolio of capital projects or programs, that is actionable and aims to achieve climate resilience outcomes and benefits across one or more of the following sectors: Human Health and Wellbeing, Governance, Infrastructure, Natural Environment, and Economy. The Investment Assessment focuses on seven key resilience measures.

Resilience Value

Resilience value encompasses the avoided costs as well as broader social, environmental, and economic benefits that may result from measures taken to prepare for, withstand, and rapidly recover from disruptions to everyday life from a changing climate.

Investment Need

Investment need is presented as a ROM estimate of the upfront capital expenditure that may be required to implement the key resilience measures.[14]

Table 1: Summary Results of Rough Order of Magnitude Investment Need Estimates by Key Resilience Measure

Key Resilience Measure	Investment Assessment Focus	Investment Need Through 2050* Rough Order of Magnitude Range
Significant and High Hazard Dams: Remove or, where not feasible, upgrade or repair significant and high hazard dams to respond to future climate conditions, protect communities' safety and security, and restore habitats for cool-water and warm-water fisheries	• Remove 200 to 300 dams (of the state-regulated dams approximately (~) 200 are significant or high hazard and in unsafe or poor physical condition)	$0.5B to $1B[15]
Small Bridges and Culverts: Replace priority undersized small bridges and culverts to reduce flood hazards for communities and critical inland infrastructure and restore fish and wildlife movement	• Replace/upsize half of the existing culverts and small bridges (based on field surveys of one-third of existing culverts)	$13B to $20B[16]
Coastal and Riverine Wetlands and Floodplains: Protect, enhance, and reconnect coastal and riverine wetlands and floodplains through: • Restoration of coastal and riverine wetland and floodplain habitat • Permanent conservation of undeveloped land • Property buyout • District-scale flood protections	• Restore coastal and freshwater wetlands (assumes 1,300 to -3,600 acres per year of wetland acreage is restored) • Install district-scale flood protection in coastal areas • Buy out 1,250 to 2,500 residential properties (assumes buy out of around 50-100 properties annually)	$7B to $15B[17]
Forest Conservation and Tree Planting: Expand forest conservation and tree planting, including urban forestry, to reduce urban heat island effect, increase carbon sequestration, improve stormwater management, and enhance cooling capacity	• Conserve 685,000 acres of forest based on the Commonwealth's 40% by 2050 conservation goals • Plant 64,000 acres of urban and riparian trees based on the Commonwealth's 2050 goals for tree planting	$7B to $11B[18]

Table 1: Summary Results of Rough Order of Magnitude Investment Need Estimates by Key Resilience Measure (continued)

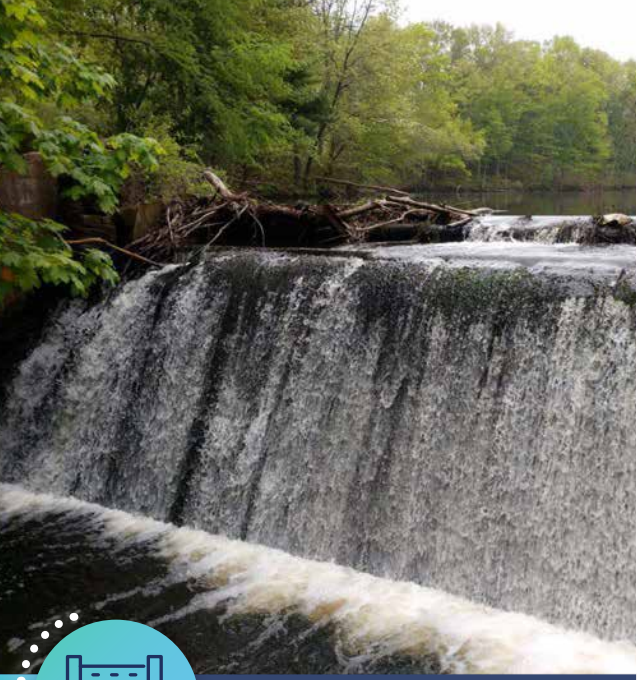
Key Resilience Measure	Investment Assessment Focus	Investment Need Through 2050* Rough Order of Magnitude Range
Strategic Transportation Infrastructure: Reduce impacts from flood waters and erosion on strategic transportation infrastructure through protection or relocation of roadways, railway, tunnels, bridges, and transit facilities and infrastructure	• Elevate, protect or otherwise maintain a portion of exposed mile of roads class 1 to 4 (highways and major roads) in the 100-year floodplain • Protect bridges with riprap and strengthen bridge piers and abutments to withstand future conditions • Install flood protection at tunnel portals in the Central Artery/Tunnel system and at Massachusetts Bay Transportation Authority (MBTA) tunnel portals, and complete pump room upgrades to protect MBTA tunnels • Elevate commuter rail that is MBTA-owned in the 100-year floodplain • Upgrade and protect transit facilities and infrastructure	$33B to $44B[19]
Drinking Water, Wastewater, and Stormwater Infrastructure: Protect and upgrade critical drinking water, wastewater and stormwater infrastructure to reduce impacts from coastal and inland flooding and extreme precipitation	• For drinking water and wastewater infrastructure, increase storage, add effluent treatment, protect or relocate facilities, and expand green and gray infrastructure to handle higher flows • For stormwater infrastructure, expand green stormwater infrastructure (GSI) to address wet weather events and invest in separating the combined sewer systems in the 19 combined sewer overflow (CSO) permittee communities across the Commonwealth	$20B to $32B[20]
Heat Preparedness and Relief: Invest in heat preparedness and relief including: • Increase in access to cooling for residents, unhoused people, and outdoor workers such as through expanded cooling in buildings and cooling centers • Increase in shade structures, splash pads, parks, swimming areas and waterfront access	• Implement cooling measures in buildings, especially schools, homes, and government buildings • Install shade structures, pools, and splash pads at Department of Conservation and Recreation (DCR) parks	$7B to $9B[21]
Total (rounded, $2024)		**$90B to $130B**

Notes:

Results are shown in 2024 United States dollars ($) and are rounded. B = Billion

The information presented reflects estimates developed using a defined set of assumptions and inputs. It is intended to illustrate the potential scale of investment that may be required to progress the above key resilience measures and does not represent final investment need or spending commitments.

*The investment assessment focuses primarily on resilience investments through 2050 for publicly owned assets, though the methodology varies by key resilience measure.



Lowes Pond Dam, Oxford, MA

Key Resilience Measure

Significant and High Hazard Dams

- Remove or, where not feasible, upgrade or repair significant and high hazard dams to respond to future climate conditions, protect communities' safety and security, and restore habitats for cool-water and warm-water fisheries.

KEY TAKEAWAYS

Resilience Value

Dam removal or repair can improve community safety through reduced risk of dam failure and can prevent costly damage to property and infrastructure. Dam removal can also improve water quality and habitat connectivity, restore fish passage, enhance public access, and reduce costs to dam owners for repairs and inspections.

Investment Need

Costs reviewed for Massachusetts dam removal projects range from less than $100 thousand (K) to $20 million (M) per dam. In a United States Geological Survey (USGS) cost database, the average removal cost for 50 dams in Massachusetts was around $800K.[22] Cost drivers are generally sediment quantity/quality, location, access, and potentially impacted infrastructure such as bridges, culverts, and buildings.

Dam repair costs can vary greatly from project to project. Dam repairs can include tasks such as spillway repair, spillway enlargement, crest raise (concrete or earth), stability berms, stability anchors, intake repair, outlet repair, gate repair, foundation grouting, filter berms, mass concrete repair, and masonry repair. While costs vary by project, the cost of repair and maintenance was **27 percent (%) to 400%** more than the cost of removal according to a case study analysis of dam removal projects in the Commonwealth.[23]

There are over 400 state-regulated dams categorized as unsafe or in poor physical condition in Massachusetts, around 200 of which are also classified as significant or high hazard. The Office of Dam Safety (ODS), which regulates nearly half of the dams within Massachusetts has identified the 43 highest priority dams for removal or repair based on hazard potential and condition.

The investment need is estimated to be $0.5 billion (B) to $1B to **remove between 200 and 300 dams.**

Project Spotlight

In 2005, Whittenton Pond Dam in the City of Taunton, Massachusetts (City) was feared to potentially fail during an extreme flooding event, causing temporary stationing of National Guard troops and the evacuation of 2,000 residents for a week. This event cost the City nearly $2.7M in emergency response costs and lost revenues to local businesses. Whittenton Dam was removed from the Mill River in 2013 at a cost of $725K. The removal was estimated to result in $3.6M in savings relative to repair.[24]

BACKGROUND

Massachusetts has ~3,000 documented dams, of which over 1,400 are state-regulated. Dams can help to maintain water supply, generate hydroelectric power, and/or reduce the risk of flooding through controlled storage and release. However, if the dam is structurally compromised or extreme weather occurs, dam failure can lead to dangerous flooding conditions. Most dams in Massachusetts were constructed in the 1700s and 1800s to power small mills. Many have outlived their original purpose and are aging, increasing their risk of failure.

INVESTMENT NEED AND RESILIENCE VALUE

Massachusetts-regulated dams (~1,400 of the ~3,000 dams) are assigned hazard codes and physical condition ratings. Hazard codes describe the risk of impact if the dam were to fail while physical condition describes the physical condition of the dam. There are just over 900 state-regulated dams categorized as significant or high hazard in Massachusetts. There are over 400 state-regulated dams categorized as unsafe or poor condition, around 200 of which are also classified as significant or high hazard. ODS has identified the 43 highest priority dams based on hazard potential and condition. The investment need analysis estimates costs for the removal of 200 to 300 dams and applies a range of costs per removal. Table 2 summarizes the estimated investment need.

Table 2: Rough Order of Magnitude Investment Need Estimates Through 2050 for Significant and High Hazard Dams

Key Resilience Measure	Low	High
Significant and High Hazard Dams	$0.5B	$1B

Notes: Results are shown in 2024 dollars and rounded. See Appendix B for more information.

Avoided Emergency Response and Flood Damages. Dam overtopping or failure poses risk to safety and property. Flooding impacts from dam failure can cause business disruption and economic losses associated with temporary business closure or relocation.[25] The potential dam failure at Whittenton Pond Dam in 2005 was estimated to exceed $2.7M in emergency response costs and economic losses.[26] In 2023, flash flooding in Leominster caused over $30M in damages, including the collapse of Brooks Pond Dam and the evacuation downstream of Barrett Park Pond Dam.[27, 28] Given that the frequency of intense precipitation events in New England has increased by 74% over the last century and is projected to increase by an additional 40% by the end of this century, the risk of dam failure is likely to increase.[29]

Avoided Repair and Maintenance Costs. A case study analysis by the Division of Ecological Resources (DER) found that the cost of dam removal for three dams was on average 60% less expensive than repair and maintenance over 30 years. Repair and maintenance costs for these dams ranged from 27% to 400% more than the cost for removal.[30] Several dams in Massachusetts are privately owned and can present cost liabilities that may impact business decisions. The Briggsville Dam removal project on the Cascade School Supplies company property preserved 150 jobs, as the cost to repair and maintain the dam would have caused the company to go out of business.[31]

Improved Water Quality and Ecological Health. Dam removal allows for habitat connectivity for fish and wildlife, and improved habitat and water quality. The Ipswich and Parker Dam removals open nearly 140 miles of main stem and tributary miles for migratory fish runs, which have direct positive potential impacts for the commercial fishing industry.[32] A University of Massachusetts-Amherst study found that impounded water had higher surface water temperatures downstream of the dams, and two-thirds of the dam impoundments studied had less dissolved oxygen in the water than upstream of the dams.[33] Contaminated sediment can also pool in stagnant water and pose risks to aquatic organisms. If a dam was to fail, this contaminated sediment could pose public health risks.[34]

North Adams, MA

Key Resilience Measure

Small Bridges and Culverts

- Replace priority undersized small bridges and culverts to reduce flood hazards for communities and critical inland infrastructure and restore fish and wildlife movement.

KEY TAKEAWAYS

Resilience Value

Many of the culverts and small bridges within Massachusetts are undersized and/or deteriorated. When floodwater exceeds the hydraulic capacity of a culvert, undersized culverts are more likely to fail and are more susceptible to debris build up. Storm-induced flooding at undersized culverts may result in damage to the culvert, road, and surrounding properties. Upsizing and upgrading culverts and small bridges can help to manage current and future storm flows, thus reducing flood risk, and allow sediment and debris to pass naturally through, improving water quality, habitat, and biodiversity.[35] Improved culverts can save money from avoided repair and replacement costs.[36]

The prototype project benefit-cost analysis estimated the avoided physical damages and business interruption, reduced traffic delays, avoided disruption of emergency medical services (EMS), and ecosystem service benefits offered by a prototypical suburban culvert replacement project in Massachusetts. The analysis found that benefits outweighed costs on a magnitude of ~2.5 to 3.5. Note not all benefits are readily monetizable, so benefits are likely understated.

Investment Need

Culvert and small bridge project costs can vary significantly depending on length of the proposed structures, complexity of the site, and design standards, among other factors. This key resilience measure specifically focuses on small bridges (defined as having spans between 10 and 20 feet in length) and culverts (structures less than 10 feet).[37]

Costs are estimated to replace and upsize existing culverts and small bridges, some of which will need to be upsized to an extent that they become small bridges and bridges, respectively.

Costs reviewed for replacing and upgrading culverts to meet road-stream crossing standards were around $500K to $1.2M per culvert. Small bridge replacement costs were in the range of $1.5M to $2M. Upsizing from a small bridge to a bridge can cost over $2M per project.

The investment need is estimated to be $13B to $20B to replace/upsize half of today's culverts and small bridges.

Project Spotlight

In the town of Raynham in southeastern Massachusetts, the original Hill Street culvert was a perched round pipe only 3 feet wide. Commercial and residential development in the vicinity of the Hill Street culvert resulted in increased impervious surface surrounding the site. The effect of this development increased stormwater loadings to the stream, resulting in flooding upstream of the culvert. Benefits of upgrading the culvert with an improved design in 2010 included:

- Avoided damages to residential properties upstream of the culvert
- Potential for increased property values of developable land and residential parcels due to reduced flood risk
- Project-supported construction of largescale industrial development, providing an estimated 300 jobs and $740K in local and regional annual tax revenues
- Increased habitat connectivity.[38]

BACKGROUND

Culverts and bridges play an integral role supporting Massachusetts' transportation network and reducing flooding. This key resilience measure specifically focuses on small bridges (defined as having spans between 10 and 20 feet in length) and culverts (structures less than 10 feet). There are nearly 25,000 documented culverts and 1,500 documented small bridges in the Commonwealth. Many have reached or are reaching the end of their designed service life and/or are undersized relative to current stream flows.[39,40] Given that climate change predictions include increases in both the frequency of severe weather and the amount of precipitation, risk of failing culverts and small bridges will likely be heightened under future conditions.[41,42]

INVESTMENT NEED AND RESILIENCE VALUE

Costs were estimated for culverts and small bridges replacement/upgrades and upsizing. Based on field surveys of ~8,500 culverts, DER estimated that at least half of all culverts and small bridges are undersized and need to be replaced to meet road-stream crossing standards. The investment need analysis estimates the cost to replace or upsize half of today's culverts and small bridges. Table 3 summarizes the estimated investment need.

Table 3: Rough Order of Magnitude Investment Need Estimates Through 2050 for Small Bridges and Culverts

Key Resilience Measure	Low	High
Small Bridges and Culverts	$13B	$20B

Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Avoided Physical and Business Interruption Damages: Storm-induced flooding at undersized culverts may result in physical damages to the culvert and road, as well as nearby infrastructure and properties. Damages can be costly, particularly if they are recurring and require temporary repair costs or if they impact nearby buildings. Businesses can avoid disruption costs caused by lack of access due to road closure or building damage.

Avoided Routine Maintenance Costs: There are significant costs for ongoing maintenance of undersized culverts, such as frequently removing debris and costly recurring road and culvert repairs. A study in Maine estimated that improved culverts would save money over a 50-year timeframe, based solely on expected reductions in repair and replacement costs.[43] The frequency of extreme storms and level of precipitation will continue to increase as the climate changes, and it is critical that road-stream crossings are appropriately sized to handle increased stream flows.

Avoided Traffic Delay and Detours: Failed culverts can lead to road closures, which can cause detours and delays. Preventing road closure can result in avoided time and vehicle operating costs, as well as avoided lost income for businesses and employees located on inaccessible roads.

Avoided Critical Service Disruption: In life-threatening situations, timely emergency care is a key factor that affects the chances of survival. If the route of EMS provider is impacted by a road closure due to a failed culvert, there may be an increase in response time, with each minute increase having potentially catastrophic consequences. Similarly, fire and police responses can be delayed if there is road closure. A culvert that is damaged may leak water which can also damage utility lines and cause utility disruption to residents and businesses. Utility disruption was not monetized in the prototypical project benefit-cost analysis.

Ecosystem Services and Environmental Benefits: Well-designed and adequately sized culverts that allow wildlife, sediment, and debris to pass naturally through a stream can provide water quality improvements, improved habitat, and biodiversity benefits. When culverts fail and there is road damage, sediment load can enter the stream which can degrade water quality and negatively impact the ecology of a stream.[44] Improved fish passage also increases populations of recreationally or commercially valuable wildlife species in the area.[45]

Property Value Benefits: While the increase in property value specifically attributable to upgrading culverts is difficult to quantify, the reduced potential for flooding of the property and of roads used to access homes can make properties more attractive to buyers.[46] Upgrading culverts can also increase the value of developable residential and industrial properties due to the reduction in flood risk.[47] This benefit was not monetized in the prototypical project benefit-cost analysis due to high variability in potential changes to property values.

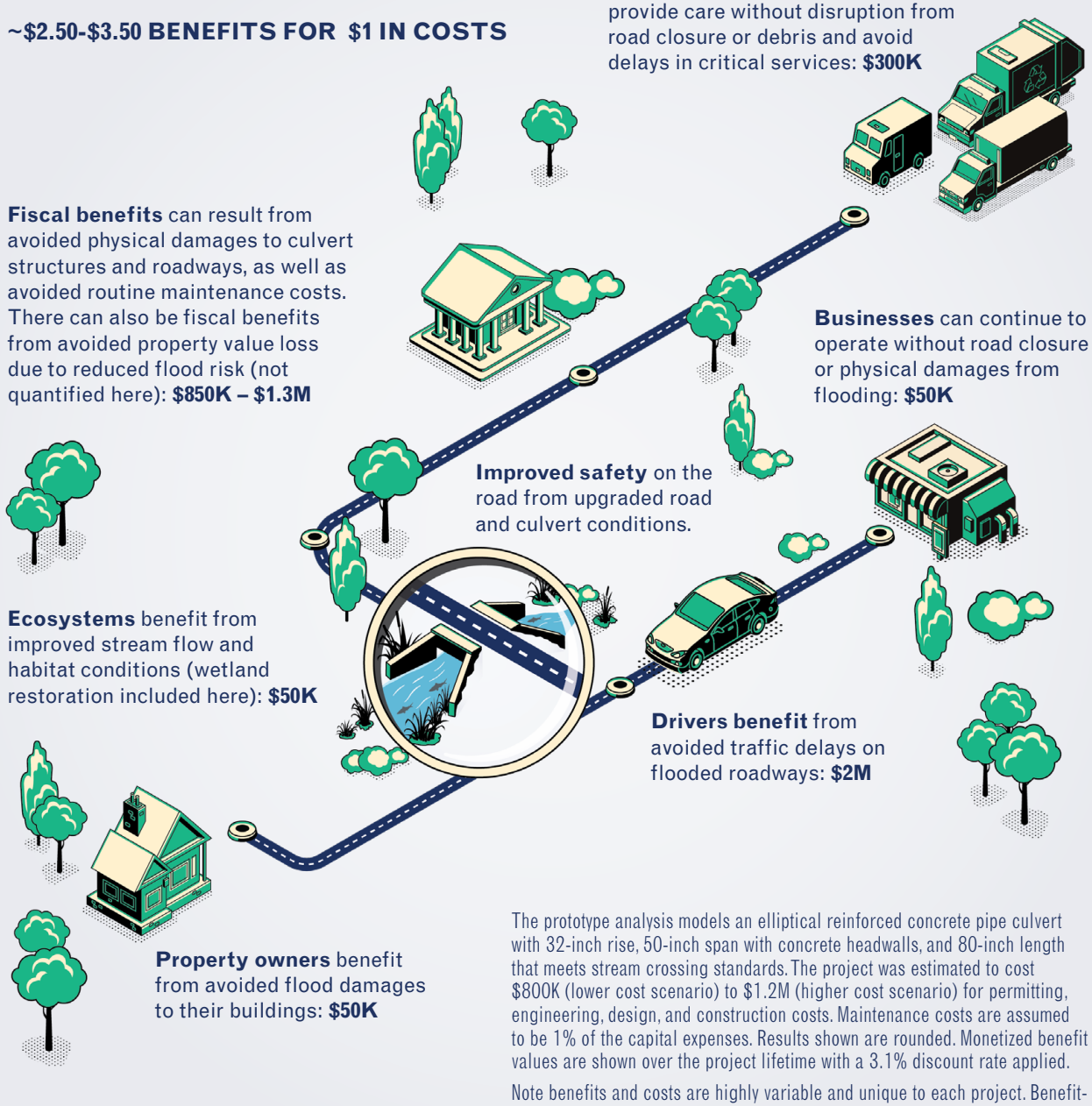
Avoided Road Safety Concerns: Poorly maintained and undersized culverts can erode stream banks and roads and become obstructed with debris, exacerbating flooding upstream. The storm flow from a culvert can also erode the sides of a paved channel or the bottom of a graded channel. When these water channels erode, they can create gullies on the side slopes that can trip the wheels of an errant vehicle or bicycle causing instability, loss of control or initiating a vehicle rollover.[48] This was not independently monetized in the prototypical project benefit-cost analysis to avoid double-counting issues related to road closures.

Suburban Culvert Prototype Project

Replacing and upsizing a culvert can offer many benefits including reduced routine maintenance costs, avoided costly structural and property damages, avoided road closures and business disruption, and ecosystem benefits. Benefit-cost analysis was conducted for a prototypical project to replace and upsize a suburban culvert. It is estimated that the project would yield $2.50-$3.50 benefits per $1 invested over a 50-year project lifetime. Note not all benefits are readily monetizable, so benefits are likely understated. Upsizing culverts could potentially increase flooding to nearby properties. The geographic context should be considered prior to an upsizing initiative.

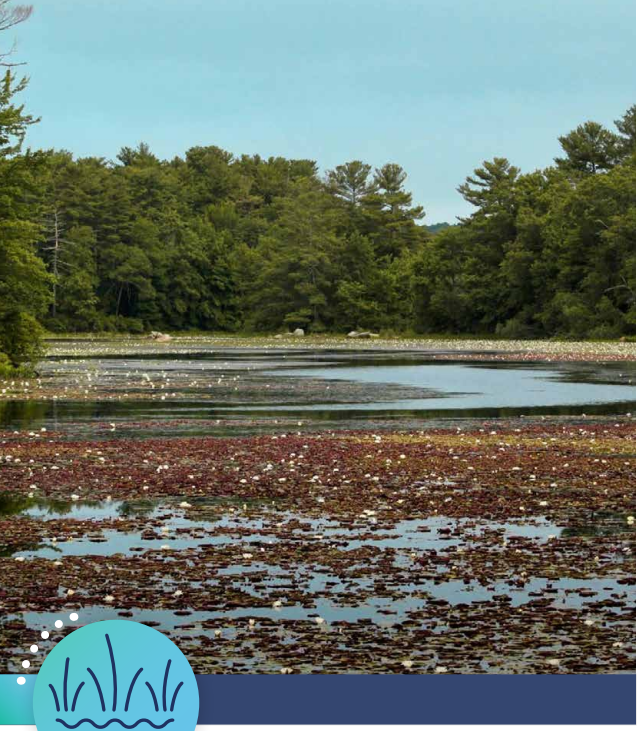
CULVERT REPLACEMENT SUBURBAN PROTOTYPE EXAMPLE

~$2.50-$3.50 BENEFITS FOR $1 IN COSTS



The prototype analysis models an elliptical reinforced concrete pipe culvert with 32-inch rise, 50-inch span with concrete headwalls, and 80-inch length that meets stream crossing standards. The project was estimated to cost $800K (lower cost scenario) to $1.2M (higher cost scenario) for permitting, engineering, design, and construction costs. Maintenance costs are assumed to be 1% of the capital expenses. Results shown are rounded. Monetized benefit values are shown over the project lifetime with a 3.1% discount rate applied.

Note benefits and costs are highly variable and unique to each project. Benefit-cost ratios shown here do not represent all projects of this type.



Hopedale, MA

Key Resilience Measure

Coastal and Riverine Wetlands and Floodplains

Protect, enhance, and reconnect coastal and riverine wetlands and floodplains through:

- Restoration of coastal and riverine wetland and floodplain habitat
- Permanent conservation of undeveloped land
- Property buyout
- District-scale flood protections

KEY TAKEAWAYS

Resilience Value

Proactive restoration of wetlands and floodplains and resilience investments through permanent conservation, buyout, and district-scale flood protection can decrease flood and flood-related damages, provide water, climate, and habitat quality improvements, and support commercial and recreation opportunity. District-scale flood protection strategies recommended for South Boston as part of *Climate Ready Boston*, including seawall installation, raising infrastructure, and increasing beach and dune restoration, had estimated benefit-cost ratios ranging from 8.7 to 44.9.[49]

Investment Need

There are many strategies that could help to protect, enhance, and reconnect coastal and riverine wetlands and floodplains. As noted in the key resilience measure description and based on data and method availability, the focus for the investment need is on permanent conservation of undeveloped lands, wetlands restoration, buyouts, and district-scale flood protections. Investment need related to land conservation is captured in **Forest Conservation and Tree Planting**.

Costs to restore wetlands can vary significantly, but typical projects are estimated around the range of $5K to $25K per acre. District-scale flood protection, which can include both gray and green infrastructure, can be implemented at-scale to protect communities. To date, studies have primarily focused on district-scale flood protection for coastal areas, including *Climate Ready Boston*, which looked at various strategies to adapt communities in Boston Harbor costing ~$4B. Property buyout programs can target high-risk properties for voluntary buyout to avoid flood-related damages over time. The cost of a buyout program depends on how many properties are purchased and the price per property. Analysis based on Redfin median home sale prices weighted by county acreage in the 100-year floodplain estimated an average sales price per home ~$675K.

The investment need is estimated to be $7B to $15B for **wetland restoration, district-scale flood protection (coastal focus),** and **property buyout.**

Project Spotlight

The Eagle Neck Creek Salt Marsh Restoration Project in Truro restored 15.4 acres of salt marsh by removing tidal restrictions. As a key site in the larger Pamet River system restoration effort, this project included installing a new culvert, widening an existing railroad berm, dredging sediment to create a new channel, and raising a stretch of road.[50] This project benefits critical salt marsh habitat by restoring ecological processes while also improving road safety. According to DER, construction costs were ~$3M, with pre-construction costs ~$600K. Additional phases of the restoration of the Pamet River will continue through 2030 to restore tidal flow across the entire estuarial system. The estimated benefit-cost ratio for the total restoration project, including benefits from carbon sequestration, nitrogen removal, and fisheries, ranges between 4.2 and 7.2.[51]

BACKGROUND

Wetlands and floodplains allow flood waters to expand and lose velocity, thereby reducing the risk of property damage and safety concerns. Wetlands and floodplains can be a natural sink for carbon within the soil and vegetation and are common breeding and feeding grounds for fish species and other wildlife.[52] Massachusetts has over 1,500 linear miles of coastline and an estimated 590,000 acres of wetlands across coastal and freshwater areas, the majority of which are freshwater.[53, 54] Climate change will exacerbate coastal and riverine flooding. Building resilience through strategies such as permanent conservation of undeveloped lands (discussed further in **Forest Conservation and Tree Planting**), wetlands restoration, buyouts, and district-scale flood protections can decrease risk.

INVESTMENT NEED AND RESILIENCE VALUE

The investment need analysis estimates the cost to restore wetlands, build district-scale flood protection (with a coastal focus), and invest in property buyout. In absence of a statewide wetland restoration target, the analysis assumes an area equal to 5% to15% of today's wetland acreage is restored. The district-scale flood protection estimate incorporates completed studies focused on estimating costs to protect against future conditions, with the low-end applying around $4B from *Climate Ready Boston* and the high-end applying costs of nearly $8B from a study focused on upgrading gray infrastructure along the shore and addressing beach and dune nourishment under future sea level scenarios. The property buyout investment need analysis estimates voluntary property buyout for 1,250 to 2,500 properties. The Massachusetts Emergency Management Agency (MEMA) is scheduled to conduct a feasibility study for a statewide voluntary flood buyout and elevation program in Fiscal Year 2026 (FY26) that will more thoroughly provide recommendations to inform the implementation of such a program. Table 4 summarizes the estimated investment need.

Table 4: Rough Order of Magnitude Investment Need Estimates Through 2050 for Coastal and Riverine Wetlands and Floodplains

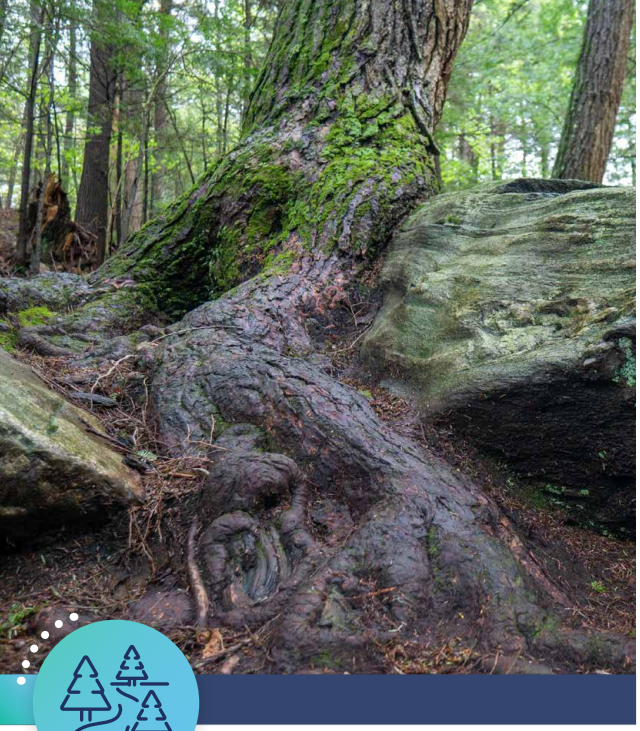
Key Resilience Measure	Low	High
Coastal and Riverine Wetlands and Floodplains	$7B	$15B

Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Avoided Flood Damage: Avoided flood damages can encompass physical damages to buildings as well as financial and systemic impacts to residents and businesses (e.g., public health impacts, fiscal impacts, business disruption, critical services disruptions, and transportation delays). According to the Massachusetts Climate Change Assessment, coastal property damage could cost over $1B per year by the 2070s, while damages to residential structures from riverine flooding are estimated to reach $226M by 2090 (nearly double the $116M estimated to occur without climate change).[55] The benefit-cost ratio for seawall, berm, or hybrid approaches on Cape Cod is estimated to be about 2.0 for protection against up to 12 feet of coastal flooding between 2021 and 2100.[56] For district-scale projects recommended for South Boston, such as seawall installation, raising infrastructure, and increasing beach and dune restoration, the estimated benefit-cost ratios range from 8.7 to 44.9.[57]

Water, Climate, and Habitat Quality Improvements: Floodplains act as natural filters that allow sediment and harmful nutrients to settle. Two wetland restoration projects in Barnstable County, on the Parkers and Pamet rivers, had benefit-cost ratios of 5.2 to 8.3 and 4.2 to 7.2, respectively, when considering direct economic, carbon sequestration, nitrogen removal, and fisheries benefits against restoration costs over a period of 2021 to 2050.[58] Separately, the benefit-cost ratio for the restoration of 410 acres of vulnerable cranberry bogs in Barnstable was between 1.1 and 2.0, based on the value of nitrogen removal and value of carbon sequestration over a period of 2021 to 2030.

Commercial and Recreation Benefits: According to the *ResilientCoasts Draft Plan*, the Massachusetts marine economy contributes $8.3B annually to the state's gross domestic product (GDP), with the fishing industry alone generating over $600M annually.[59] As of 2025, Cape Cod is estimated to lose between ~50 and 100 feet of beach width between 2040 and 2093, costing a cumulative $13B in lost value of beach recreation between 2021 and 2100.[60] Floodplain restoration and certain adaptation investments that reduce flooding, such as dune restoration, can yield benefits for commercial fisheries, recreational fishing, and other recreational and tourism activities.



Dalton, MA

Key Resilience Measure

Forest Conservation and Tree Planting

- Expand forest conservation and tree planting, including urban forestry, to reduce urban heat island effect, increase carbon sequestration, improve stormwater management, and enhance cooling capacity.

KEY TAKEAWAYS

Resilience Value

The forests and trees of Massachusetts provide many climate resilience benefits. Tree canopies provide shade and transpiration benefits that can lower pedestrian-level temperatures by up to 21 degrees Fahrenheit (°F).[61] Average reduction in national residential energy use due to urban trees is estimated to be over 7%, which could result in significant energy cost savings for low-income and energy burdened communities.[62] Urban forest ecosystems in developed areas improve air and water quality, provide habitat for wildlife and increase the aesthetic value of a neighborhood. A review of the costs and benefits of urban tree planting finds that $1 invested in urban trees can yield an average of over $5 in benefits across benefit categories including aesthetic/amenities, shading, water regulation, carbon reduction, and air quality.[63] Note not all benefits are readily monetizable, so benefits are likely understated.

Investment Need

Massachusetts has a statewide goal to plant 64,000 acres of new urban and riparian trees by 2050. According to a Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Urban Forestry Study, this goal is estimated to cost $300M.

Massachusetts has a statewide goal to permanently conserve 40% of undeveloped land and water (including wetlands) by 2050. In absence of a goal specific to forest conservation, the analysis applied this goal for the investment need. Achieving this goal will involve both acquisition and conservation restrictions. The cost of land acquisition and conservation restrictions is highly variable. From 1985 through 2022, DCR's Division of Water Supply Protection program acquired nearly 27,500 acres at an average cost of $5,235 per acre. Review of the land purchase price per acre from AcreValue for agricultural and undeveloped land ranged $11.8K to $23.8K in Massachusetts. For conservation restrictions, costs reviewed are in the range of $5K to $9K per acre.

The investment need is estimated to be $7B to $11B for **forest conservation** and **tree planting**.

Project Spotlight

The Massachusetts Greening the Gateway Cities Program is an environmental and energy efficiency program designed to reduce household heating and cooling energy use by increasing tree canopy cover in urban residential areas in Gateway Cities. This program targets Environmental Justice neighborhoods and areas with lower tree canopy, older housing stock, higher wind speeds, and a larger renter population. In addition to the direct benefits of expanding tree canopy, large-scale urban tree planting initiatives provide local employment and economic activity.[64]

BACKGROUND

The forests and trees of Massachusetts improve air and water quality, provide habitat for wildlife, and support recreation opportunities.[65] Urban forest ecosystems, including urban parks, street trees, and greenways in developed areas, increase aesthetic values of neighborhoods and reduce the impacts on stormwater infrastructure through enhanced infiltration of rainfall and prevention of erosion. Shade trees also provide a range of benefits related to microclimatic effects, such as lowering ambient temperatures and mitigating the impacts of wind events, resulting in improved quality of life and energy savings.[66, 67] Tree canopy is uneven across communities which can have negative consequences such as public health impacts on high-heat days. For example, historically redlined areas of Boston have 20% less parklands and 40% less tree canopy than other areas of the city and experience 7.5°F hotter average daytime temperatures during heat events than the rest of Boston.[68]

INVESTMENT NEED AND RESILIENCE VALUE

The investment need analysis estimates costs to permanently conserve 685,000 acres of undeveloped land and water and to plant 64,000 acres of new urban and riparian trees by 2050. Conservation is assumed to be achieved through a combination of land acquisition and conservation restrictions. Table 5 summarizes the estimated investment need.

Table 5: Rough Order of Magnitude Investment Need Estimates Through 2050 for Forest Conservation and Tree Planting

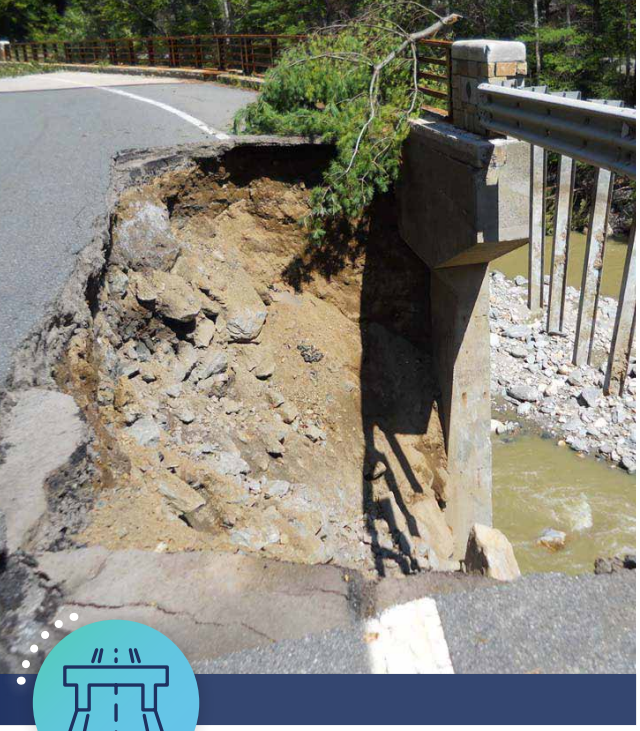
Key Resilience Measure	Low	High
Forest Conservation and Tree Planting	$7B	$11B

Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Reduction in Urban Heat Island and Other Cooling Benefits: Tree canopies provide shade and transpiration benefits that can lower pedestrian-level temperatures by up to 21°F.[69] This cooling benefit is particularly important for urban areas, where urban heat island effects can increase daytime temperatures between 1°F and 7°F higher on average than outlying areas.[70] Tree canopies are not distributed evenly across Massachusetts communities, and those communities with less coverage may experience disproportionately positive impacts from tree canopy investment. Average reduction in national residential energy use due to urban trees is estimated to be 7.2%, which could result in significant energy cost savings for low-income and energy burdened communities.[71]

Property Values and Economic Benefits: Across the Commonwealth, tree cover has been estimated to generate ~$31B in property value and $2.8B in annual quality-of-life benefits.[72] Economic output per capita generated by urban forestry-related activities was over $475 per capita in Massachusetts in 2017, or $3.3B annually.[73] The positive economic impacts of forests apply to land conservation more broadly. A panel study of land conservation in all major New England cities and towns between 1990 and 2015 found a statistically significant and positive relationship between employment and land protection, with an outsized impact on rural areas.[74]

Ecosystem Services and Carbon Sequestration: The Commonwealth's ecosystems are productive assets, or "natural capital" which provide significant ecosystem services to its residents.[75] A review of the costs and benefits of urban tree planting finds that every $1 invested in urban tree projects yields an average of $5.43 in benefits across benefit categories including aesthetic/amenities, shading, water regulation, carbon reduction, and air quality.[76] An analysis completed by the Trust for Public Land finds that every $1 invested in land conservation in Massachusetts generates $4 of economic value from ecosystem services such as water quality protection, stormwater management, and air pollution removal.[77] The Massachusetts Forest Carbon Study finds that the Commonwealth's forests serve as a long-term net-sink of atmospheric carbon and play an important role in meeting Net Zero commitments by offsetting residual emissions from other sectors, which are the most difficult and costly to reduce.[78]



Franklin County, MA

Key Resilience Measure

Strategic Transportation Infrastructure

- Reduce impacts from flood waters and erosion on strategic transportation infrastructure through protection or relocation of roadways, railway, tunnels, bridges, and transit facilities and infrastructure.

KEY TAKEAWAYS

Resilience Value

Increasing resilience of strategic transportation infrastructure promotes system reliability, supports economic activity, and protects critical routes for safety and security purposes. Proactive investment yields economic benefits and savings on repair and maintenance costs. Benefit-cost analysis of a complex proposed resilience strategy to address flooding along Morrissey Boulevard, a critical arterial roadway along the Dorchester Shoreway, estimated between $1.40 to $3.30 in avoided damages for every $1 in proposed project costs.[79] Note this is only for building-related damages, so benefits are likely understated.

Investment Need

The investment analysis focuses on the resilience of five transportation asset categories: roads, bridges, tunnels, rail, and transit facilities and infrastructure. The analysis specifically focuses on strategic transportation infrastructure, which for purposes of this analysis includes roadway classes 1 through 4, bridges over 20 feet, tunnels in the Central Artery/Tunnel system in Boston, MBTA tunnel portals, MBTA commuter rail, and MBTA transit facilities and infrastructure. Bridges under 20 feet are captured in **Small Bridges and Culverts**. Ports and airports are not included. This key resilience measure focuses on reducing impacts from riverine and coastal flooding, though it is noted that transportation infrastructure will require investments to mitigate impacts from other hazards such as extreme precipitation and heat.[80] Due to data availability, the analysis estimates the cost of resilience investments to maintain infrastructure in place rather than wholesale relocation of impacted segments of the transportation network.

A wide range of strategies to mitigate coastal and riverine flooding were reviewed, such as elevating assets, constructing physical barriers, upgrading pump rooms and flood protection for tunnel portals, and restoring nearby ecosystems for natural flood protection. Numerous studies have evaluated road adaptation strategies, such as Cape Cod's Low-Lying Road Project and strategies for arterials in the Boston area. The MBTA Tunnel Flood Mitigation program, which began in 2021, focuses on minimizing flooding in MBTA's tunnels through pump room upgrades, flood protection for tunnel portals, head houses, and other upgrades. A 2015 study, summarized more recently in the Massachusetts Department of Transportation (MassDOT) Highway Resilience Plan (2024), estimated it would cost $309M to protect tunnel portals for roads in the Central Artery/Tunnel system through 2100 (based on assumptions rather than specific designs).[81] Internal analysis completed for costs associated with elevating a segment of heavy rail applies $140M per mile as a low-end estimate and $330M per mile as a high-end estimate.

The investment need is estimated to be $33B to $44B for **road, bridge, tunnel, rail,** and **transit facilities and infrastructure.**

Project Spotlight

The MBTA completed the Fenway Flood Portal Protection Project on the Green Line in 2020. The project incorporated floodgates and large steel doors to prevent tunnel flooding as well as updates to the pumping station and cameras to monitor water levels.[82] The project protects the tunnel from riverine flooding, which has previously caused costly damages and long shutdowns for repairs. In 1996, significant flooding caused nearly $70M in damages to the Green Line as water got into the tunnel and led to flooding at Kenmore Station.

BACKGROUND

Massachusetts has over 36,000 centerline miles of road, 1,400 miles of rail, and additional supporting infrastructure as part of robust municipal and state transportation networks.[83, 84, 85] Extreme weather events, such as extreme heat, coastal flooding, and heavy precipitation, as well as accelerated sea level rise and coastal erosion can cause consequential damage to transportation infrastructure and gradual degradation of the network over time. The 2023 ResilientMass Plan notes that over 1,800 miles of road are in coastal hazard areas for a Category 1 Storm, with over 3,000 miles of road vulnerable to a Category 3 Storm.[86]

INVESTMENT NEED AND RESILIENCE VALUE

The investment need analysis estimated road resilience costs by considering the potential cost of adaptation for a portion of miles of class types 1 through 4 road (major roads and highways) located in the 100-year Federal Emergency Management Agency (FEMA) floodplain as available with MassGIS data (which covers about 90% of the Commonwealth). Bridge costs were estimated based on proactive maintenance/rehabilitation costs to strengthen and stabilize to account for projected changes in peak flows from a 100-year, 24-hour precipitation event under future conditions. Tunnel cost estimates were based on data on pump room upgrades and flood protection for transit tunnel portals provided by the MBTA, and cost estimates for highway tunnel portal protection provided by MassDOT. Rail resilience investments include a low- and high-end estimate of per mile of rail elevation based on internal analysis of heavy rail elevation scenarios, which are applied to MBTA-owned commuter rail miles in the 100-year FEMA floodplain. MBTA light rail and heavy rail (i.e., subway and Green Line) are assumed in this analysis to be made resilient with pump room upgrades and flood protection for subway tunnel portals, as well as shore-based perimeter protection measures. Transit facility and infrastructure costs were estimated based on planned projects for facilities included in the MBTA's Capital Investment Plan.

Focusing on road and rail assets exposed in the 100-year FEMA floodplain has limitations because it does not account for asset vulnerability. This approach also captures only coastal and riverine flooding and does not account for future conditions. Additional rail mileage owned by other public and private entities are not included in this analysis due to lack of data and existing studies, but it is important to note that further investment may be needed across the network to support system functionality. Heat can also degrade transportation infrastructure and would require additional investment, but flooding is the focus of the investment need analysis for this key resilience measure. Table 6 summarizes the estimated investment need.

Table 6: Rough Order of Magnitude Investment Need Estimates Through 2050 for Strategic Transportation Infrastructure

Key Resilience Measure	Low	High
Strategic Transportation Infrastructure	$33B	$44B

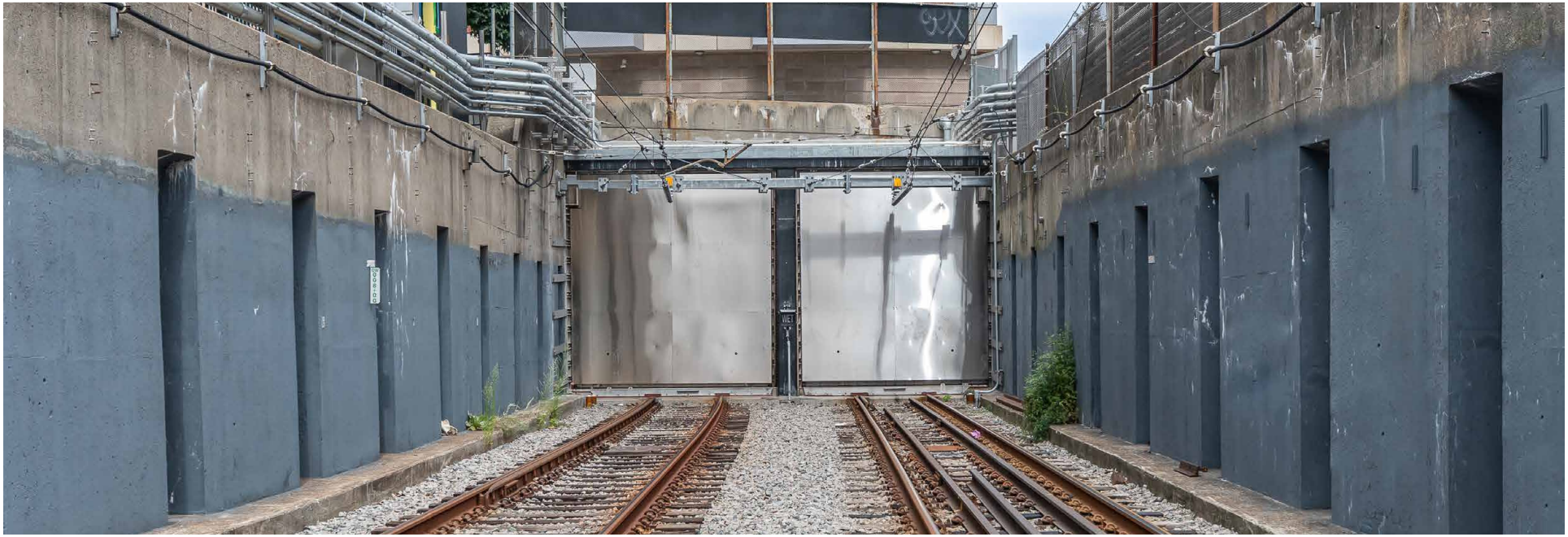
Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Avoided Physical Damages and Repair Costs: A 2023 study from researchers at the Massachusetts Institute of Technology estimates that losses solely for the MBTA rapid transit system due to sea level rise are projected to be $58M annually by 2030 without adaptation and resilience measures, while rail damages associated with extreme heat could require an additional $35M in annual repair costs; these estimates do not include damages for the remainder of the transit system.[87, 88] A national study of hazard mitigation finds that investment in resilient transportation infrastructure generates $4 of benefits for every $1 spent. Monetized benefits include reduced casualties/post-traumatic stress, avoided property loss and insurance savings, and avoided business interruption and loss

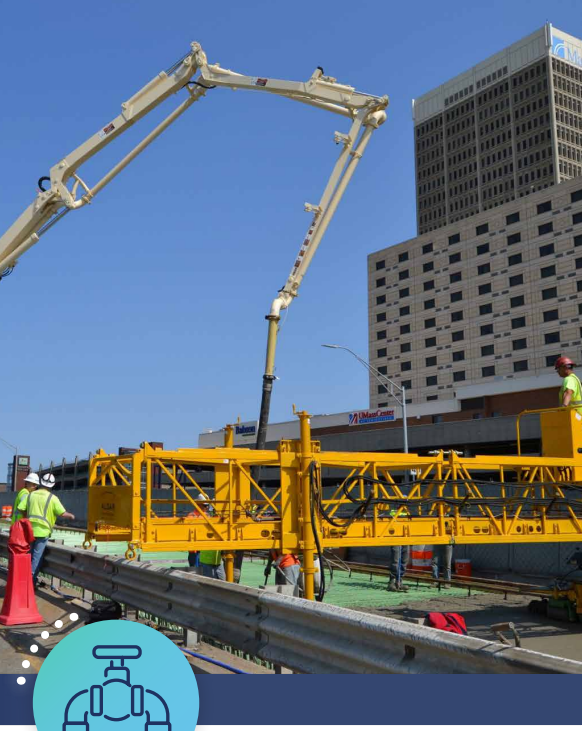
of service.[89] In the rail sector, the costs under a no-adaptation scenario are estimated between 12 and 15 times higher in 2050 compared to a proactive scenario where infrastructure is fortified in advance of impacts. In the road sector, the cost of inaction is estimated to be between 12 and 17 times higher in 2050 compared to the proactive scenario.[90]

Avoided Disruption and Delays: In Massachusetts, road delays from high tide flooding could result in over 4M vehicle hours of delay by 2030 and 40M hours of delay by 2050.[91] The economic value of the travel time delay from high-tide flooding is conservatively $128M annually in 2030 and $1.3B annually by 2050.[92] During extreme heat events and in "slow zones," trains operate at reduced speeds to compensate for heat-related stress or wear and tear on tracks—increasing travel times for riders and operating costs. Transit tunnel flooding, such as the Fenway flooding in 1996, can cause extended shutdowns and diversions while repairs are completed, but investments in tunnel protections and track dewatering can minimize the disruption and ensure safe restoration of transit service. Public transit delays disproportionately reduce economic opportunity for low-income residents and people of color, who are most dependent on reliable public transit for access to employment.[93] Investment in the MBTA Track Improvement Program has removed more than 220 slow zones, generating nearly $1M in economic benefit per day from saving riders over 40,000 hours in daily travel time delays across the Commonwealth.[94]

Reduced Public Health Impacts and Security Risks: Road closures due to flooding create detours and traffic that delay emergency services such as EMS, police, and fire responders. The economic impacts of human health and property losses related to emergency services delays from flooding events in Massachusetts are projected to be $1.4M annually by 2070.[95] Additionally, unprotected transportation infrastructure is vulnerable to washout in a flood or hurricane event, landslides, fire, and other disasters that place pedestrians and motorists at risk. Public transit is the most energy efficient form of transportation apart from people-powered movement. Making the public transit system resilient and reliable helps to support continued mode shift and long-term greenhouse gas and co-pollutant emission reductions.



Boston, MA
Source: MBTA Customer and Employee Experience Department



Springfield, MA

Key Resilience Measure

Drinking Water, Wastewater, and Stormwater Infrastructure

- Protect and upgrade critical drinking water, wastewater, and stormwater infrastructure to reduce impacts from coastal and inland flooding and extreme precipitation.

KEY TAKEAWAYS

Resilience Value

Resilient water, wastewater, and stormwater infrastructure is critical to health and safety and must be sufficiently protected from coastal and inland flooding and extreme precipitation to avoid potentially fatal consequences. The project prototype benefit-cost analysis included evaluation of a hybrid green/gray stormwater infrastructure project and a project to protect a wastewater treatment plant (WWTP) against coastal flooding and sea level rise. The hybrid green/gray stormwater project benefits outweighed costs by a ratio of 2:1 based on avoided damage to properties and ecosystem benefits of utilizing urban trees, rain gardens, and increasing open green space. The WWTP adaptation project benefits outweighed costs by a ratio of 2.5:1, with benefits from avoided physical and environmental damages and reduced service interruptions. Note not all benefits are readily monetizable, so benefits are likely understated.

Investment Need

The focus of the investment need analysis is on drinking water, wastewater, and stormwater infrastructure based on data and method availability. Presently, the Boston Water and Sewer Commission (BWSC) is planning to separate 630 acres of combined sewer area in East and South Boston from 2024 to 2029. BWSC's Coastal Stormwater Discharge Analysis provides concept cost estimates for resilience improvements at 11 locations to protect from sea level rise and storm surge totaling over $2B. In 2022, Massachusetts reported $7.7B in gray and green stormwater infrastructure needs to continue meeting federal Clean Water Act requirements over the next 20 years.[96]

There are many resilience needs associated with critical infrastructure and facilities, more broadly. MEMA has 15 ongoing generator and microgrid projects totaling over $6M for critical facilities including hospitals, fire stations, emergency operating centers, police stations, pump stations, and shelters. Massachusetts Department of Environmental Protection (MassDEP) has proposed funding emergency power at publicly owned treatment works to ensure continued operation in the event of a flood or other weather-related event resulting in a loss of power.

The investment need is estimated to be $20B to $32B for drinking water, wastewater, and stormwater infrastructure.

Project Spotlight

Newburyport's wastewater treatment facility is located in the Merrimack River coastal floodplain and is vulnerable to coastal flooding. The facility was built to process 3.4M gallons of wastewater per day but cannot withstand the additional stormwater passing through the pipes during major storm events. If no action is taken, service disruption could impact 18,000 residents and affect homes, businesses, and industrial operations for weeks or months during repair. A combination of federal, state, and local funding (including three Municipal Vulnerability Preparedness program grants) has provided nearly $50M to date to upgrade the facility and increase overall resilience.[97, 98]

BACKGROUND

Coastal flooding and precipitation can overwhelm already-deteriorated critical facilities and infrastructure. Climate change threatens the quality of source water through increased runoff of pollutants and sediment. In Boston and other older municipalities across Massachusetts, heavy rainfall can lead to CSOs that discharge toxic pollutants into water bodies, harming public health and the environment. Failure to have a functional emergency power source that is protected from flooding can result in the discharge of untreated or partially treated sewage to waterways. Resilience investments for drinking water, wastewater, and stormwater can relate to expanding green and gray infrastructure to manage higher flows, combined sewer separation, increasing treatment to address pollution, raising pump stations, relocating treatment plants, investing in backup power and increasing storage to maintain water sources and handle changes in precipitation frequency and intensity, among others.

Investment needs for power infrastructure (including transmission and distribution), communication networks, solid waste and other critical public facilities (e.g., hospitals, police stations) are not costed due to data and method limitations. Such investments could relate to increasing drainage capacity, infrastructure burying and hardening, and facility relocation and floodproofing, among others.

INVESTMENT NEED AND RESILIENCE VALUE

The investment need analysis focuses on drinking water, wastewater, and stormwater and uses methods based on available data and resources. In absence of a statewide study for resilience costs for drinking water and wastewater infrastructure, the analysis relies on the National Association of Clean Water Agencies and the Association of Metropolitan Water Agencies 2009 assessment quantifying the costs to adapt the nation's drinking water and wastewater facilities to 2050. The study estimated adaptation costs for the Northeast region. For drinking water, the study looks at costs to make up shortfalls in source water, drinking water treatment costs, and flood management costs related to a changing climate. For wastewater, the study evaluates costs for changes in wet weather program costs, wastewater facility protection and effluent pumping investments, and cooling system costs for certain regions. The investment need analysis applies a scaling factor to the calculated Northeast costs based on the ratio of water flow handled by Massachusetts relative to the study's Northeast region.

The investment need analysis estimates stormwater costs based on the cost to separate the combined sewer systems in the 19 CSO permittee communities across the Commonwealth. It also includes costs for GSI investments to respond to increased wet weather events. Importantly, the stormwater investment need analysis does not include pipe upsizing due to insufficient data and methodology to do so. Additionally, combined sewer separations, which will be increasingly important due to the increasing frequence and volume of CSOs, are already a strategy and not all costs may be attributable to resilience need specifically. Table 7 summarizes the estimated investment need.

Table 7: Rough Order of Magnitude Investment Need Estimates Through 2050 for Drinking Water, Wastewater, and Stormwater Infrastructure

Key Resilience Measure	Low	High
Drinking Water, Wastewater, and Stormwater Infrastructure	$20B	$32B

Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Avoided Property Damage: Storm-induced flooding to critical infrastructure may result in physical damages both to the asset and to nearby properties. Resilience against rising sea levels, extreme storms, and ocean tide events are a key concern for critical infrastructure close to the ocean. Facilities are prone to failure from structural, electrical, and process disruptions from high water level events. Inaction can require costly emergency repairs and higher maintenance costs, eroding the long-term financial sustainability of local utilities and increasing burdens on ratepayers.

Avoided Service Disruptions: The United States Army Corps of Engineers found that proactive flood adaptation investment yields $2 to $6 in avoided costs per $1 invested over a 50-year project lifetime, with benefits including reduced flood damage, emergency response costs, service interruptions, and regulatory fines.[99] Inaction will require emergency repairs that can cost more and occur more frequently, eroding the long-term financial sustainability of local utilities and increasing burdens on ratepayers. Without critical utilities such as water, businesses might need to temporarily close, and residents may need to relocate during the repair time.

Public Health and Safety Protections: Flooding or excess rain can lead to runoff or sewer overflow that contaminates well water and other drinking water sources with harmful pollutants or bacteria that could cause illness if consumed. Without resilience upgrades, these disruptions would endanger source water quality and public health. In Boston, stormwater pump stations protect evacuation routes and low-lying neighborhoods already facing multiple stressors. When these systems fail, consequences can cause road flooding and delay emergency response.

Ecosystem Service Co-benefits and Avoided Environmental Impacts: Stormwater runoff delivering pollutants into natural bodies of water can cause detrimental effects to public health and the environment. CSO and other sewage runoff contribute to increased algae blooms that cause loss of oxygen and threaten aquatic ecosystems.[100] When water exceeds a certain depth against the WWTP building, it can flow over or breach protective barriers and flood the building, equalizing the pressure inside and out. This can interfere with proper discharge and cause contamination from untreated effluent to the surrounding environment and nearby waterbodies. Reducing flooding, runoff, and the volume of water that enters into the stormwater system through interventions such as GSI can offer multiple co-benefits including property value benefits, heat mitigation, air quality improvement, carbon sequestration, and water quality improvement through filtration of pollutants.

Wastewater Treatment Plant Berm Prototype Project

WWTPs are often located in areas prone to flooding during extreme precipitation events and/or areas impacted by sea level rise and storm surge. Benefit-cost analysis was conducted for a prototypical wastewater treatment resilience project protecting the WWTP with a vegetated earthen berm around its perimeter. Benefits from protection relate to avoided physical damages and service disruption and avoided environmental consequences. The prototypical project is estimated to yield $2.50 in benefits per $1 invested over a 50-year project lifetime. Note not all benefits are readily monetizable, so benefits are likely to be understated.

WASTEWATER TREATMENT PLANT RESILIENCE PROTOTYPE EXAMPLE

~$2.50 BENEFITS FOR $1 IN COSTS

Benefits

- **WWTP owners** benefit from avoided structural damages: **$6M**
- **Residents** benefit from avoided disruptions and temporary relocation costs: **$12.5M**
- **Businesses and the economy** benefit from avoided business losses from service disruption: **$3.4M**
- **Environmental** impacts are avoided, namely from avoided discharges and untreated effluent that can damage the surrounding environment and contaminate nearby waterbodies: **$300K**

Building a vegetated earthen berm around the perimeter of a small, coastal WWTP (2.5 million gallons per day). The project was estimated to cost $5M for permitting, engineering, design, and construction costs. Maintenance costs were assumed to be ~3% of the capital expenses. Results shown are rounded. Monetized benefit values are shown over the project lifetime with a 3.1% discount rate applied.

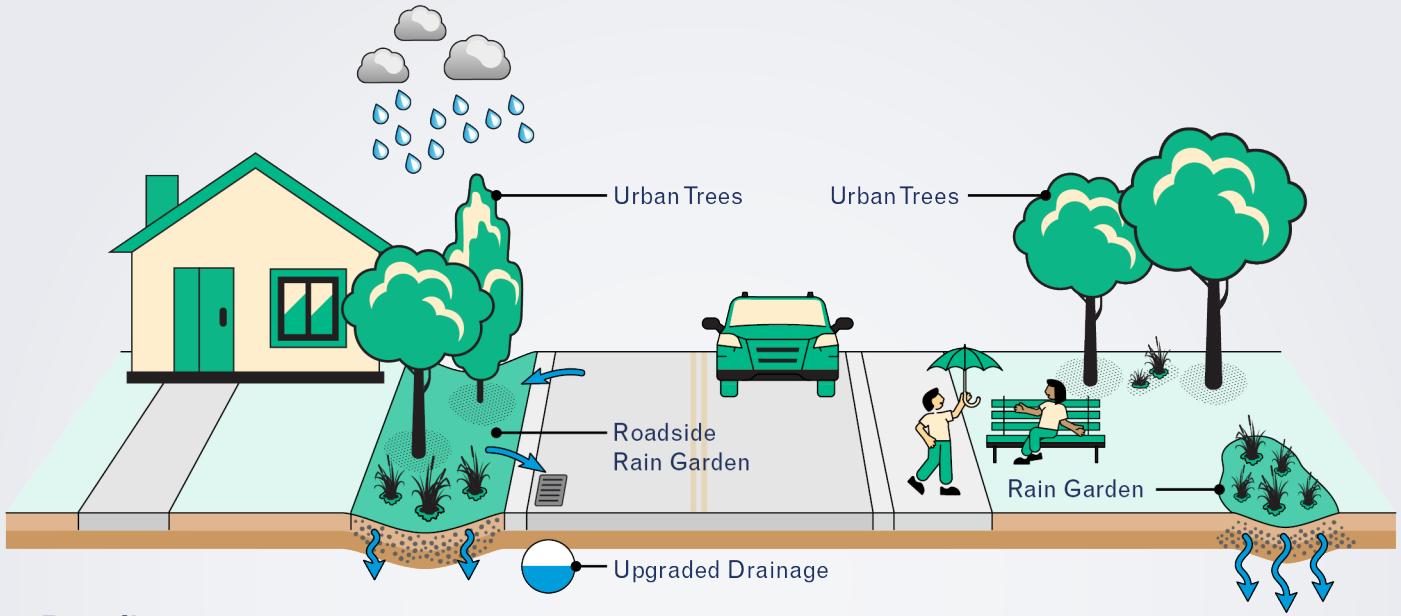
Note benefits and costs are highly variable and unique to each project. Benefit-cost ratios shown here do not represent all projects of this type.

Green/Gray Stormwater Infrastructure Prototype Project

Green and gray stormwater infrastructure can be coupled to increase project cost-effectiveness and co-benefits. GSI can help to manage stormwater at the source, capturing rainwater where it falls using elements such as urban trees, rain gardens, and permeable pavement. Alongside conventional gray infrastructure upgrades, such as pipe upsizing, GSI can provide a range of benefits including avoided property damages and ecosystem co-benefits. GSI elements can also improve property values and reduce energy costs. Benefit-cost analysis was conducted for a prototypical project in a suburban area that includes upgrading a drainage pipeline and replacing an area of impervious surface with open green space, a rain garden, and trees. It is estimated that the prototypical project would yield $2 benefits per $1 invested over a 30-year project lifetime. Note not all benefits are readily monetizable, so benefits are likely understated.

GREEN/GRAY STORMWATER INFRASTRUCTURE PROTOTYPE EXAMPLE

~$2 BENEFITS FOR $1 IN COSTS

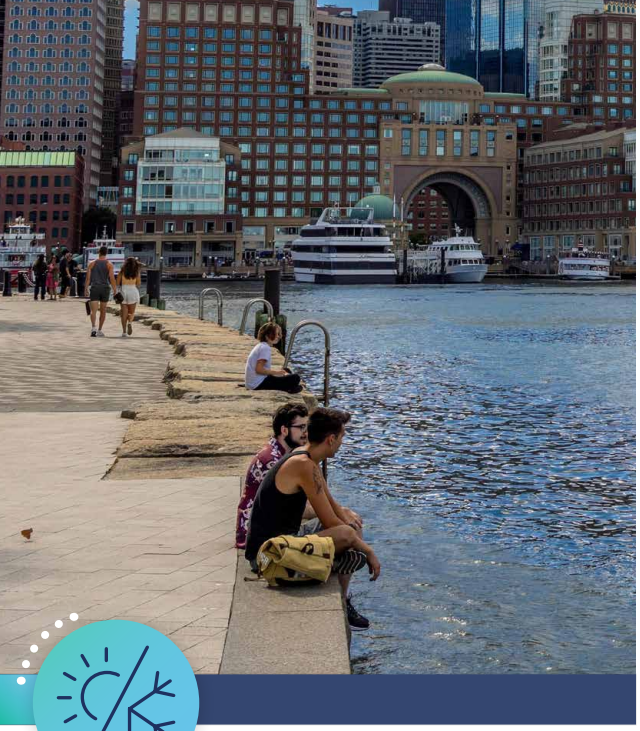


Benefits

- **Property owners** benefit from avoided flood damages to their buildings: **$1M**
- **Urban trees** provide significant stormwater volume control through rainfall interception and intensity reduction, stormwater infiltration and uptake, and nutrient load: **$400K**
- **Rain gardens** reduce peak flows within downstream sewer systems and allow pollutant removal through filtration and plant uptake: **$90K**
- **Green urban open spaces** reduce stormwater by capturing precipitation, slowing its runoff, and reducing the volume of water that enters the stormwater system: **$90K**
- Overall, green infrastructure elements can provide species habitat, water quality improvements, recreation opportunity, improved aesthetic of an area, increased property values, and cooling on hot days.

Upgrading a drainage pipeline from 15-inch reinforced concrete pipe to 36-inch reinforced concrete pipe, 110 linear feet, removing a small area of impervious surface (such as a parking lot or vacant lot in residential area) and replacing this area with ~8,200 square feet (ft²) of urban open green space, 17 trees, and ~1,500 ft² of rain garden. The project was estimated to cost $740K for permitting, engineering, design, and construction costs. Maintenance costs were assumed to be 1% of the capital expenses. Results shown are rounded. Monetized benefit values are shown over the project lifetime with a 3.1% discount rate applied.

Note benefits and costs are highly variable and unique to each project. Benefit-cost ratios shown here do not represent all projects of this type.



Boston, MA

Key Resilience Measure

Heat Preparedness and Relief

Invest in heat preparedness and relief including:

- Increase in access to cooling for residents, unhoused people, and outdoor workers such as through expanded cooling in buildings and cooling centers
- Increase in shade structures, splash pads, parks, swimming areas, and waterfront access

KEY TAKEAWAYS

Resilience Value

Heat preparedness and relief investments can provide a wide variety of benefits including public health, education outcomes, labor productivity, fiscal revenue, avoided transportation delays, and potential greenhouse gas reduction, air quality, and recreation co-benefits. Access to an air-conditioned space or cooling center during a heat event can lower the risk of mortality by 66%, while access to home air conditioning can reduce the risk of mortality by 77%.[101]

Investment Need

A variety of strategies are needed to support heat preparedness and relief, such as community cooling centers and tree planting (discussed in **Forest Conservation and Tree Planting**). Infrastructure investments, such as changes in pavement grade and grid resilience investments will also be important for adaptation but are not the focus of this measure.

Based on data availability, the investment need analysis estimates costs for cooling in buildings (schools, government buildings, and homes) and expanding the presence of shade structures, pools, and splash pads at DCR-managed parks and playgrounds.

- Cooling in Buildings: Reviewed costs range from $8K to $22K per heat pump for homes. School air conditioning installation costs reviewed are about $2M to $5M per school, while government building costs reviewed range between less than $100K to over $250K.
- Shade Structures, Pools, and Splash Pads: Reviewed costs range from less than $10K to $1M for shade structures driven by size of the structure. DCR costs for splash pads range from $500K to $800K and $8M for a new pool.

The investment need is estimated to be $7B to $9B to expand **cooling in buildings** (schools, government buildings, and homes) and to increase **shade structures, pools, and splash pads** at DCR parks.

Project Spotlight

To protect the health and wellbeing of park visitors and staff across Massachusetts, DCR is implementing Project Shade. Project Shade aims to enhance the resilience of state parks to extreme heat by strategically installing shade structures and expanding native tree canopy. DCR conducted a shade suitability assessment to identify the hottest parks that serve the most vulnerable people. From this assessment, DCR selected pilot sites to test new shade solutions using a "Kit of Parts," a catalogue of shade design standards to facilitate the rapid and effective deployment of shade in parks and public spaces.

BACKGROUND

By 2050, it is projected that Massachusetts will experience 19 to 25 more days per year above 90°F compared to historical averages (currently ~5 days per year).[102] Extreme heat has many adverse effects including increased mortality and morbidity rates, higher energy costs, and strain on existing infrastructure. Higher temperatures also lead to decreased labor productivity and contribute to poor air quality, including increases in aeroallergens and the number of days with air quality alerts.[103] Certain communities across the Commonwealth are particularly at risk for extreme heat impacts due to their exposure, vulnerability, and adaptive capacity. People experiencing homelessness, people with chronic health conditions, pregnant people, outdoor workers, low-income people, children and youth, older adults, and homebound individuals are all at an increased risk for health and mortality impacts from extreme heat events. Resilience measures can be implemented to mitigate these adverse effects.

INVESTMENT NEED AND RESILIENCE VALUE

Due to data availability, the investment need analysis focuses on increasing cooling in buildings (schools, government buildings, and homes) and investing in additional shade structures, pools, and splash pads in DCR-managed parks. Table 8 summarizes the estimated investment need.

Table 8: Rough Order of Magnitude Investment Need Estimates Through 2050 for Heat Preparedness and Relief

Key Resilience Measure	Low	High
Heat Preparedness and Relief	$7B	$9B

Notes: Results are shown in 2024 $ and rounded. See Appendix B for more information.

Vulnerable Populations and Public Health Benefits: Access to an air-conditioned space or cooling center for vulnerable residents during a heat event can lower the risk of mortality by 66%, while access to home air conditioning can reduce the risk of mortality by 77%.[104] If no adaptation action is taken by 2090, Massachusetts will experience an estimated 400 additional premature deaths attributable to extreme temperature annually, with an economic impact of over $6B by the end of this century.[105] These impacts are exacerbated for minority and language-isolated populations, which have a 22% and 28%, respectively, higher rate of premature death due to extreme heat.[106]

Recreation, Quality of Life and Environmental Benefits: Heat resilience measures such as splash pads, urban tree canopies, and shade structures can provide relief from heat, while offering co-benefits such as recreation and improved air quality. Studies have noted strong correlations between environmental conditions and quality of life indices, suggesting that environment tends to be among the highest quality of life considerations influencing household location decisions.[107]

Labor and Learning Benefits: A statewide analysis of lost wages and hours due to heat impacts for Massachusetts found that, by 2090, high heat impacts could result in lost work hours equal to over 10,000 full-time equivalent workers and lost wages of over $775M annually.[108] Heat exposure also reduces mental productivity. An analysis of over 10M Preliminary Scholastic Aptitude Test (PSAT) scores in the United States finds that, in schools without air conditioning, a 1°F hotter school year reduces that year's learning by 1%.

Public Services and Fiscal Impacts: Hotter temperatures place additional burdens on local government services. In the Commonwealth, emergency department visits are 17% above the baseline for days at or above the current 95th percentile maximum temperature.[109] A 2022 study estimating the impact of temperature on municipal expenditures found that average annual per capita municipal expenditures in Massachusetts could be $924 higher by end of century compared to the period between 1990 and 2019.[110]

Resilience Finance Roadmap: Building Capacity for Action

Ipswich, MA
Source: Adobe Stock

Introduction — Roadmap Purpose and Structure

Cambridge, MA
Source: Adobe Stock

Massachusetts is poised to build a climate-resilient future. Achieving resilience at scale requires a lasting, coordinated investment approach. This Roadmap is designed to provide a strategy for aligning public and private capital to support implementation of the Commonwealth's most urgent and high-impact climate adaptation solutions thereby reducing risk from increasing precipitation, sea level rise, and temperatures.

At its core, the Roadmap is built around five essential qualities of a strong investment system: sufficiency, equity, efficiency, adaptability, and accountability. These qualities are the building blocks of real-world implementation. The Roadmap applies them to the everyday challenges of delivering projects, identifying the fiscal, institutional, and technical shifts needed to sustain long-term, multi-community investment. It is designed to complement and advance the Commonwealth's existing resilience plans, helping to turn them into sustained, large-scale action.

The system outlined here focuses specifically on capital investment—funding the physical infrastructure and nature-based solutions that reduce risk and build resilience across Massachusetts.

This Roadmap does not introduce new climate goals or planning layers. It connects existing priorities to the funding, financing, and institutional systems required to make the priorities happen. It is centered on function rather than form, avoiding duplication and instead strengthens alignment across programs through a shared investment architecture.

The Roadmap is organized around four core priorities:

- Making it easier to develop and deliver priority resilience projects.
- Increasing access to funding and financing across communities.
- Establishing durable finance mechanisms that can scale over time.
- Building the regional and organizational capacity needed to support long-term implementation.

These priorities reflect a broader strategy, one that goes beyond any single tool or institution, to create a system that can deliver resilience effectively and equitably across Massachusetts.

The strategy unfolds in three phases:

PHASE 1

Phase 1 focuses on establishing foundational system functions through a limited number of pilot-ready investments and initiatives. These pilots test key project implementation components, build early momentum, and identify opportunities for system alignment.

PHASE 2

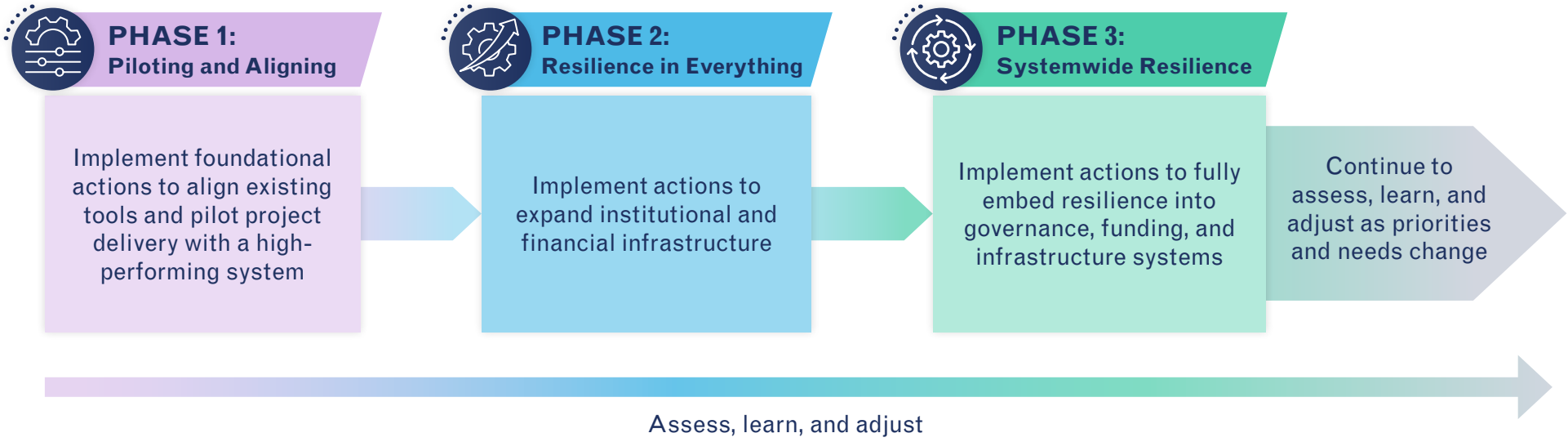
Phase 2 scales implementation capacity and strengthens governance, focusing on funding and financing tools, collaboration mechanisms, and legal and regulatory reforms.

PHASE 3

Phase 3 marks the transition to full system performance—embedding resilience investment practices into the Commonwealth's fiscal infrastructure, planning systems, and governance frameworks.

These phases do not follow fixed timeframes. Rather, they represent a practical sequence of institutional shifts, based on system readiness and lessons learned from implementation. This structure ensures flexibility while providing strategic direction. The phased approach also includes the establishment of an adaptive management framework which supports ongoing tracking of progress, continuous feedback gathering, and regular assessment of outcomes. As shown in Figure 1, this framework allows the Commonwealth to refine actions in real time and evolve future strategies based on the successes and challenges of earlier phases. As a result, many of the actions and system-building elements proposed in Phases 2 and 3 are intentionally subject to refinement, adjustment, or re-sequencing as new insights emerge.

Figure 1: Phased Implementation Process



While this Roadmap initially focuses on seven key resilience measures discussed in the preceding chapter, it is designed to support a growing portfolio of climate resilience priorities. These key resilience measures include investments in transportation and water infrastructure, wetland and floodplain restoration, and forests and urban tree canopies to mitigate flooding and heat risks. The Roadmap is intentionally structured to be responsive to emerging hazard events, enabling the Commonwealth to adjust course as new climate challenges arise.

Massachusetts has many advantages on which to build: nationally recognized programs such as ResilientMass and the Municipal Vulnerability Preparedness (MVP) Program, strong state agency leadership, and local innovation across regions.

This Roadmap proposes that the Commonwealth's next step is to weave those threads into a cohesive investment system. A system that connects local, regional, and Commonwealth-level priorities; simplifies access, reduces barriers, and enables shared progress toward common resilience goals; delivers not only more projects, but better outcomes measured in reduced climate risk, improved public health, strengthened ecosystems; and more equitable access to public investment.

By building from existing tools and focusing on system function, Massachusetts can maximize the return on public investment, improve transparency, and build trust across jurisdictions and sectors. The Roadmap seeks to align efforts, reduce friction, and ensure that every dollar spent on resilience investment helps advance long-term, system-wide objectives.

The Resilience Finance Roadmap is organized by the following sections:

- The Future Investment System section defines the structure and capabilities of the investment system Massachusetts needs to build.
- The Current Investment System Assessment section evaluates how well the current system performs against those needs, identifying gaps and strengths.
- The Pathway to Implementation section provides a phased Roadmap for transition—guiding the Commonwealth through the steps required to shift from today's landscape to a mature, adaptive, and high-performing system.

This document outlines a strategy for systemic transformation—one that builds the capacity of the Commonwealth to meet the full scale, complexity, and urgency of climate resilience for decades to come.

Becket, MA

The Future Investment System

Wellfleet, MA
Source: Adobe Stock

The resilience investment system of the future would be built around four interlocking components: project portfolios, revenue sources, financing mechanisms, and institutional structures. Together, they form the foundation for long-term, statewide implementation of the key resilience measures. Each component must perform key system functions—sufficiency, equity, efficiency, adaptability, and accountability—to ensure the system is operational, durable, inclusive, and outcome-oriented.

In this future system, project porfolios would be managed to reflect shifting climate risks, integrate multi-benefit design, and maintain geographic balance. Revenue systems would prioritize predictability and alignment with resilience goals, drawing from diversified sources that evolve with emerging needs. Financing tools would promote both scale and access—accelerating implementation while supporting participation by all communities, regardless of fiscal capacity. Institutional responsibility would be shared, grounded in strong governance, shared platforms, and continuous learning.

Investment Component: Project Portfolios. In the future investment system, project portfolios are more than lists of funded projects—they are strategic tools for delivering resilience at scale. Each portfolio embodies the traits of a high-performing system: designed for projected climate risks, implemented efficiently, distributed equitably, responsive to changing conditions, coordinated across sectors, transparent in tracking, and structured for reinvestment.

Key attributes:

- **Climate-adjusted planning and design.** Commonwealth and local projects are scoped using forward-looking climate data—temperature, precipitation, sea level rise, and storm patterns—to meet long-term risk thresholds, not just current conditions.
- **Community-informed development and oversight.** Community priorities shape design and implementation, and transparent reporting ensures accountability for outcomes. Projects that are developed with and deliver clear benefits for disadvantaged populations are prioritized, ensuring equity is embedded throughout the investment process.
- **Alignment with key resilience measures.** Alignment is not tied to a single agency's expertise or authority. It reflects a shared framework based upon the goals, plans, and expertise of each. Coordination will ensure that agency actions collectively support progress toward the key resilience measures.
- **Integration of nature-based solutions.** Where possible the portfolios routinely include and prioritize nature-based solutions—wetlands, riparian buffers, green roofs—designed to reduce risk and deliver co-benefits like biodiversity and water quality.
- **Lifecycle management and reinvestment.** Portfolios are designed for long-term impact, with monitoring, performance metrics, and reinvestment triggers that link observed results to future funding.

Investment Component: Revenue Sources. The future investment system relies on a revenue portfolio that is stable, diversified, and resilient to fiscal and environmental disruptions. Available revenues reflect the full costs and benefits of resilience, support large-scale investment, and share financial responsibility equitably across the Commonwealth.

Key attributes:

- **Dedicated resilience revenue streams.** Predictable funding sources specifically support long-term resilience investments.
- **Integration with capital systems.** Revenues are embedded in capital planning, the project pipeline, and financing systems—establishing alignment with priorities and transparent tracking.
- **Reinvestment and leverage of public funds.** Financing tools—such as revolving loan funds—can recycle proceeds from repayments into new projects, extending the impact of limited public dollars and improving long-term financial sustainability.
- **Equity-centered revenue design.** Mechanisms are structured to avoid undue burden on disadvantaged communities, using tools like rate caps, income-based tiers, or supplemental support programs.
- **Regional and sectoral flexibility.** While statewide mechanisms offer scale, the system supports local and regional adaptation of revenue strategies based on infrastructure needs and governance models.
- **Polluter-pays and value-capture alignment.** Revenues increasingly reflect either the source of climate risk (e.g., development in flood zones) or the value generated by resilience investments.
- **Transparency and public trust.** Revenue use is reported openly and shaped by community oversight—building support for sustained investment in climate resilience.

Investment Component: Financing Mechanisms. The future investment system relies on modern, flexible financing tools to amplify public funding, attract private capital, and scale implementation. Financing becomes a core driver—accelerating implementation, spreading costs over time, and tying repayment to the value generated by resilience investments.

Key attributes:

- **A resilient public finance platform.** The system provides a steady source of affordable, flexible capital for resilience projects, especially in disadvantaged communities.
- **Resilience-focused financing.** Financing approaches are tailored to support projects that deliver public value—like flood mitigation, habitat restoration, or public health improvements—even if they do not generate direct revenue.
- **Outcome-based financing models.** Innovative tools, such as pay-for-performance contracts or repayment structures tied to avoided damages, are tested where feasible.
- **De-risking strategies to enable private participation.** Instruments like loan guarantees or first-loss reserves help reduce risk and encourage private co-investment.
- **Select risk-transfer innovations.** While still emerging, mechanisms like pooled insurance or parametric coverage (which pays out automatically when climate thresholds are triggered) may offer long-term potential for stabilizing resilience investment—especially for regions with concentrated risk exposure.
- **Integration with project delivery.** Financing pathways are coordinated with permitting and planning processes so that projects are aligned with funding options early, reducing delays, and helping delivery and funding move in tandem.

Investment Component: Institutional Structures. In the future investment system, Massachusetts institutions function as a coordinated, adaptive network across sectors, jurisdictions, and levels of government. Centralizing or coordinating resilience investment functions—such as oversight, project implementation support, and performance tracking—within a lead organization or across a small set of aligned entities could help improve system coherence and accountability.

Key attributes:

- **Shared governance and strategic alignment.** Infrastructure, environmental, housing, and transportation agencies operate within a coordinated governance model that supports alignment across sectors while respecting agency-specific mandates.
- **Regional delivery and shared services.** Regional platforms offer pooled technical assistance, procurement, and grant administration—reducing burdens and aligning delivery with functional geographies.
- **Coordinated leadership with distributed implementation.** A lead institution provides statewide coordination, engages in the development and deployment of financing tools, and supports program alignment—working in partnership with agencies, regions, and communities.
- **Integrated planning and budgeting.** Resilience is embedded in capital plans, permitting, and budgets across agencies. Long-term investment aligns with capital cycles and resilience metrics.
- **Investment oversight and adaptive management.** Centralized monitoring tracks performance and system outcomes. Real-time data drives program improvement and transparent, accountable decision-making.
- **Community voice as governance.** Engagement is standard at all stages—planning, budgeting, and adaptation—ensuring investments reflect community priorities and support social and physical resilience.

These four components form the structural foundation of the Commonwealth's future resilience investment system. The sections that follow use this framework to evaluate current conditions, identify structural and functional gaps, and guide a phased transition from programmatic successes to full system performance.

Great Barrington, MA

Current Investment System Assessment

Westfield River, MA
Source: Adobe Stock

Massachusetts has made meaningful progress in advancing climate resilience investment, with agencies, communities, and sectors pursuing a wide range of models and tools. In areas like transportation and water infrastructure, core investment systems exist, but resilience-specific mechanisms are still emerging. In others—such as nature-based solutions, flood mitigation, and upgrades to public assets—progress has been driven primarily by targeted grants or short-term funding. This diversity reflects the Commonwealth's responsiveness to local needs, and it presents a key opportunity: to align current efforts into a more cohesive, long-term investment framework.

A critical framing for this assessment is the Commonwealth's dual role as a direct investor in sustainable infrastructure as well as an enabler of local action and self-sufficiency. This dual role offers broad reach but also adds complexity. Some sectors may have mature capital and revenue systems but do not consistently incorporate climate projections into designs. In areas like floodplain restoration or nature-based solutions, climate projects are incorporated, but programs often rely on short-term or grant-based funding.

The purpose of this section is to assess the Commonwealth's current position in terms of progress toward the future investment system described in the Future Investment System. It evaluates structural components (projects, revenue, financing, institutions) alongside the functional goals (sufficiency, equity, coordination, and multi-functionality) that define performance. It concludes with a review of implementation progress on the key resilience measures.

This analysis sets the stage for the Pathway to Implementation, which outlines the coordinated actions and investment tools needed to strengthen regional prioritization, streamline delivery, and build the financial and organizational capacity needed for long-term resilience.

Project Portfolios. Across the Commonwealth, communities, agencies, and technical partners are actively developing projects that address real climate risks and local needs. Initiatives such as the MVP program, Division of Ecological Restoration's (DER) regional partnerships program, and regional hazard mitigation planning through the Massachusetts Emergency Management Agency (MEMA) have built a foundation of engaged, innovative, and resilience-focused local action.

The next step is to strengthen coordination, align resource flows, and build the investment infrastructure needed to deliver resilience at scale—a transition the following sections will address. Several promising opportunities are emerging:

- **Many programs have developed strong project pipelines—but these remain largely program-specific.** New tools such as the Executive Office of Energy and Environmental Affairs (EEA) Environment and Climate OneStop can help unify fragmented pipelines, align funding streams, and support delivery of resilience at scale.

- **State agencies are incorporating resilience into capital planning.** Massachusetts Department of Transportation (MassDOT) and Division of Capital Asset Management and Maintenance (DCAMM) offer strong examples. Massachusetts can build on this momentum by developing a statewide capital planning framework that embeds climate risk, equity, and key resilience metrics into project selection. This will support more strategic and climate-informed infrastructure investment.
- **Municipalities are increasingly using climate-adjusted data in hazard mitigation and capital improvement plans.** The opportunity now is to develop a consistent statewide framework that prioritizes projects based on projected exposure, community vulnerability, and resilience co-benefits—ensuring resources go where they can have the greatest long-term impact.
- **The Commonwealth is expanding early-stage project development capacity, particularly for smaller and disadvantaged municipalities.** Massachusetts is helping communities access the support needed to scope, plan, and advance capital-ready resilience projects through initiatives like the EEA Municipal Capacity Building Strategy, the Regional Resilience Partnerships Program, the EEA Environment and Climate OneStop platform, and the Resilience Playbook, developed by regional planning agencies with support from the Barr Foundation. These efforts aim to ensure that all municipalities—regardless of size or fiscal capacity—can participate in and benefit from statewide resilience investment.

Revenue Architecture. Massachusetts already draws on a diverse mix of state, local, and federal funding sources to support resilience investments. Building on this foundation will be critical to scaling and sustaining impact.

The Commonwealth funds major capital projects directly through sector-specific revenue streams—such as fuel taxes and transportation bonding—and also plays a vital enabling role by providing grants and programmatic support to municipalities.

- **Modernizing Sector-Specific Revenue Systems.** Massachusetts channels significant capital through MassDOT and the Massachusetts Bay Transportation Authority, supported by sources such as fuel taxes, tolls, and federal matching programs. To ensure long-term resilience, these revenues should increasingly reflect climate risk, ecosystem connectivity, and equity considerations.
- **The Commonwealth can enhance local fiscal capacity by expanding tools and support for municipalities with limited financial flexibility.** This includes enabling greater access to shared services, exploring statutory reforms or exemptions to revenue and borrowing constraints, and supporting locally-driven funding mechanisms like stormwater utilities or resilience districts. By helping communities—especially smaller and rural ones—build stable, dedicated revenue streams, the state can unlock broader participation in resilience investment.
- **Maximizing State Grant Programs.** State grantmaking—such as MVP Action Grants, DER technical assistance, and Federal Emergency Management Agency-backed hazard mitigation programs—has been instrumental in advancing local resilience. Continued and expanded state support for planning, operations, and capacity-building will be essential, particularly to help communities navigate application and compliance requirements.
- **Tapping Emerging State Revenue.** New resources, such as those generated by the Fair Share Amendment are expected to yield $1.5–$2 billion annually for education and transportation. While not explicitly earmarked for climate resilience, these funds represent an opportunity to support adaptation-aligned transportation, public works, and modernization projects.

Financing Mechanisms. Massachusetts has a strong foundation for infrastructure finance. Tools like bonding, revolving loan funds, and utility-based mechanisms are regularly used for transportation, water, and energy projects, many of which align with key resilience measures. However, these tools were not designed with climate-adjusted risk, ecological performance, or social equity in mind. As a result, they are not yet structured to support the full range and scale of next-generation resilience investments, particularly in areas such as nature-based solutions, housing resilience, and community-scale risk reduction.

A central challenge lies in enabling local governments to access financing effectively. This often depends on their ability to generate sustainable, dedicated revenue streams. Unfortunately, many statutes governing local finance—like District Increment Financing (DIF) and the Betterment Law—were not created with resilience in mind, limiting the flexibility municipalities need to fund climate-related projects.

Several specific constraints illustrate these challenges:

- **Statutes set debt and property tax limits.** Municipal borrowing is capped under M.G.L. Chapter 44, Section 10 and Proposition 2½ imposes additional limits on property tax revenue. These policies protect fiscal discipline but can hinder borrowing for nontraditional, non-revenue-generating projects.
- **Financing must reflect municipal realities.** Even when tools exist, communities may be unable to use them unless repayment structures avoid tapping general funds or requiring tax overrides. Models like value capture (as described in Appendix C), credit enhancements, or shared repayment frameworks could help.
- **The definition of "financeable" is shifting.** Many priority investments—like floodplain restoration or dam removals—do not generate direct revenue. Making them financeable may require integrated capital strategies, bundling, or blending grants with low-cost loans.

Despite these constraints, promising efforts are emerging. Pilot programs test ways to bundle projects, streamline permitting, and coordinate assistance—particularly for key resilience measures like stream continuity and coastal infrastructure. These efforts suggest a future in which financing plays a stronger role in enabling scalable, resilient investments.

For financing to become a reliable tool across all project types, especially for disadvantaged communities, the Commonwealth may need to take a more active enabling role. This could include providing legal clarity, technical assistance, or credit enhancements to reduce perceived risk and support adoption.

Massachusetts is well-positioned to build this next layer of its investment system. With targeted programs, new repayment models, and continued investment in local capacity, financing can become a more accessible, equitable, and impactful tool for resilience statewide.

Institutional Structure and Capacity. Massachusetts benefits from a broad and capable network of institutions—state agencies, municipalities, regional entities, and nonprofit partners, all playing vital roles in advancing climate adaptation. Many have already begun integrating resilience into their missions, programs, and investments. The next opportunity is to link these efforts through a more cohesive and system-oriented governance approach.

Promising opportunities for institutional advancement include:

- **Optimizing distributed roles for greater alignment.** State agencies are already advancing sector-specific mandates. Formal mechanisms—such as shared frameworks or cross-agency guidance—can help align infrastructure, environmental, housing, and economic development investments around common resilience outcomes, particularly for integrated efforts like floodplain restoration and urban heat mitigation.
- **Strengthening strategic implementation.** EEA plays a central role in resilience policy, but additional coordination will benefit the full investment system. Potential improvements include centralized project pipeline development, cumulative investment tracking, and shared implementation guidance. In future phases, the Commonwealth may consider a new coordinating entity or function—but that is one option among several.
- **Building local government capacity.** While larger municipalities often manage grants and capital planning in-house, smaller and disadvantaged towns face persistent challenges. Expanding technical assistance, shared staffing, and regional service models can help ensure all communities can fully participate in resilience planning and implementation.
- **Integrating resilience into municipal priorities.** Communities across the Commonwealth are juggling aging infrastructure and competing capital needs. Embedding climate resilience into existing priorities—such as schools, roads, and water systems—requires targeted guidance, flexible tools, and reliable staff support.

Massachusetts has a strong foundation of resilience through local leadership and targeted programs. The next step is to strengthen coordination and investment systems to ensure climate resilience is delivered consistently, equitably, and at scale across all communities.

Pathway to Implementation

Westfield, MA

The Commonwealth already has the components of a high-functioning investment system in place—robust state agencies, active municipal partners, a network of planning and technical assistance entities, and a growing body of project experience. What is needed now is integration: a coordinated, durable, and well-capitalized system that can deliver resilience investments consistently and equitably across all regions and key resilience measures.

This section presents a phased implementation strategy to build that system. It outlines a deliberate transition pathway—one that builds from current conditions and recent pilots toward a fully realized system capable of delivering on the full range of resilience actions. Each phase strengthens core investment system functions such as sufficiency, adaptability, coordination, and equity, while supporting real-world project implementation along the way.

The phased strategy recognizes that system transformation must occur in tandem with continued investment. Phase 1 focuses on aligning existing programs and resources with future system behaviors. Phase 2 builds institutional capacity and expands financial infrastructure. Phase 3 formalizes and scales the system to make resilience a permanent function of government and economic planning. Throughout all phases, the key resilience measures serve as both a driver and a testbed—ensuring that system reforms are grounded in practical experience and meaningful outcomes.

Overview of the Phased Investment Strategy. Each of the three implementation phases represents a distinct stage in the development of core investment system functions—such as permitting coordination, financing infrastructure, revenue alignment, and institutional capacity—while simultaneously supporting meaningful, on-the-ground implementation of priority resilience projects. This phased approach is designed to align with real-world implementation conditions. Rather than relying on a singular reform or policy intervention, the Roadmap offers a learning-based strategy that strengthens system behaviors through action: aligning existing tools in Phase 1, expanding institutional and financial infrastructure in Phase 2, and fully embedding resilience into governance, funding, and infrastructure systems in Phase 3.

The phased approach also accounts for gathering local needs and priorities, which helps determine the best tools and interventions in the toolbox for each phase. To achieve this transformation, the Roadmap is structured around four interconnected Strategic Priorities, each addressed across the three implementation phases.

Strategic Priority 1

Make Projects Easier to Implement

Enhancing municipal and regional capabilities, especially in disadvantaged or small communities, by reducing administrative burdens, providing standardized implementation tools, and expanding access to technical assistance and early-stage support.

Strategic Priority 2

Streamline and Expand Access to Funding

Streamlining and aligning state-level programs to improve access, reduce administrative burden, and expand the scale and impact of public funding. This includes standardizing grant processes, coordinating program timelines, and expanding eligible uses of existing funds.

Strategic Priority 3

Implement Financing Mechanisms

Developing scalable, long-term financing tools and pathways—such as loan funds, value capture, and outcome-based models—to ensure sustained investment in resilience and support public-private collaboration.

Strategic Priority 4

Build Regional and Organizational Capacity

Building durable structures for statewide coordination, regional governance, and performance management—ensuring that the resilience system is accountable, adaptive, and equitable over time.

These four Strategic Priorities are woven throughout the Roadmap's three phases, with initial foundational actions beginning in Phase 1, significant expansion and institutionalization occurring in Phase 2, and full-system deployment and long-term embedding happening in Phase 3. For instance, efforts to improve local implementation capacity begin early by expanding predevelopment funding and launching pilot project implementation and investment models, while scaling these tools and providing comprehensive support becomes a focus in later phases. Similarly, while the proposed Resilience Revolving Fund is launched in Phase 1 to establish innovative financing, its full scaling and integration with other financing mechanisms occur in Phase 2 and 3. The overarching aim is to systematically build the necessary conditions and capacities across all strategic areas as the system matures.

The three phases are summarized below:

PHASE 1

Piloting and Aligning. Focuses on enabling implementation using current programs and funding sources, while laying the foundations of a more durable investment system. This includes advancing permitting alignment, expanding technical assistance, launching bundled project implementation pilots, and initiating the Resilience Revolving Fund as a proof-of-concept for scalable resilience finance.

PHASE 2

Scaling Implementation-Advancing Resilience in Everything. Focuses on institutional infrastructure, diversified revenue streams, and flexible financing tools. It formalizes the resilience project pipeline, expands shared services for regional and local implementation, and creates mechanisms for coordinated, long-term funding and project tracking.

PHASE 3

Institutionalizing and Integrating for Systemwide Resilience. Completes the transition to a fully integrated investment system, embedding resilience into the Commonwealth's capital planning frameworks, scaling financing mechanisms like the Resilience Revolving Fund, and institutionalizing systems for adaptive management, performance tracking, and reinvestment. Many of these actions are already underway and would continue to evolve.

Each phase includes specific priorities, actions, and system behaviors that signal progress toward the broader transformation. While each phase is presented sequentially, many actions can and should overlap—reinforcing the Roadmap's emphasis on learning by doing, adapting as needed, and scaling what works. Phase 1 actions are most certain, while Phase 2 and 3 actions are subject to change based on evolving conditions, priorities, and learnings. This phased approach ensures that investments across all Strategic Priorities are systematically advanced, leading to a cohesive, durable, and adaptive resilience investment platform for the Commonwealth. Figure 2 demonstrates how Strategic Priorities and actions are phased.

Figure 2: Phased Implementation of Strategic Priorities

	PHASE 1	PHASE 2	PHASE 3
Four Strategic Priorities	**Piloting and Aligning**	**Resilience in Everything**	**Systemwide Resilience**
Make Projects Easier to Implement	Develop standards, pre-approved designs, templates, and streamlining opportunities	Formalize and expand project delivery templates / frameworks	Streamline permitting, planning, and delivery processes
Streamline and Expand Access to Funding	Simplify access to existing revenues and resources via EEA Environment and Climate OneStop	Broaden EEA Environment and Climate OneStop to include additional funding programs	Establish increased access to redundant, sufficient, and diverse revenues
Implement Financing Mechanisms	Launch Resilience Revolving Fund	Expand pooled and regional financing mechanisms as needed based on Phase 1 learnings	Ensure the availability of affordable capital
Build Regional and Organizational Capacity	Pilot approaches for regional coordination and prioritization	Develop durable governance/ leadership structures	Ensure leadership accountability/ transparency

PHASE 1: PILOTING AND ALIGNING

Strategic Priority 1
Make Projects Easier to Implement

Action 1: *Lay the groundwork for bundled project delivery.*

Action 2: *Utilize and expand the Resilience Playbook to guide and accelerate implementation.*

Strategic Priority 2
Streamline and Expand Access to Funding

Action 3: *Launch and expand the EEA Environment and Climate OneStop to streamline resilience funding and strengthen project readiness.*

Action 4: *Align resilience funding with community demand.*

Strategic Priority 3
Implement Financing Mechanisms

Action 5: *Launch the Resilience Revolving Fund.*

Action 6: *Enable project-based repayment pathways.*

Strategic Priority 4
Build Regional and Organizational Capacity

Action 7: *Establish a process for tracking project pipeline implementation progress.*

Action 8: *Advance regional resilience through integrated support and governance.*

Action 9: *Establish adaptive management and cross-agency delivery framework.*

Phase 1 focuses on what can be achieved in the near-term to make meaningful progress across each of the four strategic priorities. The goal is to reduce friction, improve coordination, and establish the infrastructure, both operational and informational, needed to support adaptive, integrated investment. A central component of this phase is the launch of the Resilience Revolving Fund, a new financing tool offering low-cost, flexible capital for local and regional resilience projects. This tool would not only expedite near-term implementation but also test financing strategies and surface legal or administrative barriers that must be addressed.

Other Phase 1 actions focus on system alignment and capacity-building. These include centralized pipeline development, expansion of technical assistance platforms, and tools to support cross-program coordination. All are designed to reduce fragmentation and build the integrated systems required for broader resilience outcomes.

Phase 1 is an adaptive implementation cycle that uses performance feedback tools like ResilientMass Metrics and the Community Climate Advisory Council to track progress and refine strategies. Actions are grouped under the four strategic priorities—making projects easier to implement, expanding funding, enabling financing mechanisms, and building regional capacity. These priorities address system constraints and promote behaviors that support long-term resilience. Phase 1 combines near-term implementation of key resilience measures with broader system-building efforts such as predevelopment funding, regional coordination, and integrated permitting. These efforts accelerate current action and test features essential for long-term performance, including equity, adaptability, and institutional coordination.

Strategic Priority 1

Make Projects Easier to Implement

***Action 1:** Lay the groundwork for bundled project delivery.*

***Action 2:** Utilize and expand the Resilience Playbook to guide and accelerate implementation.*

In Phase 1, the focus is on initiating foundational improvements to strengthen municipal and regional implementation capacity—particularly in disadvantaged or smaller communities. This includes expanding access to early-stage project development support, piloting standardized project implementation tools, and deploying targeted technical assistance. The goal is to address common barriers that slow local progress on key resilience measures, such as lack of staff capacity, pre-development funding gaps, and complex administrative processes.

By building on existing Commonwealth programs and streamlining project readiness pathways, Phase 1 actions would help reduce friction at the local level and create more accessible, efficient channels for moving resilience projects from concept to implementation. This early groundwork is critical to enabling broader capacity-building and accelerating implementation in future phases.

Strategic Priority 1

Action 1

Lay the groundwork for bundled project delivery.

Bundled project delivery—implementing multiple, related resilience projects as a single coordinated effort—can improve cost-efficiency, reduce administrative burden, and support multi-benefit outcomes across sectors and jurisdictions. However, in Massachusetts, bundling remains underused due to siloed funding, fragmented permitting, and uneven municipal capacity.

In Phase 1, the focus is on developing and promoting the standards, templates, and design guidance that would enable bundled delivery in future phases. This includes creating pre-approved design packages, sample permitting pathways, and consistent scopes of work that can be used across municipalities and agencies for common project types. Initial development would center on project types with clear opportunities for bundled implementation and aligned investments.

These foundational resources would reduce administrative friction and serve as the basis for bundled projects in future phases.

ACTION 1 - PHASE 1 IMPLEMENTATION STEPS:

Develop and promote standardized templates for common project types. When appropriate, create sample scopes, pre-approved design packages, and permitting guidance for resilience project types that are well-suited for bundling.

Identify and document potential pilot clusters. Work with DER, Department of Fish and Game, and regional partners to map potential groupings of related projects that could benefit from coordinated delivery in Phase 2 or 3.

Track bundled project delivery and gather feedback. Monitor how bundled project delivery is used in practice, assess whether this approach improves permitting, procurement, or implementation processes, and collect feedback to inform future implementation.

By focusing first on the foundational standards and templates needed to streamline bundled projects, Massachusetts can build the systems and capacity required to accelerate implementation at scale in future phases.

Action 1 Case Study

Bundling for Scale: Resilience Retrofits on FDA's White Oak Campus

At the Food and Drug Administration's White Oak Campus in Maryland, resilience measures—such as floodproofing and green stormwater infrastructure—were bundled with energy and water efficiency upgrades into a single performance contract. This was possible because technical standards and guidance made it easier to integrate resilience into broader infrastructure improvements.

This approach illustrates the goals of Action 1, which focuses on developing resilience standards and technical guidance that help agencies and partners incorporate climate adaptation into mainstream capital projects. By applying similar strategies in Massachusetts—such as bundling culvert or nature-based resilience projects with other infrastructure work—Action 1 can help lower costs, unlock new financing pathways, and accelerate implementation. For more information, see pnnl.gov, *"Resilience in Performance Contracting: Case Study on Bundled Upgrades."*

Strategic Priority **1**

Action 2

Utilize and expand the Resilience Playbook to guide and accelerate implementation.

Many municipalities, particularly smaller or disadvantaged ones, face significant administrative and technical barriers to implementing resilience projects. To address these challenges, the Commonwealth is supporting the development and launch of the Resilience Playbook, led by the Metropolitan Area Planning Council and Pioneer Valley Planning Commission, with additional support from the Barr Foundation and with EEA serving in an advisory capacity.

The Playbook would provide a searchable, online hub of practical resources—offering standardized "Blueprints" that outline step-by-step guidance for implementing key project types. Following its launch, this action could focus on institutionalizing and expanding the Playbook over time, so it becomes a widely used, regularly updated platform to support delivery of resilience projects across Massachusetts.

This next phase of work could include the development of additional Blueprints, the integration of technical tools, such as the HydroRisk model, HEC-25, or others, and coordination with agency partners to ensure the Playbook is embedded into funding, permitting, and technical assistance workflows.

By formalizing and scaling the Playbook's use, the Commonwealth can make resilience implementation more consistent, efficient, and equitable, particularly for communities that lack in-house capacity to manage complex infrastructure projects.

ACTION 2 - PHASE 1 IMPLEMENTATION STEPS:

Position the Resilience Playbook to be a resource hub. Clearly establish the Playbook as a comprehensive online resource hub for resilience project delivery tools—building on its initial launch.

Consider building a shared resilience resource hub with Blueprints and technical tools. Develop a central online hub for bundled and climate-informed resilience implementation, building from tools like the MVP GEAR platform and bundled project delivery tools. Add new Blueprints for priority project types (e.g., culverts, dams, green infrastructure) and integrate technical resources such as flood tools or Climate Resilience Design Standards.

Integrate the Playbook into Commonwealth technical assistance programs and monitor its implementation. When appropriate, train technical assistance providers to actively use and promote the Playbook throughout all phases of project planning and implementation to ensure consistent delivery practices statewide. Track how the Playbook is used and collect ongoing feedback from users and project sponsors to inform future updates.

Strategic Priority 2
Streamline and Expand Access to Funding

***Action 3:** Launch and expand the EEA Environment and Climate OneStop to streamline resilience funding and strengthen project readiness.*

***Action 4:** Align resilience funding with community demand.*

In Phase 1, the focus is on initiating foundational efforts to align and streamline existing Commonwealth funding programs. This includes improving access to current resources, reducing administrative burdens for applicants, and enhancing the effectiveness of early public investments. By identifying points of fragmentation, clarifying funding pathways, and better coordinating program timelines, the Commonwealth can begin to build a more unified and accessible funding environment. These early actions are designed to improve short-term project delivery while laying the groundwork for a scalable system that can accommodate future growth in diversified revenue streams and capital deployment. Establishing this foundation is essential for enabling more efficient, equitable, and timely investment in key resilience measures across the Commonwealth.

Strategic Priority 2
Action 3

Launch and expand the EEA Environment and Climate OneStop to streamline resilience funding and strengthen project readiness.

Massachusetts would develop the EEA Environment and Climate OneStop as a unified access point for Commonwealth climate resilience and nature-based solutions funding. The platform is designed to help municipalities and other applicants more easily identify, understand, and apply for available grants—consolidating program information, aligning timelines, and reducing administrative burden.

Over time, the EEA Environment and Climate OneStop should also support efforts to improve how the Commonwealth monitors project progress and develops a pipeline of shovel-ready investments.

This integrated functionality addresses two core challenges: navigating a fragmented funding landscape and building a robust pipeline of ready-to-implement projects. By improving access, coordination, and transparency across funding and project development workflows, the EEA Environment and Climate OneStop should help municipalities—particularly disadvantaged ones—move more efficiently from planning to implementation.

ACTION 3 - PHASE 1 IMPLEMENTATION STEPS:

Consolidate and streamline funding access. Create a common grants portal where applicants can submit a single application for review by multiple climate-relevant programs—such as MVP, DER, and the Office of Coastal Zone Management—rather than submitting separate applications to each. Standardize application templates and review criteria, and coordinate funding timelines to reduce confusion, duplication, and delay.

Support project readiness. Adapt existing programs to support early-stage project activities like planning, engineering, and permitting. These changes would help build a stronger pipeline of shovel-ready projects eligible for financing through tools like the Resilience Revolving Fund.

Enable cross-program funding coordination. Coordinate across agencies and grant programs to align funding strategies for high-priority resilience projects. Support integrated funding packages that draw on multiple sources, enabling more flexible and effective use of resources. This approach focuses less on bundling projects together and more on ensuring separate programs can collaborate to jointly support shared investment priorities.

ACTION 3 - PHASE 1 IMPLEMENTATION STEPS (CONTINUED):

Provide applicant support. Launch outreach, training, and tailored technical assistance to help municipalities navigate the platform, scope viable projects, and prepare competitive applications.

Track pipeline progress. Enhance project tracking capabilities—building on the Climate Grants Viewer—to monitor progress from planning through construction. These insights would inform investment decisions, identify bottlenecks, and support continuous system learning.

Strategic Priority **2**

Action 4

Align resilience funding with community demand.

Building on infrastructure created through the EEA Environment and Climate OneStop and tools such as the Climate Grants Viewer, Massachusetts would strengthen its ability to evaluate how state and federal funding resources are responding to the needs of communities pursuing resilience projects. Understanding how available funds compare to on-the-ground demand is critical for identifying funding gaps, improving coordination, and supporting strategic allocation of limited public resources.

EEA has already begun evaluating how existing funding aligns with community climate priorities. This action expands that work by explicitly reviewing current funding sources to assess how they are supporting key resilience measures, and by developing recommendations to increase the impact of resilience investments. It also deepens the Commonwealth's understanding of where unmet needs persist and how funding strategies can better reflect regional variation and project types over time. The goal is not to suggest that state dollars could cover all needs, but to improve how funding decisions are informed—helping to prioritize investments based on risk, community need, and long-term impact.

This work would support alignment across agencies, inform the administration and delivery of grant programs that support implementation of key resilience measures, and align with the Executive Office for Administration and Finance's (A&F) budget development process. It complements related efforts in Actions 3 and 7 to improve how resilience projects are prioritized, resourced, and delivered.

ACTION 4 - PHASE 1 IMPLEMENTATION STEPS:

Inventory resilience-related funding streams. Map relevant Commonwealth and federal revenue sources that support key resilience measure-aligned investments across sectors like transportation, housing, water, and environmental restoration—including applicable legal authorities and local funding mechanisms.

Analyze demand versus awarded funding. Identify patterns and gaps by comparing community requests and needs against actual allocations. This analysis would support capital planning and help highlight disadvantaged project types, geographies, or population groups.

Support transparent, manageable reporting. Design a framework—drawing on ResilientMass Metrics—to enable periodic review of how resilience funding meets community needs. The framework would align with existing budget processes and minimize new administrative burdens for program staff.

Develop recommendations for higher resilience investment impact. Use findings to inform how funding programs can be better coordinated and structured to support deployment of key resilience measures, improve access, and increase long-term resilience benefits.

Strategic Priority 3
Implement Financing Mechanisms

***Action 5:** Launch the Resilience Revolving Fund.*

***Action 6:** Enable project-based repayment pathways.*

Phase 1 places special emphasis on launching the proposed Resilience Revolving Fund as a flagship financing initiative, which is designed to provide affordable, flexible capital to communities, water and wastewater districts, and tribal governments for high-priority resilience projects. The Resilience Revolving Fund represents a critical step in addressing gaps in the current funding landscape, particularly for entities with limited access to traditional borrowing.

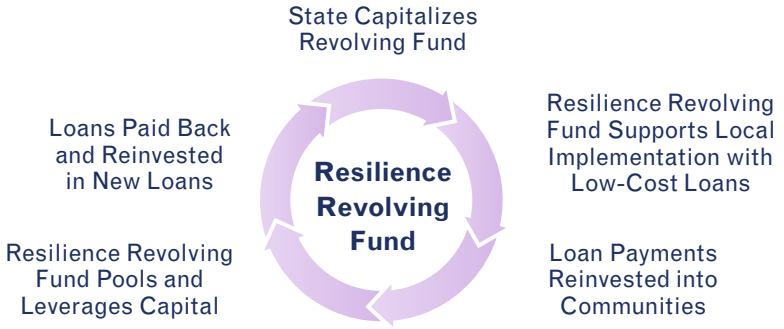
Alongside the launch of the proposed Resilience Revolving Fund, additional Phase 1 actions would begin building the foundation for a broader and more diverse financing system. These include exploring new revenue strategies, improving alignment between funding sources and project pipelines, and expanding technical assistance to help communities access and manage available tools. Collectively, these efforts aim to demonstrate the viability of innovative financing approaches, build institutional capacity, and guide the long-term development of the Commonwealth's resilience investment system.

Strategic Priority 3
Action 5

Launch the Resilience Revolving Fund.

The Commonwealth's proposed establishment of a Resilience Revolving Fund represents a foundational and transformational early action within a broader investment strategy. This effort is designed to address longstanding gaps in affordable, flexible capital for resilience projects—particularly in communities that have struggled to access traditional infrastructure financing. Just as importantly, the Resilience Revolving Fund would begin to put into practice the kind of integrated, adaptive investment system this Roadmap is working to build.

The Resilience Revolving Fund would expand access to capital for investments in municipalities, water and wastewater districts, and tribal governments. It is intended to help disadvantaged communities implement high-priority resilience projects, while also testing and refining project delivery models that can be scaled and sustained over time. Rather than wait for the full system to be built, the Commonwealth could activate this critical piece of the financing infrastructure laying the groundwork for future program growth, system learning, and broader integration.



Financing remains one of the most persistent barriers to climate resilience implementation. Many communities face challenges such as limited borrowing capacity, difficulty matching state or federal grants, cash flow constraints, or project types that fall outside conventional funding programs. A Resilience Revolving Fund could help provide affordable capital and unlock new funding strategies across jurisdictions and project types.

The Resilience Revolving Fund would launch with a proposed initial capital pool of approximately $50 million (M) to support multiple rounds of lending during Phase 1. Individual loans would typically range from $1M to $5M, with the flexibility to support larger awards where transformative opportunities exist, for example, a $10M multi-benefit flood resilience project. The fund prioritizes project categories with strong resilience value and underdeveloped financial pathways, such as culvert replacements, dam removals, green infrastructure, cooling centers, and floodplain restoration.

The Clean Water Trust would administer the loans, with EEA leading overall program management—including development of regulations, project solicitations, selection processes, strategic guidance, and technical assistance. The fund's operations would be closely coordinated with other Commonwealth programs to ensure alignment, reduce administrative burdens, and encourage bundled or sequenced investments.

ACTION 5 - PHASE 1 IMPLEMENTATION STEPS:

Initial Preparatory Steps:

Establish the Resilience Revolving Fund in statute to authorize the fund's operations.

Finalize Fund structure and interagency governance. Define roles and responsibilities and staffing structure across the Clean Water Trust, EEA, and partners for loan deployment, program oversight, performance management, and core subject matter expertise.

Define interagency coordination for the broader investment system. Establish roles, protocols, and structures across agencies to support system-wide investment planning, implementation, and evaluation.

Develop transparent project selection criteria. Align evaluation methods with resilience goals, emphasizing multi-benefit outcomes, geographic equity, and key resilience measure alignment.

Streamline administrative tools and processes. Create standardized application materials, scoring rubrics, and reporting templates to reduce burden and promote consistency, incorporating best practices from other financing tools.

Steps for First Round of Loans and Execution:

Launch an outreach and engagement campaign. Target municipalities with unmet capital needs and high exposure to climate risks. Host workshops, webinars, and office hours to walk local leaders through eligibility, application, and support offerings.

Provide comprehensive technical assistance. Deploy predevelopment advisors to help applicants scope viable projects, bundle investments, and prepare competitive applications. This technical assistance should be closely coordinated with existing programs—such as State Revolving Fund (SRF) and the EEA Environment and Climate OneStop—by aligning application windows, eligibility criteria, and project scopes to reduce duplication and enable cross-programmatic funding strategies.

Building on existing grant programs, establish a "fast track" pathway for shovel ready projects. For shovel-ready or pre-engineered projects, create a simplified review and approval track to accelerate capital deployment.

Structure program solicitations to incorporate principal forgiveness, interest-rate reductions, deferred repayment options, and affordability criteria—prioritizing projects in communities with limited borrowing capacity, high climate exposure, and demonstrated need for supplemental financing.

Continuous System Learning:

Develop a fund tracking tool to monitor performance. Collect and publish data on loan deployment, permitting timelines, bundling activity, repayment status, and project outcomes—ensuring accountability and enabling course correction.

Evaluate impacts on municipal borrowing behavior. Analyze whether access to Resilience Revolving Fund capital leads to increased municipal borrowing, improved project readiness, or shifts in long-term investment planning, particularly among disadvantaged communities.

Identify constraints and bottlenecks. Document administrative, legal, or institutional obstacles encountered during early implementation and use these insights to guide Phase 2 reforms or policy changes.

Explore integration of performance-based financing approaches. Assess opportunities to test pay-for-performance mechanisms or incentives in future Resilience Revolving Fund phases.

Strategic Priority **3**

Action 6

Enable project-based repayment pathways.

To build a truly resilient and scalable investment system, Massachusetts must equip municipalities with tools to finance resilience projects in ways that are both sustainable and workable at the local level. Many communities, particularly smaller or disadvantaged ones, struggle to move projects forward without tapping general funds, exceeding debt limits, or raising taxes. Project-based local financing options—such as value capture, utility surcharges, and targeted fees—offer practical ways to help fill that gap.

This work responds to well-documented legal and administrative barriers, including limitations in statutes like the DIF law and the Betterment Law, which often make it difficult to apply existing financing tools to climate resilience. Even where mechanisms like stormwater utilities are available, they are underused or hard to implement. Others, like special assessments or district-based financing, face procedural and political hurdles that discourage adoption.

Phase 1 lays the groundwork to make these tools more accessible and easier to deploy. By clarifying rules, reducing complexity, and building technical support, the Commonwealth can help communities take advantage of financing options already within reach. These efforts could complement broader tools like the proposed Resilience Revolving Fund and ensure that local governments have the resources and flexibility they need to invest in resilience—now and over the long term.

ACTION 6 - PHASE 1 IMPLEMENTATION STEPS:

Creating standardized legal and financial templates. Develop model ordinances, cost-benefit analysis tools, and legal guidance for resilience-focused district improvement financing, utility surcharges, special assessments, and other local financing mechanisms. These resources would align with the project types prioritized in the key resilience measure framework and made broadly applicable across community contexts. Where possible, tools would be integrated into or linked through the Resilience Playbook to support ease of access and consistent use by municipalities.

Aligning with Commonwealth financing entities. Work with MassDevelopment, the Clean Water Trust, and other authorities to ensure that local financing mechanisms can complement Resilience Revolving Fund loans and integrate with other Commonwealth financing programs where appropriate.

Linking frameworks to key resilience measure project types. Tailor legal and financial guidance to specific project categories such as culverts, floodplains, cooling infrastructure, and dam removals—highlighting the types of benefits and financial flows most suitable for capture or fee-based funding.

Providing implementation guidance and training. Deliver workshops, technical assistance, and toolkits to help municipalities evaluate, adapt, and deploy project-based financing mechanisms in real-world contexts. Focus would be placed on simplifying adoption, building local confidence, and addressing legal or procedural barriers.

Piloting frameworks with diverse communities and regional partners. Identify two or three municipalities or regional collaboratives—particularly those involved in initiatives like ResilientCoasts, Connecticut River Valley Resilience Commission, or watershed-scale MVP efforts—to test early implementation, gather lessons, and refine guidance. Piloting would proceed after foundational templates and training supports are established.

This action supports sufficiency, coordination, and equity by enabling locally grounded financing strategies that align with resilience outcomes. When paired with the Resilience Revolving Fund, project-based repayment mechanisms can significantly enhance access to capital, increase program participation, and reduce financial pressure on general funds—ensuring that communities of all sizes can contribute to and benefit from the Commonwealth's resilience investment system.

Case Study

Financing Infrastructure through Value Capture: East Hartford's Special Tax District

To fund major infrastructure upgrades, East Hartford, Connecticut, is advancing a special taxing district to support the $840M Port Eastside redevelopment. The taxing district will generate up to $125M for streets, utilities, and flood protection that support over 1,000 new homes and public spaces. This strategy uses future tax revenue generated by the project to pay for public improvements upfront.

Massachusetts communities exploring DIFs or special assessments for climate investments can draw useful lessons from how East Hartford is leveraging value capture to fund resilience infrastructure.

For more information, see ctinsider.com, *"East Hartford looks to create tax district for Port Eastside project."*

Becket, MA

Strategic Priority 4

Build Regional and Organizational Capacity

***Action 7:** Establish a process for tracking project pipeline implementation progress.*

***Action 8:** Advance regional resilience through integrated support and governance.*

***Action 9:** Establish adaptive management and cross-agency delivery framework.*

Phase 1 focuses on creating the enabling conditions for strong coordination, shared leadership, and effective oversight across the resilience investment system. This includes clarifying roles and responsibilities among state, regional, and local actors, and laying the groundwork for future governance structures that can support sustained collaboration.

A central goal of this phase is to facilitate inter-municipal collaboration to advance regionally significant resilience projects—recognizing that many of the Commonwealth's most impactful investments will cross jurisdictional boundaries. Strengthening existing partnerships while building institutional clarity and learning infrastructure would help guide implementation.

By fostering early alignment and establishing foundational platforms for system feedback, coordination, and accountability, Phase 1 sets the stage for a more cohesive and adaptive investment system—one that can evolve with changing risks, needs, and opportunities over time.

Great Barrington, MA

Strategic Priority **4**

Action 7

Establish a process for tracking project pipeline implementation progress.

A well-functioning investment system depends on a clear view of how priority resilience projects move from concept to completion. This action would establish a common framework for tracking project implementation progress across the Commonwealth's resilience investment system—focused on regionally significant and high-priority projects. The framework would help identify bottlenecks, support regional prioritization, and strengthen governance capacity at all levels.

While the EEA Environment and Climate OneStop (developed under Action 3) would integrate financial tracking, this effort would specifically monitor the advancement of selected projects through the pipeline—from early-stage concept through permitting, funding, construction, and post-implementation monitoring. As part of this effort, the state would explore a formal "priority project" designation to help regionally coordinated or high-impact projects move more efficiently through permitting, funding, and delivery processes. This designation could unlock targeted technical assistance or streamlined review protocols and serve as a visible signal of state support.

Given the central role of regional coordination, this action would engage MVP Regional Coordinators and other partners in designing and piloting the tracking approach—ensuring that it supports both state-level visibility and regional capacity-building.

ACTION 7 - PHASE 1 IMPLEMENTATION STEPS:

Design a shared project pipeline tracking framework. Develop standardized stages of project development (e.g., concept, design-ready, funded, under construction, completed), along with key tracking fields (e.g., key resilience measure alignment, permitting status, funding sources, implementation partners).

Pilot framework design and testing with MVP Regional Coordinators. Engage MVP Regional Coordinators and select regional partners in shaping the tracking framework to ensure it meets on-the-ground needs and supports regional governance and coordination.

Integrate tracking into technical assistance and governance workflows. Embed the tracking framework into the Commonwealth's technical assistance programs and regional resilience processes—enabling project sponsors and partners to contribute data and use the system to guide implementation.

Use tracking insights to inform governance and investment decisions. Apply tracking data to identify delivery constraints, guide strategic deployment of technical assistance and funding, and support ongoing system learning and performance management.

Strategic Priority **4**

Action 8

Advance regional resilience through integrated support and governance.

Many climate risks—such as inland flooding, watershed degradation, and heat-related stress—extend beyond municipal boundaries and require coordinated, multi-jurisdictional solutions. In Massachusetts, entities like Regional Planning Agencies (RPAs) and watershed coalitions already support long-range planning and intermunicipal coordination. However, their ability to directly manage funding and project implementation remains limited.

This action focuses on formalizing and enhancing regional capacity by embedding consistent support and governance structures into the statewide resilience investment system. It aims to transform regional collaboration from a project-by-project arrangement into an integrated feature of the Commonwealth's implementation approach. By building the institutional capacity to support sustained regional implementation, this action would enable more efficient, scalable, and impactful implementation of projects that address climate risks across municipal boundaries.

This action complements Action 1 (Lay the groundwork for bundled project delivery) by strengthening the regional governance and implementation platforms needed to support bundled projects and other forms of integrated resilience delivery. It is focused on building institutional and operational capacity—shared staffing, pooled procurement, and regional project pipelines—that can support a broad range of resilience investments over time.

ACTION 8 - PHASE 1 IMPLEMENTATION STEPS:

Map existing regional implementation systems. Identify active watershed councils, RPAs, councils of government, land trusts, tribal entities, commissions, corridor-based partnerships, and private sector actors in critical sectors, such as housing, healthcare, and energy, with the potential to scale or replicate regional models.

Convene regional partners to vet regional implementation models. Host workshops with RPAs, municipalities, tribal governments, land trusts, watershed groups, community-based organizations, and the private sector to explore near-term strategies for regional coordination—such as regional engineering support, pooled procurement, permitting coordination, and centralized grant management for resilience projects that span jurisdictions. These discussions would help prioritize which services are most feasible and impactful to launch in Phase 1, while also informing the potential for more formalized regional governance and implementation roles in Phase 3.

Seed flexible funding and authority for regional platforms. Provide startup funding, through contracts to RPAs and grants to qualified regional organizations such as watershed groups or land trusts, to support regional project development through processes such as pooled procurement and joint project pipelines. This approach builds on changes proposed in Mass Ready, the environmental bond bill filed by Governor Healey, to expand MVP eligibility to nonprofits that can help deliver regional capacity. Funding levels and mechanisms could be refined based on Phase 1 learning and further evaluation of regional needs.

Pilot regional implementation partnerships. Launch one or two demonstration partnerships that test multi-jurisdictional governance models and delivery capacity, generating insight into best practices for future scale-up. These pilots would focus on building and testing regional delivery systems, not solely on bundled project pilots.

By embedding regional implementation as a formal component of the resilience investment system, Massachusetts can foster more efficient, scalable, and impactful implementation of projects that address climate risks across municipal boundaries.

Strategic Priority **4**

Action 9

Establish adaptive management and cross-agency delivery framework.

This action would initiate the design of a formal framework to support adaptive management and collaboration within the ResilientMass system. Rather than a pre-existing product, this framework would be developed over time to fulfill a critical governance role—tracking system progress, supporting learning, engaging stakeholders, and guiding adjustments as implementation unfolds.

As resilience investments expand in scope and complexity, an adaptive structure would be essential to ensure that lessons learned inform future decisions, particularly as the Commonwealth transitions into Phase 2. In tandem, building mechanisms for effective cross-agency coordination would help align funding streams, reduce duplication, and improve the overall efficiency and responsiveness of project implementation.

Together, these efforts would support a more accountable, transparent, and flexible investment system—capable of evolving with changing risks, feedback, and priorities.

ACTION 9 - PHASE 1 IMPLEMENTATION STEPS:

Establish an Adaptive Management Framework. Develop a structured framework to track progress across Roadmap actions, monitor delivery of resilience investments, and support iterative learning. The framework would integrate ResilientMass Metrics—a performance measurement system that translates the Commonwealth's resilience goals into actionable, trackable indicators across sectors and geographies—leverage the Community Climate Advisory Council for public engagement and input, and incorporate learning from any disruptive events or emerging climate risks encountered during Phase 1. It would guide adjustments to priorities and processes in Phase 2 and beyond.

Enable the ResilientMass Action Team (RMAT) to guide cross-agency delivery. The RMAT should support coordination across agencies for key resilience measure project types by clarifying roles, aligning funding schedules and program guidance, and developing shared protocols. This function would help streamline implementation and improve consistency across the Commonwealth's resilience investments.

Use Adaptive Management process to inform project alignment. Apply insights from system tracking and stakeholder engagement to refine agency roles, governance structures, and implementation practices over time—ensuring that the investment system remains responsive, effective, and equitable as it scales.

Use Adaptive Management process to define Phase 1 completion criteria. The Adaptive Management Framework established in Action 9 would serve as the core mechanism for assessing Phase 1 outcomes, reviewing readiness for Phase 2, and identifying adjustments to priorities, sequencing, or delivery models.

By embedding adaptive management into the core governance of the resilience investment system, Massachusetts could ensure that its approach evolves with experience, remains aligned with key resilience measure outcomes, and delivers maximum value to communities across the Commonwealth.

PHASE 1 COMPLETION CRITERIA

Phase 1 marks the critical transition from Roadmap development to implementation, focused on establishing the core operating conditions of a resilient investment system. It is the Commonwealth's first deliberate application of the Roadmap, with the goal of aligning existing tools, activating essential system behaviors, and piloting early reforms across funding, financing, and project implementation. These efforts are not just foundational, they are experimental, enabling Massachusetts to test integrated models, build new institutional muscle, and generate feedback that would inform Phase 2.

To transition successfully from Phase 1 to Phase 2, Massachusetts must assess whether the core functions of the investment system are consistently beginning to emerge in practice.

These completion criteria serve as key transition indicators, providing a practical performance-based signal that the system is evolving toward its intended future state. Each criterion is aligned with a core investment system function and supported by specific, observable indicators. These indicators are dynamic and would continue to evolve as the Commonwealth deepens its work on metrics, evaluation, and system learning.

COMPLETION CRITERIA

1. **Sufficiency Criterion**
2. **Equity Criterion**
3. **Efficiency Criterion**
4. **Coordination Criterion**
5. **Transparency Criterion**
6. **Adaptability Criterion**
7. **Reinvestment Readiness Criterion**

1 Sufficiency Criterion

The system provides initial access to core capital tools and early-stage support mechanisms across regions and key resilience measures.

- The Resilience Revolving Fund has begun financing a diverse set of initial projects, demonstrating its foundational role as a core capital tool.
- Predevelopment funding has reached a majority of high-need communities, increasing early-stage project readiness.
- The bundled project implementation demonstration has shown early success in reducing project friction and improving execution timelines.

2 Equity Criterion

Underserved, disadvantaged, and Environmental Justice (EJ) communities are gaining improved access to planning, funding, and implementation support.

- At least half of small, rural, or climate-vulnerable municipalities—and communities prioritized under the Commonwealth's EJ criteria—have received technical or financial assistance.
- Major Commonwealth programs now incorporate standardized equity scoring into selection processes to ensure resources are directed where they are needed most.
- Demonstration projects are advancing equity outcomes in both urban and rural settings, signaling scalable models for reaching historically underserved populations.

3 Efficiency Criterion

Resilience investments are being delivered with reduced friction and higher initial impact.

- The Resilience Revolving Fund has supported projects using unified permitting and procurement processes.
- At least five funding programs have initiated streamlined applications or coordinated timelines.
- Model toolkits are supporting consistent implementation in at least ten active projects, enabling more predictable implementation.

4 Coordination Criterion

Institutional roles are becoming clearer and early examples of shared governance are emerging.

- A formal interagency team has been established to coordinate cross-agency key resilience measure progress.
- Multiple agencies contribute project data to a coordinated pipeline tracking system, improving visibility and planning alignment.
- New regional governance structures are coordinating project implementation, particularly in connection with the Resilience Revolving Fund.
- Assess whether recent climate-related events or emerging risks warrant adjustments to Phase 2 priorities, sequencing, or pacing.

5 Transparency Criterion

Resilience investments and system learning are becoming visible, trackable, and accessible to stakeholders.

- A public-facing dashboard is beginning to display key resilience measure-aligned projects and system progress.
- Early insights from the Resilience Revolving Fund and related actions are being compiled into shared learning materials.
- ResilientMass Metrics, action tracking systems, and performance reporting tools are under development to support transparency in implementation, including Resilience Revolving Fund loan performance and equity outcomes.

6 Adaptability Criterion

Pilot feedback is being used to adjust funding, permitting, or project implementation mechanisms in real time.

- Lessons from the Resilience Revolving Fund and pilot efforts have led to refinements in eligibility, loan terms, or project delivery tools.
- Revisions are directly informed by engagement with municipalities, agencies, and regional partners across the Commonwealth.
- These changes are helping to institutionalize responsive, data-driven improvement across the system.

7 Reinvestment Readiness Criterion

A sustainable investment loop is emerging, with initial steps toward system-wide reinvestment and revenue diversification.

- Resilience Revolving Fund repayment flows are confirmed for reinvestment, creating a foundation for long-term capital cycling.
- Early-stage value capture pilots and/or fee-based revenue tools are in feasibility or initial implementation phases.
- Opportunities to expand capital sources—through general funds, bonding, or philanthropy—have been prioritized for further development.

PHASE 2: SCALING IMPLEMENTATION — ADVANCING RESILIENCE IN EVERYTHING

Strategic Priority 1
Make Projects Easier to Implement

Action 10: *Deploy standardized and plug-and-play delivery tools for municipalities.*

Strategic Priority 2
Streamline and Expand Access to Funding

Action 11: *Enhance the EEA Environment and Climate OneStop platform to support resilience investment.*

Action 12: *Explore new revenue options to support scaled resilience investment.*

Strategic Priority 3
Implement Financing Mechanisms

Action 13: *Strengthen and scale the Resilience Revolving Fund to drive equitable climate investment.*

Action 14: *Test pooled procurement and other financing strategies.*

Action 15: *Build the foundation to value and eventually monetize resilience benefits.*

Strategic Priority 4
Build Regional and Organizational Capacity

Action 16: *Track project advancement in a centralized pipeline.*

Action 17: *Support capacity of regional intermediaries.*

Action 18: *Determine governance pathway for a durable resilience investment leadership structure.*

Phase 2 marks the critical transition from pilot activation to strategic system expansion. With foundational conditions established and insights gained in Phase 1—including early-stage support, initial financing access, technical assistance models, and project implementation coordination—the Commonwealth is now uniquely positioned to scale these initial efforts into a durable investment system. The primary goal of Phase 2 is to move from proof-of-concept to operational maturity: transforming promising initial demonstrations and aligned programs into an integrated, adaptive, and performance-driven system capable of delivering resilience investments statewide and at scale. It is important to acknowledge that the specific actions and priorities within Phase 2 would depend on the lessons learned and outcomes achieved in Phase 1, emphasizing an adaptive and learning-based approach to the Roadmap's evolution.

This phase is fundamentally about building the robust structural infrastructure that allows investment to flow consistently, efficiently, and equitably across all regions and key resilience measures. Key system functions such as sufficiency, coordination, and transparency must become further institutionalized. Tools developed in Phase 1 would be refined, standardized, and made broadly accessible, and would begin to reflect the characteristics of a future-facing system: bundled, data-informed, and inclusive. The criteria established for Phase 1 completion, alongside ongoing structures, such as the ResilientMass Metrics and the Community Climate Advisory Council, for assessing, engaging, learning, and evolving, would be crucial in determining the most impactful next steps for this phase.

Phase 2 also significantly advances the integration of resilience investment into the Commonwealth's long-term capital planning process. This accelerates the "resilience in everything" theme, building upon initiatives already underway (e.g., integrating resilience into capital planning and grantmaking, advancing resilience standards, and evolving building codes). Infrastructure, climate, and community development priorities would increasingly need to be aligned—not only in project execution but in funding strategies, fiscal planning, and oversight mechanisms. Where Phase 1 asked, "Can the system work differently?"—Phase 2 decisively asks, "Can it work that way consistently, at scale, and with durable support?" This systematic approach to institutionalization could be further solidified through future 5-year ResilientMass Plans, which could provide the framework for detailing and formalizing actions to carry out this phased approach.

Strategic Priority 1
Make Projects Easier to Implement

***Action 10:** Deploy standardized and plug-and-play delivery tools for municipalities.*

In Phase 2, the Commonwealth builds upon the foundational capacity established in Phase 1 for improving local implementation. This phase is dedicated to expanding the availability of hands-on technical assistance and increasing staffing support at regional and local levels, enabling a broader range of communities to advance bundled resilience projects through the pipeline. The opportunity here is to transform initial support mechanisms into a durable infrastructure for local implementation ensuring that municipalities, especially those with limited resources, are fully equipped to navigate and execute complex resilience projects. This would involve significant investment in both the reach and quality of technical assistance and operational support.

Strategic Priority 1
Action 10

Deploy standardized and plug-and-play delivery tools for municipalities.

Building on the groundwork laid in Phase 1, this action focuses on expanding and institutionalizing delivery tools that reduce administrative burden and promote consistent project execution across the Commonwealth. In Phase 2, the emphasis shifts from piloting to broad deployment—enhancing standardization, improving usability, and aligning resources across agencies.

Two key components anchor this work:

- **Universal project implementation templates** to streamline documentation, compliance, and reporting across the Commonwealth's resilience programs.
- **Modular, key resilience measure-specific implementation toolkits** offering pre-vetted scopes, procurement language, and technical standards tailored to common project types.

Together, these resources would support municipalities and regional entities with a plug-and-play foundation for resilience project delivery—enabling faster, more consistent implementation regardless of local capacity, geography, or infrastructure type.

ACTION 10 - PHASE 2 IMPLEMENTATION STEPS:

Expand development of universal project implementation templates. Develop universal project templates. Standardize scopes of work, bid and contracting language, procurement frameworks, and reporting formats across agencies for priority key resilience measure-aligned project types. Early focus areas could include culvert replacements, dam removals, floodplain restoration, and green infrastructure, with additional templates developed as system learning progresses. This effort would draw on existing models and templates from programs such as the SRF, DER's technical guidance, MassDOT project delivery resources, and relevant national best practices.

Create modular, key resilience measure-specific implementation toolkits. Design user-friendly toolkits tailored to each key resilience measure, including design guidance, permitting checklists, technical specifications, and real-world case studies.

Formalize and expand the centralized digital resource hub. Building on the initial Playbook tools made available in Phase 1, develop a more structured and fully integrated online platform where municipalities, regional entities, and technical assistance providers can access, download, and adapt standardized tools and templates. This Phase 2 expansion would focus on user interface improvements, broader key resilience measure coverage, and improved integration with the Commonwealth's technical assistance programs.

ACTION 10 - PHASE 2 IMPLEMENTATION STEPS (CONTINUED):

Test and refine tools in local settings. Pilot these expanded resources across diverse municipal and regional contexts to ensure they are adaptable, effective, and accessible for communities of varying sizes and capacities.

Integrate tools into the Commonwealth's technical assistance programs. Equip SRF and EEA Environment and Climate OneStop technical assistance providers with training and guidance to promote consistent use of these resources across all stages of project planning and implementation.

By scaling up and refining the project delivery infrastructure introduced in Phase 1, this action strengthens the foundation for efficient, scalable, and consistent resilience investment—especially for bundled, cross-sector, or multi-jurisdictional projects that currently face execution bottlenecks.

Truro, MA
Source: Adobe Stock

Strategic Priority 2

Streamline and Expand Access to Funding

***Action 11:** Enhance the EEA Environment and Climate OneStop platform to support resilience investment.*

***Action 12:** Explore new revenue options to support scaled resilience investment.*

In Phase 2, the focus shifts from early coordination to putting new revenue strategies into action while continuing to streamline and improve access to existing funding sources. Massachusetts has a strong opportunity to strengthen long-term resilience investments by reducing administrative barriers, improving coordination across programs, and enhancing tools like the EEA Environment and Climate OneStop platform.

This phase would evaluate the need and potential options for a dedicated, resilience-focused revenue stream—one that is tied to existing infrastructure systems and aligned with the key resilience measures. The goal is not to replace current funding, but to build a stable, long-term resource that can grow over time and meet evolving climate needs. These efforts build on groundwork laid in earlier assessments which show that the Commonwealth has the legal and institutional tools to advance without requiring major structural changes.

Strategic Priority 2

Action 11

Enhance the EEA Environment and Climate OneStop platform to support resilience investment.

The EEA Environment and Climate OneStop platform plays a key role in streamlining access to the Commonwealth's grant programs. By enhancing its functionality to better support resilience projects, Massachusetts can further reduce administrative burden, improve access for disadvantaged communities, and promote more strategic, bundled funding approaches.

Improvements could include integrating resilience-specific criteria, improving coordination across grant programs, expanding to include additional funding programs, and offering guidance that aligns with project development from planning through implementation.

Phase 2 implementation should consider the following, informed by Phase 1 Adaptive Management and completion criteria:

Expand program coverage. Broaden the EEA Environment and Climate OneStop platform to include additional funding programs beyond those included in Phase 1—prioritizing high-need, high-impact, and commonly used programs for climate resilience investments.

Develop public-facing search and planning features. Incorporate tools that allow users to filter programs by eligibility, project type, deadlines, and allowable uses and view application calendars.

Publish historical award data through the Climate Grants Viewer. Show where and how past funds have been distributed to help municipalities benchmark their efforts and build more competitive proposals.

Link to the centralized project pipeline. Enable EEA Environment and Climate OneStop users to view which pipeline-stage projects are eligible for upcoming funding, supporting bundled applications and stronger technical assistance targeting.

By evolving the EEA Environment and Climate OneStop into a comprehensive funding and implementation support platform, this action would strengthen the ability of local governments and regional partners to plan and implement key resilience metric-aligned resilience investments efficiently and at scale.

Strategic Priority **2**

Action 12

Explore new revenue options to support scaled resilience investment.

A dedicated revenue stream is a critical enabler of long-term, scaled resilience investment. Phase 1 efforts helped identify where gaps exist in current funding systems and highlighted areas—such as local finance capacity, bundled project delivery, and infrastructure scale where additional support may be needed. In Phase 2, the Commonwealth would begin advancing targeted efforts to address those needs by exploring and refining potential revenue strategies.

This work would not assume predetermined outcomes but would be responsive to evolving priorities, stakeholder input, and on-the-ground conditions. The goal is to design and vet revenue mechanisms that are both feasible and effective, recognizing that their adoption would depend on political, fiscal, and administrative realities. Advancing this work now ensures that when opportunities do arise, the Commonwealth and its partners are ready with well-developed, broadly supported solutions.

Detailed analysis of potential revenue mechanisms—including fee structures, implementation risks, equity impacts, and administrative considerations—has already been completed through the Investment Options Inventory and Impact Assessment components of this project. A summary of select examples and considerations from these Tasks can be found in Appendix C. These resources provide a strong foundation for informed stakeholder engagement and future decision-making.

ACTION 12 - PHASE 2 IMPLEMENTATION STEPS:

Assess revenue needs and priorities through Adaptive Management. Work with the Community Climate Advisory Council, ResilientMass Metrics, and Phase 1 learnings to assess the most critical revenue needs for resilience investment—state-level, local-level, or hybrid. Use this assessment to guide prioritization of revenue options for implementation.

Revisit and build on Task 1 finance work. Use the Inventory and Impact Assessment, stakeholder feedback, and lessons from Phase 1 to refine and prioritize revenue mechanisms. Identify which previously explored options remain most promising and surface any new concepts that should be advanced.

Advance priority revenue mechanisms through a cross-agency team, if justified by needs and conditions. Convene EEA, Office of Climate Innovation and Resilience, A&F, Department of Revenue, the Clean Water Trust, MassDOT, and other relevant entities to lead coordinated implementation planning for selected revenue options. Include legal, policy, and operational expertise.

Develop legislative or regulatory frameworks for implementation as needed. Prepare actionable policy packages for priority mechanisms with attention to legal structure, rate setting, equity considerations, and local capacity.

Engage stakeholders and build durable support. Sequence stakeholder engagement to validate selected revenue strategies, incorporating municipal, regional, utility, advocacy, and public input. Focus on building the coalition needed for successful adoption and implementation.

Case Study

San Francisco Bay Area's Measure AA: A Model for Local Climate Funding

Seeking to fortify its shores against a changing climate, the San Francisco Bay Area enacted Measure AA in 2016. This annual $12 parcel tax, applied across nine counties, is projected to raise $500M over 20 years for vital wetlands restoration, habitat protection, and nature-based flood defenses.

Administered by the San Francisco Bay Restoration Authority with a focus on regional equity and transparency, Measure AA shows Massachusetts communities a clear path to building public support for long-term, locally-controlled climate adaptation funding. For details, visit sfbayrestore.org, *"San Francisco Bay Restoration Authority."*

Strategic Priority 3
Implement Financing Mechanisms

Action 13: *Strengthen and scale the Resilience Revolving Fund to drive equitable climate investment.*

Action 14: *Test pooled procurement and other financing strategies.*

Action 15: *Build the foundation to value and eventually monetize resilience benefits.*

This strategic priority marks an important step forward in building a more comprehensive and flexible climate finance system. In Phase 2, the focus shifts from early pilots to the rollout of new financing tools that can support a wide range of projects and community needs. These tools are designed to speed up investment, align financial incentives with resilience goals, and make it easier for local, regional, and state partners to work together. The Commonwealth would focus on establishing lasting financial approaches that recognize the value of resilience, attract co-investment, and reduce the risk of trying new solutions. This includes approaches like outcome-based funding, partnerships with private investors, targeted credit support, and continued innovation in how the Commonwealth manages risk and insurance. Together, these tools would help create a stronger, more adaptable financing system that works for communities of all sizes.

Strategic Priority 3
Action 13

Strengthen and Scale the Resilience Revolving Fund to Drive Equitable Climate Investment.

Building on its initial launch in Phase 1, the Resilience Revolving Fund should evolve into a durable, equity-centered financing platform that enables sustained climate investment across regions, project types, and community contexts. By expanding access to low-cost capital and coordinating with technical assistance and grant programs, the Resilience Revolving Fund can help address critical financing gaps—particularly for disadvantaged communities and regionally significant resilience needs.

Phase 2 should focus on deepening the Resilience Revolving Fund's financial capacity, institutional integration, and equity impact.

Action 13 - Phase 2 Implementation Steps:

Expand and diversify capitalization. The Commonwealth should identify stable revenue sources to increase lending capacity and lower the long-term cost of capital, enabling support for larger or bundled investments.

Refine equity-focused loan terms. Building on Phase 1 lessons, the Resilience Revolving Fund should expand principal forgiveness, deferred repayment options, and interest-rate reductions for disadvantaged communities or projects that advance climate justice.

Integrate risk-mitigation tools. State-backed guarantees, loss reserves, or pooled insurance mechanisms should be explored to help lower barriers for municipalities with limited credit capacity.

Align with implementation infrastructure. The Resilience Revolving Fund should coordinate with the EEA Environment and Climate OneStop, Resilience Playbook, and technical assistance providers to simplify access and support project readiness, especially for smaller towns and regional collaborations.

Monitor and adapt equity outcomes. The Resilience Revolving Fund's performance should be tracked using ResilientMass Metrics, with benchmarks and a feedback loop—potentially through the Community Climate Advisory Council—to ensure funding is equitably distributed and responsive to community needs.

By scaling the Resilience Revolving Fund through these steps, Massachusetts can anchor a resilient and inclusive climate finance system that delivers measurable impact across the Commonwealth.

Strategic Priority **3**

Action 14

Test pooled procurement and other financing strategies.

As Massachusetts advances resilience investments, many of the most impactful strategies—like culvert upgrades, dam removals, and floodplain restoration—extend across municipal boundaries. These projects often require implementation across watersheds, infrastructure systems, or ecological zones, making regional collaboration essential.

Phase 2 would prioritize the development of practical mechanisms that make it easier for municipalities to work together. By jointly procuring services and pooling financing, communities can streamline implementation, share technical capacity, and unlock access to larger-scale resources. These collaborative approaches can reduce costs, simplify project management, and accelerate the implementation of resilience efforts that benefit multiple jurisdictions.

Case Study

Intermunicipal Agreements: Collaboration in Action for Regional Coastline Resilience

Facing escalating coastal erosion and storm damage along their shared Cape Cod Bay shoreline, the towns of Eastham, Wellfleet, Truro, and Provincetown in Massachusetts forged an innovative Intermunicipal Memorandum of Agreement. Recognizing that natural processes like sediment transport operate independently of municipal boundaries, this collaboration, supported by the Massachusetts Office of Coastal Zone Management, aims to move beyond fragmented, reactive local efforts.

By pooling resources for shared scientific understanding (e.g., a comprehensive geodatabase of shoreline conditions), developing consistent management strategies, and pursuing joint grant opportunities, the towns are enhancing efficiency and effectiveness in protecting their vulnerable coastlines and promoting more resilient, ecosystem-based solutions that benefit the entire shared system.

Action 14 - Phase 2 Implementation Steps:

Develop model pooled procurement agreements. Create standardized inter-municipal agreement templates for joint procurement of engineering, permitting, and construction services—prioritizing project types such as culvert replacements, dam removals, and coordinated green infrastructure.

Establish shared financing platforms. Explore and pilot shared financing mechanisms that allow multiple municipalities to combine financial resources or borrowing capacity for regional resilience initiatives. Pilot efforts would prioritize project types where multi-town implementation improves impact or feasibility, such as floodplain restoration or bundled water infrastructure retrofits.

Integrate pooled models with the Commonwealth's programs. Align pooled procurement and financing rules with MVP, SRF, and Resilience Revolving Fund program requirements to ensure that collaborative projects are eligible and easy to manage across agencies.

Provide specialized technical and legal assistance. Deliver technical assistance to municipalities and regional partners to help structure pooled arrangements, navigate legal requirements, and evaluate financial strategies.

These efforts would build on lessons from Phase 1, including potential enhancements to the Resilience Revolving Fund to better support collaborative, multi-jurisdictional projects. Additional tools—such as pooled borrowing models or shared revenue mechanisms—may also be explored to expand financing flexibility. Where feasible, the Commonwealth would consider opportunities for private-sector partnerships and co-benefit monetization (e.g., water quality credits or ecosystem services). All strategies would be piloted and refined through real-world use, ensuring they are responsive to local needs and adaptable to different regional capacities.

Strategic Priority **3**

Action 15

Build the foundation to value and eventually monetize resilience benefits.

Resilience investments generate broad public value, including flood risk reduction, cooler streets, cleaner air, and improved property stability. Today, that value is not consistently measured to support financing, repayment, or reinvestment. While full monetization is a longer-term objective, the ability to measure and value these co-benefits is a necessary first step. Linking those benefits to capital flows would become increasingly important as Massachusetts seeks to scale non-grant financing models.

Phase 1 established an initial foundation by estimating the economic value of select co-benefits associated with key resilience measures. Phase 2 should build on that work by refining benefit estimation approaches, expanding to additional project types and categories, and developing policy and operational frameworks that could eventually support outcome-based financing. Rather than attempting to fully monetize benefits all at once, this action focuses on building the analytic and institutional capabilities needed to do so over time.

ACTION 15 - PHASE 2 IMPLEMENTATION STEPS:

Identify high-potential co-benefit types and pilot use cases. Focus on categories with existing data and near-term financing relevance—such as avoided flood damage, cooling hours delivered, or increased land value tied to green infrastructure.

Commission benefit valuation frameworks. Work with academic institutions, state agencies, or third-party evaluators to develop standardized methods for estimating, validating, and documenting economic and environmental benefits across key resilience measures. These frameworks would directly relate to and inform ongoing resilience metrics work.

Embed co-benefit data collection in pilot projects. Use selected Phase 2 projects (e.g., Resilience Revolving Fund loans, regional floodplain restorations) to begin collecting data on relevant outcomes, costs avoided, or value created—even if not yet linked to financing.

Create a Commonwealth-managed co-benefit evidence library. Establish a centralized repository of validated co-benefit metrics, assumptions, and case studies to inform future capital planning, benefit-cost evaluations, and financing design.

Develop a Roadmap for integration into financing tools. Use findings from Phase 2 to shape how co-benefits might support future value capture tools, repayment structures, or resilience bond mechanisms in Phase 3 and beyond.

Strategic Priority 4
Build Regional and Organizational Capacity

Action 16: *Track project advancement in a centralized pipeline.*

Action 17: *Support capacity of regional intermediaries.*

Action 18: *Determine governance pathway for a durable resilience investment leadership structure.*

Phase 2 marks a critical transition for leadership and governance capacity, where coordination becomes a formal system function rather than relying on ad hoc collaboration. Building on the foundational clarity initiated in Phase 1, the opportunity now is to operationalize shared governance, formalize institutional roles, and establish durable delivery infrastructure. This phase would strengthen the institutional backbone needed to coordinate across agencies, align investments, and support consistent delivery at all levels of government. It is about embedding replicable, trackable, and equitable structures that position resilience investment more squarely within the Commonwealth's long-term capital planning processes, ensuring that resources are deployed effectively and strategically.

Strategic Priority 4
Action 16

Track project advancement in a centralized pipeline.

In Phase 2, the focus shifts from foundational coordination to building a more advanced, statewide pipeline system that supports consistent project delivery. Massachusetts has a strong opportunity to strengthen long-term resilience investments by reducing administrative barriers, improving engagement across programs, and aligning the pipeline to tools like the EEA Environment and Climate OneStop platform.

This phase would build directly on the pipeline framework established in Phase 1 (Action 7), scaling it into a durable, multi-agency platform that tracks projects across planning, permitting, funding, and implementation. It would expand the scope of coordination—linking data from state, regional, and municipal partners—and institutionalize processes for cross-agency integration. The goal is not to add new planning layers, but to ensure that the pipeline becomes the backbone of resilience delivery, guiding investment decisions and aligning capacity across regions. These efforts build on groundwork laid in earlier assessments which show that the Commonwealth has the legal and institutional tools to advance without requiring major structural changes.

ACTION 16 - PHASE 2 IMPLEMENTATION STEPS:

Formalize the centralized tracking platform. Expand and institutionalize the shared project pipeline tool developed in Phase 1. Ensure it captures real-time status updates, aligns with ResilientMass Metrics, and is integrated into agency workflows across EEA, MassDOT, DER, MEMA, and other key programs.

Incorporate multi-agency project data. Ensure the system aggregates data from across state and quasi-public entities, linking funding programs, permitting milestones, and implementation timelines for a unified view of progress.

Enable regional and local access. Provide municipalities and regional partners with access to pipeline data relevant to their geographies and project types, enabling better coordination, collaboration, and project development.

Support decision-making and resource allocation. Use the pipeline to identify project constraints, optimize technical assistance deployment, and inform capital planning decisions based on project readiness, risk exposure, and regional need.

Ensure public transparency and accountability. Include a public-facing dashboard that visualizes pipeline activity, project distribution, and system-level outcomes—building confidence in how resilience investments are prioritized and delivered.

By institutionalizing the pipeline as a core function of the investment system, the Commonwealth would enable more strategic and transparent implementation of resilience projects—while empowering agencies, municipalities, and regional coalitions to coordinate more effectively and deliver more impact across communities and systems.

Strategic Priority **4**

Action 17

Support capacity of regional intermediaries.

To unlock the full potential of regional resilience implementation, Massachusetts must move from demonstration to durable infrastructure—by investing in the long-term capacity of regional intermediaries. Organizations such as watershed associations and RPAs are well-positioned to serve as critical delivery partners. They act as connectors between local priorities and the Commonwealth's systems, helping municipalities, especially those with limited staff or technical resources—navigate permitting, procurement, design, and project implementation across jurisdictions.

Phase 1 established a foundation by piloting shared delivery models and formally recognizing regional platforms within program eligibility. Phase 2 builds on that progress through sustained investment in staffing, flexible operating support, and deeper integration of these entities into the Commonwealth's delivery architecture. This action works in tandem with broader efforts to clarify institutional roles and support regional governance, helping to create a more cohesive, coordinated system in which regional intermediaries are empowered to lead on-the-ground implementation at scale.

Phase 2 implementation should be informed by evaluation of regional capacity efforts in Phase 1—including what models proved effective, where adjustments are needed, and how regional delivery strategies can align with evolving funding and financing mechanisms.

ACTION 17 - PHASE 2 IMPLEMENTATION STEPS:

Provide multi-year operating support. Deliver predictable, renewable operating grants to regional entities that can serve as project aggregators, technical advisors, and administrative hubs—supporting roles such as regional grant management, engineering support, and intermunicipal coordination.

Support shared staffing models. Enable hiring of shared regional resilience staff—such as project managers, permitting liaisons, or procurement coordinators—who serve multiple communities and ensure continuity between local delivery and state-level coordination.

Develop integrated training and tools. Offer specialized training for regional staff aligned with statewide delivery tools and systems (e.g., pipeline dashboards, key resilience measure toolkits, equity screening) to ensure consistent implementation practices across geographies.

Pilot regional intermediaries as lead delivery entities. Identify two to three regions where intermediaries can serve as lead implementers for bundled, multi-key resilience measure projects—testing the full integration of governance, permitting, and funding responsibilities, including alignment with Resilience Revolving Fund, SRF, and other financing pathways.

By institutionalizing and scaling the role of regional intermediaries, Massachusetts can reduce administrative fragmentation, accelerate delivery in capacity-constrained areas, and embed resilience investment within functional geographies—ultimately delivering system-wide outcomes through locally rooted partnerships.

Strategic Priority **4**

Action 18

Determine governance pathway for a durable resilience investment leadership structure.

While existing agencies such as EEA currently play a central and expanding leadership role in setting strategic direction for financing and coordinating across secretariats and entities (building off of existing work through RMAT and the added capacity of the Resilience Finance Director), Phase 2 would involve evaluating whether an additional structure is needed to provide system-wide coordination, manage funding and financing streams, oversee delivery infrastructure, and ensure interagency performance.

This governance evaluation is intended to address the full climate resilience investment system—spanning all key resilience measures and climate risks—not limited to any single sector such as coastal resilience.

This action would rigorously assess the pathway for establishing a durable leadership structure—potentially a new resilience authority or a functionally equivalent entity—to ensure long-term alignment and sustained impact, without presupposing the creation of a new entity if current mechanisms prove sufficient.

This action is grounded in the findings of the Investment Options Inventory and the Impact Assessment components of this project, which evaluated alternative governance models, legal authorities, and administrative options for building durable institutional capacity. These materials, key portions of which are found in Appendix C, offer a robust foundation for moving forward.

Phase 2 implementation should build directly on institutional approaches tested and evolved in Phase 1, including the expanded role of EEA, the RMAT, and the Resilience Finance Director, evaluating what is working well and where additional structure or capacity may be needed.

ACTION 18 - PHASE 2 IMPLEMENTATION STEPS:

Evaluate and compare governance options through inclusive engagement. Assess current institutional performance and compare alternative models—such as a standalone authority, quasi-public entity, or enhanced coordination function—based on their ability to manage capital, oversee pipeline performance, and align regional and local delivery. Engage stakeholders throughout to ensure the chosen pathway reflects real delivery needs, political realities, and long-term sustainability.

Build interagency alignment and collaborative protocols. Coordinate with EEA, A&F, DOR, the Clean Water Trust, DER, MEMA, MassDOT, and other relevant entities to clarify respective roles, develop shared protocols, and avoid duplication, ensuring continued effectiveness of existing coordination.

Case Study

Collaborating for Resilience: Regional Coordination after Hurricane Sandy

After Hurricane Sandy, regional leaders formed the Sandy Regional Infrastructure Resilience Coordination Group to oversee implementation of hundreds of federally funded recovery projects. The team created a shared database and sequencing plan to align infrastructure investments, reduce overlap, and ensure that resilience standards were applied consistently.

This approach helped agencies prioritize investments and offers a model for how states can organize cross-jurisdictional implementation. For more information, see fema.gov, *"Hurricane Sandy Recovery: Collaborating to Build Resilience."*

PHASE 2 COMPLETION CRITERIA

To successfully transition from Phase 2 (Scaling Implementation-Advancing Resilience in Everything) to Phase 3 (Institutionalizing and Integrating for Systemwide Resilience), the Commonwealth must demonstrate that the investment system is operating at a consistently higher level of coordination, efficiency, and inclusiveness.

These criteria represent critical thresholds of institutional readiness, system alignment, and delivery performance. Each criterion is linked to a core system function and supported by observable indicators that confirm Massachusetts is prepared to shift from building system capacity to fully deploying it for statewide resilience outcomes.

COMPLETION CRITERIA

1. **Sufficiency Criterion**
2. **Equity Criterion**
3. **Efficiency Criterion**
4. **Coordination Criterion**
5. **Transparency Criterion**
6. **Adaptability Criterion**
7. **Reinvestment Readiness Criterion**

1 Sufficiency Criterion

A scalable and reliable capital platform is operational and responsive.

- The Resilience Revolving Fund has financed an additional round of projects, with increasing amounts of funding allocated to small or disadvantaged communities including funding allocated to small or disadvantaged municipalities and funding allocated to small or disadvantaged municipalities. Early repayment and reinvestment cycles have been initiated, creating a functioning model for capital sustainability.
- New revenue mechanisms or fee-based pilots (e.g., value capture tools) are in active implementation, expanding the diversity of funding streams available to municipalities.

2 Equity Criterion

Tools and programs are closing participation gaps and improving outcomes for vulnerable communities.

- Equity-scoring frameworks are embedded in all major funding programs and are actively influencing project selection and resource allocation decisions, ensuring priority for EJ populations and historically underserved municipalities.
- At least two-thirds of climate-vulnerable municipalities and disadvantaged communities have received technical assistance or funding for key resilience measure-aligned projects.
- Equity performance metrics are publicly reported and show measurable improvements in access, investment levels, and project outcomes for disadvantaged populations.

3 Efficiency Criterion

Project delivery is faster, more consistent, and better integrated across sectors.

- Bundled delivery has been scaled beyond pilots and is active in at least three regions, demonstrating improved permitting efficiency and cost-effectiveness.
- Standardized toolkits are being used in at least 25 projects across diverse geographies, demonstrating consistent documentation and reduced administrative burden.
- Multi-agency alignment on contracting and procurement processes is reducing project initiation timelines by a measurable margin.

4 Coordination Criterion

Institutional roles are clearly defined and regionally integrated.

- The RMAT has adopted formal protocols for cross-agency coordination, including shared timelines, performance metrics, and aligned funding targets to guide implementation across programs and agencies.
- Regional entities are formally integrated into delivery structures—participating in shared governance frameworks, funding coordination, and performance tracking aligned with the Commonwealth's priorities.
- Interagency and intergovernmental coordination mechanisms are routinely used to streamline permitting, accelerate funding delivery, and support bundled or multi-jurisdictional projects.

5 Transparency Criterion

Investment decisions and performance outcomes are visible and trusted.

- A public dashboard is tracking key resilience measure-aligned investments statewide, disaggregated by geography, population served, and equity indicators.
- At least three state agencies are sharing resilience investment data through an integrated reporting platform.
- Annual system performance summaries are published and reviewed by a cross-sector stakeholder group.

6 Adaptability Criterion

System improvements are emerging from pilot feedback and performance tracking.

- A structured review process—building on the adaptive management approach introduced in Phase 1—has incorporated system learning, stakeholder feedback, and lessons from disruptive events to inform Phase 3 priorities and sequencing.
- Results from Resilience Revolving Fund and bundled implementation pilots have led to formal changes in program guidance, loan terms, or implementation structures.
- Stakeholder engagement—through regional convenings, municipal roundtables, and other feedback channels—is driving refinements to funding, permitting, and technical assistance systems.
- At least two innovations in policy, finance, or implementation have been scaled from pilot to practice based on Phase 2 learnings.

7 Reinvestment Readiness Criterion

The system is positioned for sustained, long-term delivery and lifecycle reinvestment.

- Planning for Phase 3 revenue integration (e.g., from new legislation, bond initiatives, or public-private structures) is underway.
- Lifecycle investment strategies are embedded in at least two major programs, with reinvestment triggers tied to asset performance.
- A reinvestment Roadmap is developed, laying out how repayment, fee-based revenues, and public funds would sustain system operations over time.

PHASE 3:
INSTITUTIONALIZING AND INTEGRATING FOR SYSTEMWIDE RESILIENCE

Strategic Priority 1
Make Projects Easier to Implement

Activities involve streamlining permitting, planning, and delivery processes

Strategic Priority 2
Streamline and Expand Access to Funding

Activities involve establishing redundant, sufficient, and diverse revenues

Strategic Priority 3
Implement Financing Mechanisms

Activities involve ensuring the availability of affordable capital

Strategic Priority 4
Build Regional and Organizational Capacity

Activities involve ensuring leadership accountability and transparency

Phase 3 represents the full expression of the ResilientMass Investment System: a dynamic, responsive, and self-sustaining structure capable of delivering resilience outcomes at scale. This is where the system comes together—where lessons from Phases 1 and 2 translate into enduring capacity, and where Massachusetts fully activates the vision of a coordinated, efficient, and adaptive approach to climate resilience.

The actions outlined for this phase are not prescriptive commitments, but a forward-looking menu of options designed to inform future iterations of the ResilientMass Plan. They reflect advanced system capabilities the Commonwealth may choose to pursue based on ongoing learning, system maturity, and evolving climate realities. Crucially, Phase 3 is designed to adapt. As Massachusetts continues to face climate-driven shocks—whether extreme storms, flooding, or heat emergencies, the investment system must remain agile. The adaptive management framework initiated in Phase 1 ensures that priorities can evolve in real time, allowing the Commonwealth to respond to disruptions, seize new opportunities, and recalibrate investments to meet the moment.

While the Roadmap is organized into sequential phases, it is not a rigid plan. Phase 3 actions can be accelerated, delayed, or restructured depending on system readiness and external events. The goal is not just to reach a destination—but to sustain a living, learning investment system that grows more effective, equitable, and future-ready with each cycle.

- **Lifecycle investment and reinvestment,** ensuring infrastructure remains effective, maintained, and adaptive over time.
- **Mainstreaming resilience across public systems,** embedding climate risk into all infrastructure and fiscal decision-making.
- **Sustaining the investment system through learning and adaptation,** building mechanisms for continuous feedback and refinement.
- **Embedding institutional governance,** making resilience delivery a permanent, coordinated function of the Commonwealth's government.

Strategic Priority 1

Make Projects Easier to Implement

The transition from Phase 2 to Phase 3 marks a critical inflection point for local and regional implementation. Where earlier phases focused on building tools, pilots, and technical assistance systems, Phase 3 is defined by their full deployment and integration. The Commonwealth has created the enabling conditions for every municipality—regardless of size, capacity, or fiscal condition—to participate equitably in the resilience investment system. Local implementation is no longer constrained by administrative barriers or fragmented support; instead, it functions as a coordinated, adaptive, and continuously improving network.

In this mature system:

- Municipalities routinely apply standardized capital planning frameworks that embed resilience, equity, and long-term fiscal planning.
- The centralized pipeline is fully integrated with funding and permitting processes, creating a transparent and predictable project lifecycle.
- Regional hubs and shared services enable seamless support for technical assistance, grant administration, procurement, and compliance.
- Smaller and disadvantaged communities access the same level of implementation support as larger municipalities, ensuring no part of the Commonwealth is left behind.

These conditions are the result of sustained investment in tools, training, legal infrastructure, and fiscal alignment throughout Phases 1 and 2. Now, in Phase 3, Massachusetts leverages that foundation to deliver consistent, measurable resilience outcomes across every region.

To sustain and expand this capacity, the Commonwealth may:

- **Advance a Shared Capital Planning Framework.** In Phase 3, Massachusetts would embed resilience into the core of state capital planning, making climate risk, equity, and key resilience measure alignment standard criteria for all major investments and grants. Building on efforts by EEA, A&F, and others, this framework would apply consistent resilience evaluation across agencies, linking project planning with permitting and funding milestones. Resilience would be integrated across programs, ensuring every public dollar supports a stronger, more future-ready Commonwealth.
- **Institutionalize interagency permitting and delivery coordination.** Build on early pilot efforts by making cross-agency collaboration a standard part of project delivery. This includes formalizing interagency memorandums of understanding, streamlining joint review processes for multi-benefit and bundled projects, and adopting shared documentation protocols to reduce administrative burden and speed up implementation.
- **Support alignment between local capital planning and statewide resilience goals.** Provide technical guidance, regional planning incentives, and tools that help municipalities align local capital plans with the key resilience measure framework and statewide resilience priorities. This would include using the centralized project pipeline to inform local infrastructure strategies, integrating resilience considerations into local capital improvement plans, and equipping regional intermediaries to support multi-jurisdictional planning aligned with the Commonwealth's long-term vision.
- **Build a culture of continuous learning and feedback within permitting systems, integrating outcome data from implemented projects into permitting reforms.** Regular cross-agency forums and real-time dashboard insights would support iterative improvement and increased predictability.
- **Ensure all communities, especially small and disadvantaged municipalities, can participate fully and equitably in resilience delivery.** This would be achieved through shared administrative infrastructure, embedded technical assistance, and regional intermediaries that reduce the transaction costs of engaging in the system.

Strategic Priority 2

Streamline and Expand Access to Funding

By Phase 3, the difficult policy and political decisions made in Phase 2 have reshaped the Commonwealth's fiscal foundation for resilience. Massachusetts has established a revenue system that is equitable, sufficient, and diversified—capable of supporting the full lifecycle of resilient infrastructure and investment across all key resilience measures. This system no longer relies as heavily on appropriations or one-time grants. Instead, it is designed to be stable, adaptive, and capable of sustaining implementation over the long-term.

The Commonwealth's revenue architecture now features:

- **Redundancy and diversification,** with multiple revenue streams—such as value capture mechanisms, utility surcharges, impact fees, and resilience-linked leasing—working together to reduce pressure on general funds.
- **Equitable design,** ensuring that revenue tools are accessible, affordable, and scaled to local capacity, with safeguards for low-income and frontline communities.
- **Integration with fiscal policy,** making resilience a core consideration in budget planning, bond issuance, and capital investment decisions.
- **Built-in adaptability,** allowing revenue strategies to evolve as climate risks change and as community needs grow more complex.

Massachusetts no longer treats resilience funding as an exception—it is a standard, institutionalized component of public finance. The systems created and refined in earlier phases are now operating in sync, generating a steady and reliable flow of resources to support capital deployment, reinvestment, and innovation. Competitive grant cycles no longer serve as the primary delivery model; instead, communities are increasingly supported through predictable, formula-based funding allocations that reflect resilience need, risk exposure, and equity priorities. This allows municipalities to plan and implement with confidence, backed by a durable revenue system designed to deliver resilience at scale.

To ensure this capacity is maintained and strengthened, the Commonwealth may:

- **Institutionalize benefit-based revenue strategies** that link public revenues to the long-term value created by resilience investments—such as avoided damages, enhanced infrastructure performance, and public health improvements.
- **Support locally tailored, dedicated revenue options,** as justified by community needs, including tools like DIFs that generate new revenue through financing mechanisms; and ensure all communities have the legal, technical, and administrative support to implement them transparently, equitably, and effectively.
- **Embed resilience revenue mechanisms into core Commonwealth functions,** from capital planning and project permitting, to loan repayment structures and funding guidance.
- **Expand shared-governance and pooled-revenue models** that help small and rural communities benefit from innovative revenue approaches without incurring prohibitive administrative costs.

Strategic Priority 3

Implement Financing Mechanisms

In Phase 3, Massachusetts has completed the transformation of its financing system from fragmented and reactive to integrated, innovative, and forward-looking. This is where the system actively drives down risk, reduces long-term costs, and builds community wealth by turning resilience into a structural feature of how capital is accessed, deployed, and leveraged.

The Commonwealth's financing architecture now:

- Ensures **affordable, flexible capital** is available to communities that need it most, especially those historically excluded from traditional financial tools.
- Deploys **insurance-like mechanisms** and pooled risk tools that protect public investments, lower premiums, and promote investment in risk-reducing infrastructure.
- Aligns **procurement systems with resilience outcomes,** using performance-based contracts and bundled delivery strategies to reward impact and efficiency.
- Incentivizes **climate-smart land use and development,** with financial tools that discourage new investment in high-risk areas and prioritize long-term sustainability.
- Engages the **private sector not as a supplement but as a partner,** using co-financing strategies and credit enhancements to scale capital deployment and innovation.
- Promotes **equity and community wealth-building,** with resilience investments designed to deliver economic opportunity, local ownership, and reinvestment pathways for vulnerable populations.

These innovations did not emerge overnight—they are the product of piloting, testing, and scaling throughout Phases 1 and 2. Now, they define the Commonwealth's financing system as it enters an era of sustained, self-correcting, and mission-driven investment.

To maintain momentum and extend this transformation, Massachusetts may:

- Expand resilience loan products and institutionalize permanent finance platforms, like the Resilience Revolving Fund, to support capital recycling and equitable access to low-cost capital.
- Embed outcome-based repayment models that reward measurable impact—tying financing terms to equity, climate, and service outcomes.
- Develop specialized financial advisory services, procurement innovation hubs, and technical partnerships to support municipalities in leveraging complex tools.
- Strengthen fiscal safeguards that limit the proliferation of unsustainable development in vulnerable areas through disincentive-based financial policy.
- Use climate finance strategies to anchor regional economic development, creating place-based opportunities for job creation, small business participation, and shared returns on resilience investment.

By Phase 3, Massachusetts is not just financing resilience. It is reshaping the financial logic of infrastructure and land use to reflect the full value of adaptation and risk reduction.

Strategic Priority 4

Build Regional and Organizational Capacity

By Phase 3, Massachusetts has fully embedded climate resilience into the institutional fabric of Commonwealth and regional governance. What began in Phase 1 as temporary coordination structures has now evolved into a lasting, cross-cutting system of leadership, oversight, and accountability. The Commonwealth no longer relies on isolated champions or ad hoc working groups—instead, it has formalized the roles, responsibilities, and feedback loops necessary to sustain climate resilience delivery over the long term.

This priority reflects the shift from building capacity to maintaining and evolving it. Institutions must not only coordinate investment and oversee performance, but continuously learn, adapt, and course-correct based on data, community needs, and changing climate conditions.

The system is now characterized by:

- **Enduring leadership structures** with clear authority to align capital flows, oversee project pipelines, and drive performance.
- **Integrated roles and mandates across agencies,** ensuring that resilience is embedded in operations, staffing, and budgets.
- **Institutional memory and learning capacity,** supported by performance dashboards, evaluation frameworks, and regular strategy cycles.
- **Formalized stakeholder engagement channels,** making community voices a standing part of governance—not an afterthought.
- **Clear accountability mechanisms,** where goals are tracked, outcomes are reported, and continuous improvement is expected.

Looking forward, Massachusetts may:

- **Establish a permanent resilience authority to manage long-term financing,** coordinate implementation, and ensure accountability, if experience in earlier phases justifies the institutional change and additional resource needs.
- **Institutionalize adaptive governance cycles,** linking ResilientMass Plan updates to capital planning, fiscal policy, and program design.
- **Align budgeting and staffing practices with resilience mandates,** ensuring that agencies are resourced to fulfill their climate responsibilities, not just encouraged to do so.
- **Facilitate institutional partnerships with academic institutions,** regional organizations, and community-based networks to expand reach, innovation, and trust.

Ultimately, this strategic priority ensures that the resilience system does not stall when leadership changes or budgets shift. Instead, it is locked into the day-to-day machinery of government. It is a standing function that evolves alongside Massachusetts' infrastructure, communities, and risks. Resilience becomes not just a policy agenda, but a defining feature of how the Commonwealth governs for the future.

Conclusion — Advancing a Resilient Future

Chester, MA
Source: Adobe Stock

Massachusetts is entering a decisive phase in its resilience journey. Based upon its strong track record in climate planning and project development, the ResilientMass Roadmap offers a clear, actionable strategy to align investment with the Commonwealth's long-term climate adaptation goals. It is designed not just to guide infrastructure or funding decisions, but to strengthen the systems and partnerships necessary to support lasting, equitable progress.

The Roadmap envisions a future in which resilience is a routine function of public investment and community development. It outlines a path where all communities, regardless of size or geography, have access to the resources and capacity needed to reduce risk and adapt to a changing climate. By coordinating local initiatives with the Commonwealth's leadership, and leveraging both public and private tools, Massachusetts can build a more integrated and scalable model for climate resilience.

This strategy recognizes that meaningful change requires sustained effort. The phased approach—anchored in near-term pilots, institutional development, and long-term system alignment—is structured to be both ambitious and practical. It focuses not only on what needs to be built, but on how the Commonwealth can deliver projects more effectively, allocate resources more equitably, and adapt to emerging needs over time.

Equity remains central to this vision. Building resilience at scale requires that all communities, especially those that have historically been disadvantaged, are able to shape and benefit from investment. The Roadmap emphasizes inclusive engagement, targeted support, and alignment of funding mechanisms with community needs.

Innovation is also a recurring theme—whether in financing approaches, regional collaboration, or the integration of nature-based solutions. The investment system outlined in this document provides a flexible foundation to support learning, experimentation, and continuous improvement as conditions evolve.

This Roadmap is not an endpoint. It is a starting point, based upon the Commonwealth's firm foundation of resilience programs and successes, for coordinated implementation and long-term institutional transformation. Future success would depend on collaboration across agencies, levels of government, sectors, and communities. The tools are in place. The direction is clear. With sustained focus and shared commitment, Massachusetts can turn this strategy into action and resilience into a core function of how the Commonwealth plans, invests, and grows.

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14 The investment need analysis does not estimate project-by-project costs. Costs for projects within each key resilience measure are highly variable. The investment need analysis relies on existing data and methodologies. Key resilience measures may cover a wide range of project types, all of which may not be captured in the investment need analysis. Changes in policy, such as streamlining permits, are not incorporated in the analysis and could ultimately reduce project costs by key resilience measure though generally focuses on investment need to 2050. Phasing, asset prioritization, and implementation schedules are not accounted for in the investment need analysis. All results from the investment need analysis are presented in 2024 $. See Appendix B for more information.

15 SIGNIFICANT AND HIGH HAZARD DAMS: There are 200 significant or high hazard state-regulated dams classified as unsafe or poor condition. The analysis assumes removal of 200 to 300 dams (agonistic to which dams are removed) and applies a distribution of cost removal/dam based on reviewed data. In both the low- and high-end estimate, the majority are assigned between $0.8M and $1.5M, with smaller percentages assigned higher cost ranges. Some dams may require repair rather than removal, such as if they have public purposes related to drinking water supply or flood control. Reviewers noted, however, that it was not possible to estimate the costs for repair relative to removal. Dams that must remain will incur not only repair costs but also ongoing maintenance and inspection costs. Costs are highly variable and specific to each project. See Appendix B for more information.

16 SMALL BRIDGES AND CULVERTS: Both the low- and high-end estimate assume that half of today's culverts and small bridges need replacement. However, the high-end assumes more culverts require upsizing to small bridges (35% of culverts compared to 15% for the low-end) and more small bridges (35% of small bridges compared to 15% for the low-end) require upsizing to bridges. Unit cost ranges differ for the low- and high-end values based on the range of data reviewed ($800K to $1.2M for culvert replacement, $1.35M to $1.5M for culverts upsized to small bridges and for small bridges that stay as small bridges, $3M to $5M for small bridges upsized to bridges). Costs are highly variable and specific to each project. See Appendix B for more information.

17 COASTAL AND RIVERINE WETLANDS AND FLOODPLAINS: The investment need analysis assumes 1,300 to 3,600 acres per year, or 31,500 to 90,000 acres over 25 years of wetland acreage is restored. The analysis applies a cost of $4K to $20K per acre for coastal wetlands and $26K per acre for freshwater wetlands. The district-scale flood protection costs focus on coastal areas and apply existing cost estimates completed for protection against future conditions. The low-end cost applies the cost from Climate Ready Boston for around $4B to protect neighborhoods around the Boston Harbor. The high-end estimate applies the 2015 coastal infrastructure inventory and assessment report update estimated cost of nearly $8B to upgrade public structures and restore private ones to function under future sea level scenarios. The report is based on data from the Massachusetts Ocean Resource Information System which inventories gray infrastructure (seawalls, bulkheads, revetments, groins and jetties), as well as beach and dune renourishment. The property buyout investment need analysis assumes 50 to 100 properties annually, or 1,250 to 2,500 properties total over a 25-year period. The analysis applied a sales price of $675K per property based on county-level residential sales data from Redfin weighted by land acreage in the 100-year flood zone. Costs are highly variable and specific to each project. See Appendix B for more information.

18 FOREST CONSERVATION AND TREE PLANTING: For forest conservation, the low-end investment need estimate assumes 30% of the 685,000 acres will be through conservation restrictions at a cost of $7K per acre and that the remaining will be protected through acquisition at a cost of around $11.5K per acre based on PLACES Lab data for market value of vacant land for a subset of counties. The high-end estimate assumes 20% of the 685,000 acres will be protected through conservation restrictions also at a cost of $7K per acre, and that the remaining acres are acquired at a cost of $18K per acre based on PLACES Lab data for market value of vacant land for a subset of counties. The investment need for tree planting includes costs for urban and riparian trees and are the same for the low- and high- scenarios, as these costs were extrapolated from the EEA study which did not include a range. Costs are highly variable and specific to each project. See Appendix B for more information.

19 STRATEGIC TRANSPORTATION INFRASTRUCTURE: In absence of statewide targets or investment need analyses for transportation infrastructure, the investment need analysis assumes a minimum of 50% and maximum of 75% of the 609 miles of road classes 1 to 4 in the 100-year floodplain require investment at a low end of $15M and high-end of $20M per road centerline mile. Bridge costs are estimated using the Environmental Protection Agency's (EPA) 2017 *Climate Change Impacts and Risk Analysis* (CIRA) for proactive bridge rehabilitation by proportioning the estimated costs for the Northeast to Massachusetts based on number of bridges. CIRA models projected changes in peak flows from a 100-year, 24-hour precipitation event for two future conditions (2050 and 2090) under two future emissions scenarios (Representative Concentration Pathway [RCP] 4.5 and RCP 8.5) and quantifies costs for riprap to stabilize bridges and bridge pier and abutment strengthening with the use of additional concrete. The investment need analysis applies the cost range for the annual 2050 conditions over a 25-year period. The tunnel investment need is based on two estimates from transportation agencies: a 2015 study estimate to protect tunnel portals for roads in the Central Artery/Tunnel system through 2100 and costs for MBTA pump room upgrades and protection of tunnel portals. The rail analysis assumes that elevation of MBTA commuter rail right-of-way (ROW) miles in the FEMA 100-year floodplain. Based on input from MBTA, the analysis applied a range of $140M to $330M per mile. Transit facilities and infrastructure are costed based on the FY26 to Fiscal Year 2030 MBTA capital investment plan requests for Guideway Signal and Power, Passenger Facilities, and Maintenance and Administrative Facilities. This cost was multiplied by five to account for a time period through 2050. Costs are highly variable and specific to each project. See Appendix B for more information.

20 DRINKING WATER, WASTEWATER, AND STORMWATER INFRASTRUCTURE: The National Association of Clean Water Agencies and the Association of Metropolitan Water Agencies conducted a cost assessment of adaptation to address the likely impacts of climate change on the United States' drinking water and wastewater facilities to 2050. The study estimated wastewater and drinking water adaptation costs for the entire Northeast (defined as Massachusetts, Connecticut, Delaware, Washington DC, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia). Using a scaling factor of 11% (calculated from the ratio of water flow handled by Massachusetts relative to the northeast) and excluding costs associated with operations and maintenance and financing, AECOM calculated an estimated capital investment. Stormwater costs are estimated for the separation of the combined sewer systems in the 19 CSO permittee communities across the Commonwealth. A cost per acre of separation is applied based on recent projects in Boston and the City of Lynn. It also includes costs for DRINKING WATER, WASTEWATER, AND STORMWATER INFRASTRUCTURE investments to respond to increased wet weather events, applying a per acre cost to impervious acre controlled. Impervious acreage controlled is calculated based on the predicted change in wet weather events in 2050. Costs are highly variable and specific to each project. See Appendix B for more information.

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