Chapter 5
Climate Adaptation & Resilience Solutions

Introduction

Building resilience against climate hazards demands strategic physical infrastructure improvements. Therefore, to supplement the Chapter 2: Resilient Rhody 2025 Actions, this document presents ten targeted solutions designed to strengthen Rhode Island's resilience.

Intent

This document seeks to serve as both a reference for viable alternatives to address relevant climate risks and a practical guide for municipal planners, state agencies, utilities, and partners to help move projects from risk identification to implementation.

These solutions are tailored to priority assets identified through this Plan's prioritization process, which incorporated a statewide vulnerability assessment and stakeholder input. While grounded in these known priorities, the guidance is intended to be flexible and adaptable to additional assets as needs evolve.

Organization:

Solutions are organized into three categories based on asset type:

- Critical Infrastructure
- Natural Systems
- Community Resilience and Emergency Preparedness

Contents

Each solution described herein includes:

- Strategy guidance
- Cost estimates
- Funding approaches

Continue for guidance on how to read this document.

Climate Adaptation & Resilience Solutions:

- **Road & Bridge Flood Mitigation Solutions** with a focus on evacuation routes
- **Resilient Port Infrastructure Solutions**
- **Energy Resilience Solutions** with a focus on Washington County and Block Island
- **Sewer & Stormwater Infrastructure Solutions**
- **Wastewater Treatment Facilities Hardening**
- **Drinking Water & Reservoir Resilience**
- **Beach & Wetland System Restoration**
- **River & Stream Restoration** with a focus on the Moshassuck River
- **School & Public Safety Building Solutions** with hardening and relocation opportunities
- **Hospital Flood & Energy Resilience Solutions**

This document also supports ongoing initiatives at Providence Station and Fox Point Hurricane Barrier that are essential to Rhode Island's resilience.

Prudence Island © RIDEM

How to Read this Document

Each solution includes the following four sections:

A Priority Assets Summary Pages

- Overview of asset type and climate hazard challenges
- List of at-risk assets and statewide map

B Solution Summary Pages

- Current and future climate risks to asset type being addressed
- Past and ongoing state initiatives
- Steps for Implementation
- Representative Priority Assets with site-specific challenges

C Solution Strategy Pages

- Specific strategy guidance
- Details on strategy mechanisms, innovation level, hazards addressed, and relative cost

D Funding Strategy Pages

- Summary of costs, benefits, and economic impacts of intervention
- Summary of cost of consequence
- Potential state and federal funding sources and mechanisms
- State role in supporting project type

Continue for guidance on how to read each section.

Priority Assets Summary Pages

How to Read this Document

1. Solution Group: Each solution is in one or two of the four asset groups. The highlighted box indicates the asset group. These bars are at the top of every page.

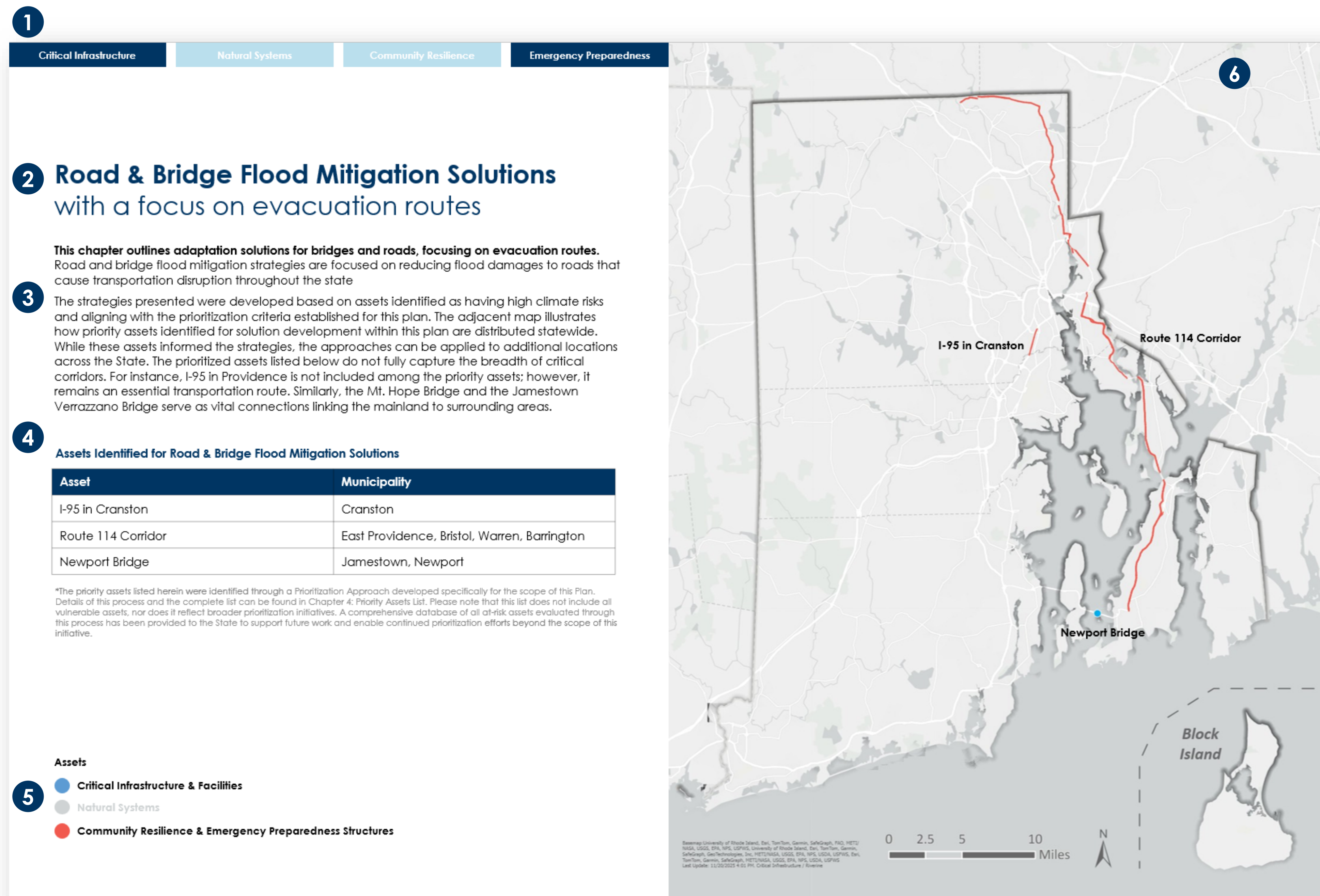
2. Asset-Specific Solution: Each section is organized by solutions for specific asset types.

3. Problem Statement: High-level summary of the solution type with a problem statement that identifies the relevant climate hazards and challenges.

4. Identified Priority Assets: Table of the priority assets identified through Chapter 3: Statewide Climate Vulnerability Assessment (SCV) and the prioritization process. These locations represent the asset types that the solution is designed to address.

5. Map Legend: Legend that highlights the relevant asset categories included in the solution. Asset categories in gray are not represented in the map.

6. Map: Display of the identified assets and their locations within the state.


1
Critical Infrastructure
Natural Systems
Community Resilience
Emergency Preparedness

2
Road & Bridge Flood Mitigation Solutions
with a focus on evacuation routes

3
This chapter outlines adaptation solutions for bridges and roads, focusing on evacuation routes. Road and bridge flood mitigation strategies are focused on reducing flood damages to roads that cause transportation disruption throughout the state

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the State. The prioritized assets listed below do not fully capture the breadth of critical corridors. For instance, I-95 in Providence is not included among the priority assets; however, it remains an essential transportation route. Similarly, the Mt. Hope Bridge and the Jamestown Verrazzano Bridge serve as vital connections linking the mainland to surrounding areas.

4
Assets Identified for Road & Bridge Flood Mitigation Solutions

Asset	Municipality
I-95 in Cranston	Cranston
Route 114 Corridor	East Providence, Bristol, Warren, Barrington
Newport Bridge	Jamestown, Newport

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

5
Assets
Critical Infrastructure & Facilities
Natural Systems
Community Resilience & Emergency Preparedness Structures

Solution Summary Pages

How to Read this Document

1. Summary: Narrative summary describing the Rhode Island climate change impacts for the identified assets. Discusses how the solution will address the identified challenges.

2. Ongoing Actions: Summary of the current ongoing Rhode Island activities for the solution and asset types.

3. Resources: Links to the direct resources covered by the ongoing actions.

4. Precedent Image: Image of one of the representative priority assets.

5. Steps for Implementation: High level list of the necessary steps key players need to take to implement solutions.

6. Representative Priority Assets: One to two assets from the identified priority asset lists are selected as representative priority assets. The solutions developed were specifically created for these assets. Results from Chapter 3: Statewide Climate Vulnerability Assessment (SCV) are included under the climate risks. A symbol represents high or very high climate risk in the identified time horizon, see legend below:

- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Critical Infrastructure | Natural Systems | Community Resilience | Emergency Preparedness

1 **Road & Bridge Flood Mitigation Solutions Summary**

Flooding from heavy rain, rivers, and coastal storms increasingly threatens low lying roads and bridges throughout the state. Flooding can wash out roads, weaken bridges, and cut off safe routes, including emergency evacuation routes. Strategies like road raising, flood barriers, nature-based solutions (NbS), and strategic relocation help keep evacuation routes accessible.

More frequent and intense storm events are increasing the risk of flooding on roads and bridges, especially along critical evacuation routes like Route 114, which spans from East Providence to Bristol, and I-95 in Cranston and Providence. Flooding in these areas has caused repeated closures, erosion of embankments, and damage to bridge foundations, limiting safe access for residents and emergency responders. These routes are also vital evacuation routes. Flooding events cause damage leading to isolation, safety hazards, and costly repairs.

Communities can adopt a mix of strategies tailored to local conditions, including elevating roads, implementing NbS, improving storm sewer system capacities, constructing flood barriers, and upgrading culverts at road and stream crossings. In certain cases, voluntary retreat can represent the most sustainable long-term approach. Beyond physical interventions, developing a climate data platform is essential to help municipalities identify effective flood mitigation measures and advance the RIDOT Resilience Improvement Plan.

2 **Ongoing Actions**

In 2024, RIDOT published their Resilience Improvement Plan, which identified vulnerabilities and potential adaptation strategies to reduce risk to the State's transportation infrastructure.

Communities across the State are also working to address their vulnerable roadways and bridges. For example, Barrington, Warren, and Bristol evaluated flood-vulnerable areas along the Route 114 corridor.

3 **Resources**

- RIDOT Resilience Improvement Plan (2024)
- RIDSP Resilient Route 114 Corridor Study (2025)

4

Interstate 95 in Cranston© Kyle Kane for WPRI-TV

Steps for Implementation 5

1. **Stakeholder Engagement** Identify key stakeholders early and maintain engagement throughout the project planning process to build project support.
2. **Data Collection and Existing Conditions Analysis** Review existing conditions to understand limitations to potential alternatives, such as as-builts and local flood models. Collect data such as critical elevations, utility information, and natural resource delineations. Identify potential technical assistance programs to support implementation.
3. **Vulnerability Assessment** Conduct a vulnerability assessment to identify flood pathways and better define the flood risk impacting assets and populations. Utilize climate data from STORMTOOLS and RIDOT.
4. **Hydrologic and Hydraulic (H&H) Modeling and Analysis** Perform H&H modeling to simulate flood conditions, identify elevations that provide effective flood protection, and develop approaches to avoid downstream impacts.
5. **Optioneering Analysis** Identify and assess multiple strategies to improve flood mitigation, including NbS, gray infrastructure, hybrid, and retreat approaches. Assessing site-specific conditions, such as available space, natural resources (e.g., wetlands), land use, etc., will dictate which alternatives may be feasible for further analysis and design.
6. **Conceptual Designs, Design Developments, and Construction Documents** Develop concept-level designs of the identified alternatives. Selected concepts will move forward for design development and final design.
7. **Costs and Funding Assessment** Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final design.
8. **Permitting and Construction** Obtain all required local, state, and federal approvals to ensure compliance with environmental, safety, and regulatory standards before construction begins. Initiate and complete construction.
9. **Maintenance and Monitoring** Establish a routine inspection and maintenance protocols to maintain functionality and longevity of roads and bridges. Monitor project success at reducing risk to hazards.

Representative Priority Assets 6

Route 114 Corridor in East Providence, Bristol, Warren, and Barrington and **Interstate 95** in Cranston are major roads and **evacuation routes** selected as representative priority assets due to their criticality for **transportation and climate risk** to coastal, stormwater, and riverine flooding.

Route 114 Corridor
Municipality: East Providence – Bristol
Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:
Context: Evacuation Route, Three Miles From a Hospital, Major Route in Rhode Island, and Community Identified.

Interstate 95
Municipality: Cranston
Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:
Context: Evacuation Route, Three Miles From a Hospital, and Major Route in Rhode Island.

Strategy Pages

How to Read this Document

1. Summary of Strategies: This page provides examples of solution strategies that work together to address the current climate challenges.

2. Strategy Type: Each strategy section starts with the title of the strategy. There is then supporting narrative that explains the strategy and how it addresses climate challenges.

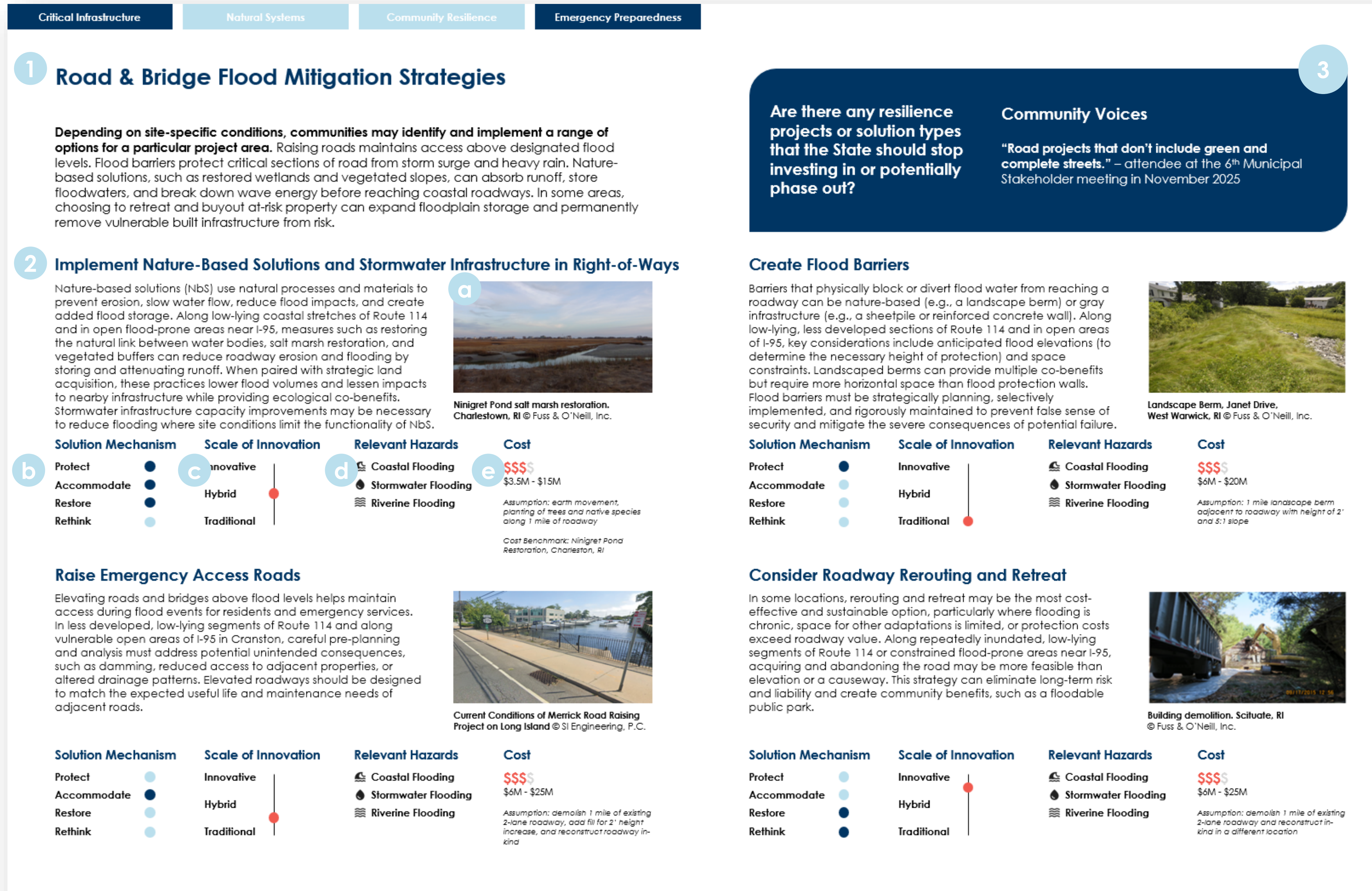
a. Precedent Image: A precedent image shows what strategy implementation looks like or a potential asset where the strategy could be applied.

b. Solution Mechanism: Highlights the relevant solution mechanism.

- **Protect:** Defend vulnerable areas using physical or engineered measures.
- **Accommodate:** Adapt buildings and infrastructure to withstand changing conditions.
- **Restore:** Rehabilitate natural systems to buffer against hazards.
- **Rethink:** Reevaluate planning strategies and support people, infrastructure, and critical assets relocate away from high-risk areas.

c. Scale of Innovation: Ranks the scale of innovation. Traditional represents routine best practice, innovative is a more novel approach, and hybrid is a mixture of the two.

d. Relevant Hazards: Identifies the climate hazards that are mitigated by the strategy. The same icons are used from the prior slide.


Critical Infrastructure | Natural Systems | Community Resilience | Emergency Preparedness

1 Road & Bridge Flood Mitigation Strategies

Depending on site-specific conditions, communities may identify and implement a range of options for a particular project area. Raising roads maintains access above designated flood levels. Flood barriers protect critical sections of road from storm surge and heavy rain. Nature-based solutions, such as restored wetlands and vegetated slopes, can absorb runoff, store floodwaters, and break down wave energy before reaching coastal roadways. In some areas, choosing to retreat and buyout at-risk property can expand floodplain storage and permanently remove vulnerable built infrastructure from risk.

3 Are there any resilience projects or solution types that the State should stop investing in or potentially phase out?

Community Voices

"Road projects that don't include green and complete streets." – attendee at the 6th Municipal Stakeholder meeting in November 2025

2 Implement Nature-Based Solutions and Stormwater Infrastructure in Right-of-Ways

Nature-based solutions (NbS) use natural processes and materials to prevent erosion, slow water flow, reduce flood impacts, and create added flood storage. Along low-lying coastal stretches of Route 114 and in open flood-prone areas near I-95, measures such as restoring the natural link between water bodies, salt marsh restoration, and vegetated buffers can reduce roadway erosion and flooding by storing and attenuating runoff. When paired with strategic land acquisition, these practices lower flood volumes and lessen impacts to nearby infrastructure while providing ecological co-benefits. Stormwater infrastructure capacity improvements may be necessary to reduce flooding where site conditions limit the functionality of NbS.

a **Ninigret Pond salt marsh restoration. Charlestown, RI** © Fuss & O'Neill, Inc.

b Solution Mechanism: Protect, Accommodate, Restore, Rethink
c Scale of Innovation: Innovative, Hybrid, Traditional
d Relevant Hazards: Coastal Flooding, Stormwater Flooding, Riverine Flooding
e Cost: $$$$ $3.5M - $15M
Assumption: earth movement, planting of trees and native species along 1 mile of roadway
Cost Benchmark: Ninigret Pond Restoration, Charleston, RI

Create Flood Barriers

Barriers that physically block or divert flood water from reaching a roadway can be nature-based (e.g., a landscape berm) or gray infrastructure (e.g., a sheetpile or reinforced concrete wall). Along low-lying, less developed sections of Route 114 and in open areas of I-95, key considerations include anticipated flood elevations (to determine the necessary height of protection) and space constraints. Landscaped berms can provide multiple co-benefits but require more horizontal space than flood protection walls. Flood barriers must be strategically planning, selectively implemented, and rigorously maintained to prevent false sense of security and mitigate the severe consequences of potential failure.

Landscape Berm, Janet Drive, West Warwick, RI © Fuss & O'Neill, Inc.

Solution Mechanism: Protect, Accommodate, Restore, Rethink
Scale of Innovation: Innovative, Hybrid, Traditional
Relevant Hazards: Coastal Flooding, Stormwater Flooding, Riverine Flooding
Cost: $$$$ $6M - $20M
Assumption: 1 mile landscape berm adjacent to roadway with height of 2' and 5:1 slope

Raise Emergency Access Roads

Elevating roads and bridges above flood levels helps maintain access during flood events for residents and emergency services. In less developed, low-lying segments of Route 114 and along vulnerable open areas of I-95 in Cranston, careful pre-planning and analysis must address potential unintended consequences, such as damming, reduced access to adjacent properties, or altered drainage patterns. Elevated roadways should be designed to match the expected useful life and maintenance needs of adjacent roads.

Current Conditions of Merrick Road Raising Project on Long Island © SI Engineering, P.C.

Solution Mechanism: Protect, Accommodate, Restore, Rethink
Scale of Innovation: Innovative, Hybrid, Traditional
Relevant Hazards: Coastal Flooding, Stormwater Flooding, Riverine Flooding
Cost: $$$$ $6M - $25M
Assumption: demolish 1 mile of existing 2-lane roadway, add fill for 2' height increase, and reconstruct roadway in-kind

Consider Roadway Rerouting and Retreat

In some locations, rerouting and retreat may be the most cost-effective and sustainable option, particularly where flooding is chronic, space for other adaptations is limited, or protection costs exceed roadway value. Along repeatedly inundated, low-lying segments of Route 114 or constrained flood-prone areas near I-95, acquiring and abandoning the road may be more feasible than elevation or a causeway. This strategy can eliminate long-term risk and liability and create community benefits, such as a floodable public park.

Building demolition. Scituate, RI © Fuss & O'Neill, Inc.

Solution Mechanism: Protect, Accommodate, Restore, Rethink
Scale of Innovation: Innovative, Hybrid, Traditional
Relevant Hazards: Coastal Flooding, Stormwater Flooding, Riverine Flooding
Cost: $$$$ $6M - $25M
Assumption: demolish 1 mile of existing 2-lane roadway and reconstruct in-kind in a different location

e. Cost: Represents the estimated scale of cost.

$: < $1M
$$: $1M – $5M
$$$: $5M – $15M
$$$$: > $15M

Unit metrics and cost assumptions are also included for each solution.

3. Community Voices: Shows a relevant quote or takeaway from the engagement process.

Funding Strategy Pages

How to Read this Document

1. Funding Summary: This page provides a summary of the funding strategy needed to implement the solution.

2. Costs: Provides a summary of the assumptions and the relative cost of the strategy including the specific precedents and assumptions used.

3. Benefits: Provides a summary of the benefits of implementing the solution particularly as they relate to the consequences assessed in the Chapter 3: Statewide Climate Vulnerability Assessment (SCV).

a. Benefit Types: Highlights the relevant benefits associated with the solution

- **Three Dots:** Benefit addresses the primary consequence in the SCV assessment.
- **Two Dots:** Benefit addresses a cascading consequence in SCV assessment, or the benefit was found very significant in literature review research.
- **One Dot:** Benefit identified in the prioritization criteria process or through the literature review research.
- **No Dot:** Benefit not relevant.

4. Economic Impacts: Summary of the impact (jobs, earnings, sales) and fiscal benefit (sales tax and income tax) that would be generated for Rhode Island for the proposed projects.

5. Consequences of Inaction: Description of the consequences that could occur for the asset and State more broadly if action is not taken.

6. Funding Strategy: Description of example potential funding mechanisms, the state's role in implementation and immediate next steps.

Critical Infrastructure | Natural Systems | Community Resilience | Emergency Preparedness

1 Road & Bridge Flood Mitigation Strategies Funding Strategy

Evacuation route mitigation solutions in Rhode Island can be supported by both federal and state transportation funding programs. The following sections summarize anticipated implementation costs, cost-effectiveness considerations, and the life safety, ecosystem, and community benefits these solutions provide. It also outlines a funding strategy to identify the necessary next steps the State needs to take to construct and implement the road and bridge solutions.

2 Costs

Costs for this group of strategies generally focus on roadways, nominally sized for a one-mile stretch. Projects involving greater roadway extents, increased height, and right-of-way acquisition (excluded from this exercise) will require greater capital investment and schedule. Cost and resilience for these strategies are generally positively correlated, with the retreat and rerouting strategy having the most resilience and greatest cost. However, the highest resilience solution is also associated with strong longevity and low maintenance, reducing needed long-term investments significantly. Although this strategy assumes the construction of a new road to replace the demolished existing road, the road could theoretically be abandoned if the broader transportation network could accommodate the trips that previously utilized the abandoned route; this approach would result in lower capital cost.

3 Benefits

Flood mitigation strategies protect roads and bridges, allowing transportation routes to remain operational during extreme flood events. The SCV assessment estimated that Route 114 Corridor currently experiences 5 ft of flooding during a 100-year coastal flood event, and this is projected to increase to 7 ft by 2100. Interstate 95 is expected to see an increase of nearly 4 ft in coastal flood levels for the 500-year coastal flood between now and 2100. These assets are designated RIEMA evacuation routes that are critical pathways to hospitals and other emergency providers. Roads also serve as RIDOT bus routes. Their continual operation is urgent to preserving life safety and daily-life commute for all Rhode Islanders. Implementation of the resilient strategies reduces damage, minimizing the amount of planning and funding efforts needed to restore roads and bridges after a flood event. When implemented, NbS bring co-benefits of enhanced biodiversity and ecosystems.

a Benefits

Benefits	
Avoided Damage	●●○
Avoided Disruption	●●●
Preserved Life Safety	●●○
Other	●○○

Co-benefits include protection of evacuation routes, RIDOT bus routes, and improved biodiversity

4 Economic Impacts

Investing in flood-resilient roads and bridges generates significant economic returns through construction employment, reduced repair costs, and sustained commerce. Infrastructure improvements create immediate jobs in engineering, construction, and materials supply while preventing costly emergency repairs and economic losses from road closures. Maintaining accessible evacuation routes and RIDOT bus services protects workforce mobility and business continuity. By avoiding repeated flood damage, Rhode Island saves millions in reconstruction costs while preserving tax revenue from uninterrupted commercial activity. These investments strengthen supply chains, support tourism, and enhance property values, demonstrating clear fiscal returns.

5 Consequence of Inaction

The consequence of inaction on Rhode Island's road and bridges is medium-high. Roads are highly at risk to damage and disruption when they are inundated by 2 ft of flooding, and Route 114 currently is expected to be exposed to more than 2 ft of flooding during a 100-year coastal storm. Inaction could lead to disruptions in emergency response and economic activity. Route 114, and the Newport Bridge are key corridors that connect communities, hospitals, and other critical infrastructure.

b Consequence of Inaction: High / Medium / Low

6 Funding Strategy

These funding programs provide strong support for transportation resilience projects that reduce flooding along critical roads and bridges. The PROTECT Program advances elevation, drainage upgrades, and nature-based right-of-way solutions, while the Municipal Road & Bridge Revolving Loan Fund enables municipalities to finance essential road and bridge improvements that strengthen long-term performance. These mechanisms help advance flood-ready transportation corridors across Rhode Island.

Mechanism Title: Promoting Resilience Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program

Mechanism Type: Grant/Formula Funding

Level: Federal

Agency: US Department of Transportation

The PROTECT Program funds transportation resilience projects that reduce climate-driven risks to roads, bridges, and evacuation routes. Eligible activities include elevating road segments, installing flood barriers, upgrading drainage and culverts, and integrating nature-based practices within transportation rights-of-way. PROTECT also supports planning for long-term adaptation of key travel corridors.

State Role: Provide statewide flood, hydrology, and risk data to support project scoping.

Next Steps: Complete preliminary flood assessments and coordinate with RIDOT to position projects for PROTECT funding.

Mechanism Title: Municipal Road & Bridge Revolving Loan Fund (MRBRF)

Mechanism Type: Low-Interest Loan/Technical Assistance

Level: State

Agency: Rhode Island Infrastructure Bank (RIIB), applications submitted through RIDOT

MRBRF provides low-interest financing for municipal transportation projects that improve the safety, condition, and resilience of local roads and bridges. Funds can support elevation of roadways, flood mitigation retrofits, drainage upgrades, and protective infrastructure in areas experiencing chronic flooding.

State Role: Provide technical review and coordination with RIDOT on design standards.

Next Steps: Prepare preliminary design materials and project readiness inquiry to RIIB and coordinate with RIDOT on permitting and engineering requirements.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

b. Consequences of Inaction Scale: Relative consequence of inaction.

- **High:** Severe consequences, including major life safety risks and cascading failures.
- **Medium:** Significant disruptions, economic losses, and potential damage to infrastructure, but no immediate life safety threats.
- **Low:** Minimal impact due to existing redundancies.

Assumptions and Qualifications

Data & Information

This report relies on information provided by others to determine current and future climate conditions for hazard assessment and to develop resilience solutions. Arup does not accept responsibility for the content, including the accuracy and completeness, of such information. Arup emphasizes that the forward-looking projections, forecasts, or estimates, are based upon interpretations or assessments of available information at the time of this project.

Priority Assets, Resilience Strategies & Jurisdiction

The current and future natural hazard exposure and risk of any site is dependent on many factors beyond Arup's control, including uncertainties around existing project sites and their construction details, natural hazards, and climate change.

Any climate resilience strategy includes potential residual risks. The resilience solutions described in this report are not guaranteed nor intended to eliminate all climate risk but are intended to be a tool to reduce climate-related damage and/or disruption. Arup shall not be responsible for damages or impacts associated with the performance of the climate resilience systems.

The realization of the prospective risks is dependent upon the continued validity of the assumptions on which it is based. Actual events frequently do not occur as expected, and the differences may be material. For this reason, Arup bears no responsibility for the realization of any projection, forecast, opinion or estimate. Findings are time-sensitive and relevant only to current conditions at the time of writing.

This plan does not confirm the feasibility or effectiveness of the strategies outlined as they relate to the designated Priority Assets. It provides a framework of specific steps to advance the proposed solutions from initial identification through to potential implementation. All proposed strategies require comprehensive due diligence, stakeholder engagement, detailed planning, design, and costing for each strategy and location identified.

Actions and strategies outlined in this plan may fall under municipal rather than state jurisdiction. Therefore, successful implementation of these actions may require local participation and coordination.

Costing

Cost estimates for each solution type are categorized as Class 5 based on the Association for the Advancement of Cost Engineering International (AACEi) cost estimate classification matrix based on indicative scope and benchmark projects.

The accuracy range for these class 5 cost estimates are assumed to be +100% / -50%.

Benchmark projects are sourced from desktop research and Arup's internal database. Benchmark costs are normalized to Rhode Island cost basis using 2025 City Cost Indices from RSMeans. Benchmark costs are escalated to 2025 cost basis using the Construction Cost Index (CCI) from Engineering News Record (ENR).

Scope assumptions are made based on benchmark projects, proposed scope to be included, and sized relative to other strategies considering possible size of potential future projects. Parametric costing (utilizing a defined quantity and unit rate) is employed where possible. Allowances are estimated to account for scope intended to be included in the project when sufficient detail or context for parametric costing was not available.

Costs for actual projects will vary based on a variety of factors including but not limited to defined extent of scope, project-specific risks, site constraints, environmental scope, construction delivery method, stakeholder engagement, funding mechanisms, existing asset operations and potential downtime, and/or market factors.

Funding

Funding sources were identified in Summer 2025 and represent a point in time assessment. This plan does not guarantee the availability, continuation, or applicability of these sources.

All funding sources should be verified for current availability and applicability before pursuing them.

Due to changing federal priorities in both policy and funding, agencies across state government have been facing challenges in program implementation. As these changes impact agency resources including the state budget, timelines and commitments will shift, as necessary.

Nag Marsh Sunset © Narragansett Bay National Estuarine Research Reserve (NBNERR)

Critical Infrastructure Adaptation Solutions

Road & Bridge Flood Mitigation Solutions with a focus on evacuation routes

Resilient Port Infrastructure Solutions

Energy Resilience Solutions with a focus on Washington County and Block Island

Sewer & Stormwater Infrastructure Solutions

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Assets

- **Critical Infrastructure & Facilities**
- Natural Systems
- **Community Resilience & Emergency Preparedness Structures**

Road & Bridge Flood Mitigation Solutions Summary

Flooding from heavy rain, rivers, and coastal storms increasingly threatens low lying roads and bridges throughout the state. Flooding can wash out roads, weaken bridges, and cut off safe routes, including emergency evacuation routes. Strategies like road raising, flood barriers, nature-based solutions (NbS), and strategic relocation help keep evacuation routes accessible.

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Ongoing Actions

In 2024, RIDOT published their Resilience Improvement Plan, which identified vulnerabilities and potential adaptation strategies to reduce risk to the State’s transportation infrastructure.

Communities across the State are also working to address their vulnerable roadways and bridges. For example, Barrington, Warren, and Bristol evaluated flood-vulnerable areas along the Route 114 corridor.

Resources

- RIDOT Resilience Improvement Plan (2024)
- RIDSP Resilient Route 114 Corridor Study (2025)

Interstate 95 in Cranston © Kyle Kane for WPRI-TV

Steps for Implementation

1. **Stakeholder Engagement**
   Identify key stakeholders early and maintain engagement throughout the project planning process to build project support.
2. **Data Collection and Existing Conditions Analysis**
   Review existing conditions to understand limitations to potential alternatives, such as as-builts and local flood models. Collect data such as critical elevations, utility information, and natural resource delineations. Identify potential technical assistance programs to support implementation.
3. **Vulnerability Assessment**
   Conduct a vulnerability assessment to identify flood pathways and better define the flood risk impacting assets and populations. Utilize climate data from STORMTOOLS and RIDOT.
4. **Hydrologic and Hydraulic (H&H) Modeling and Analysis**
   Perform H&H modeling to simulate flood conditions, identify elevations that provide effective flood protection, and develop approaches to avoid downstream impacts.
5. **Optioneering Analysis**
   Identify and assess multiple strategies to improve flood mitigation, including NbS, gray infrastructure, hybrid, and retreat approaches. Assessing site-specific conditions, such as available space, natural resources (e.g., wetlands), land use, etc., will dictate which alternatives may be feasible for further analysis and design.
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   Develop concept-level designs of the identified alternatives. Selected concepts will move forward for design development and final design.
7. **Costs and Funding Assessment**
   Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final design.
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9. **Maintenance and Monitoring**
   Establish a routine inspection and maintenance protocols to maintain functionality and longevity of roads and bridges. Monitor project success at reducing risk to hazards.

Representative Priority Assets

Route 114 Corridor in East Providence, Bristol, Warren, and Barrington and **Interstate 95** in Cranston are major roads and **evacuation routes** selected as representative priority assets due to their criticality for **transportation and climate risk** to coastal, stormwater, and riverine flooding.

Route 114 Corridor
Municipality: East Providence – Bristol

Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:

Context: Evacuation Route, Three Miles From a Hospital, Major Route in Rhode Island, and Community Identified.

Interstate 95
Municipality: Cranston

Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:

Context: Evacuation Route, Three Miles From a Hospital, and Major Route in Rhode Island.

Road & Bridge Flood Mitigation Strategies

Depending on site-specific conditions, communities may identify and implement a range of options for a particular project area. Raising roads maintains access above designated flood levels. Flood barriers protect critical sections of road from storm surge and heavy rain. Nature-based solutions, such as restored wetlands and vegetated slopes, can absorb runoff, store floodwaters, and break down wave energy before reaching coastal roadways. In some areas, choosing to retreat and buyout at-risk property can expand floodplain storage and permanently remove vulnerable built infrastructure from risk.

Are there any resilience projects or solution types that the State should stop investing in or potentially phase out?

Community Voices

"Road projects that don't include green and complete streets." – attendee at the 6th Municipal Stakeholder meeting in November 2025

Implement Nature-Based Solutions and Stormwater Infrastructure in Right-of-Ways

Nature-based solutions (NbS) use natural processes and materials to prevent erosion, slow water flow, reduce flood impacts, and create added flood storage. Along low-lying coastal stretches of Route 114 and in open flood-prone areas near I-95, measures such as restoring the natural link between water bodies, salt marsh restoration, and vegetated buffers can reduce roadway erosion and flooding by storing and attenuating runoff. When paired with strategic land acquisition, these practices lower flood volumes and lessen impacts to nearby infrastructure while providing ecological co-benefits. Stormwater infrastructure capacity improvements may be necessary to reduce flooding where site conditions limit the functionality of NbS.

Ninigret Pond salt marsh restoration. Charlestown, RI © Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore ●
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid ●
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$3.5M - $15M

Assumption: earth movement, planting of trees and native species along 1 mile of roadway

Cost Benchmark: Ninigret Pond Restoration, Charleston, RI

Create Flood Barriers

Barriers that physically block or divert flood water from reaching a roadway can be nature-based (e.g., a landscape berm) or gray infrastructure (e.g., a sheetpile or reinforced concrete wall). Along low-lying, less developed sections of Route 114 and in open areas of I-95, key considerations include anticipated flood elevations (to determine the necessary height of protection) and space constraints. Landscaped berms can provide multiple co-benefits but require more horizontal space than flood protection walls. Flood barriers must be strategically planning, selectively implemented, and rigorously maintained to prevent false sense of security and mitigate the severe consequences of potential failure.

Landscape Berm, Janet Drive, West Warwick, RI © Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ●
- Accommodate ○
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$6M - $20M

Assumption: 1 mile landscape berm adjacent to roadway with height of 2' and 5:1 slope

Raise Emergency Access Roads

Elevating roads and bridges above flood levels helps maintain access during flood events for residents and emergency services. In less developed, low-lying segments of Route 114 and along vulnerable open areas of I-95 in Cranston, careful pre-planning and analysis must address potential unintended consequences, such as damming, reduced access to adjacent properties, or altered drainage patterns. Elevated roadways should be designed to match the expected useful life and maintenance needs of adjacent roads.

Current Conditions of Merrick Road Raising Project on Long Island © SI Engineering, P.C.

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- ● (between Hybrid and Traditional)
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$6M - $25M

Assumption: demolish 1 mile of existing 2-lane roadway, add fill for 2' height increase, and reconstruct roadway in-kind

Consider Roadway Rerouting and Retreat

In some locations, rerouting and retreat may be the most cost-effective and sustainable option, particularly where flooding is chronic, space for other adaptations is limited, or protection costs exceed roadway value. Along repeatedly inundated, low-lying segments of Route 114 or constrained flood-prone areas near I-95, acquiring and abandoning the road may be more feasible than elevation or a causeway. This strategy can eliminate long-term risk and liability and create community benefits, such as a floodable public park.

Building demolition. Scituate, RI © Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ○
- Accommodate ○
- Restore ●
- Rethink ●

Scale of Innovation
- Innovative
- ● (between Innovative and Hybrid)
- Hybrid
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$6M - $25M

Assumption: demolish 1 mile of existing 2-lane roadway and reconstruct in-kind in a different location

Road & Bridge Flood Mitigation Strategies Funding Strategy

Evacuation route mitigation solutions in Rhode Island can be supported by both federal and state transportation funding programs. The following sections summarize anticipated implementation costs, cost-effectiveness considerations, and the life safety, ecosystem, and community benefits these solutions provide. It also outlines a funding strategy to identify the necessary next steps the State needs to take to construct and implement the road and bridge solutions.

Costs

Costs for this group of strategies generally focus on roadways, nominally sized for a one-mile stretch. Projects involving greater roadway extents, increased height, and right-of-way acquisition (excluded from this exercise) will require greater capital investment and schedule. Cost and resilience for these strategies are generally positively correlated, with the retreat and rerouting strategy having the most resilience and greatest cost. However, the highest resilience solution is also associated with strong longevity and low maintenance, reducing needed long-term investments significantly. Although this strategy assumes the construction of a new road to replace the demolished existing road, the road could theoretically be abandoned if the broader transportation network could accommodate the trips that previously utilized the abandoned route; this approach would result in lower capital cost.

Benefits

Flood mitigation strategies protect roads and bridges, allowing transportation routes to remain operational during extreme flood events. The SCV assessment estimated that Route 114 Corridor currently experiences 5 ft of flooding during a 100-year coastal flood event, and this is projected to increase to 7 ft by 2100. Interstate 95 is expected to see an increase of nearly 4 ft in coastal flood levels for the 500-year coastal flood between now and 2100. These assets are designated RIEMA evacuation routes that are critical pathways to hospitals and other emergency providers. Roads also serve as RIDOT bus routes. Their continual operation is urgent to preserving life safety and daily-life commute for all Rhode Islanders. Implementation of the resilient strategies reduces damage, minimizing the amount of planning and funding efforts needed to restore roads and bridges after a flood event. When implemented, NbS bring co-benefits of enhanced biodiversity and ecosystems.

Benefits

Benefits	
Avoided Damage	●●○
Avoided Disruption	●●●
Preserved Life Safety	●●○
Other	●○○

Co-benefits include protection of evacuation routes, RIDOT bus routes, and improved biodiversity

Economic Impacts

Investing in flood-resilient roads and bridges generates significant economic returns through construction employment, reduced repair costs, and sustained commerce. Infrastructure improvements create immediate jobs in engineering, construction, and materials supply while preventing costly emergency repairs and economic losses from road closures. Maintaining accessible evacuation routes and RIDOT bus services protects workforce mobility and business continuity. By avoiding repeated flood damage, Rhode Island saves millions in reconstruction costs while preserving tax revenue from uninterrupted commercial activity. These investments strengthen supply chains, support tourism, and enhance property values, demonstrating clear fiscal returns.

Consequence of Inaction

The consequence of inaction on Rhode Island's road and bridges is medium-high. Roads are highly at risk to damage and disruption when they are inundated by 2 ft of flooding, and Route 114 currently is expected to be exposed to more than 2 ft of flooding during a 100-year coastal storm. Inaction could lead to disruptions in emergency response and economic activity. Route 114, and the Newport Bridge are key corridors that connect communities, hospitals, and other critical infrastructure.

Consequence of Inaction

High

Medium

Low

Funding Strategy

These funding programs provide strong support for transportation resilience projects that reduce flooding along critical roads and bridges. The PROTECT Program advances elevation, drainage upgrades, and nature-based right-of-way solutions, while the Municipal Road & Bridge Revolving Loan Fund enables municipalities to finance essential road and bridge improvements that strengthen long-term performance. These mechanisms help advance flood-ready transportation corridors across Rhode Island.

Mechanism Title: Promoting Resilience Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program

Mechanism Type: Grant/Formula Funding

Level: Federal

Agency: US Department of Transportation

The PROTECT Program funds transportation resilience projects that reduce climate-driven risks to roads, bridges, and evacuation routes. Eligible activities include elevating road segments, installing flood barriers, upgrading drainage and culverts, and integrating nature-based practices within transportation rights-of-way. PROTECT also supports planning for long-term adaptation of key travel corridors.

State Role: Provide statewide flood, hydrology, and risk data to support project scoping.

Next Steps: Complete preliminary flood assessments and coordinate with RIDOT to position projects for PROTECT funding.

Mechanism Title: Municipal Road & Bridge Revolving Loan Fund (MRBRF)

Mechanism Type: Low-Interest Loan/Technical Assistance

Level: State

Agency: Rhode Island Infrastructure Bank (RIIB), applications submitted through RIDOT

MRBRF provides low-interest financing for municipal transportation projects that improve the safety, condition, and resilience of local roads and bridges. Funds can support elevation of roadways, flood mitigation retrofits, drainage upgrades, and protective infrastructure in areas experiencing chronic flooding.

State Role: Provide technical review and coordination with RIDOT on design standards.

Next Steps: Prepare preliminary design materials and project readiness inquiry to RIIB and coordinate with RIDOT on permitting and engineering requirements.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Resilient Port Infrastructure Solutions

This chapter outlines adaptation solutions for ports and commercial harbors. Resilient port infrastructure strategies are focused on reducing flooding impacts to reduce damage and ensure continual operations of Rhode Island's ports.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

Assets Identified for Resilient Port Infrastructure Solutions

Asset	Municipality
Block Island - Port of Galilee Ferry Connectivity	New Shoreham and Narragansett
Port of Providence Infrastructure	Providence

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- Critical Infrastructure & Facilities
- Natural Systems
- Community Resilience & Emergency Preparedness Structures

Resilient Port Infrastructure Solutions Summary

Rhode Island ports generate more than $200 million and provide 2,400 jobs for the State, while also providing important non-economic benefits such as mental well-being, social connection, recreation, and cultural identity. However, flooding and extreme wind impacts may cause damage to infrastructure and cascading disruptive impacts to delivery time and other port operations.

Rhode Island ports—like Port of Providence and Port of Galilee—are critical for year-round ferry service, cargo operations, and community access. Frequent flooding and extreme wind events are accelerating infrastructure degradation and causing widespread damage and cascading disruption. Rhode Island ports have experienced hurricane-related damage in the past, notably Hurricane Sandy caused harm to Port of Galilee's facilities and docks in 2012 (URI, 2016).

The port infrastructure solutions outlined herein are tailored to protect port and ferry infrastructure from flooding and extreme wind impacts and allow for incremental accommodating of changing conditions. Additionally, solutions support energy resilience to ensure continual operation of critical equipment, like cargo handling, storage, and security equipment at ports. Strategies follow Rhode Island Coastal Resources Management Council (CRMC) regulatory guidance.

Ongoing Actions

Current projects in the state include a Master Plan at Port of Providence (developed by ProvPort, Inc. and URI), a $15M elevation of port structures at Port of Galilee and Wickford Dock, as well as other climate studies and implementation projects.

Resources

- Clean Marina Program (2022)
- Freight Advisory Committee (2022)
- ProvPort Master Plan (Ongoing)
- Providence Community-Port Collaboration Pilot Project (2017)
- University of Rhode Island (URI) and City of Providence EMA Study (2024)
- Port of Galilee FEMA Project (2024)

Steps for Implementation

1. **Stakeholder Input**
Conduct engagement with port leadership, operators, and staff to identify current challenges at the port and continue engagement throughout the project. Ensure that solutions align with stakeholder input and other ongoing resilience projects, such as the Port of Galilee FEMA project.
2. **Community Input**
Conduct community engagement with local businesses and residents early to balance commercial needs with public access. Build off the lessons learned from the ProvPort MPAC and EPA Providence Community – Port Collaboration Project. Utilize the EPA Community-Port Collaboration Toolkit.
3. **Vulnerability Assessment**
Conduct a vulnerability assessment to identify flood pathways and better define the flood risk impacting port infrastructure and accessibility. Utilize climate data from STORMTOOLS.
4. **Feasibility Planning and Optioneering Analysis**
Develop a feasibility plan, factoring in near- and long-term adaptation strategies for climate change. Conduct an optioneering analysis to determine the most effective resilience solution.
5. **Conceptual Designs, Design Developments, and Construction Documents**
Develop concept-level designs for port infrastructure improvements based on community and stakeholder input and feasibility and optioneering analysis. Selected concepts will move forward for design development and final design.
6. **Costs and Funding Assessment**
Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final design.
7. **Permitting and Construction**
Procure the necessary permits for all infrastructure and water adjacent improvements, including working with the Rhode Island Coastal Resources Management Council (CRMC) and Army Corps of Engineers (ACOE) for approvals. Initiate and complete construction.
8. **Commissioning, Maintenance, and Monitoring**
Conduct necessary commissioning of energy systems to ensure functionality. Establish a routine inspection and maintenance protocols for of docks, bulkheads, NbS, and energy system, identifying roles for port operators. Monitor project success at reducing risk to hazards.

Port of Providence © Gridwealth

Representative Priority Assets

The **Port of Galilee** and **Port of Providence,** two key commercial and industrial hubs, are selected as representative priority assets due to their significant **climate risk** for coastal and stormwater flooding and critical role in supporting the **state's economy and operations**, as identified by stakeholders. Port of Galilee also provides ferry service to Block Island.

Port of Galilee and Ferry Service
Municipality: Narragansett

Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:

Context: Commercial and Industrial Use Types and Stakeholder Identified. Ferry services provides Evacuation Route between mainland and Block Island.

Port of Providence
Municipality: Providence

Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:

Context: Commercial and Industrial Use Types and Stakeholder Identified.

Resilient Port Infrastructure Solutions Strategies

Together, these strategies protect against flooding, maintain vessel access, ensure continuity of critical operations, and enhance ecological resilience. This layered approach also provides alignment across ports. Currently, there are siloed port resilience projects and a lack of standardization and integration between projects. Statewide resilience standards can be developed from these strategies to help address a lack of standardization across projects and project components.

What's one vulnerable place or asset in your municipality we should not miss?

Community Voices

"Port of Galilee ferry connectivity." – attendee at the 2nd Municipal Meeting in July 2025

Integrate Dock and Pier System Improvements for Accessibility

Upgrade docks and piers with floating systems, reinforced decking, and ADA-compliant gangways to maintain safe and reliable access during tidal changes and after storm events. These improvements allow flexibility for varying water levels and ensure operational continuity for ferries and cargo handling. Follow municipal and State priorities for floating dock design and use hurricane-rated hardware for durability. Regular maintenance includes annual inspections of connections and decking, adjusting gangways, and replacing worn components to extend the design life of 25–40 years. Also incorporate shade structures to provide protection from extreme heat at passenger queueing areas.

Port of Galilee © Town off Narragansett

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore ○
- Rethink ●

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Coastal Flooding
- Riverine Flooding
- Extreme Heat

Cost

$$$$
$9M - $35M

Assumption: replace 10 existing fixed piers (each 150'x10') with floating concrete docks with accessible gangways and associated utility works

Cost Benchmark: Port of Galilee – North Facility, Narragansett, RI

Elevate Bulkheads and Flood Barriers

Raise and strengthen bulkheads to withstand sea-level rise while maintaining operational access for ferries and cargo vessels. Improvements include using corrosion-resistant steel or reinforced concrete, adding tie-back anchors for stability, and integrating deployable flood barriers for extreme weather events. Where feasible, hybrid designs combine bulkheads with nature-based elements to reduce wave energy and improve habitat. Maintenance includes annual inspections for cracks, corrosion, and settlement and periodic structural reinforcement. Installing sensors or visual markers can help monitor movement and erosion over time.

Port of Galilee © Pare Corporation

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Coastal Flooding
- Riverine Flooding

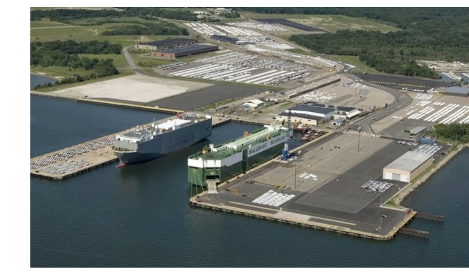
Cost

$$$$
$25M - $95M

Assumption: site clearance and demolish of existing pavement, construct new bulkhead 3' above existing one, backfill, install tiebacks (10' spacing) to existing bulkhead, apply corrosion-resistant surfacing, and allowance for miscellaneous equipment and utility modifications

Design Hybrid Nature Based Solutions

Add salt marsh plantings, oyster reefs, and vegetated buffers along low-energy areas of ports to reduce wave energy, limit erosion, and improve water quality. These features work with bulkheads to protect infrastructure while supporting habitat. Such features can be partnered with species conservation and restoration measures to provide additional co-benefits. Design life varies; nature-based components need monitoring for plant health and sediment buildup. Best practices include hybrid designs where bulkheads meet natural edges and alignment with CRMC restoration guidelines.



Port of Quonset © Providence Journal

Solution Mechanism
- Protect ○
- Accommodate ○
- Restore ●
- Rethink ○

Scale of Innovation
- Innovative ●
- Hybrid
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$
$5M - $20M

Assumption: 1 mile of nature-based shoreline (e.g., salt marsh plantings, oyster reef, etc.)

Cost Benchmark: US Army Corps North Atlantic Coast Comprehensive Study

Install Energy and Backup Power Systems

Install elevated backup generators, solar PV, and battery storage to maintain critical port operations during outages. Generators provide immediate power for navigation aids, refrigeration, pumps, and security systems, while solar and battery systems add redundancy and sustainability. Microgrids can isolate essential loads during emergencies. Equipment should be elevated above flood levels and housed in waterproof enclosures, with systems sized for operational load requirements. Implementation should include automatic transfer switches and planning for at least 72 hours of backup power, coordinated with DEM's electrical upgrade priorities.

Exeter Mail solar Farm in Rhode Island
© Laura Paton for Rhode Island Current

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- ● (between Hybrid and Traditional)
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Cost

$$$$
$3M - $15M

Assumption: install new back-up generators, solar PV, and battery storage

Cost Benchmark: Port of Seattle (Pier 69 Solar Project, Fishermen's Terminal Solar Demonstration Project)

Resilient Port Infrastructure Solutions Funding Strategy

Rhode Island's resilient port infrastructure strategy can be advanced through a mix of federal, state, and partnership-based funding that supports both structural upgrades and nature-based solutions. The following sections outline anticipated implementation costs, cost-effectiveness considerations, and the economic and community benefits of these investments. They also outline a few of the major funding mechanisms available, the State's role, and the next steps needed to position priority port assets for funding and construction.

Costs

Port infrastructure projects involving larger areas, increased barrier heights and number of dock improvements will require greater capital investments and increased duration for planning and implementing the strategy. Lower-cost measures, such as installing energy and backup power systems can vary in cost depending on the capacity of power systems installed. Mid-range investments like dock and pier system improvements enhance accessibility and operational continuity; however, total life cycle costs may increase when considering annual maintenance costs. The higher cost strategy, elevating bulkheads and flood barriers offers the most comprehensive protection against flooding and storm surge, significantly reducing vulnerability for critical assets, which could result in long-term savings.

Benefits

Ports are a key economic hub in Rhode Island, providing jobs and industry in shipping, commercial fishing, and recreation. The SCV assessment estimated that the Port of Providence and Galilee currently experience approximately 4.5 ft of flooding during a 100-year coastal flood event, and this is projected to increase to 7 ft of flooding by 2100. Resilient port infrastructure solutions minimize damage and disruption to port operations from extreme floods and winds. This directly protects economic resources for the state and for Rhode Islanders. Life safety is also protected for the operators and visitors at the port. The identified resilient strategies work together to bring additional co-benefits: backup power ensures reliable energy, ADA upgrades improves accessibility, and NbS enhances biodiversity and ecosystems.

Benefits

Avoided Damage	●●●
Avoided Disruption	●●●
Preserved Life Safety	●○○
Other	●○○

Co-benefits include improved economy, energy resilience, accessibility, and biodiversity.

Economic Impacts

Port resilience investments deliver economic benefits through sustained maritime commerce, protected jobs, and reduced disruption costs. Rhode Island's ports generate revenue and provide jobs in shipping, fishing, and recreation sectors plus the indirect impacts of that activity in supply chain and support industries. Infrastructure hardening prevents costly damage to critical facilities while maintaining ferry services, cargo operations, and supply chain reliability. Construction activities create direct employment in marine engineering and specialized trades. By ensuring operational continuity during climate events, these improvements protect port-dependent businesses, preserve tax revenues, and maintain Rhode Island's competitive position in regional maritime commerce.

Consequence of Inaction

The consequence of inaction on Rhode Island's port infrastructure is medium. Failure to invest in resilient port infrastructure can lead to disruptions in Rhode Island's transportation systems and economy. Communities like Block Island rely on ports for critical transportation needs. Ports also serve as hubs for maritime commerce, jobs, and the state supply chain. At the same time, there are less immediate life safety impacts related to port infrastructure, and resilience interventions are often expensive, reducing cost-effectiveness.

Consequence of Inaction

High

Medium ●

Low

Funding Strategy

These funding mechanisms provide support for resilient port infrastructure solutions. These mechanisms enable both the structural upgrades needed to safeguard commercial and industrial port operations; the nature-based shoreline solutions that reduce erosion, wave energy; and long-term maintenance costs.

Mechanism Title: Port Infrastructure Development Program (PIPD)

Mechanism Type: Competitive Grant

Level: Federal

Agency: US Department of Transportation

PIDP funds port infrastructure projects that enhance safety, efficiency, and climate resilience. Eligible improvements include elevating or strengthening bulkheads, hardening docks and piers, upgrading electrical and backup power systems, modernizing navigation support structures, and improving access and cargo-handling infrastructure.

State Role: Support integration of multi-benefit components to strengthen competitiveness. Coordinate with port operators to align project scopes with statewide resilience priorities.

Next Steps: Develop preliminary designs and cost estimates.

Mechanism Title: Coastal Zone Management (CZM) Program

Mechanism Type: Technical Assistance / Competitive Grant

Level: Federal-State Partnership

Agency: RI Coastal Resources Management Council (CRMC)/ NOAA

The CZM Program funds coastal resilience and shoreline management activities, including hybrid NbS, vegetated buffers, marsh enhancement, erosion control measures, and shoreline stabilization adjacent to port assets. CZM also supports site assessments, engineering design, and permitting steps needed to integrate ecological resilience with port infrastructure upgrades.

State Role: Ensure alignment with Shoreline Change SAMPs and state coastal resilience strategies.

Next Steps: Begin early consultation with CRMC, RIDEM Coastal, and NOAA.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Energy Resilience Solutions with a focus on Washington County and Block Island

This chapter outlines adaptation solutions for electrical transmission lines. Energy resilience strategies are focused on reducing flooding and extreme wind impacts to reduce power outages and ensure the reliable delivery of electricity.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

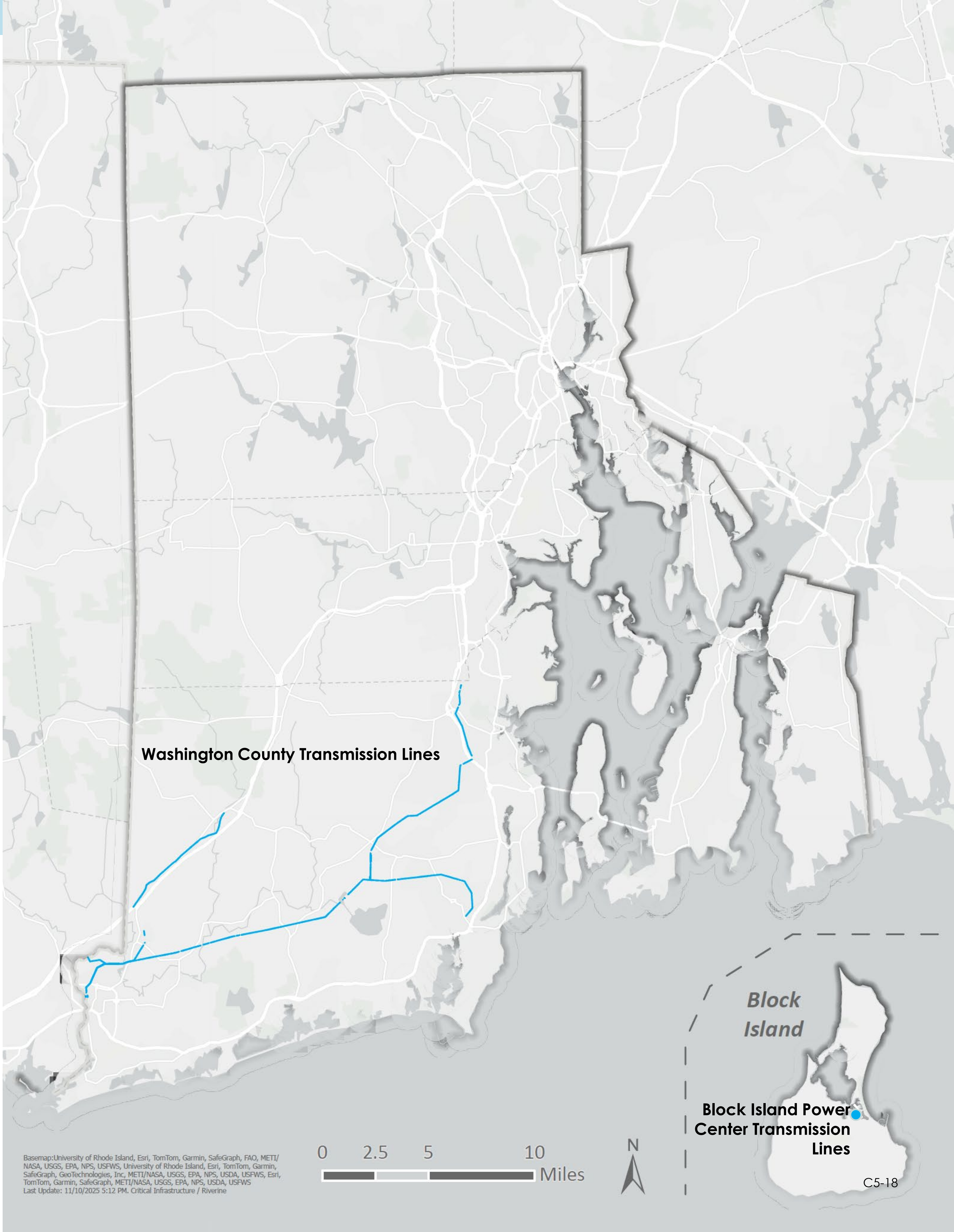
Assets Identified for Energy Resilience Solutions

Asset	Municipality
Block Island Energy Resilience (Transmission Lines & Block Island Power Company (BIPC) Connectivity)	New Shoreham
Washington County Transmission Lines	Multiple

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- **Critical Infrastructure & Facilities**
- Natural Systems
- Community Resilience & Emergency Preparedness Structures



Energy Resilience Solutions Summary

Electrical transmission lines distribute electricity throughout Rhode Island. Damage to these assets from climate impacts can cause power outages throughout the state. Reliable power is necessary for healthcare and everyday life, making energy resilient solutions critical.

Everyday flooding, hurricanes, and Nor'easters can cause direct damage to transmission infrastructure, often resulting in downed power lines. At the same time, extreme heat increases energy demand for cooling systems, straining the electrical grid. Energy assets must be built for future intensified climate conditions to ensure continual reliable power throughout the state.

Transmission lines in areas with limited redundancy, like Block Island, and those at risk to extreme winds, like Washington County, should be prioritized for energy resilience solutions to ensure connectivity. To remove exposure to extreme wind, transmission lines should be constructed underground. To improve redundancy, the number of interconnection points between transmission lines and number of alternative routes should be increased. Vegetation and debris management also needs to be a part of regular maintenance procedures to reduce damage and downtime.

Ongoing Actions

Grid modernization and resilience planning is happening in Rhode Island through state planning efforts. The Rhode Island Energy 2025 ISR plan lays out the utility's strategy for improving reliability through the state.

Resources

- Rhode Island Energy Proposed FY 2025 Electric Infrastructure, Safety, and Reliability Plan (2023)
- Grid Modernization Plan (2022)
- Power Sector Transformation (2017)
- Rhode Island State Energy Plan (2015)

Steps for Implementation

1. **Feasibility Assessment and Stakeholder Engagement**
Analyze soil conditions for undergrounding, identify high-risk corridors, and evaluate existing assets using data from the Rhode Island Energy 2025 Electric ISR Plan. Identify which assets are at End of Useful Life (EUL) and should be prioritized for retrofit. Coordinate with state and local utilities to determine current and future energy demand.
2. **Land Acquisition and Community Engagement**
Engage communities to secure right-of-way and ensure equitable benefits. Partner with Health Equity Zone (HEZ) communities for inclusive planning throughout the project.
3. **Route Selection and Engineering Design**
Select corridors for implementation. Plan trenching, determine optimal locations for additional substations or alternate routes, and set capacity, voltage, and reliability standards. Consider future energy demand in system design.
4. **Costs and Funding Assessment**
Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final designs.
5. **Construction and Permitting**
Obtain approvals for projects and source equipment. Excavate for and install conduits, new lines, substations, and interconnection facilities.
6. **Commissioning and Maintenance**
Perform integrity and load tests. Integrate into existing electricity grid infrastructure. Conduct regular vegetation and debris removal for above ground transmission lines, monitor new assets, and conduct periodic inspections for compliance. Align upgrade and replacement strategy with EUL of existing assets. Consider embodied carbon impacts in the removal of energy assets.

Downed tree on electrical line in Rhode Island © The Providence Journal

Representative Priority Assets

The Block Island Power Company transmission lines are selected as a representative priority asset due to the system's criticality to the **island's operations,** as well as its **climate risk** to coastal flooding, stormwater flooding, and extreme heat. Additional **Washington County Transmission Lines** are selected, because they face **high wind risk**, causing power outages.

Block Island Power Company (BIPC)
Municipality: New Shoreham

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Electric Utility, Capacity 7.1 MW, and Community Identified.

Washington County Transmission Lines
Municipality: Multiple

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: The County faces some of the highest wind risk in the state.

Energy Resilience Solutions Strategies

Together, these strategies will create energy resilience corridors that strengthen grid reliability, reduce outage risks, and enable rapid restoration after power disruptions. They offer a range of intervention levels to protect against climate hazards, from undergrounding transmission lines to developing new transmission lines and interconnection points. All transmissions lines should develop vegetation management into their maintenance operations to reduce the number of downed powerlines.

Expand Right-Of-Way (ROW) Area and Vegetation Management

Expand right-of-way (ROW) and vegetation and debris management to 65-100 feet (20-30 meters). Increasing right-of-way reduces the likelihood of vegetation or debris-related outages. These measures generally require higher upfront costs for land acquisition and construction, as well as ongoing vegetation management. At the same time, regular maintenance reduces costs for emergency repairs and outage frequency. Along with ROW enhancement, robust tower design on these routes can maximize resilience.

Arborist working in Rhode Island
© Allscapes Tree Service

Solution Mechanism
- Protect ●
- Accommodate
- Restore
- Rethink

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Extreme Wind

Cost
$$$$
$1M - $4M

Assumption: clear 80' of ROW and trim vegetation along edges along 10-mile transmission corridor

Create Alternative Transmission Routes

Develop redundant pathways to maintain service continuity during outages or damages to primary lines. This strategy is useful for rural communities, like New Shoreham, where there are fewer transmission routes. Building redundant pathways requires significant upfront investment in lines, substations, and land acquisition. While maintenance costs increase due to more infrastructure, these expenses are offset by reduced outage-related costs and improved resilience, which can prevent major economic losses during power disruptions.

Transmission lines in Greenwich, RI
© EG NEWS

Solution Mechanism
- Protect
- Accommodate
- Restore
- Rethink ●

Scale of Innovation
- Innovative
- Hybrid ●
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Wind

Cost
$$$$
$20M - $80M

Assumption: add 10 mile of new backup transmission line within existing ROW including minor expansion of local substations

Cost Benchmarks: Building Electric Transmission Lines Review (Lawrence Berkely National Laboratory)

Participants at Community Forum 2 © Civic

Community Voices

"Barrington routinely has wind-related power failures. 2,000 properties recently, twice in past month, have a lot of trees and wind related storm damage." – attendee at the 2nd Municipal Stakeholder Meeting in July 2025

Increase the Number of Interconnection Points

Increase the number of interconnection points between transmission systems in a meshed network design to enhance grid flexibility and reliability. This strategy can increase overall maintenance requirements by increasing the number of energy assets to maintain. However, additional interconnections allow for rerouting power during outages, reducing the risk of cascading failures.

An electrical substation in Providence, RI
© E.S. Boulos Company

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
- Innovative
- Hybrid ●
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Wind

Cost
$$$$
$25M - $110M

Assumption: add 10 mile of new primary overhead transmission lines to create another connection point including minor expansion of local substations

Cost Benchmarks: Building Electric Transmission Lines Review (Lawrence Berkely National Laboratory

Underground Transmission Lines in High-Risk Areas

Underground transmission lines in urban areas and areas at particularly high climate risk, such as North and South Kingstown. While underground transmission lines often require higher initial investment, these measures can reduce storm-related repair costs and improve long-term system reliability. Maintenance includes monitoring for water ingress, insulation integrity, and corrosion of metallic components, especially in areas with high groundwater or soil salinity or areas vulnerable to coastal flooding.

Workers replacing underground electrical lines © Associated Press

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Extreme Wind

Cost
$$$$
$55M - $230M

Assumption: remove 1 mile of existing overhead lines and reinstall them underground

Cost Benchmark: Fairfield & Bridgeport Underground Transmission Line Project

Energy Resilience Solutions Funding Strategy

Rhode Island's energy resilience strategy can be advanced through coordinated federal and state funding that supports undergrounding transmission lines, adding redundancy through new interconnection points, and developing alternative routes for high-risk areas. The following sections summarize anticipated implementation costs, cost-effectiveness considerations, and the reliability, public safety, and economic benefits these upgrades provide. They also outline funding mechanisms available, the State's role, and the next steps needed to position priority transmission corridors for investment.

Costs

Projects that involve greater extents, modification to existing infrastructure, expanded capacity, and right-of-way acquisition (excluded from this exercise) will require greater capital investment and schedule. Energy related costs are generally higher than other resilience solutions, partially due to the increased coordination and sensitivity for these networks. Vegetation management within ROW is the lowest cost intervention. Adding or modifying electrical infrastructure requires significant investment but can prove worthwhile if intended benefits are realized. Backup transmission lines are generally less costly than new main lines, and construction within existing ROW and existing towers saves money compared to new lines in new ROW. Underground transmission is significantly more expensive vs. overhead but may only be necessary for urban applications; underground transmission represents a much more resilient alternative and requires less maintenance.

Benefits

Hurricanes, Nor'easters, and flood events bring extreme wind events that down transmission lines directly, or indirectly through fallen vegetation debris, causing widespread power outages. Energy resilient solutions protect transmission lines from this damage and accommodate for power outages through redundant and alternative pathways. Reliable energy is especially essential in rural areas, like Block Island, where there are fewer backup options. Electrical power is a critical necessity to ensure operation of every-day activities and public health needs, from food refrigeration to critical health care procedures.

Benefits

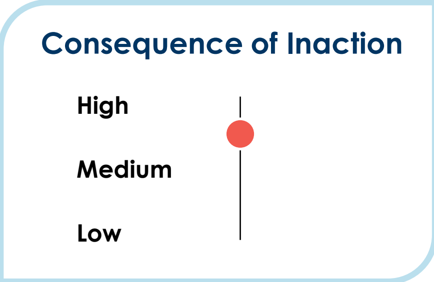
Benefits	
Avoided Damage	●●●
Avoided Disruption	●●○
Preserved Life Safety	●●○
Other	○○○

Economic Impacts

Upgrading transmission infrastructure creates construction jobs while preventing economic losses from power outages. Reliable electricity is essential for healthcare, business operations, and daily commerce throughout Rhode Island. Underground lines and enhanced interconnections reduce storm-related repair costs and service interruptions that disrupt economic activity. These investments support grid modernization efforts, attract businesses requiring reliable power, and protect critical facilities. By minimizing outage frequency and duration, energy resilience measures preserve productivity, prevent spoilage losses, maintain digital commerce, and protect the state's reputation for infrastructure reliability.

Consequence of Inaction

The consequence of inaction on Rhode Island's energy infrastructure is medium-high. Electrical transmission lines face a high risk of damage and disruption during a 100-year Category 2 wind event. Current projections from the SCV Assessment indicate that Washington County transmissions lines could be exposed to theses wind speeds, underscoring the need for action. Energy failure could trigger cascading disruptions across multiple sectors. Rural areas, like Block Island, are more vulnerable due to limited backup. However, resilience interventions tend to be costly, making proactive planning critical.



Funding Strategy

These funding mechanisms provide strong support for energy system upgrades that improve grid reliability and reduce outage risks. These programs offer a coordinated pathway to advance transmission resilience in high-risk areas such as Washington County and Block Island.

Mechanism Title: Grid Resilience and Promoting Resilient Outage Prevention (PROP) - Section 40101(d)

Mechanism Type: Grant

Level: Federal

Agency: US Department of Energy & RI OER

PROP provides formula funding to states and territories to strengthen electric grid resilience against extreme weather and natural hazards. Funds support utility and community-scale projects that reduce outage frequency and duration through infrastructure hardening, equipment upgrades, innovative technologies, and enhanced system operations.

State Role: Distribute annual formula allocations, set project selection criteria, and coordinate with utilities and OER to prioritize high-risk areas and resilience benefits.

Next Steps: Align with state hazard mitigation goals and prepare the next round of applications under the PROP formula program.

Mechanism Title: RI OER/State Energy Program (SEP) Implementation

Mechanism Type: Grant/Technical Assistance

Level: State

Agency: Rhode Island Office of Energy Resources

SEP implementation funding supports state-led energy resilience and grid modernization initiatives. Eligible activities include planning for undergrounding, evaluating interconnection expansions, conducting vegetation or ROW management assessments, and supporting design of redundant transmission paths. SEP funding strengthens coordination between state energy policy and utility-led infrastructure investments.

State Role: Offer modeling resources and review designs for alignment with statewide resilience goals.

Next Steps: Develop conceptual designs or planning studies and coordinate with OER on SEP eligibility.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Sewer & Stormwater Infrastructure Solutions

This chapter outlines adaptation solutions for sewered areas, sewer overflows, and stormwater treatment units. Sewer and stormwater infrastructure strategies are focused on reducing flooding impacts to reduce damage to infrastructure and ensure it can remain operable.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

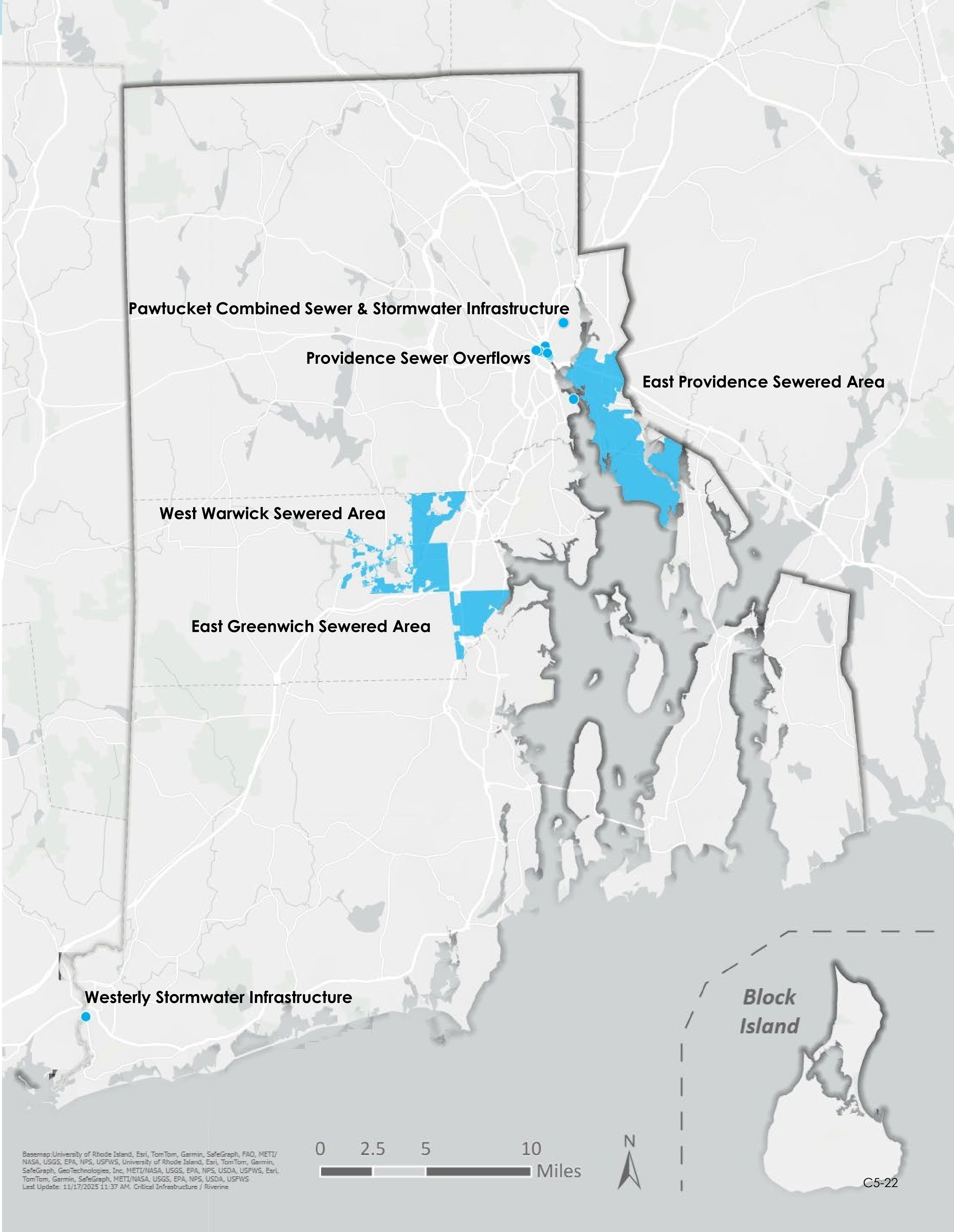
Assets Identified for Sewer & Stormwater Infrastructure Solutions

Asset	Municipality
East Greenwich Sewered Areas	East Greenwich
East Providence Sewered Area	East Providence
Pawtucket Combined Sewer & Stormwater Infrastructure	Pawtucket
Providence Sewer Overflows Mitigation	Providence
Westerly Stormwater Infrastructure	Westerly
West Warwick Sewered Areas	West Warwick

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- **Critical Infrastructure & Facilities**
- Natural Systems
- Community Resilience & Emergency Preparedness Structures



Sewer & Stormwater Infrastructure Solutions Summary

Increasing heavy precipitation and flooding are straining stormwater, sanitary, and combined sewage overflow (CSO) systems. This solution integrates infiltration and inflow (I/I) repairs, stormwater–CSO separation, groundwater recharge, and hardening to reduce runoff and protect assets, with sustainable funding improving reliability and resilience during major storms and coastal surge events.

Sanitary, stormwater, and CSO systems across Rhode Island face increasing risk from more frequent extreme precipitation, inland and coastal flooding, and rising groundwater. Priority assets such as pipes, pump stations, culverts, and drainage structures, particularly in older sewered areas like parts of East Providence and low-lying, flood-prone communities such as Westerly, are becoming more susceptible to exceedance and failure as climate hazards intensify.

Repairing pipes and structures to reduce infiltration and inflow (I/I) lowers loading on CSO systems and separate sewer systems. Stormwater recharge practices (e.g., green and gray practices) reduce runoff entering storm and CSO systems. Separating stormwater drainage from CSO systems can further reduce stress on CSO systems. Hardening strategies help protect critical assets and maintain functionality during flood events. Increasing storm drain capacity, adding storage, and upsizing culverts enhances conveyance during major storms. Sustainable funding helps implement solutions.

Ongoing Actions

Many local, regional, and state agencies are advancing projects to address challenges related to stormwater capacity, sewer system demands, and CSOs. The Narragansett Bay Commission (NBC) has spent decades implementing its multi-phase CSO Abatement Program. Phases I (2008) and II (2014) added deep-rock storage, sewer separations, interceptors, and a constructed wetlands facility, while Phase III (ongoing) is constructing a second storage tunnel to Pawtucket and Central Falls to further eliminate overflows. Key challenges include high costs and increasingly frequent high-intensity rain events, making green–gray integration and expanded funding essential for continued progress.

Resources

- RIDEM RISDISM (2018)
- Narragansett Bay Commission CSO program (2014)
- NEIWPCC TR-16 (2016)

Steps for Implementation

1. **Community Engagement**
   Maintain public engagement throughout the project planning process to better understand neighborhood flooding issues and to develop a plan to address local needs.
2. **Data Collection and Existing Conditions Analysis**
   This step must be tailored to each project and may include field investigations, such as flow metering, dye testing, culvert assessments, land surveying, and CCTV inspections, as well as desktop reviews of GIS data and modeling, all of which help determine the sources and volumes of stormwater to be managed.
3. **Vulnerability Assessment**
   Modeling (e.g SWMM, SewerGEMS, StormCAD, HEC-RAS) will often be used to better understand the vulnerability of overall system elements. The model can then be used to assess mitigation alternatives impacts.
4. **Optioneering Analysis**
   Both traditional and nature-based approaches should be evaluated to find the most feasible and cost-effective solution. A Benefit-Cost Analysis can indicate if a potential alternative is financially feasible for the anticipated benefits. Infrastructure/land ownership and permitting limitations should also be assessed to identify necessary collaboration with private property owners or state agencies (e.g., RIDOT).
5. **Conceptual Designs, Design Developments, and Construction Documents**
   Concept designs should be adaptable to ongoing climate change impacts and approached with a proactive mindset, designing for future storm events and/or sea-level rise. Phasing could be considered to minimize over-design. Selected concepts will move forward for design development and final designs.
6. **Costs and Funding Assessments**
   Several state, federal, and local stormwater funding sources are available for these mitigation measures and should be considered when evaluating alternatives. Cost estimates should also account for design and permitting, construction administration, surveying, mobilization, bonds and insurance, and as-built documentation in addition to construction costs.
7. **Construction and Permitting**
   Construct and procure the necessary permits for all stormwater infrastructure improvements, including working with RIDEM for approvals.
8. **Maintenance and Monitoring**
   Establish a routine maintenance and monitoring program for stormwater infrastructure improvements working with local municipalities. Monitor project success at reducing risk to hazards.

Flooding at Salty Brine in Narraganset, RI © WJAR

Representative Priority Assets

East Providence Sewered Areas and **Westerly Stormwater Infrastructure** are selected as representative priority assets because they serve communities with high **social vulnerability** and face significant climate risks from **stormwater and coastal flooding**. Additionally, East Providence Sewered Areas are adjacent to biodiversity and wellhead protection areas.

East Providence Sewered Areas
Municipality: East Providence

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Adjacent to High Social Vulnerability Index (SVI) Census, Biodiversity, and Wellhead Protection Areas, and Community Identified.

Westerly Stormwater Infrastructure
Municipality: Westerly

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

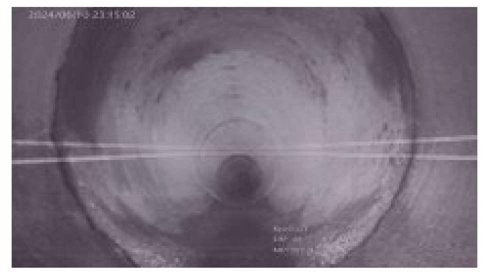
Context: Adjacent to High Social Vulnerability (SVI) Census.

Sewer & Stormwater Infrastructure Solutions Strategies

These strategies reduce the flow of stormwater into stressed combined sewer and storm drain systems, increase system capacity, or protect system infrastructure from damage during floods. Reducing stormwater runoff volumes is often more cost effective and resilient to future storms than larger system capacity upgrades, as site-specific solutions can be more adaptable to severe events. For example, gray infrastructure is typically only protective to a fixed elevation or flow rate while disconnecting stormwater will often provide some level of reduction even for events larger than the design storm. A range of alternatives should be considered when developing a mitigation plan.

Disconnect Infiltration/Inflow (I/I) Sources

Reducing infiltration (groundwater entering the sewer system) and inflow (stormwater or coastal water entering the system) decreases the volume that sanitary sewers must handle. This is particularly critical in low-lying areas near the Pawcatuck River in Westerly and in older sewered neighborhoods in East Providence. To identify defects that allow infiltration and inflow, utilities can use flow metering, dye and smoke testing, and CCTV inspections. Once identified, mitigation measures such as CIPP lining, point repairs, and disconnection of improper connections can significantly reduce loading on combined sewer overflow (CSO) systems.



CCTV pipe inspection image from Providence, RI © RIDOT

Solution Mechanism
- Protect ●
- Accommodate ○
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

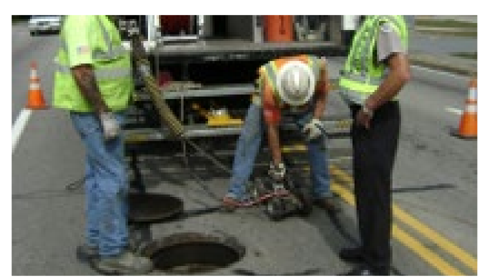
Cost
$$$$ (1 of 4)

$450K - $2M

Assumption: inspect of stormwater sewer pipe, point repairs, and 1,000 LF of CIPP lining

Increase Storm Drain Capacity

Increasing storm drain storage and conveyance capacity is a common strategy for managing stormwater impacts; however, this approach presents several challenges. Enlarging storm drains can increase the risk of downstream flooding, and installing larger pipes, storage systems, and pumps within a crowded public right-of-way can be costly and logistically complex. These complexities include avoiding utility conflicts, meeting minimum pipe cover requirements, and managing the disposal of potentially contaminated soils.



Storm drain investigation in Warren, RI
© Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Stormwater Flooding

Cost
$$$$ (2 of 4)

$800K - $3.1M

Assumption: Remove and replace 1000 LF of stormwater sewer pipe, install 20,000-gal tank and pump

#1 Most Pressing Issue

Community Voices

Stormwater Infrastructure ranked the #1 most pressing issue during the 1st Municipal Stakeholder Meeting held in June 2025.

Replace Undersized Culverts

Culverts convey stream and river flows beneath roadways, and when undersized, they can restrict flow and contribute to roadway overtopping and upstream flooding during storm events. Strategically upsizing culverts is an effective approach to reducing stormwater-related flooding and improving resilience to more intense rainfall, though downstream conditions should be evaluated to avoid increased flooding or erosion. New culverts can also be designed to improve aquatic organism passage, utilizing open bottom and box culvert techniques.

Upsized culverts on Belfield Dr. Johnston, RI
© Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$ (2 of 4)

$700K - $3M

Assumption: remove existing culvert, install larger culvert, reinstate site

Cost Benchmark: Belfield Drive Floodplain Restoration, Johnston, RI

Harden Infrastructure in Floodplain

Infrastructure such as pump stations and gravity sanitary sewers located in floodplains can either be damaged by floodwaters and/or convey floodwaters to other wastewater infrastructure, resulting in sewer overflow events. Solutions can range from floodproofing pump stations, raising critical equipment (e.g., generators) to recommended flood-resilience elevations, and using bolted and gasketed manhole covers on low-lying roads that are frequently inundated to keep floodwaters out of the sewer systems.

Raised critical equipment. Scituate, RI
© Fuss & O'Neill, Inc.

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional
- ● (between Hybrid and Traditional)

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$ (1 of 4)

$300K - $1.5M

Assumption: raise equipment within pump stations; allowance to floodproof manholes

Sewer & Stormwater Infrastructure Solutions Strategies

The solutions identified are focused on restoring natural hydrogeology for increased absorption of water, reducing flood risk. Increase in green infrastructure, pervious surfaces, and NbS accommodate more absorption of water. Green infrastructure also brings additional co-benefits, including enhanced urban cooling, increased biodiversity, and enhanced environmental health. Gray infrastructure improvements, like hardening infrastructure and increasing storm drain capacity of pipes and culverts to accommodate for more water capacity, are also critical strategies. Gray and green infrastructure strategies work in tandem to improve flood resilience, however, sustainable funding mechanisms will be necessary to implement these projects.

Rainfall flooding Reservoir Avenue in Cranston © WPRI

Community Voices

"Combined sewers and stormwater infrastructure discharge into other waterways."
– attendee at the 2nd Community Forum at East Providence's Weaver Library in July 2025

Develop Nature-based Flood Storage

Safely storing stormwater during flood events can reduce hydraulic loads to the conveyance system and move stormwater away from infrastructure. Storage opportunities exist in rural and urban conditions. Examples include designing and utilizing floodable parks, enhanced floodplains, and other open space to store water during floods when those spaces are not used. This approach is also a good way to create community co-benefits.

Floodable park space. Providence, RI
© Fuss & O'Neill, Inc.

Solution Mechanism		Scale of Innovation	Relevant Hazards	Cost
Protect	○	Innovative ●	Coastal Flooding	$$ (of $$$$)
Accommodate	●	Hybrid	Stormwater Flooding	$1.5M - $6M
Restore	●	Traditional	Riverine Flooding	
Rethink	○			

Assumption: excavation, geotextile and for ~1 acre, ~1M gallon reservoir w/drainage and native planting strip around perimeter

Cost Benchmark: Nichols Nature-based Stormwater Park

Develop Green Stormwater Infrastructure

Green stormwater infrastructure (GSI) can be a cost-effective method to reduce stormwater loadings to storm and combined sewers. In Westerly, GSI is well suited to upland areas that drain toward downtown or low-lying zones near the Pawcatuck River, where surface storage and groundwater recharge can reduce pluvial flooding. GSI can also redirect runoff to bioretention, groundwater recharge practices, or subsurface systems and reduces inflow to aging pipes and CSO systems. Routine inspection and upkeep are needed to sustain long-term performance.

Green stormwater infrastructure on Pine Street. Pawtucket, RI © Fuss & O'Neil, Inc.

Solution Mechanism		Scale of Innovation	Relevant Hazards	Cost
Protect	○	Innovative	Stormwater Flooding	$$ (of $$$$)
Accommodate	●	● (between Innovative and Hybrid)	Riverine Flooding	$550K - $2M
Restore	○	Hybrid		
Rethink	○	Traditional		

Assumption: 15,000 SF of rain gardens and bioretention areas and associated infrastructure

Cost Benchmark: Pawtucket, RI Green Infrastructure on Pine Street

Remove & Disconnect Impervious Coverage

Impervious cover (e.g., parking lots and roadways) prevents rainfall from infiltrating into the ground, leading to higher stormwater runoff volumes, flooding, and water pollution. Approximately 10–15% of Rhode Island's land area consists of impervious surfaces, with coverage reaching as high as 40% in urban areas such as Providence (URI, 2007). Imperviousness contributes to flooding challenges following rainfall events. Removing pavement and replacing it with permeable materials reduces flooding to CSO systems, improves water quality, and enhances groundwater recharge. RIDEM continues to support projects across that State that involves removing impervious cover and revegetating the area.

Pervious pavers on Pine Street. Pawtucket, RI
© Fuss & O'Neill, Inc.

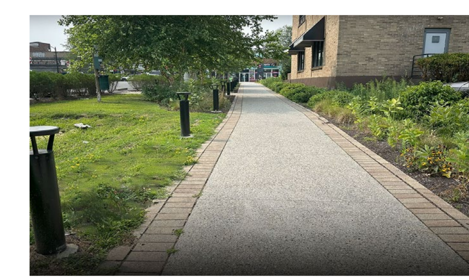
Solution Mechanism		Scale of Innovation	Relevant Hazards	Cost
Protect	○	Innovative	Stormwater Flooding	$$ (of $$$$)
Accommodate	●	● (between Innovative and Hybrid)	Riverine Flooding	$800K - $3M
Restore	●	Hybrid		
Rethink	●	Traditional		

Assumption: demolish 1,000 linear feet of sidewalk (8' width) and replace w/permeable surface system

Cost Benchmark: Pawtucket, RI Green Infrastructure on Pine Street

Stormwater Mitigation Funding Mechanisms

Creative funding tools like stormwater utility funds and enterprise funds provide stable, dedicated revenue to manage and reduce flooding at the local level. These fees encourage landowners, such as homeowners or businesses, to reduce runoff while ensuring equitable cost-sharing for infrastructure upgrades and maintenance. Though establishing such funds can be complex and politically sensitive, such mechanisms offer a sustainable path to financing long-term stormwater resilience.



Citizens Bank GIS Parklet Providence,
© RIDOT

Solution Mechanism		Scale of Innovation	Relevant Hazards	Cost
Protect	○	Innovative ●	Coastal Flooding	$ (of $$$$)
Accommodate	○	Hybrid	Stormwater Flooding	$150K - $600K
Restore	○	Traditional	Riverine Flooding	
Rethink	●			

Assumption: hire consultant to develop stormwater funding mechanism plan

Sewer & Stormwater Infrastructure Solutions Funding Strategy

Rhode Island can advance sewer, stormwater, and CSO resilience through a combination of federal and state funding programs that support culvert and pipe repair, pump station hardening, storm drain upgrades, and green-gray stormwater solutions. The following sections summarize anticipated implementation costs, cost-effectiveness considerations, and the community and economic benefits of these investments. They also outline the major funding mechanisms available, describe the State's role, and identify next steps to position priority assets for implementation.

Costs

This suite of strategies includes a wide variety of interventions. Costs for these strategies scale with size – greater capacity for conveyance, storage, and runoff management will require greater capital investment but potentially result in long-term savings. The lowest cost solution includes studies of existing conditions and identifying a funding mechanism. Focused projects to address specific issues are generally lower cost, but greater impact and long-term savings can be achieved by completing larger projects and a series of connected projects across different solution types at a higher overall cost. Modifying existing stormwater systems, particularly those below grade, is generally a more costly solution than operating in greenfields and/or surface-level improvements. Repairs are cheaper than replacements and upgrades to address minor issues quickly, but may not provide long-term benefits in the same way as larger projects, and could increase overall long-term costs. The current estimate for increasing stormwater system capacity only accounts for upgrading conveyance; additional works required for storage and pumps would require greater capital investment.

Benefits

Solutions for sewer and stormwater infrastructure are designed to reduce the extent of damage and disruption. The SCV assessment estimated that Westerly is currently exposed to 2 ft of flooding during a 100-year coastal event; however, this is expected to rise to 4.5 ft by 2100. The strategies aim to control runoff of both every-day and extreme flood events, reducing stress on CSO systems. This protects community spaces, drinking water supplies, and ecosystems from the harmful pollutants in runoff, such as chemicals and waste. The identified representative priority assets are adjacent to wellhead protection areas, meaning the strategies are prioritized to protect drinking water supplies. The assets are also prioritized in socially vulnerable communities, ensuring benefits are equitably distributed. The NbS bring additional co-benefits of improved biodiversity and ecosystem health.

Benefits

Avoided Damage	●●●
Avoided Disruption	●●●
Preserved Life Safety	●○○
Other	●○○

Co-benefits include improved social equity and biodiversity.

Economic Impacts

Stormwater and sewer infrastructure investments generate construction employment while preventing flood damage to properties and businesses. Reducing system overflows protects water quality, supporting the tourism and recreation economies that depend on clean waterways. Infrastructure improvements in high social vulnerability areas promote equitable economic development and stability of property values. Green infrastructure projects create jobs in landscape design, native plant cultivation, and specialized installation. By managing stormwater effectively, communities avoid costly emergency responses, protect drinking water supplies, reduce treatment costs, and maintain business continuity during severe weather events, demonstrating measurable fiscal returns.

Consequence of Inaction

The consequence of inaction on Rhode Island's stormwater infrastructure is medium-high. Sewer and stormwater infrastructure are highly at risk to disruption and damage when they are inundated by 2 ft of flooding, and currently Westerly is expected to be exposed to more than 2 ft of flooding during a 100-year coastal storm. Infrastructure failure can lead to significant public health and environmental consequences with urban areas facing higher risk. However, in most areas of the State, redundancy and emergency pumping can mitigate most severe impacts.

Consequence of Inaction

High

Medium

Low

(Indicator marked between High and Medium)

Funding Strategy

These mechanisms support planning and implementation of sewer, stormwater, and CSO upgrades that reduce flooding and improve water quality. The CWSRF aligns directly with pipe repairs, pump station hardening, storm drain upgrades, and green–gray stormwater solutions. RIDEM's Climate Resilience Fund complements these efforts by funding municipal and regional projects that reduce climate-driven flood impacts and build long-term drainage resilience.

Mechanism Title: Clean Water State Revolving Fund (CWSRF)

Mechanism Type: Low-Interest Loan/Principal Forgiveness

Level: Federal

Agency: Rhode Island Infrastructure Bank (RIIB), RIDEM, and EPA

CWSRF funds planning, design, and construction of wastewater, stormwater, and CSO system improvements. Eligible activities include pipelining and replacement, pump station floodproofing, culvert upgrades that provide aquatic habitat benefits, and construction of certain stormwater system improvements including green stormwater infrastructure.

State Role: Provide technical support with project scoping, and SRF eligibility review.

Next Steps: Prepare preliminary engineering reports and complete a sewer/stormwater assessment.

Mechanism Title: Rhode Island Climate Resilience Fund (CRF)

Mechanism Type: Grant

Level: State

Agency: Rhode Island Department of Environmental Management

The Climate Resilience Fund provides grants for municipal and regional projects that reduce climate-driven flood, stormwater, and drainage impacts. The program prioritizes projects that address social vulnerability, protect public health, and support nature-based or hybrid approaches that improve long-term system resilience.

State Role: Set criteria and coordinate with municipalities to align sewer and stormwater upgrades.

Next Steps: Prepare projects for upcoming CRF funding rounds and provide technical assistance for conceptual design.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Wastewater Treatment Facility Hardening

This chapter outlines adaptation solutions for wastewater treatment facilities. Wastewater treatment facility hardening strategies are focused on reducing flooding impacts to ensure continual operation of the facilities and reduce contamination from runoff, preserving public health.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

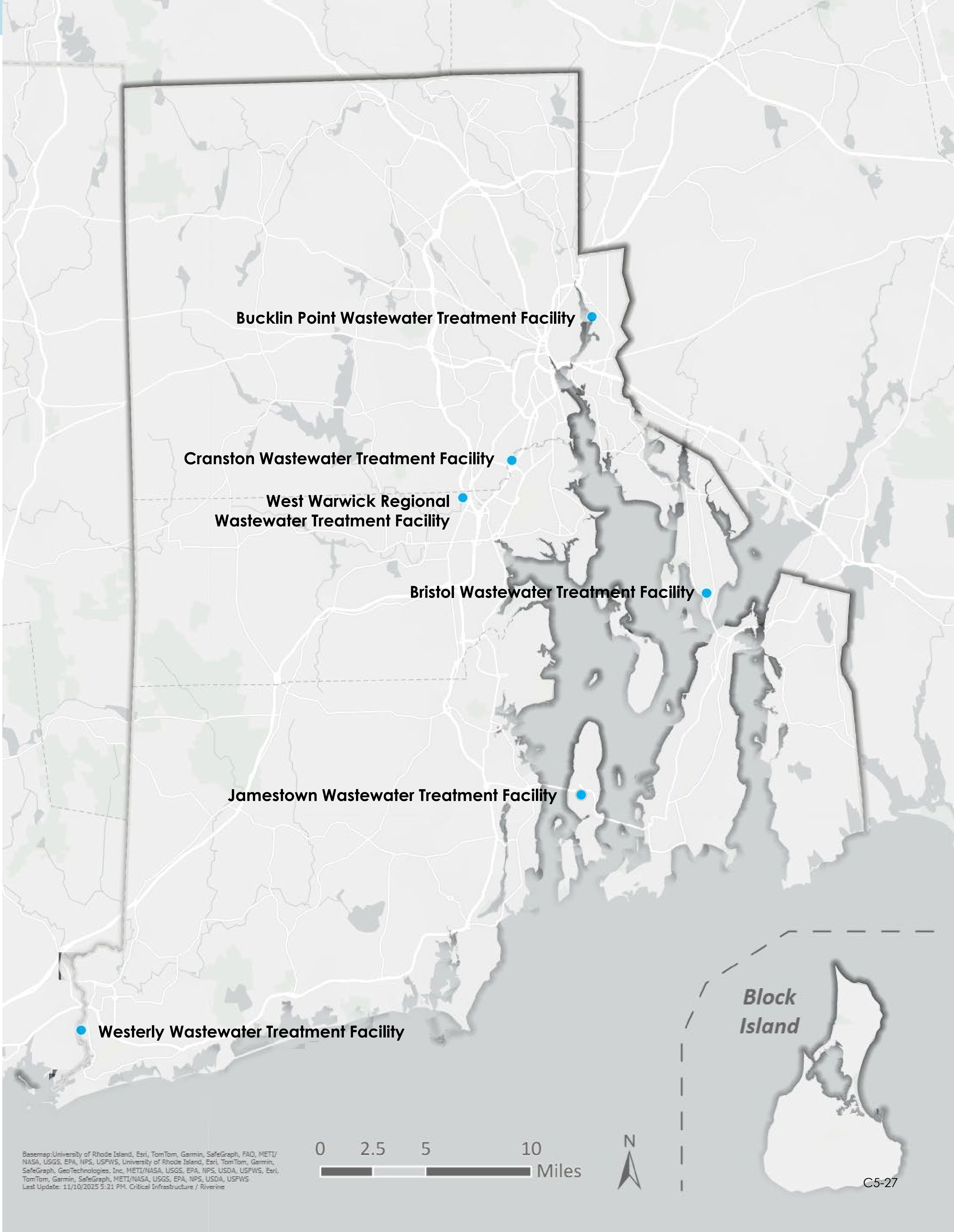
Assets Identified for Wastewater Treatment Facility Hardening

Asset	Municipality
Bristol Wastewater Treatment Facility	Bristol
Bucklin Point Wastewater Treatment Facility	East Providence
Cranston Wastewater Treatment Facility	Cranston
Jamestown Wastewater Treatment Facility	Jamestown
Westerly Wastewater Treatment Facility	Westerly
West Warwick Regional Wastewater Treatment Facility	West Warwick

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- **Critical Infrastructure & Facilities**
- Natural Systems
- Community Resilience & Emergency Preparedness Structures



Wastewater Treatment Facility Hardening Summary

Wastewater treatment facilities (WWTFs) play a critical role in cleaning contaminated water so it can be safely returned to the natural environment. However, during periods of excessive flooding, these facilities can exceed their design flow capacity, creating operational challenges and increasing the risk of untreated discharges. Hardening strategies help protect these facilities from damage and maintain functionality during extreme events, ensuring continued treatment and environmental protection.

There are 19 WWTFs throughout Rhode Island that work to process a total of 120 million gallons of wastewater per day. Innately, WWTF and pump stations are positioned by bodies of water and in low lying areas to allow for efficient discharge of treated water. However, their location makes them susceptible to flooding.

As flooding events become more intense the design loads of facilities become overwhelmed, causing sanitary sewer overflow (SSO) events. When SSO events occur, untreated sewage is discharged into the environment, causing public health issues and pollution impacts to waterways. During a four-year period, Cranston WWTF experienced SSOs during 18% of extreme flood events and West Warwick Regional WWTF experienced them for 33%. Cranston WWTF, vulnerable to coastal and stormwater flooding, and West Warwick Regional WWTF, vulnerable to riverine and stormwater flooding, represent facilities that should consider resilience strategies.

Ongoing Actions

Rhode Island provides holistic resilience planning and design guidance for Wastewater Treatment Facilities (WWTFs). Their 2017 report completed a detailed resilience analysis for all WWTFs in the state. Multiple WWTF have implemented resilience projects with grant support from the RIDEM WWTF Resiliency Fund.

Resources

- RIDEM WWTF Resources (2025)
- Implications of Climate Change for RI WWTF (2017)
- Bucklin Point Resiliency Improvements (Ongoing)
- Jamestown WWTF Resilience Plan (Ongoing)
- West Warwick WWTF Levee Project (2017)
- CHAMP (Ongoing)

Steps for Implementation

1. **Existing Conditions Analysis and Stakeholder Engagement**
WWTFs are all unique. Some plants have processes or locations that are more inherently resilient than others. Identify which facilities are most vulnerable, considering the daily flows (and therefore community importance). Conduct stakeholder engagement throughout the project planning process to better understand the site and community challenges. Assess if there are any network opportunities to utilize capacity at other WWTFs or space at the assessed WWTF. Prioritize projects with WWTF operators based on risk, impact, and ease of execution.
2. **Optioneering Analysis**
Based on the analysis, conduct an optioneering analysis to determine the most effective select hardening strategies.
3. **Land Acquisition and Community Engagement**
If relocation or expansion are required, engage affected communities to ensure equitable impacts.
4. **Conceptual Designs and Detailed Plans**
Develop concept designs for hardening strategies based on the existing conditions and future climate change impacts. Move conceptual designs to design development and final design after discussion with stakeholders and community members.
5. **Costs and Funding Assessment**
Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final designs.
6. **Permitting and Construction**
Obtain permits, permits of modifications, and/or Orders for Approval for chosen resilience measures from RIDPES. Construct any new equipment, facilities, or protections.
7. **Commissioning and Maintance**
Perform tests to ensure proper water treatment or flood protection functions. Conduct regular equipment inspections, maintenance, performance tests and trainings for any deployable or active resilience measures.

West Warwick Regional Wastewater Treatment Facility, © West Warwick Wastewater

Representative Priority Assets

Cranston Wastewater Treatment Facility and **West Warwick Regional Wastewater Treatment Facility** are selected as representative priority assets due to their **climate risk to flooding.** The West Warwick WWTF is vulnerable due to its smaller size and limited water capacity, while the Cranston WWTF is also vulnerable because it plays a critical role in serving a larger population.

Cranston Wastewater Treatment Facility
Municipality: Cranston

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Design Flow [20.2 MGD].

West Warwick Regional Wastewater Treatment Facility
Municipality: West Warwick

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Design Flow [7.9 MGD] and Stakeholder Identified.

Wastewater Treatment Facility Hardening Strategies

These strategies offer multiple pathways for wastewater treatment facilities (WWTFs) to address flooding risks at their sites. Facilities can harden on-site infrastructure by installing additional pumps and incorporating redundant wet-weather storage processes. However, if a WWTF faces extreme climate risk or lacks capacity to accommodate future flood loads, relocation strategies may be necessary. Relocation can involve completely moving the facility to a less vulnerable area or redirecting sewage through pipelines to another WWTF without physically relocating the original facility.

Protect or Relocate Facilities and Equipment

WWTFs in the floodplain can consider moving the entire facility out of the floodplain. This strategy should be prioritized for older facilities that may be nearing end of useful life (EUL). WWTFs that remain within the present-day and future anticipated floodplain should at least elevate their critical equipment (e.g. blowers, control panels, electrical equipment, chemical storage) to higher locations above the future anticipated Base Flood Elevation (BFE) and consider additional flood mitigation strategies. Other strategies may include flood barriers that physically block or divert flood water away from the WWTF, or an on-site wastewater treatment systems.

Flooding at Warwick Wastewater Treatment Facility © Warwick Beacon

Solution Mechanism
- Protect ●
- Accommodate ○
- Restore ○
- Rethink ●

Scale of Innovation
- Innovative
- Hybrid ●
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$

$40M - $155M

Assumption: demolish existing WWTF, redirect 1 mile of piping, and construct new WWTF at higher elevation

Cost Benchmarks: WWTFs in East Providence, Westerly, and Attleboro RI

Provide Storage and Emergency Disinfection

During an extreme flood event, large flow rates may overload process equipment, short-circuit treatment, and discharge raw sewage. WWTFs can buffer this by providing wet weather flow emergency treatment through storage and process redundancy to increase capacity. Innovative high-rate process technologies utilizing settling, filtration, and/or flotation-based techniques at auxiliary facilities are beneficial to providing wet weather flow treatment. WWTF should provide more wet weather capacity to ensure that backup disinfection occurs to limit pollution of waterways, regulatory fines, and punishments.

Disinfection at Woonsocket WWTF © Michael Salerno/Rhode Island Current

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid ●
- Traditional

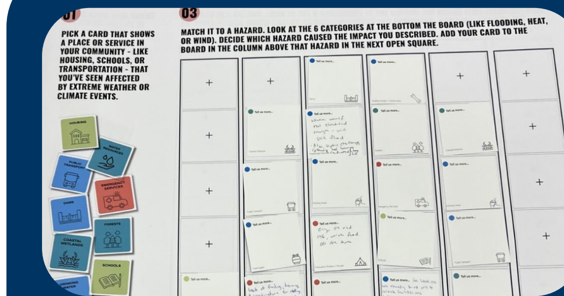
Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$

$2.5M - $9M

Assumption: create new storage area (excavation, geotextile), new outfall pipe, allowance for disinfection system

Cost Benchmark: Newport Wellington Avenue CSO Facility



Asset x Hazard Mapping at Community Forum 02 © Civic

Community Voices

"Westerly is concerned with stormwater flooding because of road closures, effect on water quality, and infiltration to the wastewater system."
- attendee at the 2nd Municipal Stakeholder Meeting in July 2025

Install Submersible Pumps and Ensure Access to Backup Pumps

Submersible pumps offer a resilient solution because they can remain operable during flooding events, ensuring continued pumping capacity when other systems might fail. Facilities should also maintain access to backup pumps to provide redundancy. Portable pumps can help restart treatment processes. Having reliable backup pumping options is critical for all wastewater treatment facilities to maintain operations during flood conditions.

Flooding at Fields Point WWTF © Brian P. D. Hannon/ecoRI News photos

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional ●

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$

$750K - $3M

Assumption: install new submersible pumps at existing WWTF

Redirect Sewage Flows, Where Possible

Connection to another WWTF located in a more resilient area provides operational flexibility and can be a cheaper alternative to relocating or completely protecting an existing WWTF. This involves an assessment of existing connections and construction of new pipe connections and lift stations. The receiving WWTF should not be vulnerable to the same hazards as the redirecting WWTF. The receiving WWTF should have excess storage and treatment capacity to accept new flows. Redirected sewage flows should avoid low lying areas. Improvement of septic systems and other upland sewage management strategies in rural areas supports this approach. This approach can also be utilized for vulnerable pump stations.

Scarborough WWTF © RIIB

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative ●
- Hybrid
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$

$15M - $55M

Assumption: modify existing WWTF and associated pump stations, redirect ~1 mile of pipe to another WWTF

Cost Benchmark: Long Beach, NY Water Pollution Control Plant Consolidation

Wastewater Treatment Facility Hardening Funding Strategy

Rhode Island can advance wastewater treatment facility hardening through a combination of state and federal funding sources that support structural upgrades, flood-proofing, and resilience improvements. The following sections outline anticipated costs, cost-effectiveness considerations, and the public health and community benefits of reducing overflow and contamination risks. They also detail available funding mechanisms, define the State's role, and identify the next steps needed to position priority WWTF assets for funding and implementation.

Costs

These strategies reflect a range of costs based on scope and complexity. Installing submersible pumps and wet weather storage provide targeted improvements for operational continuity during flooding or equipment failure at a lower cost. The costliest interventions involve significant expenses to modify, demolish and construct new WWTFs. The cost for redirecting wastewater to an existing facility and relocating an existing facility are relatively high, significantly impacted by their scale: size and capacity of the facilities, distance for redirection, ROW and property implications, etc. For example, redirecting flow between West Warwick and Cranston WWTF's is only about 3 miles point-to-point, but other facilities may be more remote and more challenging to redirect flow and operations to another. Larger scale resilience solutions can, however, deliver long-term cost savings in the form of future mitigated damages.

Benefits

Wastewater treatment facility hardening solutions protect facilities from costly damage due to extreme flood events. Reduction in damage also translates to avoided damage costs and disruption to WWTF processes. When these processes are disrupted, untreated sewage can be released into nearby waterways, threatening public and environmental health. WWTF hardening solutions directly preservers life safety.

Benefits

Avoided Damage	●●●
Avoided Disruption	●●○
Preserved Life Safety	●●○
Other	●○○

Co-benefits include improved environmental health.

Economic Impacts

Hardening wastewater facilities protects public health infrastructure essential for economic activity. Preventing treatment disruptions avoids costly emergency repairs, regulatory fines, and environmental remediation expenses. Facility upgrades create specialized engineering and construction jobs while ensuring continuous operations that support residential and commercial development. Reliable wastewater treatment protects Rhode Island's beaches and waterways, preserving tourism revenues and property values. By preventing sanitary sewer overflows, these investments protect water quality, maintain regulatory compliance, reduce long-term operational costs, and support sustainable economic growth dependent on functioning sanitation infrastructure.

Consequence of Inaction

The consequence of inaction on Rhode Island's wastewater treatment facilities is high. The SCV assessment found that a current 100-year coastal flood event could result in damage equal to 10-30% of the total value of Cranston WWTF facility with this rising to more than 30% by 2100, making implementation of these strategies essential. While interventions are often costly, untreated sewage discharge can cause major public health risks, ecological impacts, and potential regulatory issues.

Consequence of Inaction

High ●
Medium
Low

Funding Strategy

The proposed solutions align closely with the identified funding programs. These state and federal funding mechanism support the planning and implementation of WWTF hardening and upgrades that safeguard critical infrastructure, minimize contamination during storm events, and strengthen long-term system resilience.

Mechanism Title: Rhode Island Voter-Approved Green Bonds and Municipal Revenue Bonds

Mechanism Type: Bonds

Level: State/Municipal

Agency: State of Rhode Island; Local Municipalities

RI voter-approved Green Bonds, which fund statewide grant and loan programs, and municipal green or revenue bonds issued by cities and towns for local capital projects, offer two financing pathways to help eligible capital projects that improve environmental outcomes, including WWTF upgrades that reduce pollution risk and increase resilience..

State Role: Help municipalities structure bond issuances, verify Green Bond eligibility, and coordinate with RIIB to layer grants or loans as needed. Align project scopes with legislative priorities to improve bond package competitiveness.

Next Steps: Prepare preliminary project scopes and cost estimates for upcoming bond cycles, and work with RIIB to identify blended financing and document resilience benefits.

Mechanism Title: Clean Water State Revolving Fund (CWSRF)

Mechanism Type: Loan/Principal Forgiveness

Level: Federal

Agency: Rhode Island Infrastructure Bank (RIIB), RIDEM, & EPA

CWSRF financing can support many WWTF hardening activities, especially those tied to water quality protection. The fund offers low-interest loans and, for disadvantaged communities, principal forgiveness for eligible improvements such as pump station upgrades, treatment process resiliency, system redundancies, and floodproofing.

State Role: Provide pre-application guidance, confirm eligibility of specific hardening components, and help identify opportunities for principal forgiveness where applicable.

Next Steps: Submit a Project Priority List (PPL) request and begin preliminary engineering to support application.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Drinking Water & Reservoir Resilience

This chapter outlines adaptation solutions for drinking water infrastructure. Drinking water and reservoir resilience strategies are focused on reducing flooding and extreme heat impacts to Rhode Island's drinking water reservoirs, ensuring both quantity and quality of potable water.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

Assets Identified for Drinking Water & Reservoir Resilience Solutions

Asset	Municipality
Easton Pond Reservoir & Dam	Newport - Middletown
Gardiner Pond Reservoir	Newport - Middletown
Green End Pond Reservoir	Newport - Middletown
Nelson Pond Reservoir	Newport - Middletown
North and South Pond Reservoir	Jamestown
Scituate Reservoir	Scituate

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- **Critical Infrastructure & Facilities**
- Natural Systems
- Community Resilience & Emergency Preparedness Structures

Drinking Water & Reservoir Resilience Summary

Rhode Island's 49 public water reservoirs deliver drinking water throughout the state. Climate impacts are a threat to the quality of drinking water due to increase risk for contamination of public water reservoirs. Potable drinking water is needed to sustain everyday life and preserve public health.

Climate hazards can contaminate public water reservoirs in several ways. Flooding increases polluted runoff into reservoirs, while sea level rise and coastal flooding may lead to saltwater intrusion. Extreme heat can trigger algal blooms and promote bacterial growth, both of which degrade water quality. These solutions focus on preserving water quality to protect public health.

North and South Pond Reservoir (coastal reservoirs) and Scituate Reservoir (the largest reservoir in the state) represent vulnerable drinking water assets that are essential to delivering clean drinking water throughout the state. Rhode Island reservoirs should consider fortification and planning strategies to bolster against flood and heat events, such as elevating embankments, enhancing existing spillways, and implementing heat reduction measures. In times of water shortage, municipalities need to also work with their neighboring municipalities to share water resources.

Ongoing Actions

Maintaining the quality of drinking water is a priority goal in Rhode Island and it is demonstrated by the extensive research and planning efforts. There are active resilience reservoir projects at Easton Pond Reservoir and Scituate Reservoir. Furthermore, URI built the first municipal-scale PFAS removal treatment system in the state which can serve as a model to addressing compounding water quality impacts, such as PFAS contamination.

Resources

- Nonpoint Source Management (2024)
- Rhode Island Water 2030 (2012)
- Rhode Island Water Quality 2035 (2016)
- Safe Water RI (2013)
- Saltwater Intrusion Water Study (2022)
- Easton Pond Reservoir Resilience (2019)
- Jamestown Brook Watershed Plan (2021)
- Scituate Reservoir Forest Restoration (2024)

Steps for Implementation

1. **Data Collection and Stakeholder Engagement**
Collect current and future climate data, water quality, and past historic events. Conduct interviews with stakeholders to collect data on the current challenges at the reservoirs. Incorporate stakeholder engagement throughout the project planning process.
2. **Multi Hazard Risk Assessment**
Conduct a reservoir-specific multi-hazard risk assessment looking across key hazards like flooding, saltwater intrusion, and extreme heat under current and future time horizons. These should account for coastal flooding risks associated with future seal-level rise scenarios. Utilize the assessment to assess the risk at key areas of the reservoirs. The most vulnerable reservoirs should be prioritized for resilience solutions.
3. **Catchment Management Plan**
Develop a comprehensive catchment management plan that addresses key issues identified in the multi hazard risk assessment. The plan should be focused on monitoring and operational strategies to improve climate resilience.
4. **Desalination Plant Feasibility Study**
Review RI Water 2030 and previous desalination plant feasibility studies, such as the Quonset Development Corporation Study or Supplemental Source Water Study. Utilize plans to identify best practices for sites, identifying the necessary space and cost requirements.
5. **Optioneering Analysis and Engineering Design**
Create high-level concept designs for the optioneering process. Use the process to identify the most ideal solution for the reservoir, and/or prioritize areas of improvement. Reach out to relevant stakeholders, such as RI Coastal Resource Management Council (CRMC), to prioritize reservoir resilience strategies. Transform concept designs into detailed engineering designs.
6. **Costs and Funding Assessment**
Develop order-of-magnitude costs for construction and identify potential funding sources available for implementation of the final designs.
7. **Permitting and Construction**
Obtain permits for chosen final designs. Construct any new equipment, facilities, or protections.
8. **Commissioning and Maintenance**
Perform tests to ensure proper drinking water reservoir and dam functions. Conduct regular equipment inspections, maintenance, performance tests and trainings for any deployable or active resilience measures.


Scituate Reservoir © John Mernick for Shutterstock

Representative Priority Assets

Jamestown's North and South Pond Reservoir is selected as a representative priority asset due to its **climate risk** and the presence of **ongoing resilience efforts in neighboring reservoir areas. Scituate Reservoir** is selected due to its criticality in the state, providing **60% of Rhode Island with drinking water**.

North and South Pond Reservoir
Municipality: Jamestown

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: This asset was identified through the engagement process and Technical Assistance Packages (TAP) as an area of concern.

Scituate Reservoir
Municipality: Scituate

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Stakeholder identified & provides water to 60% of the State.

Drinking Water & Reservoir Resilience Strategies

The strategies work together to provide resilience strategies for both coastal and inland reservoirs. All reservoirs should consider elevating their embankment to minimize flood risk. Coastal reservoirs need to be particularly concerned about saltwater intrusion. They should consider installing temporary or permanent barriers to their existing emergency spillway and feasibility of a desalination plant. Integrated watershed-scale planning offers an essential pathway for safeguarding drinking-water supplies. For example, the Big River Management Area demonstrates how protected watershed lands can be strategically managed to secure future drinking-water sources.

Gardiner Pond © Tom Murphy for The Providence Journal

Community Voices

"Concerned about drinking water facilities located near shorelines, [because] salt intrusion [is] becoming an issue with rising sea levels."
- attendee at the 2nd Community Forum at East Providence's Weaver Library in July 2025

Implement Watershed Management and Heat Reduction Measures

Effective watershed management to conserve and restore vegetated riparian buffers reduces the amount of nitrogen and phosphorus inputs to reservoirs. When combined with rising temperatures, these chemicals can cause algal blooms in reservoirs. By reducing contaminants, riparian buffers can lessen increased algal growth due to extreme heat. Water conservation strategies, such as outdoor water bans during summer months, can also be a strategy to deal with summer water shortages.

Riparian Buffer © Virginia Department of Forestry

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore ●
- Rethink ●

Scale of Innovation
- Innovative (selected)
- Hybrid
- Traditional

Relevant Hazards
- Extreme Heat

Cost
$$$($)
$7M - $30M

Assumption: earth moving, thin layer soil placement, native plantings, trees, and grass for 1 mile (50' width)

Cost Benchmark: Ninigret Pond Restoration, Charleston, RI

Enhance Existing Emergency Spillway

Coastal reservoirs should enhance existing emergency spillways by installing additional barriers to protect from surface water saltwater intrusion. A temporary barrier option is a flexible inflatable bladder, but this is not ideal as a long-term solution. For a more permanent barrier, hydraulic gates can also be implemented on a case-by-case scenario. By improving and implementing barriers, it will reduce the risk of surface saltwater intrusion and ensure the water quality is not impacted significantly. Barriers will not protect against saltwater intrusion via groundwater, which primarily impacts wells drawing upon aquifers. Groundwater salt intrusion would need to be addressed through desalination, well relocation, or other methods.

Inflatable Rubber Dam © Inflatable Dam

Solution Mechanism
- Protect ●
- Accommodate ○
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid (selected)
- Traditional

Relevant Hazards
- Coastal Flooding
- Riverine Flooding

Cost
$$$($)
$5M - $15M

Assumption: install flexible, inflatable tube across dam / spillway

Cost Benchmark: San Juan Watershed Project, CA

Improve Embankment

Improving embankment structures and increasing crest elevation are strategies that strengthen reservoir banks, making them more robust and better prepared for storm surges, wave-induced overtopping, and higher flood levels during extreme weather events. Bank improvement projects have been proposed as mitigation measures for Rhode Island's coastal reservoirs, such as Easton Pond Reservoir.

Easton Pond North in Newport County, RI, © City of Newport

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ○

Scale of Innovation
- Innovative
- Hybrid
- Traditional (selected)

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$
$25M - $90M

Assumption: 8k-10k linear feet of embankment raised and reinforced, installation of crest and tidal gates, and associated controls

Cost Benchmark: Easton Pond Dams Resiliency Project, RI

Build a Desalination Plant

Desalination plants allow saltwater to be treated for drinking by removing salts and other minerals utilizing various methods (e.g. membranes, reverse osmosis). The RI Water 2030 plan identified desalination as a strategy to adapt to saltwater intrusion in drinking water. The plan discusses the importance of conducting feasibility studies and following the Safe Drinking Water Act. Aquidneck Island and other coastal areas have conducted feasibility studies, but financial constraints have prevented projects from progressing. The desalination plant in Brockton, MA represents one of the most recent regional case studies. Water recycling may be considered as an alternate strategy to reduce pressure on freshwater supplies.

Pure Water Center © El Paso Water

Solution Mechanism
- Protect ○
- Accommodate ●
- Restore ○
- Rethink ●

Scale of Innovation
- Innovative (selected)
- Hybrid
- Traditional

Relevant Hazards
- Coastal Flooding

Cost
$$$$
$90M - $350M

Assumption: 5M gallon per day water reuse/recycling desalination plant

Cost Benchmark: Pure Water Center, El Paso, TX

Drinking Water & Reservoir Resilience Funding Strategy

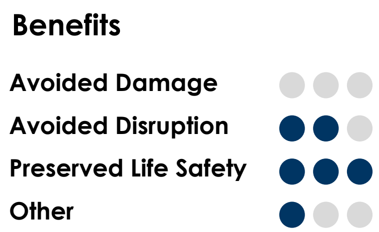
Rhode Island can advance drinking water and reservoir resilience through a combination of state and federal sources that support embankment upgrades, spillway improvements, watershed protection, and nature-based solutions. The following sections summarize anticipated costs, cost-effectiveness considerations, and the public health and ecosystem benefits of improving reservoir resilience. They also outline key funding mechanisms, describe the State's role, and identify next steps to position priority reservoir assets for implementation.

Costs

This diverse group of strategies address unique aspects of the potable water system. The cost of each one is strongly correlated with scale. Drinking water and reservoir improvement costs vary by solution type. Temporary measures (e.g., Tigerdams) are the least expensive, followed by watershed management approaches such as riparian buffer construction. Soil embankment improvements (i.e. raising and reinforcing embankment and adding flow control structures) and permanent hard structures (e.g., concrete and steel) are more costly, while dynamic structures (e.g., gates and controls) are typically the most expensive. The cost of desalination plants can vary drastically based on size; large plants can be extremely costly, but can reduce long-term costs associated with addressing over-topping of existing structures during storm events.

Benefits

Drinking water infrastructure is directly tied to public health. Both quality and quantity of water is needed to maintain statewide health. Floods threaten the quality of drinking water, since runoff may bring saltwater intrusion or additional runoff contamination. The solutions reduce the amount of unwanted runoff into reservoirs, and the desalination plant helps make saltwater potable. Similarly, extreme heat may bring increased algal growth, however, effective watershed restoration reduces chemical inputs that drive algal blooms, protecting the quality of the water. Reservoirs are also ecosystems, so the solutions help further enhance habitats and biodiversity.



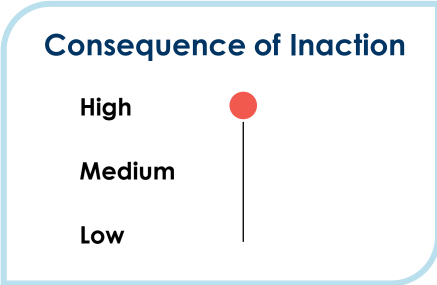
Co-benefits include improved biodiversity and ecosystems.

Economic Impacts

Protecting drinking water infrastructure safeguards public health and economic stability. Rhode Island's reservoirs serve much of the state's population; disruptions would halt business operations and residential activities. Resilience investments create jobs in watershed management, engineering, and water quality monitoring. Preventing contamination avoids costly treatment upgrades and emergency water supply expenses. Clean, reliable water supplies attract businesses, support property values, and enable economic development. Catchment management and infrastructure improvements reduce long-term operational costs while ensuring the water security essential for sustained economic activity and population health.

Consequence of Inaction

The consequence of inaction on Rhode Island's drinking water and reservoir systems is high. Investing in resilience measures offers cost-effectiveness by ensuring uninterrupted access to safe water during emergency events. While intervention costs vary, proactive solution strategies are less costly than the consequences of failure. In contrast, failure to act exposes Rhode Island communities to public health risks, emergency expenditures, and long-term infrastructure damage.



Funding Strategy

The proposed solutions align closely with the identified funding programs. Funding sources can cover infrastructure upgrades that protect drinking water quality, including embankment reinforcement, spillway modifications, and reservoir management planning. While others complement these efforts by supporting nature-based and watershed strategies that reduce runoff, prevent saltwater intrusion, and improve resilience to extreme weather. These programs collectively support both the engineered and ecological components of reservoir resilience.

Mechanism Title: Drinking Water State Revolving Fund (DWSRF)

Mechanism Type: Loan/Grant

Level: Federal

Agency : Rhode Island Infrastructure Bank (RIIB) & RIDOH

DWSRF can fund many reservoir resilience activities, including spillway upgrades, watershed protection planning, and infrastructure improvements that protect drinking water quality.

State Role: Provide guidance on project eligibility, support and technical assistance for preliminary engineering reports, and help identify opportunities for principal forgiveness.

Next Steps: Submit projects for the Priority List, prepare preliminary design, and coordinate with RIIB on financing structure.

Mechanism Title: NOAA Coastal Resilience Grants

Mechanism Type: Grants

Level: Federal

Agency: National Oceanic and Atmospheric Administration

For coastal-influenced reservoirs, NOAA funding can support nature-based stabilization, watershed protection, and embankment resilience that reduces runoff and improves water quality.

State Role: Coordinate with CRMC to align projects with coastal zone priorities and provide required consistency determinations. Identify regional partners (watershed groups, NGOs, university) to support competitive applications. Support development of any needed saltwater intrusion studies.

Next Steps: Develop a concept proposal and identify partners for collaborative application.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Natural Systems Adaptation Solutions

Beach & Wetland System Restoration

River & Stream Restoration with a focus on the Moshassuck River

Beach & Wetland System Restoration

This chapter outlines adaptation and resilience solutions for coastal beaches, barrier, and wetland systems. Beach and wetland system restoration strategies are focused on reducing coastal flooding impacts to conserve and protect these natural systems, as well as the built environment around them.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

Assets that Informed the Beach & Wetland System Restoration Solutions

Asset	Municipality
Napatree Barrier Beach	Westerly
Salt Pond Region Beaches and Barriers: Cards Pond, Green Hill Pond, Maschaug Pond, Ninigret Pond, Point Judith Pond, Potter Pond, Quonochontaug Pond, Trustom Pond, and Winnapaug Pond	Charlestown, Narragansett, South Kingstown, Westerly
Bristol County Coastal Wetlands	Bristol, Warren, Barrington
Newport County Coastal Wetlands	Newport, Portsmouth, Middletown, Little Compton, Tiverton, Jamestown
Washington County Coastal Wetlands	Narragansett, North Kingstown, Westerly, Charlestown

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- Critical Infrastructure & Facilities
- Natural Systems
- Community Resilience & Emergency Preparedness Structures

Beach & Wetland System Restoration Summary

Coastal beaches, barriers, and wetland systems are on the front lines of coastal flooding. With sea level rise and ongoing natural erosion processes, these areas are losing critical marine habitats and natural protections that once shielded coastal development from floods.

Beach and wetland systems, including Salt Pond Region beaches and barriers and the Napatree Point Conservation Area, support biodiversity, natural buffers against wave energy and coastal flooding, and store carbon. Yet, according to CRMC, 50% of Rhode Island's shoreline is vulnerable to erosion, and ongoing degradation of these connected systems threatens both marine ecosystems and coastal communities.

Restoration strategies are geared towards building on the efforts of conservation groups, like the Salt Ponds Coalition and Watch Hill Conservancy. In more undeveloped areas, like Napatree Point Conservation area, strategies are strengthening natural systems with NbS, such as marsh and dune restoration, to better withstand future sea level rise and erosion. In more developed areas, like Salt Pond Region, strategies are focused on rethinking policies and zoning regulations to limit coastal development and initiate steps towards voluntary managed retreat.

Ongoing Actions

There have been multiple climate studies, pilot projects, and guidance documents developed to further promote resilience for Rhode Island's beaches and wetlands. RI Coastal Resources Management Council (CRMC) is leading many of the efforts.

Resources

- Freshwater Wetlands and Buffer Protection (2022)
- Section 1.3.1(G) of CRMC Program (2022)
- CRMC Beach SAMP (2018)
- CRMC Coastal Erosion (2016)
- CRMC SAID Pilot (2019)
- Aquidneck Island Watershed Plan (2025)
- CCMP for Narragansett Bay (Ongoing)
- Easton's Beach Resilience Plan (Ongoing)

Trustom Pond National Wildlife Refuge © U.S. Fish and Wildlife Service

Steps for Implementation

1. **Assessment and Stakeholder Engagement**
   Conduct site assessments, stakeholder engagement, restoration planning and identify performance indicators. Work with Rhode Island Coastal Resources Management Council (CRMC) to identify relevant stakeholders to lead the project process.
2. **Optioneering Analysis and Planning**
   Conduct an optioneering analysis to evaluate restoration solutions. Create concept designs for physical restoration and pilot voluntary managed retreat projects. Work with Salt Pond Region community members to identify pilot locations for the retreat program. Transform concept designs into final designs.
3. **Costs and Funding Assessment**
   Develop order-of-magnitude costs for construction of restoration efforts and implementation of pilot managed retreat programs. Identify potential funding sources available for implementation, working with RI CRMC and additional funding agencies.
4. **Physical Restoration**
   Develop salt marsh and barrier beach restoration plans with input from natural resource managers to restore coastal habitats and make them more resilient to sea level rise. Engage partners, such as the Watch Hill Conservancy, and build off existing plans, such as the Aquidneck Island Watershed Plan, to identify and phase restoration projects.
5. **Policy and Regulation**
   Prepare adaptive development regulations – setback requirements, building standards for development, and restrictions on new development. Identify properties for buyouts and relocation initiatives. Conduct outreach with Rhode Island's Health Equity Zone (HEZ) communities to ensure equitable policy implementation.
6. **Monitoring and Adaptive Management**
   Establish monitoring programs to track dune and wetland elevations, health, and buffer zone effectiveness. Monitor compliance with development regulations, update restoration strategies based on monitoring data and climate projections, and incorporate lessons learned into future planning and implementation cycles.

Representative Priority Assets

Salt Pond Region Beaches and Barriers, including Winnapaug Pond, Quonochontaug Pond, Ninigret Pond, Trustom Pond, and Maschaug Pond, are selected as representative priority assets due to the need for **development regulation**, as identified by stakeholders. **Napatree Point Conservation Area** is selected to support ongoing **conservation and restoration** efforts.

Salt Pond Region Beaches and Barriers
Municipality: Charlestown, Narragansett, South Kingstown, Westerly

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Exposed to wave-action, moderately developed to developed, and stakeholder identified.

Napatree Point Conservation Area
Municipality: Westerly

Current Climate Risks*:

2050 Climate Risks*:

2100 Climate Risks*:

Context: The asset is an undeveloped conservation area and stakeholder identified.

*The Napatree Point Conservation Area was not identified as high risk for coastal flooding in the Statewide Climate Vulnerability Assessment. However, through this plan's stakeholder engagement process, erosion and storm surge were identified as critical risks for the area.

Beach & Wetland System Restoration Strategies

These strategies work together to create a layered coastal resilience system for Rhode Island. By strengthening natural defenses, restoring ecological functions, and guiding development away from high-risk areas, they reduce storm impacts, improve water quality, and allow coastal landscapes to adapt to changing conditions. This integrated approach aligns with RI CRMC guidance and regional climate goals, combining nature-based solutions with proactive planning to protect communities and ecosystems over the long term.

Enhance Dynamic Dunes and Barriers

Rebuild and stabilize dunes through sediment nourishment, planting native vegetation, and installing sand-friendly fencing to trap windblown sand. Beneficial reuse of clean sediment can also support dune and habitat restoration. These measures help reduce over wash during storms, maintain sediment transport, preserve habitat, and protect against erosive forces. Best practices include enhancing plant diversity, controlling invasive species, and redirecting visitor traffic away from dune areas to prevent damage. Maintenance requires sand replenishment and vegetation management, especially after major storm events, along with monitoring for erosion and ecological health. Move infrastructure inland to create room for dune restoration projects.

Napatree Point © Yankee Magazine

Solution Mechanism

Protect	○
Accommodate	○
Restore	●
Rethink	○

Scale of Innovation

Innovative

Hybrid

Traditional ●

Relevant Hazards

Coastal Flooding

Cost

$$$$

$3.5M - $15M

Assumption: 1 mile of beach dune construction (5' tall)

Cost Benchmarks: Beach Renourishment Projects, Duval & St. Johns County, FL

Restore Wetlands and Buffer Zones

Restoring tidal wetlands and buffer zones helps absorb floodwaters, filter pollutants, and provide critical habitat. This strategy focuses on improving hydrologic connectivity, maintaining tidal exchange, and planting vegetation of native species to stabilize soils and support biodiversity. Techniques such as sediment placement raise marsh elevation to keep pace with sea-level rise, while hydrological restoration corrects drainage issues. When combined with land acquisition, marsh migration corridors can also be preserved to provide continued ecological and resilience wetland benefits. Long term success requires ongoing adaptive management of salt marsh restoration areas and marsh migration corridors as sea levels rise.

Sediment Replacement Project at Quonochontaug Pond © NOAA

Solution Mechanism

Protect	○
Accommodate	●
Restore	●
Rethink	○

Scale of Innovation

Innovative

Hybrid ●

Traditional

Relevant Hazards

Coastal Flooding

Stormwater Flooding

Riverine Flooding

Cost

$$$$

$6M - $20M

Assumption: earth moving, thin layer soil placement, trees and in-water plantings for 1 mile (50' width)

Cost Benchmark: Ninigret Pond Restoration, Charleston, RI

Community Voices

"Private residential development on barriers is largely not something that can be protected. We need tools to disincentive investment and incentivize relocation." - attendee at the 1st Community Forum held at Providence Public Library in June 2025

Damage from Hurricane Sandy at Roy Carpenter's Beach © Rhode Island Sea Grant

Weeakapug, RI © Redfin

Implement Voluntary Buyout Program

This strategy reduces risk by controlling where and how development occurs and by planning for the relocation of critical infrastructure away from eroding shorelines.

A voluntary buyout program for the most vulnerable coastal communities is recommended. The program will build off RI CRMC's existing adaptive development regulations that mandate setbacks and coastal buffer zones for new construction. However, this program will target existing buildings, offering incentives like voluntary buyouts and relocation programs. The time and resources required to acquire parcels will vary greatly based on market conditions, location, and assets located on the real estate of interest. Public engagement and equity considerations are essential to ensure fair implementation and community support.

For new development, additional regulations should limit new construction in high-hazard zones and require resilient design for redevelopment, while infrastructure planning focuses on phased relocation of roads, utilities, and public facilities to safer areas.

Rhode Island's Beach SAMP (Shoreline Change Special Area Management Plan) is central to this approach, providing science-based tools such as updated shoreline change maps, STORMTOOLS flood projections, and the Coastal Hazard Application process, which evaluates erosion and sea level rise risks before permits are issued.

Solution Mechanism

Protect	●
Accommodate	○
Restore	○
Rethink	●

Scale of Innovation

Innovative

● (between Innovative and Hybrid)

Hybrid

Traditional

Relevant Hazards

Coastal Flooding

Cost

$$$$

$500K - $1.5M

Assumption: hire consultant to develop pilot voluntary buyout program

$$$$

$1.5M - $5.5M

Assumption: purchase 5 parcels, remove homes and structures, stabilize flood prone area and revegetate

Cost Benchmark: Blue Acres Flood Buyout, Cranford, NJ

Beach & Wetland System Restoration Funding Strategy

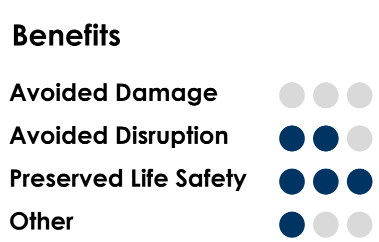
Rhode Island can advance beach and wetland restoration through a combination of federal and state programs that support habitat restoration, dune and barrier enhancement, erosion control, and nature-based shoreline management. The following sections summarize anticipated costs, cost-effectiveness considerations, and the ecological and community benefits these investments can deliver. They also outline key funding mechanisms, describe the State's role, and identify next steps to position priority coastal assets for implementation.

Costs

Dune restoration is a coastal adaptation technique that can involve adding sand either from upland or off-shore sources to create beach and dune habitat. Plantings stabilize sand and help allow dunes to capture wind-blown sand. Salt marsh restoration projects can vary from smaller scale hydrology restoration projects to larger landscape scale sediment placement projects that increase the elevation of the marsh and provide an area for future marsh migration. Larger, landscape scale marsh restoration projects will require greater capital investment, however, projects with increased stability through plantings have greater chance of sustained success, reducing long-term costs. Monitoring and maintenance is also required to ensure both strategies maintain effectiveness over time. The buy-out program set-up costs may be relatively low, but it is important to consider the ongoing investment required by local stakeholder agencies to run the program into the future as well as the financing required to acquire land, which can vary significantly based on market conditions, location, and assets located on the real estate of interest.

Benefits

The beach and wetland system restoration solutions protects undeveloped areas through enhancing ecosystems and developed areas through regulating property development. The solutions reduce damage from erosion, minimizing the cascading disruption it causes to natural habitats and developed communities. The prioritized assets are also areas near Tidal Migration Areas and in areas that have lower terrestrial resilience and/or lower social vulnerability, meaning that co-benefits are distributed to the most vulnerable habitats and communities. Life safety may be a considerable factor for privately owned assets not assessed here, but which would be benefited by a voluntary buyout program.



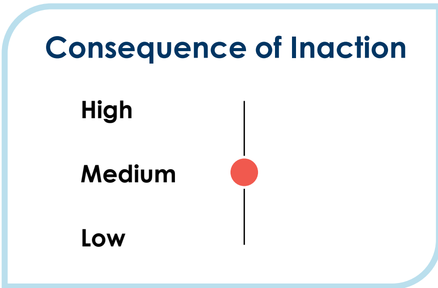
Co-benefits include improved biodiversity and ecosystems.

Economic Impacts

Coastal restoration protects tourism infrastructure and property values while creating jobs in ecological restoration, marine construction, and environmental management. Rhode Island's beaches generate significant tourism revenue; protecting these assets sustains hospitality, recreation, and service sector employment. Restored wetlands reduce flood damages to coastal development, lowering insurance costs and property losses. Nature-based solutions provide cost-effective flood protection compared to gray infrastructure. By maintaining natural buffers, communities avoid expensive emergency repairs, protect real estate investments, and preserve the coastal amenities essential to Rhode Island's economy and quality of life.

Consequence of Inaction

The consequence of inaction on Rhode Island's beaches and coastal wetlands is medium. Beaches and wetlands are highly at risk to consequences when they are inundated by 2 ft of flooding. Currently, the Salt Pond Region is expected to be exposed to 8.5 of flooding during a 100-year coastal flood event, and this is projected to increase to 12 ft by 2100, according to the SCV assessment. While beach and wetland restoration interventions are somewhat costly, failing to act can lead to escalating erosion and habitat loss.



Funding Strategy

The recommended beach and wetland restoration strategies align closely with USFWS National Coastal Wetlands Conservation Grants and the state's OSCAR Fund. The USFWS program provides capital funding for habitat restoration, coastal wetland enhancement, and conservation projects that increase resilience to flooding and erosion. OSCAR supports nature-based projects that reduce climate-driven flood risks and enhance coastal buffers. These mechanisms fund both large-scale restoration activities and state-prioritized resilience projects.

Mechanism Title: National Coastal Wetlands Conservation Grants (NCWCG)

Mechanism Type: Grant

Level: Federal

Agency: US Fish and Wildlife Service

NCWCG provides funding for the acquisition, restoration, and enhancement of coastal wetlands that protect habitat, improve water quality, and reduce coastal flood risks. This mechanism is a strong match for dune enhancement, wetland restoration, and barrier stabilization in areas at risk of sea level rise or storm surge.

State Role: Provide statewide habitat data, coastal mapping, and climate projections to strengthen proposals. Coordinate with DEM and CRMC to identify eligible restoration sites.

Next Steps: Develop a restoration or conservation concept and confirm site eligibility, secure match commitments.

Mechanism Title: Ocean State Climate Adaptation and Resilience (OSCAR) Fund

Mechanism Type: Grant

Level: State

Agency: RIDEM, CRMC, RIIB

OSCAR supports nature-based coastal resilience projects that reduce flood and erosion impacts in vulnerable coastal areas. This mechanism is well-suited for dune stabilization, marsh enhancement, buffer restoration, invasive species removal, and managed retreat strategies that provide measurable resilience benefits.

State Role: Prioritize projects that offer ecological benefits and community flood risk reduction. Provide guidance on resilience metrics, scoring criteria, and readiness requirements.

Next Steps: Prepare concept designs or site plans, identify match sources, and confirm regulatory alignment.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

River and Stream Restoration

This chapter outlines adaptation and resilience solutions for rivers and streams. River and stream restoration strategies are focused on reducing flooding and heat impacts to protect habitats and enhance ecosystems.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

Assets Identified for River and Stream Restoration Solutions

Asset	Municipality
Moshassuck River	Lincoln, Providence, Pawtucket, Central Falls

Additional Priority Assets Identified for River and Stream Restoration Solutions

Asset	Municipality
Blackstone Canal and River	Lincoln
Wood-Pawcatuck River	Washington and Kent Counties
Pawtuxet River	Kent and Providence Counties

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. This Plan acknowledges the inherent interconnections between rivers, streams, and other water resources in Rhode Island. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- Critical Infrastructure & Facilities
- Natural Systems
- Community Resilience & Emergency Preparedness Structures

River and Stream Restoration Summary

Restoring rivers and inland water areas helps improve water quality, reduce pollution, and manage flooding. By reconnecting floodplains, restoring wetlands and other natural habitats, improving how water moves through a watershed, and using green infrastructure to filter runoff and reduce impervious surfaces, communities can improve ecosystem, human health, and watershed resilience.

Historic industrial development has altered Rhode Island's watersheds, narrowing channels, hardening banks, and reducing their ability to carry floodwaters while introducing pollutants. The Moshassuck River, flowing through Lincoln, Central Falls, Pawtucket, and Providence, illustrates these challenges with frequent flooding, degraded habitat, and extensive invasive vegetation.

Strategies focusing on restoring floodplains, wetlands, riparian buffers, and addressing stormwater-related challenges can help restore natural function and enhance resilience of degraded rivers and streams. Efforts such as reconnecting floodplains, restoring wetlands, improving watershed hydraulics, and implementing green infrastructure can help store floodwaters, filter pollutants, and enhance habitat. Along the Moshassuck, these NbS not only reduce flood risk and improve water quality but also create community spaces that reduce heat island effects, support recreation, habitat, and long-term climate resilience.

Ongoing Actions

Restoration efforts across Rhode Island, including work on the Moshassuck, Woonasquatucket, Pocasset, and Wood-Pawcatuck Rivers, reflect a growing focus on addressing flooding, water-quality issues, and habitat loss with coordinated, NbS. Work by the regional Southeast New England Program (SNEP) advances restoration through annual technical assistance and grant funding, and non-profit partners provide project scoping support. On the Moshassuck River, floodplain and wetlands restoration, invasive-species management, and green infrastructure are planned to strengthen watershed resilience.

Resources

- Friends of the Moshassuck
- SNEP Network
- WRWC Habitat Restoration
- NRCS Watershed Protection Program (2023)

Aguntaug Swamp wetland restoration. Westerly, RI © Fuss & O'Neill, Inc.

Steps for Implementation

1. **Stakeholder Engagement**
Coordinate with affected municipalities, relevant state agencies (e.g., RIDEM), landowners, residents, and watershed groups to gather feedback on past flooding impacts, current vulnerabilities, ongoing initiatives, and identify potential challenges. Continue engagement throughout the project.
2. **Existing Conditions Analysis**
Review of existing data such as floodplain maps, culvert/dam inventories, impervious cover, and existing water-quality or habitat assessment reports. Delineate natural resource conditions (e.g., wetlands) and identify potential sources of water quality or habitat impairments.
3. **Vulnerability and Alternatives Assessment**
Identify flood, water-quality, and ecological vulnerabilities; identify best placement for solutions; and develop potential alternatives. Proposed solutions should address flooding, invasive species management and ecological restoration challenges, and potential project co-benefits like community greenspace.
4. **Feasibility Analysis**
Evaluate technical, environmental, and financial feasibility of alternatives, including site constraints, permitting implications, constructability, long-term maintenance needs, and cost-benefit trade-offs. Develop rough order-of-magnitude opinion of cost estimates for each alternative.
5. **Modeling and Conceptual Design**
Conduct hydrologic and hydraulic modeling to evaluate flood-reduction benefits and potential upstream or downstream impacts. Develop concept-level designs for the preferred alternative, refine cost estimates, and begin pre-application meetings with permitting agencies such as RIDEM (wetlands), U.S. Army Corps of Engineers (CWA §401/404), and local stormwater authorities. Develop concept designs into final designs.
6. **Costs and Funding Assessment**
Develop order-of-magnitude costs for construction of restoration efforts. Identify potential funding sources available for implementation.
7. **Permitting and Construction**
Prepare final engineering plans, obtain permits, and complete construction activities.
8. **Monitoring and Maintenance**
Establish a long-term monitoring and maintenance plan.

Representative Priority Assets

The Moshassuck River is selected as a representative priority asset for River and Stream Restoration due to its **climate risk to coastal flooding, stormwater flooding, and extreme heat**. Additionally, this asset was **identified through community engagement**, showing its importance to the state's ecosystem. Restoration approaches can also be applied to other degraded rivers, such as the Blackstone, Wood-Pawcatuck, Pawtuxet, Maidford, and Seekonk Rivers.

Moshassuck River
Municipality: Lincoln, Providence, Pawtucket, Central Falls

Current Climate Risks:

2050 Climate Risks:

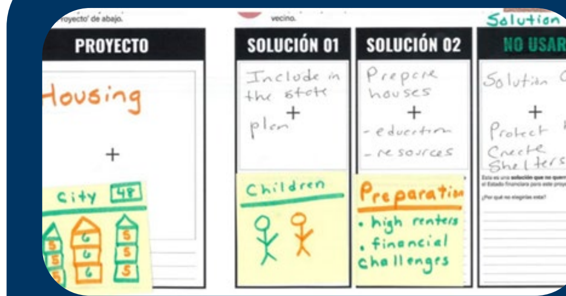
2100 Climate Risks:

Context: Stakeholder Identified.

Moshassuck River Preserve © The Nature Conservancy

River and Stream Restoration Strategies

The solutions presented offer four key strategies for restoring resilience in river and inland water areas: reconnecting floodplains, restoring wetlands, expanding green infrastructure, and improving watershed hydraulics. Floodplain and wetland restoration help rivers and streams store and slow water, reducing flooding and improving habitat. Green infrastructure further slows and filters runoff and cools urban areas, while hydraulic improvements safely convey water during major storms. When combined, these strategies create a more climate-resilient watershed that protects communities while enhancing ecological health and public access.



Solution Development Activity at HEZ Meeting © Civic

Community Voices

"Protect the banks of the rivers, the regulation on these areas should be strong and should not be negotiable as private property, they are natural benefits whose original dimensions and surfaces should be respected and recovered." – attendee at the Health Equity Zone (HEZ) Meeting held in Olneyville in October 2025.

Improve Water Quality with Green Infrastructure

Green infrastructure, such as bioswales and rain gardens, enhances water quality by filtering runoff and removing pollutants before they reach rivers and ponds, while also supporting watershed restoration. These measures reduce pluvial flooding, lower urban temperatures by replacing impervious surfaces, and increase groundwater recharge which may alleviate localized flooding during heavy storms. Best practices include proper sizing, use of native vegetation, and integration into redevelopment projects. Long-term effectiveness depends on routine maintenance.

Rain garden in Paradise Valley Park. Middletown, RI © Fuss & O'Neill, Inc.

Solution Mechanism

- Protect ○
- Accommodate ●
- Restore ●
- Rethink ○

Scale of Innovation

Innovative — Hybrid — Traditional (between Innovative and Hybrid)

Relevant Hazards

- Stormwater Flooding
- Riverine Flooding
- Extreme Heat

Cost

$$$$

$550K - $2M

Assumption: 15,000 SF of rain gardens and bioretention areas and associated infrastructure
Cost Benchmark: Pawtucket, RI Green Infrastructure on Pine Street

Restore Wetland Function

For the Moshassuck River, restoration should focus on filled or degraded wetlands, low-lying parcels with poor drainage, and heat-vulnerable urban areas lacking vegetation. Wetland function can be reestablished by reshaping the site through earthmoving and grading, installing water control structures to restore natural hydrology, and planting native species with erosion control measures to stabilize soils. These restored systems improve water storage, filtration, and habitat, but require ongoing invasive species management and vegetation monitoring during the initial years to ensure long-term success.

Wetland restoration at Blackamore Pond. Cranston, RI © Fuss & O'Neill, Inc.

Solution Mechanism

- Protect ○
- Accommodate ●
- Restore ●
- Rethink ○

Scale of Innovation

Innovative — Hybrid — Traditional (between Innovative and Hybrid)

Relevant Hazards

- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat

Cost

$$$$

$5M - $20M

Assumption: earth moving, thin layer soil placement, native plantings for 1 mile (50' width)

Cost Benchmark: Ninigret Pond Restoration, Charleston, RI

Reconnect Floodplains and Increase Riparian Buffer Capacity

Conserving and restoring floodplains allows rivers to spread naturally during storms, reducing pluvial flooding and increasing riparian buffer capacity as climate-driven extreme rainfall becomes more frequent. Along the Moshassuck River, suitable sites can be identified by targeting low-lying parcels with frequent overbank flooding or previously filled floodplain areas. Some projects require removing structures or impervious surfaces, but restoration offers long-term benefits with minimal maintenance beyond periodic vegetation and debris management.

Floodplain restoration in West Warwick, RI © Fuss & O'Neill, Inc.

Solution Mechanism

- Protect ○
- Accommodate ●
- Restore ●
- Rethink ●

Scale of Innovation

Innovative — Hybrid — Traditional (between Innovative and Hybrid)

Relevant Hazards

- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$1.5M - $6M

Assumption: earthwork, plantings, and other works to improve drainage and reconnect floodplains

Cost Benchmark: Maidford River Restoration, Middletown, RI

Improve Watershed Hydraulics

Hydrologic and hydraulic modeling is essential to understand flow dynamics and prevent shifting flood risk downstream. Assessments should identify undersized culverts, constrained channels, and other areas with limited conveyance. Dam removal should also be explored in these assessments. Targeted improvements—such as enlarging culverts or opening channels—can reduce flooding and erosion while creating opportunities for open space, ecological restoration, and public access. These enhancements provide long-term benefits but require ongoing monitoring and management.

Culvert replacement. Maidford River, Middletown, RI © Fuss & O'Neill, Inc.

Solution Mechanism

- Protect ○
- Accommodate ●
- Restore ●
- Rethink ○

Scale of Innovation

Innovative — Hybrid — Traditional (Traditional)

Relevant Hazards

- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost

$$$$

$2.5M - $10.5M

Assumption: conduct assessment, remove existing 1,000 LF culvert, replace w/larger culvert, remove existing dam, earthwork

Cost Benchmark: Belfield Drive Floodplain Restoration, Johnston, RI

River and Stream Restoration Funding Strategy

Rhode Island's river and stream restoration strategy can be advanced through federal, state, and partnership-based funding that supports floodplain reconnection, wetland restoration, green infrastructure, and hydraulic improvements. The following sections outline anticipated costs, cost-effectiveness considerations, and the ecological and community benefits of restoring river systems like the Moshassuck. They also summarize the major funding mechanisms available, the State's role, and the steps needed to position priority inland water assets for competitive funding and implementation.

Costs

Strategies in this category overlap with some of those for Critical Infrastructure, but may vary in terms of scope and scale to achieve greater positive outcomes for inland water systems, watersheds, and the environment. Additional scope may include a focus on filtration, water treatment, control structures, and other relevant ecological interventions. While the costs provided here assumed scope for pointed interventions, they can be packaged together to create a greater impact on the broader area or region, typically achieving efficiencies of scale. Decision-makers should also consider not only upfront costs but also long-term benefits, maintenance requirements, and the potential for combined strategies to maximize resilience and ecological value. Watershed scale approaches and well placed solutions, while potentially having higher initial costs, can lead to lower overall costs when long-term resilience benefits are realized.

Benefits

River and stream restoration can restore connectivity to riverine systems and improve the health and function of wetlands and flood plain habitat. This is especially important for endangered species that live in rivers and streams. The Moshassuck River was identified due to its ecological significance and pollution exposure due to runoff from flooding. The SCV assessment estimates that the river is exposed to 5.5 ft of flooding during a current-day 100-year coastal flood event and this rises to nearly 8 ft by 2100. Restoration strategies help protect inland communities from these flooding events. Green infrastructure reduces the amount of polluted runoff entering streams and rivers from streets and communities. The river was identified by the community due to its ecological significance.

Benefits

Avoided Damage	●○○
Avoided Disruption	●●●
Preserved Life Safety	●●●
Other	●○○

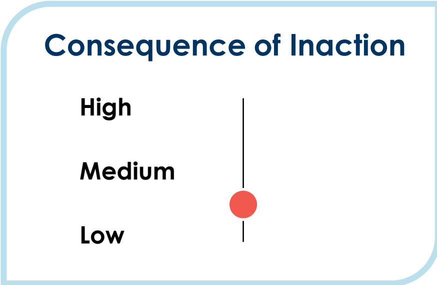
Co-benefits include improved biodiversity and ecosystems.

Economic Impacts

River and stream restoration creates employment in environmental engineering, habitat restoration, and green infrastructure installation. Improved water quality supports recreation economies and reduces municipal treatment costs. Restored floodplains prevent costly property damage while creating community spaces that enhance property values. Green infrastructure projects reduce stormwater management expenses compared to traditional systems. By reconnecting natural systems, communities lower flood insurance costs, avoid emergency response expenses, reduce heat-related health costs, and create amenities that attract residents and businesses, demonstrating measurable economic and fiscal benefits.

Consequence of Inaction

The consequence of inaction on Rhode rivers and streams is low-medium, as potential impacts from the Moshassuck River are localized to the river's watershed. While proactive resilience strategies can reduce localized flooding, prevent property damage, and protect habitats, the return on investment is modest compared to other priorities. In contrast, failing to act may still lead to repair costs and environmental degradation in and around the river.



Funding Strategy

These funding mechanisms support planning, design, and implementation for comprehensive riverine restoration that improve water quality, restore ecological function, and reduce stormwater impacts. Mechanisms directly align with floodplain reconnection, wetland restoration, green infrastructure, and hydraulic improvements along the Moshassuck River. Complementary funding for nature-based resilience projects that reduce flooding, improve water quality, and enhance community resilience are also critical in developing funding strategy.

Mechanism Title: EPA Southeast New England Program (SNEP) Watershed Implementation Grants (SWIG)

Mechanism Type: Grant/Technical Assistance

Level: Federal

Agency: Environmental Protection Agency

SNEP Watershed Implementation Grants fund on-the-ground projects that restore degraded watersheds, reduce stormwater impacts, and improve water quality through nature-based and community-driven approaches.

State Role: Provide technical assistance, data, and letters of support. Help applicants align proposed projects with statewide watershed priorities.

Next Steps: Develop a watershed-scale concept plan, identify local and regional partners, and begin scoping design elements eligible under SWIG.

Mechanism Title: Rhode Island Climate Resilience Fund (CRF)

Mechanism Type: Grant

Level: State

Agency: Rhode Island Department of Environmental Management

CRF funds projects that reduce climate-driven flood and stormwater risks using nature-based or hybrid approaches. For the Moshassuck River, CRF can support wetland restoration, reconnection of historic floodplains, stormwater improvements, green infrastructure, and hydraulic upgrades.

State Role: Provide guidance on scoring criteria and eligible project types. Support identification of match sources for projects seeking to leverage federal funds.

Next Steps: Prepare a preliminary design or concept plan, identify match funding, and confirm timing with CRF application cycles.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Community Resilience & Emergency Preparedness
Adaptation Solutions

School & Public Safety Building Solutions with hardening and relocation opportunities

Hospital Flood & Energy Resilience Solutions

School & Public Safety Building Solutions

This chapter outlines adaptation and resilience solutions for schools and public safety buildings, including fire and police stations. The strategies are focused on reducing flooding, extreme heat, and extreme wind impacts to ensure these community and emergency service providers can continue to serve Rhode Island.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

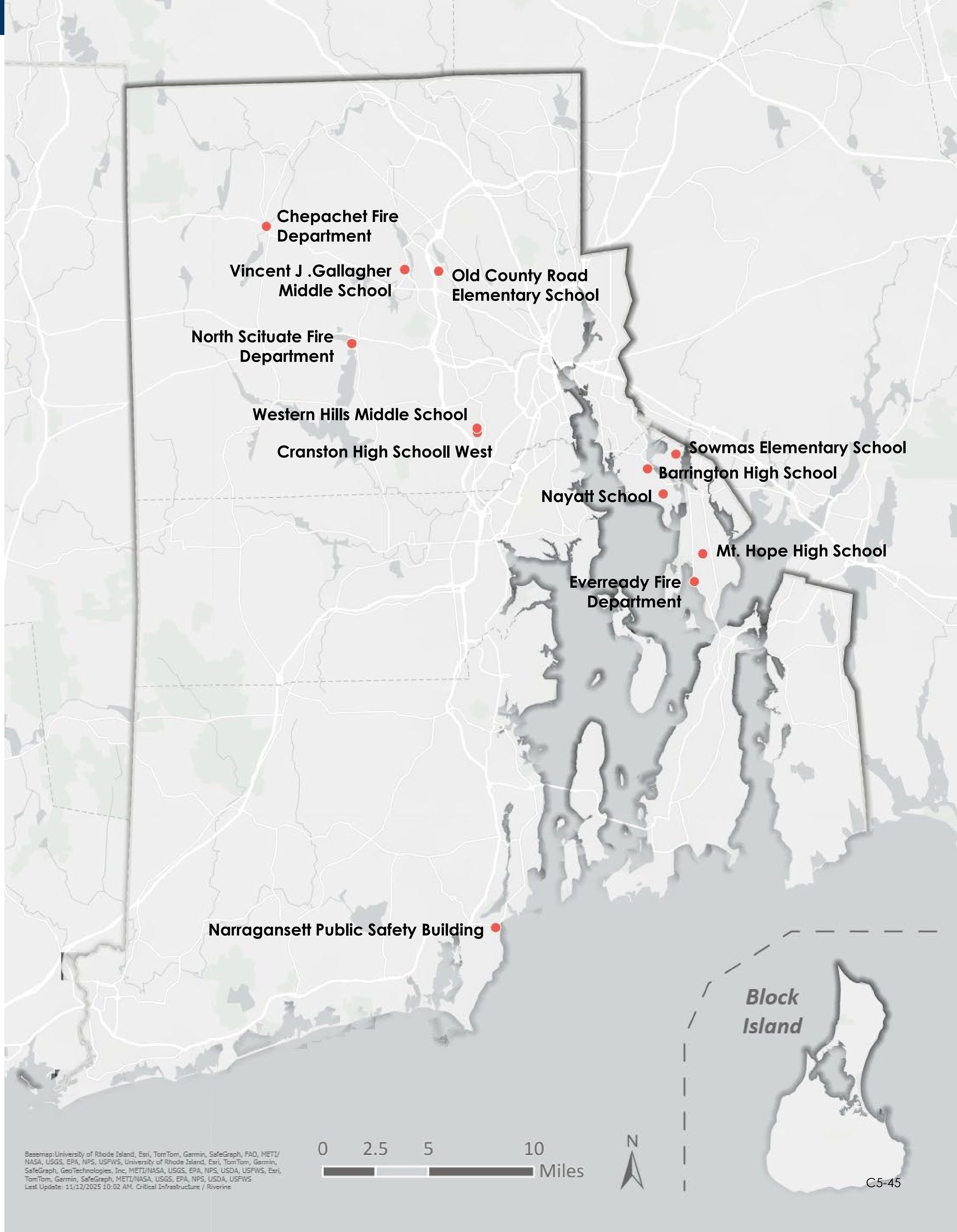
Assets Identified for School & Public Safety Building Solutions

Asset	Municipality
Barrington High School	Barrington
Cranston High School West	Cranston
Nayatt School	Barrington
Sowams Elementary School	Barrington
Mt. Hope High School	Bristol
Old County Road Elementary School	Smithfield
Vincent J. Gallagher Middle School	Smithfield
Western Hills Middle School	Cranston
Chepachet Fire Department	Glocester
Everready Fire Station	Bristol
North Scituate Fire Department	Scituate
Narragansett Public Safety Building	Narragansett

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- Critical Infrastructure & Facilities
- Natural Systems
- **Community Resilience & Emergency Preparedness Structures**



School & Public Safety Building Solutions Summary

Many schools and public safety buildings, including fire and police stations, are not built to withstand current or future climate impacts. Many are at heightened risk for flooding, leading to building damage and disruption to critical educational and emergency services.

Rhode Island's building stock is aging: the average age of a school in the state is 82 years old. Many schools and public safety buildings were constructed in locations that were once safe from flooding or in flood-prone areas where conditions have worsened. Their proximity to trains, highways, and wastewater facilities increases the risk of runoff contamination during floods. Schools and public safety buildings, many of which are designated emergency shelters, face flood damage that disrupts educational and emergency services while threatening occupant health.

North Scituate Fire Department and Barrington High School were identified as high risk for flooding and extreme heat. It is recommended that these buildings consider relocation out of the floodplain or retrofit their buildings to mitigate against future flooding. As key community spaces, these buildings also have an opportunity to transform their buildings into resilience hubs, acting as hardened emergency shelters.

Ongoing Actions

Rhode island is supporting hazard mitigation planning, property development guidance, and school modernization initiatives led by Rhode Island Department of Education (RIDE). The state also provides a wireless broadband network to emergency providers. Locally, community centers are transforming into resilience hubs.

Resources

- Coastal Property Guide (2014)
- Local Hazard Mitigation Planning (2025)
- RIDE Modernization Plans (2023)
- RIDE Statewide Assessment (2025)
- Rhode Island First Responder Network Authority (FirstNet) and AT&T (2017)
- Olneyville Resilience Hub (Ongoing)

Steps for Implementation

1 **Stakeholder and Community Engagement**
Partner with Rhode Island's Health Equity Zone (HEZ) communities and RIDE to identify building candidates for resilient building solutions and lead the implementation projects.

2 **Flood Hazard Assessment and Project Identification**
Conduct on-site flooding assessments at buildings to identify areas susceptible to flooding. Use results to identify priority flood mitigation projects.

2 **Concept and Final Designs**
Create concept designs for flood mitigation projects and evaluate them with RIDE. Transform concept designs into final designs.

3 **Cost and Funding Assessment**
Determine the costing of the various building solutions at identified schools and public safety buildings, including both construction and operational costs. Identify the most cost-effective solutions.

4 **Resilience Hub Preparation**
Identify the priority buildings for a resilience hub based on outreach, the flooding assessment, and cost planning. Engage with the local community at the resilience hub site to identify a resilience hub leadership team. The team should identify the goals of the resilience hub and lead implementation. Connect with the Olneyville Resilience hub to understand resilience hub best practices.

5 **Relocation Preparation**
Identify the priority buildings for relocation based on outreach, the flooding assessment, and cost planning. Develop a transition plan for the relocated school to ensure students and teachers do not lose educational hours.

6 **Permitting and Construction**
Procure the relevant permitting needed for the resilience solutions and implement construction, working with relevant state agencies (such as RIDE) and the Municipal Building Department throughout the relevant procedures.

7 **Maintenance**
Partner with public safety and school building facility managers and relevant state agencies (such as RIDE) to develop a maintenance program.

North Scituate Fire Department, © North Scituate Fire Department

Representative Priority Assets

North Scituate Fire Department is selected as a representative priority asset because it is **more than a mire away from another fire station,** and it faces **stormwater and riverine flooding risk.** The asset is also identified as a **candidate for relocation. Barrington High School** is selected due to its **coastal, stormwater, and riverine flooding risk** and **ongoing flood mitigation need**.

North Scituate Fire Department
Municipality: Scituate

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: More than a mile away from another fire station.

Barrington High School
Municipality: Barrington

Current Climate Risks:

2050 Climate Risks:

2100 Climate Risks:

Context: Ongoing flood mitigation need.

School & Public Safety Building Solutions Strategies

The solutions presented offer two key resilient options for school and public safety buildings: relocation or building hardening. Buildings at the highest level of flood risk should consider relocating out of flood zones, maximizing protection. Where relocation is not feasible, buildings can elevate critical infrastructure and utilize storm-resistant materials and dry floodproofing, protecting against flooding. Building retrofits can also incorporate community features to serve as broader resilience hubs. Resilience hubs provide community space for preparedness before emergencies, provide shelter and essential services during climate or disaster events, and support recovery afterward.

Relocate Programming Out of Flood Zones

Move schools and emergency operations to new buildings outside of FEMA-designated Special Flood Hazard areas. This reduces long-term risk and aligns with local hazard mitigation plans. A candidate for relocation is North Scituate Fire Department, which is extremely vulnerable to riverine flooding due to its proximity to the Scituate Reservoir. Recently, the town of Scituate created a new police station outside of the flood zone to reduce flood risk.

Rhode Island School Bus
© Rhode Island Current

Solution Mechanism
- Protect
- Accommodate
- Restore
- Rethink ●

Scale of Innovation
Innovative – Hybrid – Traditional ●

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$ (1 of 4)
$300K - $1.2M

Assumption: hire consultant to develop plan to relocate programming out of flood zones, demolish public safety building (e.g. North Scituate Fire Department), clear building site & surrounding area

Elevate Critical Infrastructure

Raise electrical panels, mechanical systems, and emergency generators above anticipated flood levels to maintain functionality during storm events and reduce downtime. Where elevation is not feasible, use waterproof enclosures and secure anchoring to prevent damage. Aging school infrastructure often lacks elevated critical equipment, making these measures essential to withstand future storms.

High Efficiency Boils mounted above the BFE
© Steven Winters Associates and Enterprise

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
Innovative – Hybrid ● – Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$ (1 of 4)
$50K - $250K

Assumption: clear 500sf equipment room, raise equipment, and other supportive works

Participants at the 1st Community Forum, Credit: Civic

Community Voices

"Without HVAC in schools, [K-12 and universities] close early in June [due to extreme heat]. "
- attendee at the 2nd Community Forum at East Providence's Weaver Library in July 2025

Retrofit and Reinforce

Apply dry floodproofing measures such as watertight doors, flood shields, and sealants to prevent water intrusion. Install hurricane-rated doors, windows, and roofing systems to withstand wind speeds common in Rhode Island Nor'easters and hurricanes. Use impact-resistant glazing and reinforced frames. Apply wet proofing measures through utilizing flood resistant materials.

Narragansett Public Safety Building
© Narragansett Police Department

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
Innovative – Hybrid ● – Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Wind

Cost
$$$$ (2 of 4)
$2M - $8M

Assumption: upgrade existing doors, windows, and roofing to be floodproof and weather resistant, purchase deployable flood barriers and conduct preparatory works

Create a Resilience Hub and Microgrid

Convert part of the facility into a resilience hub by retrofitting spaces to support community needs before, during, and after climate or emergency events. Install reliable backup power such as generators or solar systems with battery storage. Designate areas with adequate storage for safe drinking water and food supplies. Include shower and sanitation facilities for extended stays and create a secure communication zone equipped with charging stations.

Olneyville Resilience Hub
© City of Providence

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink ●

Scale of Innovation
Innovative ● – Hybrid – Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Cost
$$$$ (3 of 4)
$4M - $15M

Assumption: Install backup power, emergency supplies, shower and sanitation facilities
Cost Benchmark: Olney Resilience Hub

School & Public Safety Building Solutions Funding Strategy

Rhode Island can advance school and public safety building resilience through a combination of federal and state programs that support relocation from high-risk areas, structural retrofits, and the creation of resilience hubs. The following sections summarize anticipated costs, cost-effectiveness considerations, and the community benefits of protecting critical educational and emergency services**.** They also outline the key funding mechanisms available, define the State's role, and identify next steps to position priority assets for implementation.

Costs

Costs for this group of strategies focus on operational shifts, hardening buildings, and creating dedicated resilient spaces. Developing a plan to move operations out of floodplains can be a relatively low-cost alternative, but it is important to consider that operational costs will change, staff and users of public facilities will be impacted, and other existing facilities may require investment to modify them to accommodate potentially increased activity and uses (including the possibility of needing to construct brand new facilities). Raising equipment is typically less expensive than other more extensive hardening measures. Those measures are directly correlated to the size of the building requiring retrofit. It is typically less expensive to build new buildings to resilient standards rather than beginning with lower grade specifications and upgrading later. Costs for hardening and building resilient hubs greatly depend on the number and type of specific interventions pursued as part of a larger suite of solutions.

Benefits

School and public safety buildings solutions are geared towards protecting buildings from damage and preserving life safety. Protection from damage will help reduce associated damage costs and disruption to everyday life for students, families, and community members. Additionally, many schools serve dual purposing acting as RIEMA emergency shelters or could be designed as resilience hubs. The prioritized buildings were selected based on their redundancy. North Scituate Fire Department is the only fire department for three miles, making it a critical community asset to protect.

Benefits

Benefits	
Avoided Damage	●●●
Avoided Disruption	●●○
Preserved Life Safety	●●●
Other	●○○

Co-benefits include protection of RIEMA emergency shelters and essential fire stations in rural areas.

Economic Impacts

Protecting schools and emergency facilities ensures continuous education and public safety services during climate events. Building improvements create construction jobs while preventing costly flood damage and operational disruptions. Resilient schools maintain property values in surrounding communities and avoid expensive temporary relocations. Emergency facilities that remain operational during disasters reduce response times and save lives, preventing economic losses from delayed emergency services. Resilience hub development creates community assets that support economic recovery after events. These investments protect essential public services infrastructure while generating employment and demonstrating fiscal responsibility.

Consequence of Inaction

The consequence of inaction on Rhode Island's school and public safety buildings is medium. Redundancy across the state allows students and emergency responders to relocate if facilities fail. Proactive strategies can improve continuity, reduce disruption, and prevent relocation costs. The SCV assessment estimated that a current day 100-year coastal flood event could result in damage of 10-30% of the total value of Barrington High School, raising to more than 30% of the value by 2100. Protection from damage will translate into reduced disruption of services.

Consequence of Inaction

- High
- **Medium** ●
- Low

Funding Strategy

These funding programs support planning and implementation of resilience upgrades for schools and public safety buildings. The USDA Community Facilities Program aligns with relocation, structural retrofits, and upgrades to critical systems that ensure essential services remain operational during extreme weather. The RIIB Municipal Resilience Program complements this by supporting community-identified projects that reduce flooding, improve building performance, and strengthen long-term resilience.

Mechanism Title: USDA Community Facilities Grant/Loan Program

Mechanism Type: Grant/Loan

Level: Federal

Agency: US Department of Agriculture - Rural Development

The Community Facilities Program funds construction, expansion, relocation, and modernization of essential public buildings in eligible communities. This includes fire stations, EMS facilities, schools, and emergency operations centers.

State Role: Provide technical guidance on relocation planning, site assessment, and risk reduction benefits. Assist communities in confirming 'essential community facilities' classification.

Next Steps: Identify eligible buildings and relocation/retrofit needs and conduct preliminary design.

Mechanism Title: Municipal Resilience Program (MRP)

Mechanism Type: Grant/Technical Assistance

Level: State

Agency: Rhode Island Infrastructure Bank (RIIB)

MRP funds community-led resilience projects that reduce flooding, protect critical facilities, and support climate adaptation. Eligible activities include storm proofing, elevating building systems, green infrastructure, and developing resilience hubs. The program's focus on municipal priorities makes it well suited for schools and public safety buildings.

State Role: Provide technical support for cost estimation, project readiness, and benefit assessment.

Next Steps: Participate in a MRP workshop, prepare conceptual designs, and submit priority projects.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.

Hospital Flood & Energy Resilience Solutions

This chapter outlines adaptation and resilience solutions for hospitals. Hospital flood and energy resilience solutions are focused on reducing flooding, extreme heat, and wind impacts. These climate hazards can physically damage hospital buildings and impact life safety for patients, staff, and facility operators. Cascading impacts from climate damages can also lead to downtime of these critical facilities due to power outages or reduced transportation access.

The strategies presented were developed based on assets identified as having high climate risks and aligning with the prioritization criteria established for this plan. The adjacent map illustrates how priority assets identified for solution development within this plan are distributed statewide. While these assets informed the strategies, the approaches can be applied to additional locations across the state.

Assets Identified for Hospital Flood & Energy Resilience Solutions

Asset	Municipality
Landmark Medical Center (Woonsocket Hospital)	Woonsocket
Rhode Island Hospital	Providence
South County Hospital	South Kingstown

*The priority assets listed herein were identified through a Prioritization Approach developed specifically for the scope of this Plan. Details of this process and the complete list can be found in Chapter 4: Priority Assets List. Please note that this list does not include all vulnerable assets, nor does it reflect broader prioritization initiatives. A comprehensive database of all at-risk assets evaluated through this process has been provided to the State to support future work and enable continued prioritization efforts beyond the scope of this initiative.

Assets

- Critical Infrastructure & Facilities
- Natural Systems
- **Community Resilience & Emergency Preparedness Structures**

Hospital Flood & Energy Resilience Solutions Summary

Hospital flood and energy resilience solutions aim to reduce damages and downtime from flooding events and improve redundancy of backup power. Flood events put the operational capacity of critical equipment at risk and block transportation routes. Climate impacts put more strain on the electricity grid, heightening the chance of power outages and enhancing the need for energy resilience solutions.

Rhode Island's 17 hospitals are critical to the state and neighboring states' public health, with residents from Massachusetts and Connecticut traveling to utilize facilities. The hospitals offer various healthcare options, including critical, psychiatric, women and infant, and pediatric care. It is imperative that all hospitals remain open and accessible during climate events.

Rhode Island Hospital, South County Hospital, and Landmark Medical Center were identified as high risk across various climate hazards, specifically flooding and extreme heat. It is recommended that these hospitals develop Hazard Mitigation Plans (HMP) to more deeply understand site climate vulnerabilities. To combat flooding, hospitals should integrate gray and green infrastructure solutions and move their evacuation routes out of areas prone to flooding. To combat power outages associated with climate impacts, hospitals should develop on-site microgrids.

Ongoing Actions

Rhode Island developed a Hospital Preparedness Program and Resilient Microgrids for Critical Services Program which provides resilient planning resources for hospitals. Cities and hospital institutions are also including resilience considerations into their long-term planning efforts.

Resources

- Hospital Preparedness Program (Ongoing)
- Resilient Microgrids for Critical Services Program (Ongoing)
- City of Providence Hospital District Vision Plan (2025)
- Rhode Island Hospital Institutional Master Plan (2025)

Steps for Implementation

1. **Hazard Mitigation Planning**
Develop a hazard mitigation plan to identify key climate hazards and develop emergency plans. Incorporate best practices from the City of Providence Hospital District Vision Plan and the Rhode Island Hospital Institutional Master Plan.
2. **Stakeholder Engagement**
Conduct stakeholder outreach with key facility operators, staff, and patients to understand the current climate and operational challenges at the hospital. Identify priority criteria for the microgrids system with the stakeholders. Continue stakeholder engagement throughout the project.
3. **Site Flooding Assessment**
Conduct a site flooding assessment to identify key areas of ponding and priority locations for flood mitigation projects.
4. **Energy Feasibility Analysis**
Utilizing the resources from Resilient Microgrids for Critical Services Program, assess the back up power needs and evaluate the potential for renewable energy solutions. Consider feasibility based on lot size, as well as the hospital's maintenance and operational capacity. Analyze various energy scenarios, evaluating differing types of interventions with microgrids (solar, wind, etc.), load sizes, and phasing approaches. For the different scenarios, conduct an additional analysis based on the criteria defined by the stakeholders to identify the ideal microgrid solution.
5. **Design and Cost Planning**
Develop design factoring in feasibility. Assess costs by factoring in capital and long-term maintenance costing.
6. **Permitting and Construction**
Procure the relevant permitting needed for the resilience solutions and implement construction.
7. **Commissioning and Maintenance**
Commission and test energy systems to ensure functionality. Partner hospital facility managers and relevant state agencies to develop a maintenance plan.

Rhode Island Hospital © Brown Surgical Associates

Representative Priority Assets

Rhode Island Hospital and **South County Hospital,** two major hospitals serving all of Rhode Island, are selected as representative priority assets due to their climate risk across **coastal flooding, stormwater flooding, riverine flooding, and extreme heat.**

Rhode Island Hospital
Municipality: Providence
Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:
Context: 719 hospital beds.

South County Hospital
Municipality: South Kingstown
Current Climate Risks:
2050 Climate Risks:
2100 Climate Risks:
Context: 100 hospital beds.

Hospital Flood & Energy Resilience Solutions Strategies

These strategies create a comprehensive resilience pathway for Rhode Island hospitals. Further studying climate vulnerabilities and facility challenges aligns with the RIDOH Hospital Preparedness Program and lays the groundwork needed for implementable solutions. Pairing microgrids with site and building design flood and heat mitigation strategies will reduce damage and downtime at hospitals and enhance healthcare access and public health throughout the state.

Need weighted highest in the priority criteria

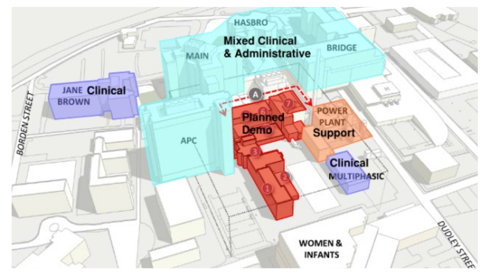
During the 3rd Community Forum

Community Voices

"Hospital, substation, and roads would probably be highest need." – attendee at the 3rd Community Forum held at Newport Public Library in September 2025

Conduct Multi Hazard Mitigation Planning

Develop hospital-specific multi hazard mitigation plans (HMP) to identify vulnerabilities and develop emergency plans. Include a future-projecting climate assessment, interviews with stakeholders (facility operators, staff, and patients), and a review of past climate and emergency events. Emergency planning should include scenario planning to identify key roles, protected evacuation routes, and microgrid operations. The HMP should build off past hospital planning efforts, such as the Rhode Island Hospital Institutional Masterplan.



Rhode Island Hospital Institutional Masterplan
© City of Providence

Solution Mechanism
- Protect
- Accommodate
- Restore
- Rethink ●

Scale of Innovation
- Innovative
- Hybrid
- Traditional ← marker

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Cost
$$$$
$150K - $650K

Assumption: hire consultant to conduct multi hazard mitigation planning

Comprehensive Floodproofing & Façade Enhancements

Floodproof hospitals by elevating critical equipment out of the floodplain, sealing openings such as windows and doors, and utilizing flood resistant materials. Install permanent and/or deployable flood walls and provide permanent and portable pumps for emergency flood events. Ensure there is designated storage and trained staff for deployable flood walls. Utilize impact resistant materials for the façade to protect against wind drive rain. Implement passive design strategies, such as insulated windows and panes, shading devices, and reflective materials on facades to mitigate extreme heat. For new hospitals, consider the orientation, layout, and ventilation to maximize sunlight in winter and minimize heat gain in the summer.

South County Hospital
© South County Hospital

Solution Mechanism
- Protect ●
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
- Innovative
- Hybrid ← marker
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Cost
$$$$
$1.5M - $5M

Assumption: raise equipment, purchase deployable flood barriers and conduct preparatory works

Cost Benchmark: Tampa General Hospital (1,000 LF, 9' tall Aquafence)

Emergency Access Protective Measures

Design and maintain elevated or protected access routes for emergency vehicles and personnel. Include redundant entry points and ensure compliance with ADA and emergency egress standards. Conduct a user-centric transportation analysis for hospital facilities maintain continuity of care. Prioritize routes that minimize delays for emergency responders while maintaining safe access for all. Add protected loading docks and reinforce egress redundancy to support critical operations during disruptions.

Park Nicollet Methodist Hospital
© Jeffrey Thompson for MPR News

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
- Innovative
- Hybrid
- Traditional ← marker

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding

Cost
$$$$
$1M - $5M

Assumption: demolish existing 1,000 LF 2-lane roadway, add fill to raise 2', reconstruct in-kind, build parallel 6' sidewalk

Create Microgrids

Install renewable energy sources and batteries to act as a microgrid. The microgrid will act as additional back up and allow the hospital to island off the utility provider during a power outage event. Ensure that the microgrid works in tandem with existing generators and electricity distribution network. Equipment should be elevated above flood levels. Implementation should include automatic transfer switches and planning for at least 72 hours of backup power. Train relevant personnel on the microgrid operational procedures.

Kaiser Permanente Hospital Microgrid
© Fierce Healthcare

Solution Mechanism
- Protect
- Accommodate ●
- Restore
- Rethink

Scale of Innovation
- Innovative ← marker
- Hybrid
- Traditional

Relevant Hazards
- Coastal Flooding
- Stormwater Flooding
- Riverine Flooding
- Extreme Heat
- Extreme Wind

Cost
$$$$
$3M - $10M

Assumption: solar PV system and battery storage system

Cost Benchmark: Kaiser Permanente Microgrid (2MW solar, 9MWhr storage)

Hospital Flood & Energy Resilience Solutions Funding Strategy

Rhode Island can advance hospital flood mitigation and energy resilience through a mix of federal and state programs that support emergency access improvements, flood-proofing, microgrids, and renewable backup power. The following sections summarize anticipated costs, cost-effectiveness considerations, and the public health and operational benefits of protecting critical healthcare facilities. They also outline key funding mechanisms, define the State's role, and identify next steps to position priority hospital assets for implementation.

Costs

Hospital flood and energy resilience solution costs vary based on the scale and type of implementation. Microgrid costs are directly correlated to the capacity of the system. While hospitals already have backup power generation requirements, implementing renewable-based microgrids can help reduce energy consumption from the grid and decrease reliance on traditional backup fuels. Emergency access costs will increase for longer access routes or greater elevation changes. Developing a multi-hazard mitigation plan should consider level of stakeholder engagement and complexity of the hospital's operations when evaluating cost. Permanent hardening works are also feasible for a higher cost to minimize operational and recovery costs for the long-term, but the deployable flood barriers provide a compelling alternative due to minimized up-front cost and limited downtime for hospital operations during construction. Note that a proper plan, trained staff, and sufficient time and resources are required to respond and prepare when incoming storms and flooding are expected. Costs increase with greater height and length of flood barrier.

Benefits

Hospital and energy resilience solutions protect facilities from damage and life safety impacts from climate hazards. Implementing resilience strategies now helps avoid escalating repair costs, protects patient safety, and ensures continuity of care as climate risks intensify. Solutions are geared towards improving hospital coordination through strategic planning, reducing power outages through the microgrid, and protecting transportation routes with flood resilience strategies. Failing to implement resilience solutions exposes facilities not only to public health risks but also to mounting repair costs, emergency expenditures, and reputational harm.

Benefits

Avoided Damage	●●●
Avoided Disruption	●●○
Preserved Life Safety	●●●
Other	○○○

Co-benefits include improved hospital coordination, reduced power outages, and protected transportation routes.

Economic Impacts

Hospital resilience investments protect Rhode Island's multi-billion dollar healthcare sector and associated employment. Preventing flood damage and ensuring backup power maintains critical healthcare services that support economic productivity. Hospital disruptions cascade through the economy, affecting emergency response, public health, and business operations. Infrastructure improvements create specialized construction jobs while reducing costly emergency repairs and patient transfers. Reliable hospital operations attract healthcare professionals and support medical tourism. Microgrids and flood protection demonstrate fiscal prudence by preventing revenue losses, maintaining healthcare access, and protecting facilities serving Rhode Island and neighboring states.

Consequence of Inaction

The consequence of inaction on Rhode Island's hospitals is high with numerous, cost-effective strategies available for mitigating risks to hospitals. Investing in resilience measures directly safeguards life safety and reduces damage costs. The SCV assessment found that a current-day 100-year coastal flood event could result in damage equal to more than 30% of the total value of Rhode Island Hospital facilities. During a 2050 100-year coastal flood event, damage could result in 10% - 30% of the total value of South County Hospital facilities.

Consequence of Inaction

High ●
Medium
Low

Funding Strategy

These funding mechanisms support planning, design, and implementation of hospital flood mitigation and energy resilience projects. The USDOT PROTECT Program aligns with improvements to emergency access routes, flood-proofing of transportation connections, and infrastructure upgrades while the DOE State Energy Program supports microgrids, renewable backup power, and energy resilience upgrades for critical facilities. These programs provide a pathway for hospitals to reduce flood impacts, maintain reliable operations, and enhance emergency preparedness.

Mechanism Title: Promoting Resilience Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program

Mechanism Type: Grant/Formula Funding

Level: Federal

Agency: US Department of Transportation

PROTECT funds can be used for transportation resilience projects that protect critical routes from flooding, erosion, and climate impacts. For hospitals, PROTECT can support elevated or protected emergency access routes, flood-proofed entrances, improved drainage around roads and parking areas, and transportation-focused resilience planning.

State Role: Assist municipalities and hospitals in aligning proposed projects with statewide transportation resilience goals. Provide hazard and flood mapping data to support project scoping.

Next Steps: Coordinate with RIDOT to confirm project eligibility under PROTECT.

Mechanism Title: USDOE State Energy Program (SEP)

Mechanism Type: Grant/Technical Assistance

Level: State

Agency: Rhode Island Office of Energy Resources (OER)

SEP supports energy resilience and efficiency improvements for critical facilities. For hospitals, eligible activities include developing microgrids, expanding renewable energy generation, installing backup storage, and improving on-site energy reliability. SEP can be used to plan, design, or implement clean energy solutions that reduce outages and ensure uninterrupted healthcare operations.

State Role: Provide technical assistance on microgrid design and feasibility.

Next Steps: Conduct microgrid or energy resilience assessment and coordinate with OER to confirm SEP funding pathways.

Note: The Funding Strategy outlines two potential mechanisms for implementing project solutions; however, it does not represent a comprehensive list of all available funding options. For a complete overview, please refer to the Future Investment Strategy.