Resilient Connecticut Synthesis Report

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CIRCA

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Resilient Connecticut
Synthesis Report

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Table of Acronyms

AEP: Annual Exceedance Probability

BCA: Benefit-Cost Analysis

BFE: Base Flood Elevation

C3RP: Connecticut Connections Coastal Resilience Plan

CCVI: Climate Change Vulnerability Index

CDBG-DR: Community Development Block Grant - Disaster Recovery

CIRCA: Connecticut Institute for Resilience and Climate Adaptation

CMT: Community Management Team

COG: Council of Governments

DECD: Department of Economic and Community Development

DEEP: Department of Energy & Environmental Protection

DEMHS: Department of Emergency Management and Homeland Security

DOH: Department of Housing

DOT: Department of Transportation

DPH: Department of Public Health

EJ: Environmental Justice

EO: Executive Order

EV: Electric vehicle

FEMA: Federal Emergency Management Agency

FIRM: Flood Insurance Rate Map

GC3: Governor's Council on Climate Change

GI: Green Infrastructure

GIS: Geographic Information Systems

HUD: Department of Housing and Urban Development

LOMR: Letter of Map Revision

MetroCOG: Metropolitan Council of Governments

MHHW: Mean Higher High Water elevation

NDRC: National Disaster Relief Competition

NGO: Non-Governmental Organization

NHMP: Natural Hazard Mitigation Plan

NOAA: National Oceanic and Atmospheric Administration

NVCOG: Naugatuck Valley Council of Governments

OPM: Office of Policy and Management

POCD: Plan of Conservation and Development

PROTECT: Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation

RBD: Rebuild By Design

RCC: Resilient Connecticut Collaborative

RFQ: Request for Qualifications

ROAR: Resilience Opportunity Area

ROW: Right-of-way

SAFR: State Agencies Fostering Resilience

SCRCOG: South Central Regional Council of Governments

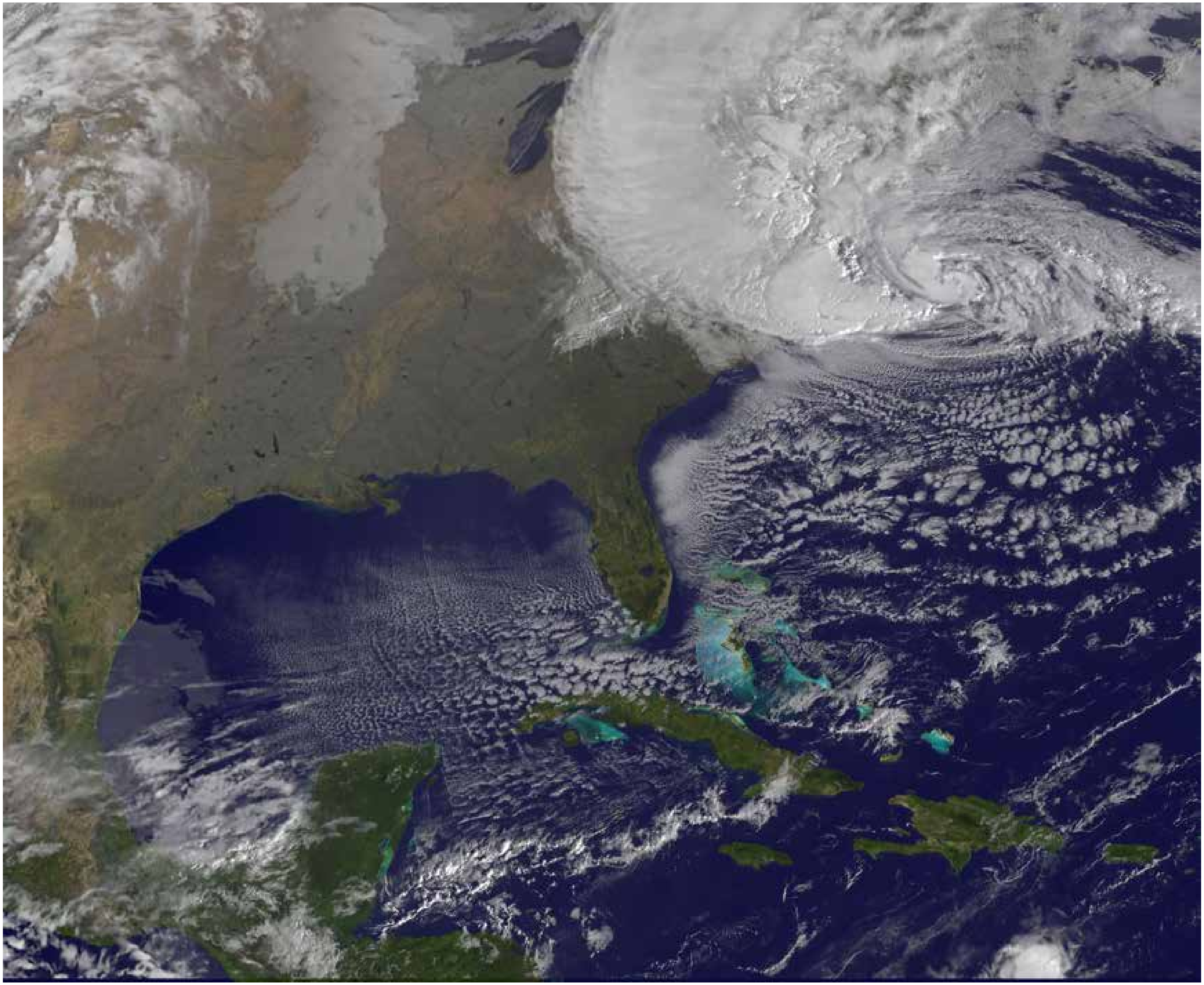
TDR: Transferable Development Rights

TOD: Transit-Oriented Development

UConn: University of Connecticut

WestCOG: Western Council of Governments

ZSR: Zone of Shared Risk



Superstorm Sandy satellite image, GOES 13 Oct 29 at 910 am EDT.

1.0 Introduction

On October 29th, 2012, the center of Superstorm Sandy (Ostiguy et al, 2018) crossed the shoreline of New Jersey. The strong and persistent winds from the east created extensive damage to the electrical power network across Connecticut. They also created a large storm surge in Long Island Sound that led to extensive flooding along the shoreline, but particularly in New Haven and Fairfield Counties which were designated as federal disaster areas. Since this severe weather event came only a year after two others, Tropical Storm Irene and the Halloween Nor-easter of 2011, the political leadership of the state recognized the need to accelerate the design and implementation of measures to increase the resilience of the state's infrastructure to weather hazards and the impacts of climate change.

In response to Superstorm Sandy, the federal government provided recovery support and created new initiatives to assist areas affected by natural disasters in developing innovative, forward-looking resilience strategies. These included President Obama's Hurricane Sandy Rebuilding Task Force, and the resulting Rebuild by Design (RBD) competition and implementation program. The RBD process provided the opportunity for interdisciplinary research and design teams to develop innovative approaches to resilience and climate adaptation in Sandy-impacted communities, including the City of Bridgeport, CT (Rebuild by Design, 2015).

(Sandy event photos obtained from CIRCA and Nara & Dvids public domain archive)

Building on these initial steps, The U.S. Department of Housing and Urban Development (HUD) launched the National Disaster Resilience Competition (NDRC) in 2014. A consortium of State agencies and stakeholder organizations coordinated by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) developed a successful NDRC proposal with two complementary components: expansion of the RBD pilot project to provide flood protection, enhanced recreational resources and economic development opportunities to a vulnerable area of Bridgeport (Resilient Bridgeport - South End); and an innovative process that would extend planning opportunities to develop resilience projects in other vulnerable communities of New Haven and Fairfield Counties, a project we refer to as Resilient Connecticut.

The goals of the Resilient Connecticut project were to increase coordination across scales of planning (local, municipal, regional, and statewide) through utilization of a watershed based and climate science informed approach to identifying flood risks and vulnerabilities, also known as "Zones of Shared Risk." The project also aimed to establish a framework for investment and project implementation that integrates risk reduction strategies with economic development framed around transit-oriented development, conservation strategies, and critical infrastructure improvements. Connecticut is a small state in southern New England with a complex geological history (Stone et al., 2005) that has played an important role in determining patterns of human settlement and land use, and the geography of the risks created by climate change in the Anthropocene (Zalasiewicz et al., 2021).

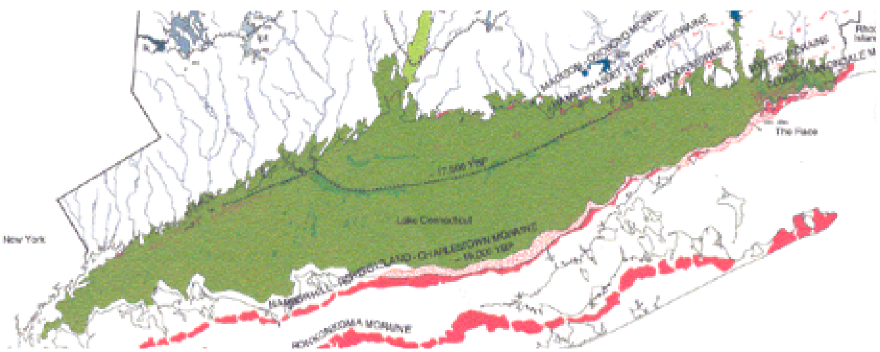
In this report we outline the planning process we developed and synthesize our understanding of the outcomes. We conclude with comments on the effectiveness of the process and ongoing and future work. In section 2, we summarize the patterns of geomorphology, development, and political organization that create challenges to cohesive resilience and adaptation planning in Connecticut. In Section 3 we outline the three phases of the project. In section 4 we summarize the results of the planning process and the prioritization for near-term action. We then summarize the projects that emerged as priorities and adaptation actions. In Section 5, we conclude with a summary of challenges and lessons learned from the planning process and recommendations for a Resilience Road Map for the State of Connecticut and beyond.

(Sandy event photos obtained from CIRCA and Nara & Dvids public domain archive)

2.0 Geomorphology and Historical Development Patterns

2.1 Geomorphology

The rifting associated with the creation of the Atlantic Ocean, and subsequent cycles of glaciation in Connecticut have created a landscape that is characterized by almost north-south oriented ridges and valleys. The glaciations of the Pleistocene also created moraine deposits to the south of Connecticut at what is now Long Island NY. At the end of the last (Wisconsin) glaciation, the mean level of the ocean was approximately 100m below current levels, and the moraines of Long Island dammed the meltwater from the retreating glaciers to create what Lewis and Stone (1991) call glacial Lake Connecticut.



Major Glacial Lakes in Connecticut during Late-Wisconsinian Deglaciation, Map courtesy of US Geological Survey.

At approximately 17,000 years the surface of Lake Connecticut was close to present sea level. As glaciers retreated to the northwest, the rivers flowed south through valleys carrying glacially eroded sediments and created deltaic deposits around the northern shore of the lake. Since the beginning of the Holocene (approximately 12,000 years ago) sea levels have been rising. Approximately 8,000 years ago, Lake Connecticut drained into the ocean and the- lake bottom was exposed to the atmosphere. As the ocean level continued to rise, Lake Connecticut was transformed into Long Island Sound (LIS), a large tidal estuary (Lewis, 2013) and tidal currents, surface gravity waves (O'Donnell et al, 2014), and salt marsh building processes (van de Plassche, 1991) have rearranged the coastal sediments to create the rocky headlands, and spit-sheltered coves and marshes that now characterize much of Connecticut's shoreline. Glacio-isostatic uplift has also occurred and has led to the relic delta deposits being a few meters above current mean sea level.

2.2 Historical Development

There is evidence of Paleo-Indian settlement along the inland rivers of Connecticut as early as 12,500 years before present (Leslie, et al., 2020). Rising sea levels have likely destroyed evidence of early Holocene habitation at the shoreline, but the interpretation of 17th century maps and land records of Spiess (1935) suggests that Connecticut had many, at least seasonal, tribal settlements at the shoreline. The first trading posts and colonial settlements of the Dutch and British occurred between 1632 and 1635 (DeForest, 1851) along the Connecticut River, and in the following decades, many other settlements were established at the shoreline of LIS. Disease (Cook, 1973) and warfare (Mandel, 2010) during this period led to a rapid decline in the population of the native peoples. The relatively flat areas of glacially derived sand and gravel deposits at the shoreline of LIS were attractive sites for farming, fishing, shipbuilding, and the coordination of trade along the north-south oriented rivers, and along LIS with Boston and New York.

By the mid-eighteenth century, the agrarian economy of Connecticut had grown to include the production of livestock on cleared hillsides and “agricultural manufacturing” (Daniels, 1980), i.e., the processing of farmed goods into products that could be exported and traded, much of which was with the West Indies. However, a substantial crafts and manufacturing industry had also evolved to meet the demands of new settlements in the state which exploited the products of iron and coal mines in the western hills and the resources of local forests and rivers. Much of the production in Connecticut during the Revolutionary war period was reoriented to support military operations and replace products embargoed by the British. After independence, innovators and entrepreneurs in CT created cotton and woolen mills and factories on many of Connecticut’s rivers to refine the products of the southern states. Steam power replaced hydropower in most of the mills and factories by the mid-nineteenth century. This allowed substantial expansion in capacity and workforce and transformed Connecticut into an urbanized manufacturing state. Fuller (1915) shows that in 1880 the population of CT was double what it had been in 1840. Further, the number of people living in towns larger than 10,000 had increased by a factor of ten.

The need to transport raw materials and finished goods also led to a concurrent expansion of steam-powered railways. North-south routes were also constructed along the major river valleys first since the grades were low and the need for major river crossings was limited. The major cities of New Haven and Hartford were linked in 1839, and the line extended to Springfield, MA, five years later. Additional lines up the Housatonic, Naugatuck, Connecticut, and Thames River valleys were completed by 1850 (CTDOT). A track along the shoreline connected New York to New Haven in 1849 and extended to New London a year later. A track between New London and Stonington brought the network to the eastern end of the state in

Connecticut railway map 1893, prepared by S.D. Tilden, Hartford, Library of Congress.

1858. The map prepared for the Connecticut Railroad Commissioners by Tilden (1893) shows the impressive extent of the most comprehensive rail system in the country at the time.

At the beginning of the twentieth century, the long-distance rail transportation system was complemented in most Connecticut cities by electric trolley networks operated by private companies. The State Highways Commission (1900) recognized that the existing road network had developed to facilitate “farm to market” transportation, but not through traffic. A comprehensive plan was established with ten north-south roads that largely followed river valleys and paralleled the rail lines, and four east-west “trunk” roads, including the Boston Post Road along the shoreline. These required ferries and bridges. The plan was 60% fulfilled by 1914 and established the framework for transportation in Connecticut. Federal investments in interstate highways in mid-twentieth century led to two high-capacity east-west (I95 and I84) and two north-south (I91 and I395) routes but largely conformed to the topography in the same way as earlier roads. But as in other parts of the United States, since the interstate highways prioritized the speed of through traffic, they were often routed through existing communities.

2.3 Political Context

The political organization of towns and the state evolved within a tradition of "home rule", which allowed settlements to form municipalities and granted local autonomy over matters such as land use regulation, taxation, education, and other services. This tradition favoring "localism" was officially enacted in state law in 1915 and later codified into the state's constitution in 1969 (Griffith, 1983). Today there are 169 individual municipalities across Connecticut, which each have taxing, land-use, and zoning authority as defined by the State legislature. Connecticut's history of locally controlled planning and zoning resulted in the unique character of its large and small New England towns, but also enabled the stark segregation of populations and unequal distribution of resources along racial and socioeconomic lines that can be observed in present day (Buchanan and Abraham, 2015), (Bronin, 2022). By the early 20th century, much of Connecticut's coastline had been privatized, developed, and segregated between densely populated, urban manufacturing centers, and heavily restricted local enclaves of private property interests, with limited areas remaining for public access to the shoreline (Schlichting, 2014).

Along with socioeconomic division came the steady intensification of industry, infrastructure, buildings, assets, and people within and around the low-lying floodplains and river valleys that characterize Connecticut's coastal zone. By the time of Superstorm Sandy's impact in 2012, 60% of the state's population lived in coastal communities, including more than 32,000 homes in the FEMA defined 100-year floodplain (FEMA, n.d.), and $542 Billion in assets at risk (SAFR Connecticut Connections, 2016) . That trend has only continued and accelerated in the decade since Sandy, as recent analysis indicated the pace of housing growth in areas of high flood risk has been 3 times faster than in areas of low risk in Connecticut (Climate Central & Zillow, 2019).

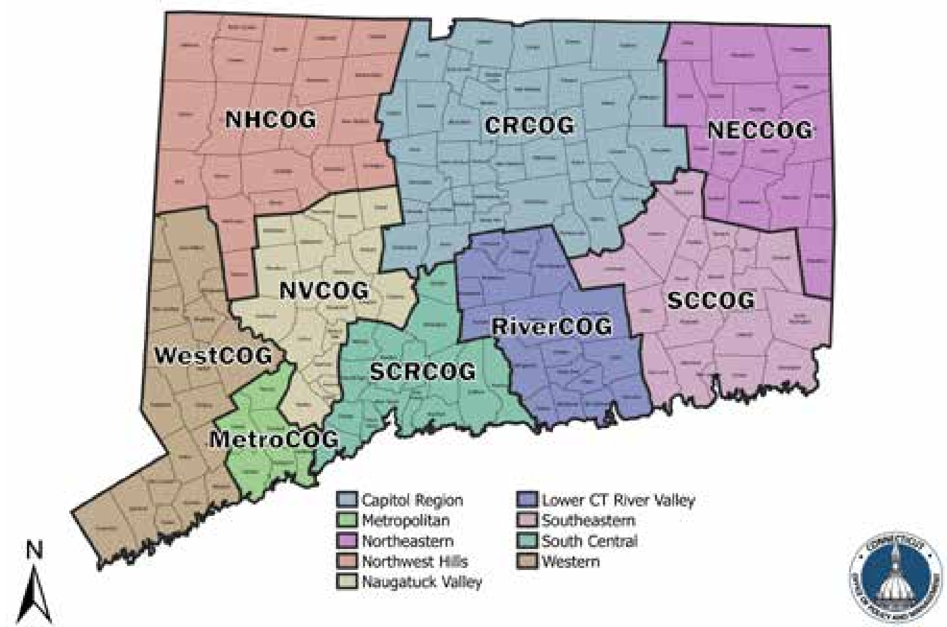
Following Sandy, several coastal municipalities received Federal recovery funds to develop resilience plans, which included recommendations for policy-driven actions as well as flood mitigation infrastructure projects (CIRCA, 2019a). Additionally, municipalities have begun incorporating the assessment of climate-driven risks into natural hazard mitigation plans, which are required to be maintained and updated every 5 years to qualify for Federal disaster recovery support (Phase II Report, Appendix B). Comprehensive municipal "Plans of Conservation and Development" are required by the State on a 10-year cycle and must now include a consideration of sea-level rise impacts (Public Act No. 18-82, 2018). Other sector specific, and workshop driven approaches to identifying local climate risks and developing mitigation strategies have been carried out, with varying degrees of success towards implementation of resulting actions (Phase II Report, Appendix B).

Regional Planning in Connecticut

Regional approaches to land use planning in Connecticut have been voluntary, ad-hoc, and often constrained by tensions around maintaining local political control and a lack of realized mutual benefits between municipalities for shared services (Tondro, 1999). Having formally dissolved county government in 1959 (OLR, 1998), the State legislature enabled a network of metropolitan planning agencies, and later, regional Councils of Governments (COGs) to assist municipalities with addressing regional concerns through voluntary inter-municipal compacts and shared technical assistance (Connecticut General Statutes §§ 8-31a to -37b). Today the COGs support towns in meeting a variety of planning requirements such as 10-year Regional Plans of Conservation and Development, Natural Hazard Mitigation, Long-Range Transportation, Affordable Housing, and Economic Development Plans.

Despite some initial efforts and successes, planning for and adapting to the impacts of climate change remains a novel process requiring technical capacity that can be difficult for many Connecticut municipalities to manage in isolation or through existing frameworks. Significant local gaps exist between municipalities, largely as a result of property tax disparities, competing service demands on municipal budgets, and heterogeneity among local staff experience and capacity (DECD, 2022). The lack of formal regional planning authority or mechanism for coordination between towns means that larger scale interventions with potentially broader benefits. may be difficult to identify, prioritize, fund, and implement. Lacking a framework for prioritization of climate risks and proposed projects, municipalities have largely focused on smaller scale resilience initiatives, without addressing more transformational, longer term adaptation needs.

Regional Councils of Governments in Connecticut



3.0 Resilient Connecticut

In response to Superstorm Sandy, and at former Governor Danel Malloy's directive, a cohort of Connecticut state agencies formed a working group called the State Agencies Fostering Resilience or SAFR (SAFR Connecticut Connections, 2016). SAFR provided a forum for coordination of the post-Sandy recovery response and ultimately led to a multi-phase proposal to HUD's National Disaster Resilience Competition (CT DOH, 2015). The proposal focused on pilot projects in Bridgeport and New Haven, Connecticut, as well as the development of a framework and planning process that could create alignment across local, regional, and state resilience projects. The proposal initially called for a regional coastal resilience plan (Connecticut Connections Coastal Resilience Plan or C3RP), connecting resilience strategies across the most Sandy-impacted coastal towns in Fairfield and New Haven Counties. The resulting project was later renamed Resilient Connecticut in recognition of the need to extend planning opportunities to inland and non-coastal areas of Fairfield and New Haven Counties, which also face significant climate risks.

The goal of the regional planning project adopted by the SAFR working group was "to establish resilient coastal communities where structures and critical infrastructure in the flood zone are adapted to withstand occasional flooding and protected by healthy buffering ecosystems, where critical services, infrastructure and transport hubs are located on safer, higher ground, and where strong connections exist between the two." This resilience concept was intended to build on investments the State has made in supporting transit-oriented development along the Metro-North/I-95 corridor, to simultaneously reconnect and protect economically isolated coastal neighborhoods to existing transportation nodes.

Resilient Connecticut also proposed the integration of planning concepts that emerge from the state's unique geomorphology and political evolution. First, "Zones of Shared Risk" (ZSR) would be delineated across watershed scales based on hydrologic and hydraulic characteristics of flooding, to identify common risks faced by populations, land-uses, assets, and infrastructure. ZSR can serve as a framework for negotiation and coordination between neighboring sub-populations when developing resilience interventions. Second, the process would seek to identify and prioritize "Resilient Corridors", which could connect low lying areas of flood risk to higher elevation north-south ridgelines left by glacial processes. Resilient Corridors, Resilient Nodes, and Resilient Zones could allow towns and the state to coordinate and focus forward-looking transportation, housing, and economic development investments in locations that are resilient to future sea-level rise and climate change impacts, while also serving to encourage multimodal, transit supportive development around the State's existing transit infrastructure. The approach provides both adaptation and emissions mitigation benefits by not-only reducing long term risk for communities through focusing development on higher ground, but also supporting communities in transitioning to more transit supportive and less energy intensive patterns of development.

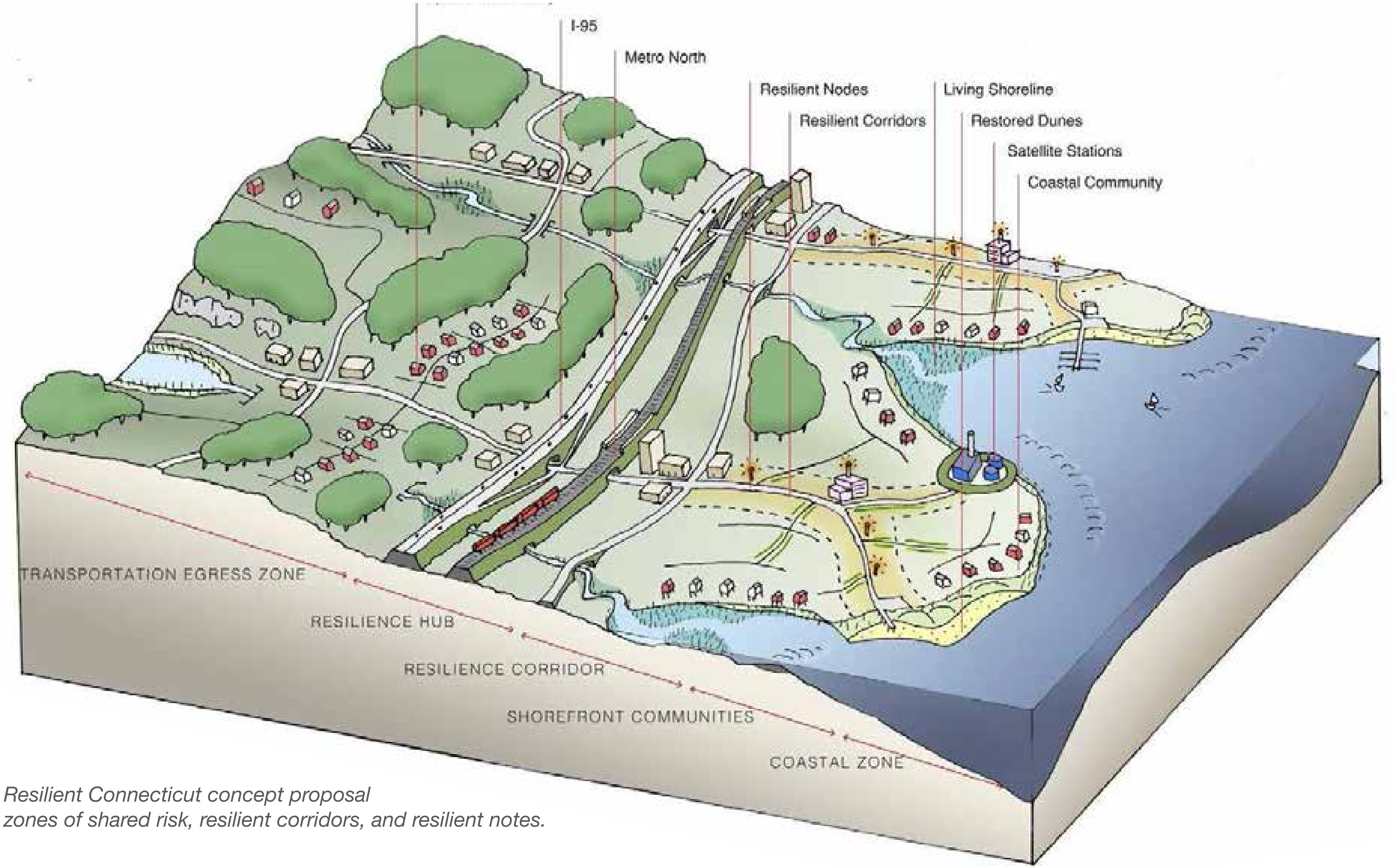


Fig.1 Resilient Connecticut concept proposal
feat1 zones of shared risk, resilient corridors, and resilient notes.

The project was proposed in three phases: 1). Develop Resilience Planning Framework, 2). Conduct Resilience Planning in New Haven and Fairfield Counties, and 3). Synthesize, prioritize, and develop implementation plans (O'Donnell, et. al, 2017). The three project phases were proposed to allow for ongoing post-Sandy recovery projects and plans to inform the process through lessons learned and information gathering in Phase 1. It was also anticipated that implementation of the Framework would involve planning across multiple scales and would consider the vulnerability of infrastructure systems in Phase 2, with the goal of developing multi-scale strategies for resilience in Phase 3. Following the awarding of funds in Spring 2018, the project team was assembled and initiated Phase 1 in the Fall of 2018.

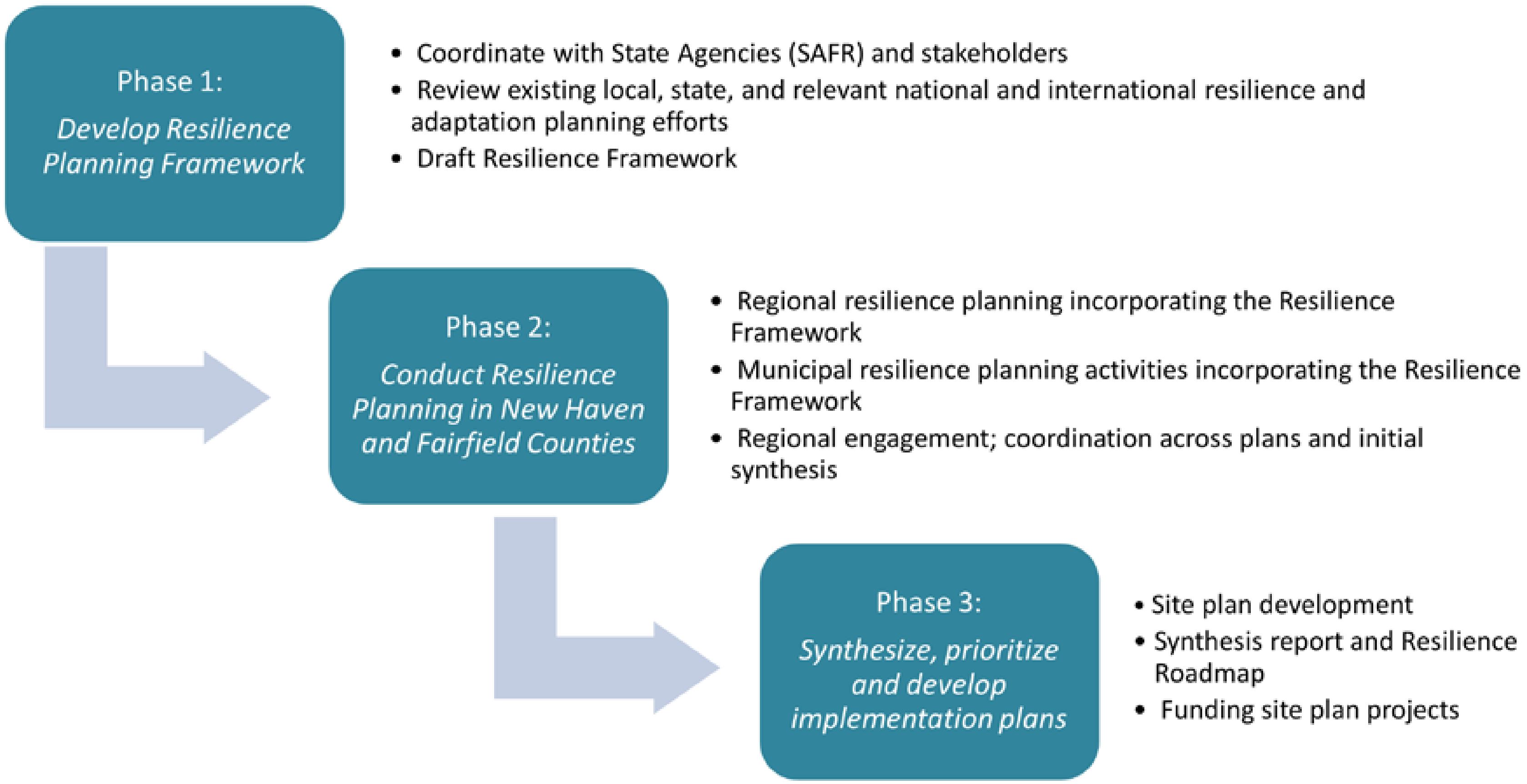


Fig. 2: The 3 phases of Resilient Connecticut as outlined in the original proposal.

3.1 Phase I

Phase I began with a comprehensive inventorying of current and previous planning documents in Fairfield and New Haven Counties, as well as a review of national and international climate adaptation and resilience planning approaches that could inform the process in Connecticut. Connecticut state, regional, and local Plans of Conservation and Development (POCD) are primary planning documents, required by state statute which outline local and regional priorities for land use, growth, and protection of natural resources. Natural Hazard Mitigation Plans (NHMP) are required by the Federal Government for receiving hazard mitigation assistance funding and outline physical and climate hazards to local and regional infrastructure, as well as proposing actions to mitigate those hazards. Following Superstorm Sandy, the Connecticut Dept. of Housing also received and distributed $159 Million in CDBG-DR recovery funding for housing and infrastructure projects, along with providing funds to several municipalities to develop “coastal resilience plans.” These plans follow a similar approach to NHMPs in defining the range and locations of coastal hazards including sea-level rise and propose mitigating actions. The first set of coastal resilience plans followed a structure funded by NOAA and piloted by the Town of Guilford, but the organization of plans ultimately evolved. Other local and regional plans were reviewed including neighboring initiatives in New Jersey, Massachusetts, New Hampshire, New York, and Rhode Island, along with sector specific resilience planning for public drinking water, wastewater treatment, and historic resources (CIRCA, 2022).

Following the inventory and review of existing plans, a series of stakeholder engagement meetings were scheduled to discuss the state of resilience planning and project implementation with coastal towns and regional COGs in Fairfield and New Haven Counties. A 6-month workshop was held in May of 2019 to gather stakeholders, review climate resilience planning approaches, and solicit input on the Phase 1 deliverable: Resilient Connecticut Planning Framework (Workshop Summary Report, 2019).

Fig. 3: A panel featuring municipal and regional planners discussing previous resilience planning in Connecticut was held during the First 6-Month Workshop during Phase I of Resilient Connecticut on May 22nd, 2019 in Stamford, CT.

Several changes in the scope of the regional planning process emerged through this stakeholder engagement and feedback. First, many expressed the need to move beyond the coastal boundaries, to include inland communities. The post-Sandy period in Connecticut resulted in funding for planning that primarily supported coastal municipalities. Inland communities of the region had lacked opportunities to assess climate risks and develop plans beyond natural hazard mitigation. In addition, there were identified unmet technical capacity needs around the assessment of fluvial (riverine) and pluvial (stormwater) flooding as well as, the impacts of extreme heat due to climate change in the region.

Additionally, the stakeholders expressed a strong desire to leverage existing partnerships and coastal resilience plans that had been developed following Sandy, to avoid duplicating efforts, and burdening the communities that had received attention after Sandy with “planning fatigue.” The stakeholder feedback resulted in expanding the scope of the regional planning process to include more communities, while also shifting focus to areas of the region with compounding risks due to the combination of climate stressors (coastal, riverine, and stormwater flooding, as well as extreme heat).

Fig. 4: Members of the State Agencies Fostering Resilience (SAFR) Council discuss the Resilient Connecticut Planning Framework during a panel discussion at the 1st Annual Resilient Connecticut Summit, November 2019.


4. Enact Equitable & Informed Prioritization of Site-scale Pilot Projects

a. Identify the highest priority projects through inclusive stakeholder engagement processes

b. Focus on implementable projects or include buildable projects as components of larger visionary projects

c. Incorporate the Resilient Connecticut PERSISTS decision support criteria to assess near, mid, and long term strategies:

Permittable	can get all necessary federal, state and local permits
Equitable	considers impacts to vulnerable populations
Realistic	can be realistically engineered and is plausibly fundable
Safe	reduces risks to people and infrastructure
Innovative	process has considered innovative options
Scientific	apply and improve on the best available science
Transferable	can serve as a model for other communities
Sustainable	socially, economically, and ecologically sustainable and supported by the public and leadership

d. Prioritize and select pilot projects and develop implementation plans including conceptual designs, cost estimates, and proposed funding pathways

e. Develop a quantitative and qualitative cost/benefit analysis of identified projects

CIRCA

Resilient Connecticut Planning Framework 01.20.2020

The resulting Resilient Connecticut Planning Framework (circa, 2020) was presented at the 1st Annual Summit of the project in November of 2019 (CIRCA, 2019c). The Framework featured a long term vision for establishing resilient communities in Fairfield and New Haven Counties which included the following goals: Focusing community development around transit (resilient TOD); Creating corridors resilient to climate change (Resilient Corridors); Creating opportunities for affordable housing, and preserving and enhancing the quality of life of existing affordable communities; Developing energy, economic, and social resilience; Increasing transit connectivity; Adapting structures and critical infrastructure in the flood zone to withstand occasional flooding, and; Protecting communities through healthy buffering ecosystems, where critical services, infrastructure and transport hubs are located on safer, higher ground, and where strong connections exist between the two.

The document also proposed a step-wise process to assess climate risks, develop adaptation scenarios, and prioritize actions and projects following a mulit-criteria decision support pneumonic PERSISTS: Permittable - can get all necessary local, state, and federal permits; Equitable - considers impacts to vulnerable populations; Realistic - can be realistically engineered and is plausibly fundable; Safe - reduces risks to people and infrastructure; Innovative - process has considered innovative options; Scientific - apply and improve on the best available science; Transferable - can serve as a model for other communities; and Sustainable - socially, ecologically, and economically sustainable and supported by the public and leadership.

The Framework also emphasized working closely with the regional COGs as a convening entity, which would allow the planning process to highlight and prioritize issues that span localized political boundaries between municipalities.

Building on the example set through Rebuild by Design, CIRCA developed a scope of work guided by the Planning Framework in Phase I, and solicited proposals from planning, design, and engagement teams through a Request for Qualifications (RFQ) in March of 2020. The RFQ resulted in 7 teams which assembled a diversity of expertise to support both Phase II and III of the project. A team led by SLR International was selected to lead the Phase II process in Summer of 2020.

3.2 Phase II

Phase II of the project commenced in mid-2020. The central component of Phase II was a regional vulnerability assessment for all 51 municipalities in New Haven and Fairfield Counties coupled with identification of “zones of shared risk” in the 33 municipalities of New Haven and Fairfield Counties with potential for Transit Oriented Development (TOD) along the state’s regional transit system. This balance was struck to allow the regional assessment to benefit as many towns as possible while focusing more in depth planning to areas along the Metro North/I-95 transit corridors, in keeping with the original goals of the proposal. The analysis and resulting reports were informed by extensive stakeholder engagement, which is described in a

[Phase II Engagement Report (CIRCA, 2022)](). The period of 2020 to 2021 was a uniquely challenging time to conduct stakeholder outreach and engagement. Virtual meeting platforms were utilized for nearly all engagement activities during this phase. While in person engagement was not possible due to the global pandemic caused by Covid-19, the virtual meeting format allowed for additional flexibility in scheduling and attending meetings which kept the project moving.

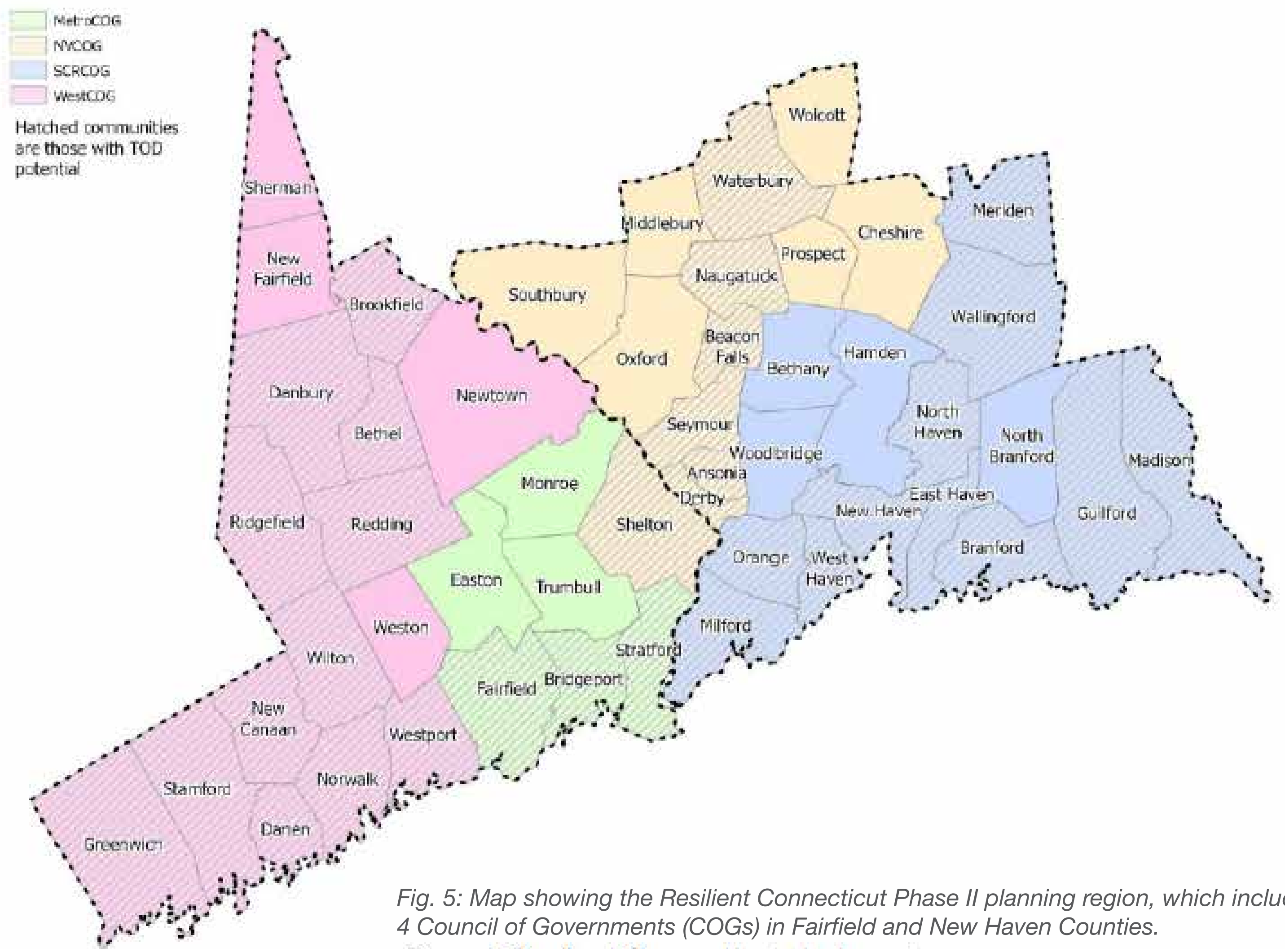


Fig. 5: Map showing the Resilient Connecticut Phase II planning region, which included each of the 4 Council of Governments (COGs) in Fairfield and New Haven Counties.

The core components of the Phase II vulnerability assessment process were:

1. Extensive coordination, engagement, and data collection with the 4 regional COGs in New Haven and Fairfield Counties (West COG, Naugatuck Valley COG, Metro COG, and South-Central COG) and the municipalities they serve:
   See Phase II Engagement Report.
2. The delineation and mapping of Zones of Shared Risk: See ZSR Report.
3. Development of a Climate Change Vulnerability Index (CCVI) mapping tool for both flooding and extreme heat: See Climate Change Vulnerability Index Viewer.
4. The identification of Resilience Opportunity Areas (ROARs) based on a series of "recipes" incorporating the resilience vision in the Phase I Resilient Connecticut Planning Framework:
   See Vulnerability Assessment Report and Resilience Opportunity Areas.

These components provided the foundation for stakeholder discussions; through participation in ongoing COG board and committee meetings throughout 2020-2021, a series of regional workshops which were held in partnership with each COG, in Winter/Spring 2021, and engagement with individual municipalities throughout Phase II.

Coordination, engagement, and data collection with the four regional COGs began through a kickoff meeting held in January of 2020 to discuss the scope and data collection needs for Phase II with staff from all four COGs simultaneously. Following the kickoff meeting, bi-weekly meetings were held with GIS staff leads for each COG to assist in compiling the spatial database that would form the basis of the CCVI. Notwithstanding recent efforts in Connecticut to centralize coordination and quality control of spatial data, through a central GIS office (Public Act No. 21-2, 2021), at the time of Phase II's kick-off in 2020-21 each COG contributed their own inventory of spatial datasets collected and used for ongoing planning activities. A single Resilient Connecticut GIS data inventory was created to allow for consistency between spatial data layers across all 51 municipalities in the study area and to ensure common data schema and formatting were utilized. In addition, each COG provided a monthly platform for the Resilient Connecticut team to present on progress and project milestones through updates to various multijurisdictional planning committees including: transportation technical advisory committees, conservation technical advisory committees, regional planning committees, and updates to COG Chief Executive Boards, which are comprised of chief elected officials from each municipality. These efforts allowed the initial focus of the vulnerability assessment to remain at the regional (multi-jurisdictional) scale and to facilitate cross jurisdictional discussions of climate issues among towns.

3.3 Zones of Shared Risk

The concept of identifying a “zone of shared risk” was first utilized in Connecticut in 2011 by the Yale Urban Ecology Lab in the development of the state’s first coastal resilience plan in the town of Guilford, funded through a combination of NOAA and Town resources (Town of Guilford, 2014).

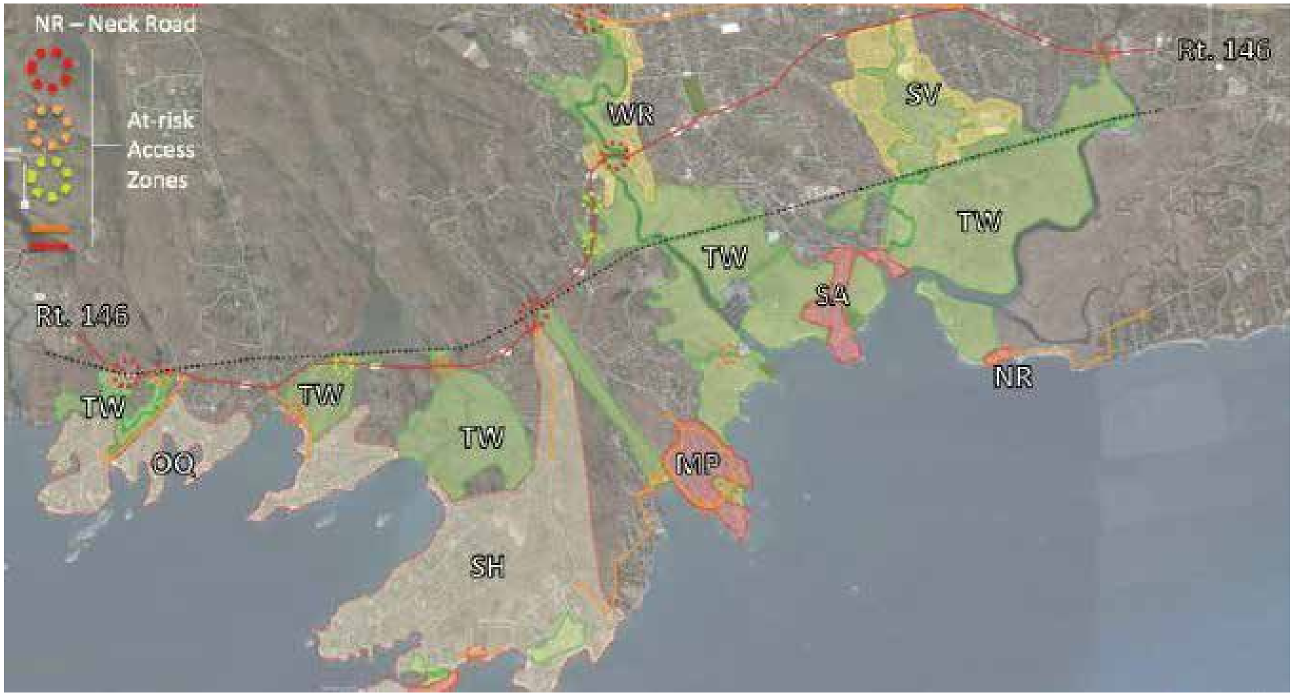


Fig. 6: Zones of shared risk identified in the Town of Guilford’s Coastal Resilience Plan, 2014. Yale Urban Ecology Lab.

Zones of shared risk are “regions that face common challenges where flood risks are shared among or between groups of people that may have different perspectives and priorities for coastal resilience (ref. Guilford plan).” A Zone of Shared Risk (ZSR) includes the houses, land, infrastructure, hydrological, ecological, social, and institutional elements that contribute to the functioning of a place. Given the heterogeneity of the state’s coastal and riverine flood plains, which feature patches of flooding interspersed amongst housing, infrastructure, different land uses, ecological assets, and political jurisdictions, a ZSR provides a spatial scale that can support the implementation of adaptation strategies such as flood protection infrastructure, zoning overlays, and other approaches. ZSR can also leverage existing formal and informal networks such as housing associations and community groups, to enable ongoing feedback and negotiation between stakeholders in the process of adaptation planning.

An initial set of ZSR maps for coastal towns in the Phase II planning region, was assembled by the UConn Community Research & Design Collaborative during the inventory and research period of Phase I (Wu, et. al. 2020) building on the methodology used in the Guilford coastal resilience plan. The approach utilized a series of base maps (topography/elevation, flood overlay, ecological systems, structures/roadways, land uses and social characteristics) to create a draft set of ZSR maps, which were presented to project stakeholders during the first annual Resilient Connecticut Summit in November 2019 (Resilient Connecticut Summit 1 Zones of Shared Risk Charrette) (Miniutti, 2019).

Fig. 7: Participants in the Zones of Shared Risk Charrette provide feedback on draft maps during a breakout session at the 1st Resilient Connecticut Annual Summit in November 2019.

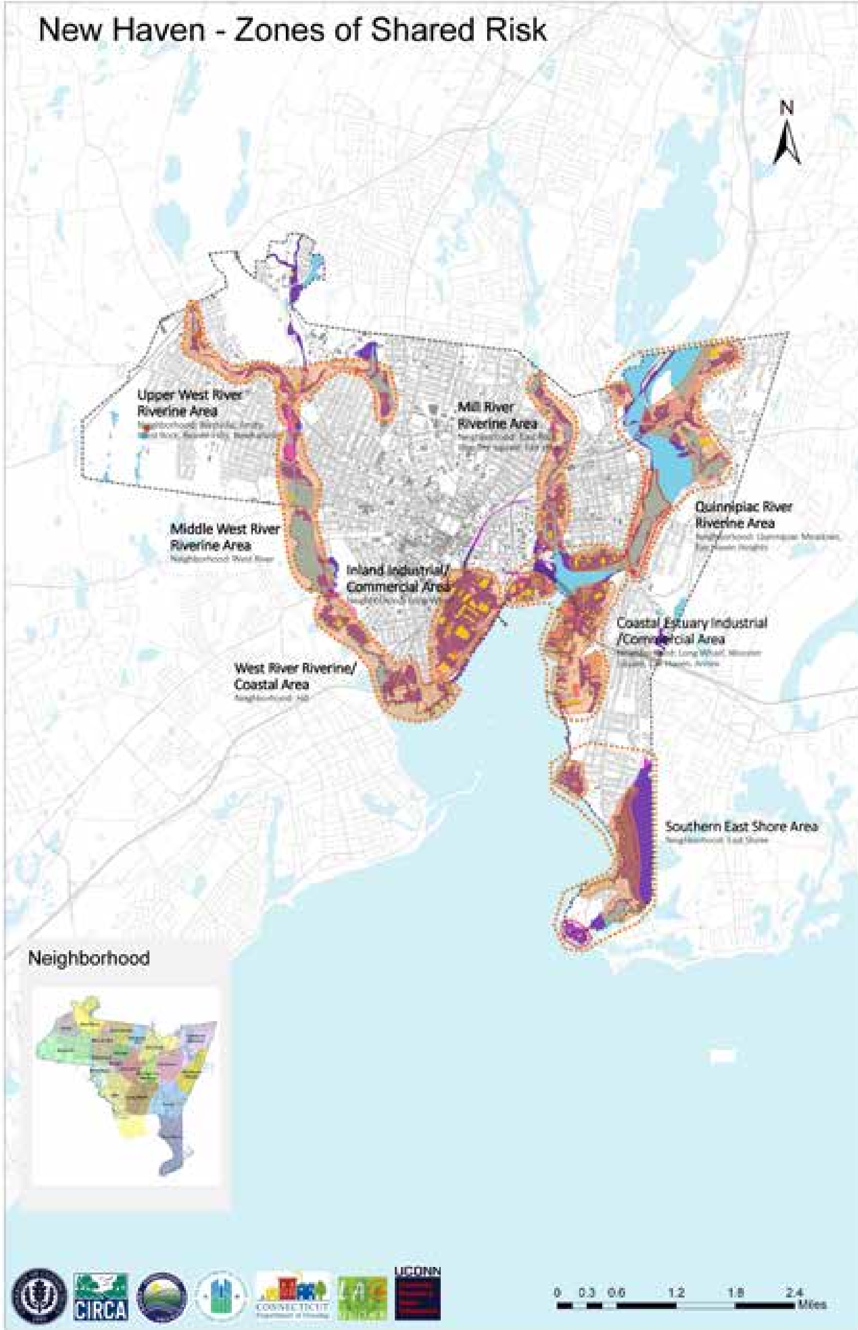


Fig. 8: Zones of Shared Risk maps for New Haven, CT.

As the Phase II process began, the approach was expanded to the 33 municipalities in the study area, located along the regional transit system. Additionally, a series of typological categories was used, building on the approach from the Guilford plan. 5 types of ZSR were identified and mapped using the following categorization [(see memo documentation of ZSR methodology) [CIRCA, 2021]:]

1. An “Access” ZSR contains risks primarily derived from the ability (or lack thereof) to enter or exit an area due to flooding caused by increasing sea levels or storm surges.
2. A “Location” ZSR contains risks primarily derived from a prevalence of low-lying lands within an area. These lands are vulnerable to flooding caused by increasing sea levels or storm surges due to their low elevation.
3. A “Proximity” ZSR contains risks primarily derived from adjacency to low-lying, vulnerable lands. These lands are vulnerable by being close to areas that will experience more flooding caused by increasing sea levels or storm surges, and likely to experience some flooding of their own.
4. A “Natural protection” ZSR contains risks to lands that provide natural flood protection. These lands can attenuate flooding and damage from storm surges, contribute to both improved water quantity and quality in non-storm events, and provide valuable ecological services. This Zone of Shared Risk type often overlaps with the previous three types.
5. An “Underpass” ZSR identifies the roadway and bridge underpass locations that, during heavy precipitation events, often flood due to poor drainage, and are a

source of either disruption due to roadway closure or stranded vehicles.

While automated GIS tools, such as Network Analyst, were reviewed for potential use in delineating the ZSR, these programs were unable to account for the nuances associated with Connecticut's geography and municipal characteristics. The approach that we used relied on user knowledge, hazard mitigation plans, and coastal resilience plans; and was aided by stakeholder engagement feedback. A checklist method with baseline criteria was employed which included the following within or adjacent to an area of current or future flood risk: Several buildings, a critical facility, a segment of collector/arterial roadway, natural systems that could protect buildings and infrastructure, community assets such as: shared shelters, shared heating/cooling centers, shared medical facilities or hospitals, shared water utilities, use of private wells, shared sewer utilities, or use of septic systems in a defined neighborhood or region. The starting point for analysis was identification of coastal and riverine FEMA-delineated flood zones (both the 1% and 0.2% annual chance risk areas) and areas of exposure to sea level rise, which are easily identified using GIS methods. The criteria listed above were then applied to determine which should be subject to delineation of ZSRs. Human interpretation was used to further refine ZSRs into the various types (either access, location, proximity, natural protection, and underpass). This process resulted in the delineation of over 600 ZSR in the 2-county study area. Narratives were prepared for each area or subset groups of areas for use in stakeholder workshops and discussions with municipal staff. For more on the ZSR narratives please see the ZSR Narrative Report [CIRCA, 2021).

3.4 Climate Change Vulnerability Index

Vulnerability to climate driven flooding and heat impacts can be characterized by assessing how factors contributing to exposure, sensitivity, and adaptive capacity vary throughout a region. (IPCC, 2001). Exposure can be analyzed by looking at physical features or characteristics of the landscape that are likely to increase the impacts of a hazard event, as well as the climate change-related factors that increase the magnitude and frequency of hazard events. Both sensitivity (susceptibility to harm) and adaptive capacity (potential to adjust to climate change and cope with the consequences) can be broken down further by examining factors that relate to social, ecological, and built components of the environment. The Climate Change Vulnerability Index (CCVI) is a spatial data index mapping tool which was developed to support the identification and assessment of locations within the study area which are vulnerable to both flooding and extreme heat impacts. Separate index tools were developed for flooding and extreme heat. While the CCVI is a reflection of vulnerability, the presumption is that vulnerability is proportional to risk and therefore the tool generally expresses an indicator of risk.

The CCVI for Fairfield and New Haven Counties contained a total of 84,605 10m x 10m grid cells, each with its own flood and heat vulnerability score. Numerous contributing factors were ranked from 1 (low) to 5 (high) based on their contribution to sensitivity, exposure, or adaptive capacity, within a grid cell. A score of 0 indicates the absence of a contributing factor. These three component scores (sensitivity, exposure, and adaptive capacity) were then calculated based on the geometric mean of their relative factors. Once each component score was determined, overall vulnerability was scored for each cell by multiplying sensitivity and exposure and dividing by adaptive capacity. Factor, component, and vulnerability scores are relative, unitless values and therefore most useful for comparison across locations or characterizing smaller geographic areas.

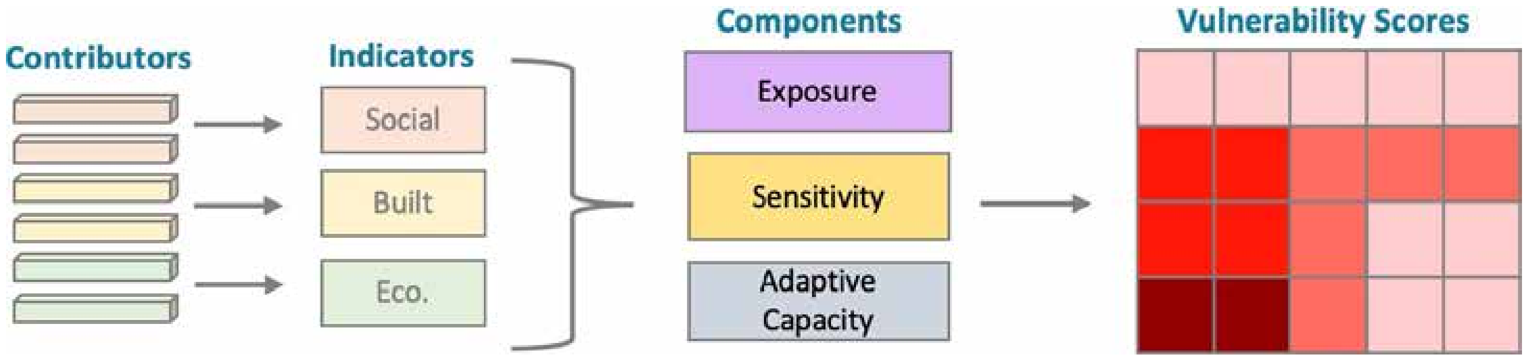


Fig. 9: Components contributing to CCVI vulnerability grid cell scores.

Most contributor layers are readily available for public use as geographic information system (GIS) files as either point, line, or polygon features. Other layers, however, were developed specifically for the CCVI and formatted into the appropriate layer type. For example, pooling areas, distance to shelters or highways, and flood protection systems were either digitized for the CCVI or produced using other data and analyses. Values associated with each data layer were converted into rank scores on a scale of 1 to 5 and incorporated into each contributor layer. To translate these contributor layers and their rank into the index, each layer was spatially joined to a regional grid. The spatial join technique and merge rule varied depending on the layer type and information being conveyed. Specific layer identification, source, and join information for each contributor can be found in the Appendix C supporting documentation from the [Phase II vulnerability assessment report.](#) (SLR & CIRCA, 2021). Once each contributor was joined to the grid, forming a new, contributor-specific grid layer, a union was performed to combine contributor grids into their respective indicator grids. For example, a union was conducted on multiple social-sensitivity-related contributor grids to generate a single social sensitivity indicator grid. The geometric mean of the contributors was then calculated to generate a "social sensitivity score". This process was repeated for each of the indicators for flooding and heat. To better convey the overall climate vulnerability, final overall vulnerability scores are normalized to a range of 0 to 1. This normalization was done at a regional level, so all cells in New Haven and Fairfield counties were included, however, this process could be replicated to normalize within a municipality or COG if necessary. The CCVI is meant to act as an informational planning tool to be used in conjunction with other resources such as social vulnerability mapping, zones of shared risk, and other environmental data such as soil or geologic information.

Sensitivity

Social

Average number of emergency visits for asthma over 10 years, per population
Heat Stress
Percent Housing Units with No Vehicle Present
Household Median Income
Over 5 with a Disability
Percent living below 185% federal poverty level

Percent over 25 without a high school diploma
Percent Over 65
Percent population under 5
Percent population unemployed
Population density
Non-White Population

Speaks English less than well/not at all
Outside Employment
Over 65 Living Alone (households)
Single Parent households

Built

Private Well Coverage
Median Structure Age
Public Housing Units

Exposure

Physical

Emissivity
Roadway Usage Classification (Traffic Emissions)
Impervious surfaces
Building Density

Climate

Maximum Land Surface Temperature

Adaptive Capacity

Social

Proximity to Bus Hubs (Plus transit, bus stations)
Percent population with (no) health insurance
Percent of Owner-Occupied Housing Units

Proximity to Swimming Areas
Proximity to Healthcare Facility
Proximity to Shelter
Proximity to Cooling Center

Ecological

Percent Tree Cover
Normalized Difference Vegetation Index (NDVI)

Fig. 10: Contributing data layers used to calculate the CCVI for heat vulnerability.

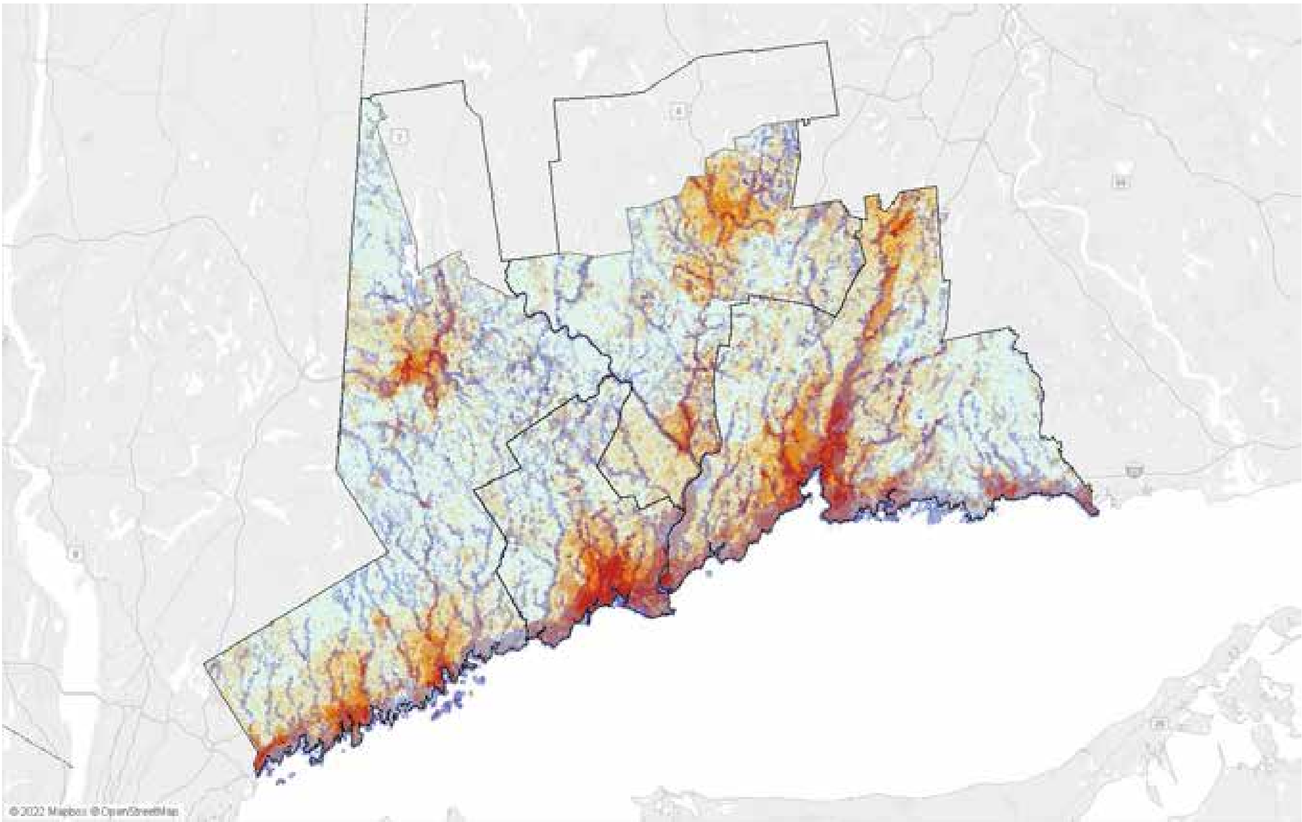


Fig. 11: Results from the Climate Change Vulnerability Index in Fairfield and New Haven Counties. Areas in red indicate areas of relatively high vulnerability to both flooding and heat.

3.5 Resilience Opportunity Areas

As the 4th component of the Phase II planning process, the previous analysis tools were presented through stakeholder discussions, to identify a subset of specific priority locations, referred to as Resilience Opportunity Areas or ROARs. ROARs are identified in locations where adaptation strategies can be developed into projects that improve whole community resilience, and where investments can be coordinated across scales of decision making (state agencies, municipal governments, service providers, landowners, community-based organizations, residents, and others). Each ROAR in the 2-County study area represents the intersection of unique climate driven challenges with the planning objectives outlined in the Phase I Planning Framework's long-term vision for resilient communities. A series of “recipes” was created to highlight specific themes in the Framework such as transit-oriented development, affordable communities, and critical infrastructure (wastewater, drinking water, energy, and others). The identification of each ROAR followed a sequence of spatial data overlays of the following steps:

1. Initial identification of a resilience theme from the Phase I Planning Framework (e.g. areas of existing or potential transit-oriented development);
2. Application of climate-driven vulnerability data layers using ZSR and CCVI maps (e.g. areas of coastal flood risk along with high vulnerability to extreme heat);
3. Application of supporting spatial data relevant to each resilience theme (e.g. proximity and/or density of transit assets, affordable housing assets, presence of critical infrastructure, etc.)
4. Manual review and screening of the resulting maps and:
5. Collection of place specific context through stakeholder discussions, (local experiences of different types of flooding, ongoing local or regional project planning in the area, and land-use priorities as outlined in local Plans of Conservation and Development).

3.6 Regional Workshops

A series of workshops organized by each of the 4 COG planning regions in the study area, was held to present initial inventories of locations and discuss additional locations based on local knowledge. For more detailed information about the Phase II stakeholder workshops, please see the Stakeholder Workshop Report: https://resilientconnecticut.media.uconn.edu/wp-content/uploads/sites/2761/2021/12/Appendix-A.pdf. Through breakout discussions, the boundaries of the ROARs were fine-tuned, and the understanding of specific flooding and extreme heat issues was further defined.

Fig. 12: CCVI maps showing relative vulnerability to both flooding and heat for the Fair Haven section of New Haven, used to support the identification of Resilience Opportunity Areas in Fairfield and New Haven Counties during Phase II workshops.

Additional information from various stakeholder groups was compiled and summarized for each location into a publicly accessible series of maps and information sheets. The process resulted in the delineation of 64 ROARs across Fairfield and New Haven Counties, which represent unmet needs for additional site to neighborhood scale planning, development of adaptation strategies, and implementation of actions. A Phase II Vulnerability Assessment Report and resulting maps for the 64 ROARs can be found on the Phase II site here: https://resilientconnecticut.uconn.edu/roar-maps-index/

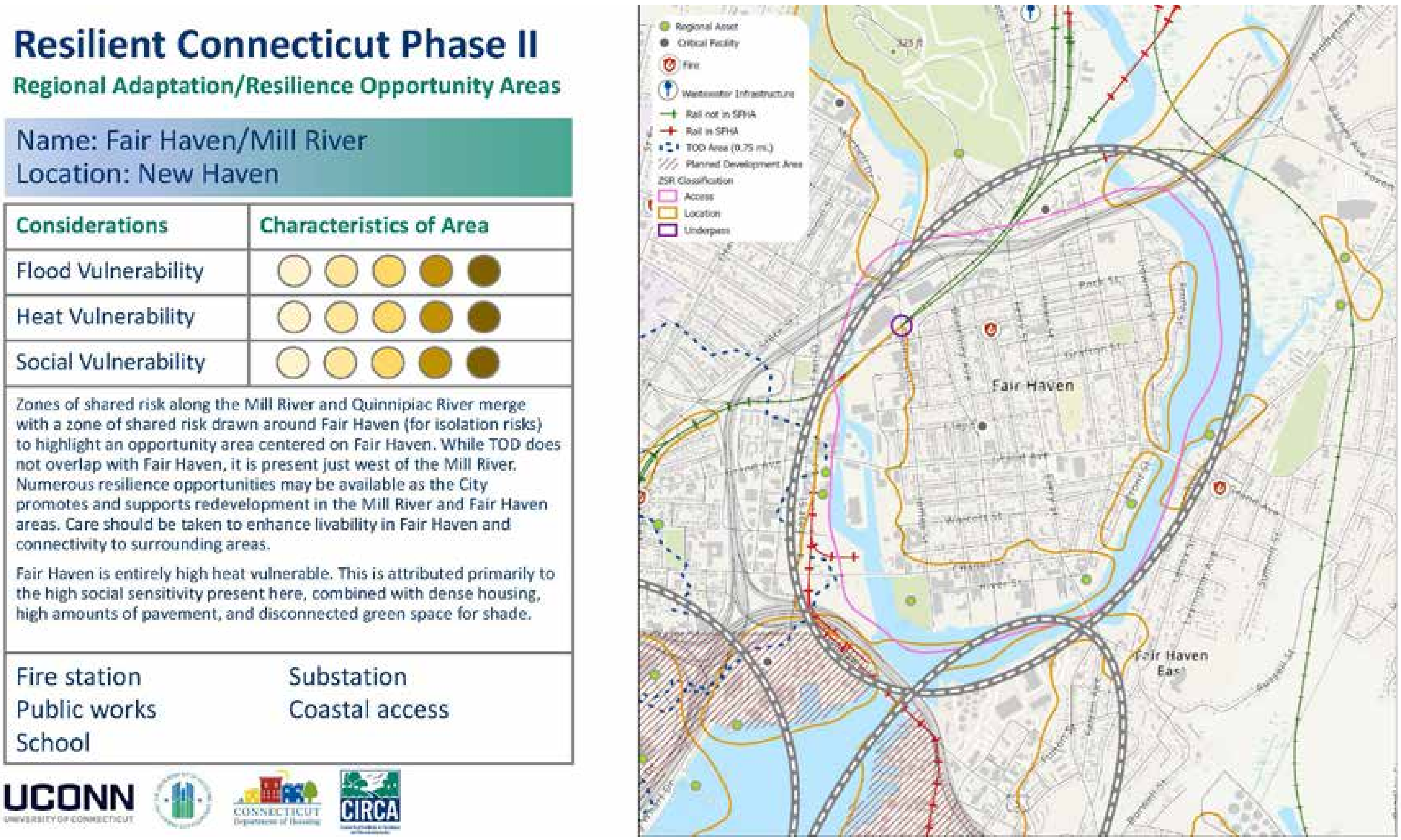


Fig. 13: Shows an information sheet summarizing the Resilience Opportunity Area identified in the Fair Haven/Mill River area of the New Haven, Connecticut, during Phase II workshops.

3.7 Synthesizing and Prioritizing ROARs for Phase III

The third and final phase of the Resilient Connecticut project focuses on the development of site scale adaptation strategies and pilot projects, which can improve the resilience of community assets in key locations and provide a blueprint for addressing a range of typological conditions found across Connecticut and beyond. The inventory of ROARs, resulting maps, and data collected for these areas are building blocks that can be integrated with other planning efforts to develop a resilience "project pipeline" that can help prioritize projects and coordinate key investments going forward. While the Phase II process revealed a vast need for additional planning in one region of Connecticut, a process of prioritization was used to select 7 pilot project areas for Phase III, to align with budget and schedule constraints of the NDRC funding. The prioritization and selection process used by the project team to ultimately select 7 ROARs from the portfolio of 64 areas is described below.

PERSISTS Decision Support Criteria		
Permittable	1. Are there historic or ecological sensitivities to consider?	Yes = 0, no = 1
Equitable	1. Does the opportunity area contain elements of high social vulnerability?	High = 3, moderate = 2, no = 0
Realistic	1. Are there potential adaptation options proportionate to the identical problem? (indicates realistic pathway for funding)	Yes = 1, unsure = 0, no = remove
Safe	1. Does the opportunity area have elements that would address public safety? (# of critical lifelines in ROAR)	Yes (3 or more) = 3, some (1-2) = 2, no = 0
Innovative	1. There is an opportunity for a multidisciplinary approach for climate solutions that incorporates greenhouse gas (GHG) mitigation and adaptation.	Yes = 2, maybe = 1, no = 0
	2. There is interest among multiple communities or jurisdictions to participate in the planning process.	Yes = 2, no = 0
	3. There is an opportunity to apply a new approach to planning, design, engagement, or financing that has been successful in other states that could be applied here.	Yes = 2, maybe = 1, no = 0
Scientific	1. There is an opportunity to develop new data sets that will contribute to the scientific literature on adaptation.	Yes = 1, no = 0
Transferable	1. Represents a common resilience typology in Connecticut: land use, infrastructure, or social, and could serve to demonstrate an approach or best practices.	Yes = 2, maybe = 1, no = 0
Sustainable	1. There is strong support from political leadership, municipal staff, and local community to engage in planning process in the opportunity area.	Yes = 3, unsure = 1, no = remove
	2. Are there strong community partners who could be directly involved in planning?	Yes = 2, maybe = 1, no = 0
	3. Is there a local commitment to resilience, as demonstrated by active involvement in resilience planning?	Yes = 2, somewhat = 1, no = 0
	4. Is there potential significant state support for a project (state agency involvement, state or regional priority, etc.?)	Yes = 2, maybe = 1, no = 0

Fig. 14: PERSISTS scoring rubric used to evaluate potential ROARs for Phase III site planning.

Section 4.c. of the Resilient Connecticut Planning Framework7 calls for incorporation of the “PERSISTS decision support criteria to assess near, mid-, and long-term strategies.” PERSISTS was envisioned as a way to evaluate climate adaptation actions for their potential to balance multiple goals and priorities between stakeholder groups. In April 2021, a “Resilient Connecticut Collaborative” workshop was held to work through ideas for specific metrics across each category of PERSISTS, that could then be used to both evaluate locations for selection in Phase III as well as evaluate adaptation alternatives that would be proposed in those locations. A variety of questions and metrics for each category were proposed. A subset of questions from the workshop was selected and refined to assist the team in evaluating each of the 64 ROARs for potential inclusion in Phase III. Using these questions, the team developed a scoring rubric which assigned points across the 8 categories of PERSISTS for a total of 30 possible points (Reference and Fig.).

In addition to the PERSISTS criteria, each ROAR was also assigned one or more typological categories to enable selection of a cross section of different land use, infrastructure, and socioeconomic conditions to be included in the Phase III project areas. The typologies used for this evaluation were the following sets of conditions that are found in the study area:

1. Coastal flood risk transportation infrastructure typology: This represents the overlap of coastal flood risks with important transit and transportation infrastructure that is critical to efforts to enable more resilient, transit-oriented development along the Metro North, Amtrak, and Interstate 95 corridors.

2. Riverine or inland stormwater flood risk and transportation infrastructure typology: Similar to typology 1, this represents riverine and stormwater flood risks that impact major TOD corridors along the Naugatuck River Valley, Danbury transit line, and Interstate 91/Hartford line.

3. Climate vulnerable community assets (flood prone locations, heat-vulnerable populations in affordable housing areas): This typology captures issues of flood and heat risks to affordable housing and critical infrastructure that impact socially vulnerable and/or environmental justice communities.

4. Evacuation and isolation flood risk typology: This typology represents zones of shared risk and communities that are potentially isolated during flooding and in need of the development of resilient corridors that can allow for egress to higher ground both in the near and longer term.

5. Multijurisdictional or large-scale critical infrastructure typology (wastewater, drinking water, power, and critical infrastructure that affects multiple communities, neighborhoods, or jurisdictions): This typology represents flood and heat risks to critical assets and infrastructure whose impacts are felt across political and jurisdictional boundaries.

The evaluation of the 64 ROARs also included discussion of relevant previous planning efforts, feasibility considerations, and the potential support and commitment of local partners in participating in Phase III. Follow up discussions with the COGs were conducted in December 2021 to narrow the list of potential Phase III project areas to 5 in each COG jurisdiction for a total of 20 across the two counties that were the finalists for selection in Phase III. Additional meetings were held with individual state agencies to understand the overlap with parallel planning efforts and inform prioritization. The State Agencies Fostering Resilience Council met in December 2021 to review the project areas. Additional follow-up discussions with individual municipalities were also held to confirm interest in possible participation in Phase III.

4.0 Phase III - Adaptation Options and Implementation Planning

7 ROARs were selected for Phase III of Resilient Connecticut. Proposals from engineering, design, and engagement teams were solicited in Spring of 2022, from the consultant teams that responded to the Request for Qualifications issued in Phase II, and projects commenced during the Summer and Fall of 2022. Each project consisted of a scope of work that included community engagement, site scale climate risk assessment, evaluation of adaptation options, benefit cost analysis, and concept designs. The 7 sites selected for Phase III represent a range of both typical and unique characteristics that are representative of climate challenges that are found both along the coast and inland across the study area and the State of Connecticut. A summary synthesis of findings and recommendations for each Phase III site plan is provided in the following sections. For more detailed information on each planning study please refer to project websites and final reports which are referenced here.

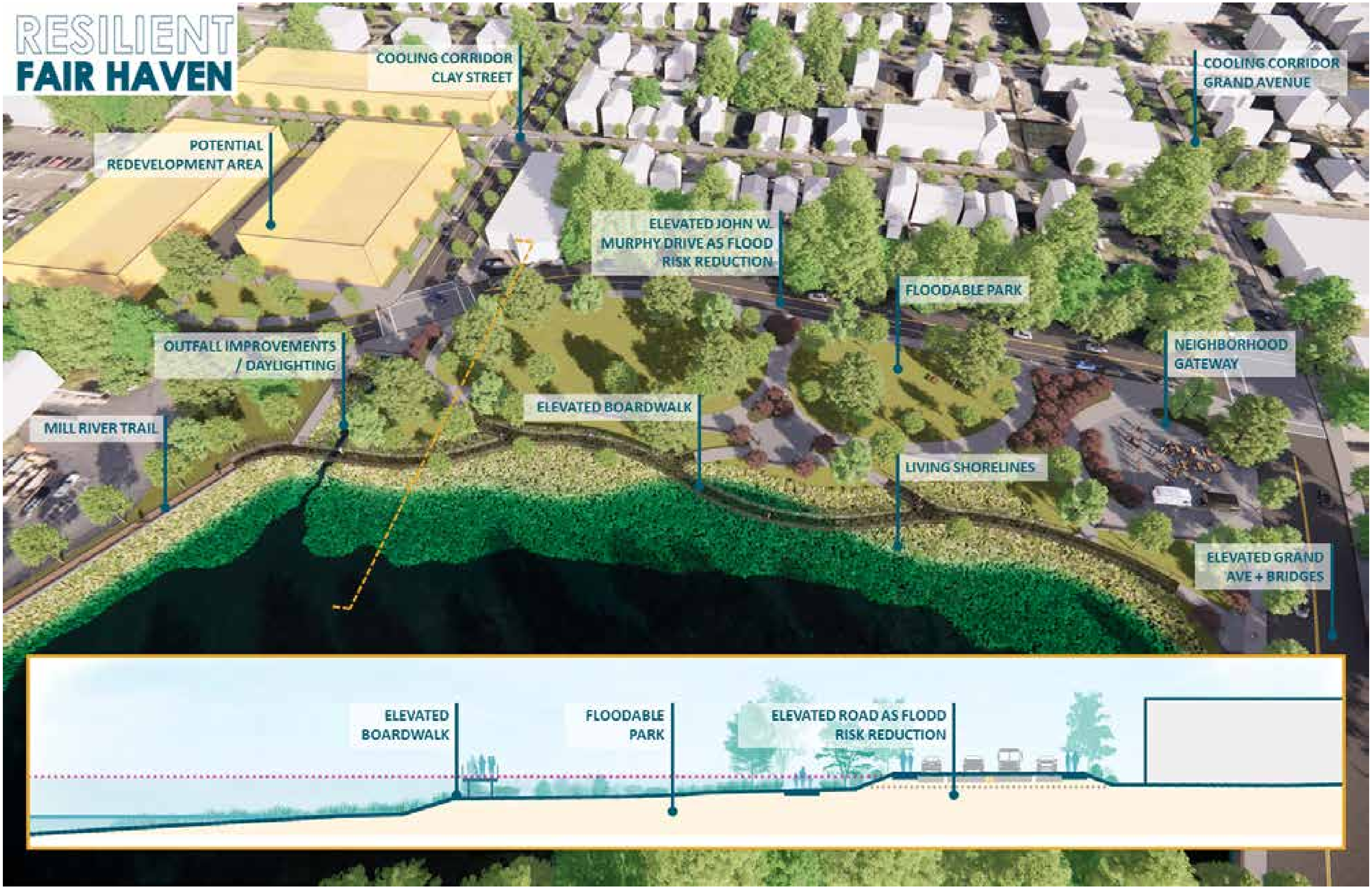


Fig. 15: Resilient Fair Haven design concept depicting various resiliency elements along the Mill River and John Murphy Drive area.

4.1 Downtown Danbury

Downtown Danbury, CT serves nearly 80,000 City residents as well as the greater Danbury region. The subject neighborhood – located along Main Street and extending eastward to Town Hill Avenue – has endured decades of flooding caused by aged, undersized drainage systems directed to a watercourse called "East Ditch" that is constrained within a culvert. Flooding therefore has hydrologic and hydraulic contributions. Existing pipes and culverts cannot handle the volumes of water generated during severe storms over the small urban catchment, nor can they handle the hydraulic characteristics of the flows. Flooding presents public safety challenges to residents of the city, leading to closures of Main Street in front of a community health center where patients have been previously trapped by flooding events. Flooding has also caused damage to various properties situated along the East Ditch alignment. Downtown Danbury is also vulnerable to extreme heat. This is attributed primarily to the high social vulnerability within the community, combined with dense housing, impervious surfaces, disconnected green spaces for mitigating high heat impacts, and an absence of nearby formal cooling centers and/or shelters. This project focuses on developing adaptation strategies and implementable project concepts which will help to mitigate the impacts of current and future climate induced flooding to key community assets; as well as help mitigate the impacts of extreme heat for the community.

Fig. 16: There is significant drainage-related flooding in Downtown Danbury as shown in the photos above, which were all taken at the Main Street and Elmwood Place intersection. Flooding occurs in the streets and, under certain conditions, extends onto adjacent properties and into basements.

Public involvement and community engagement was sought throughout the process. Three (3) Technical Advisory Committee meetings and three (3) public engagement events were held throughout the course of the project to gather input on priorities and get feedback on concept designs. A flood model was developed for the East Ditch watershed and used to project future climate induced flood conditions, as well as test possible interventions to reduce flood risks.

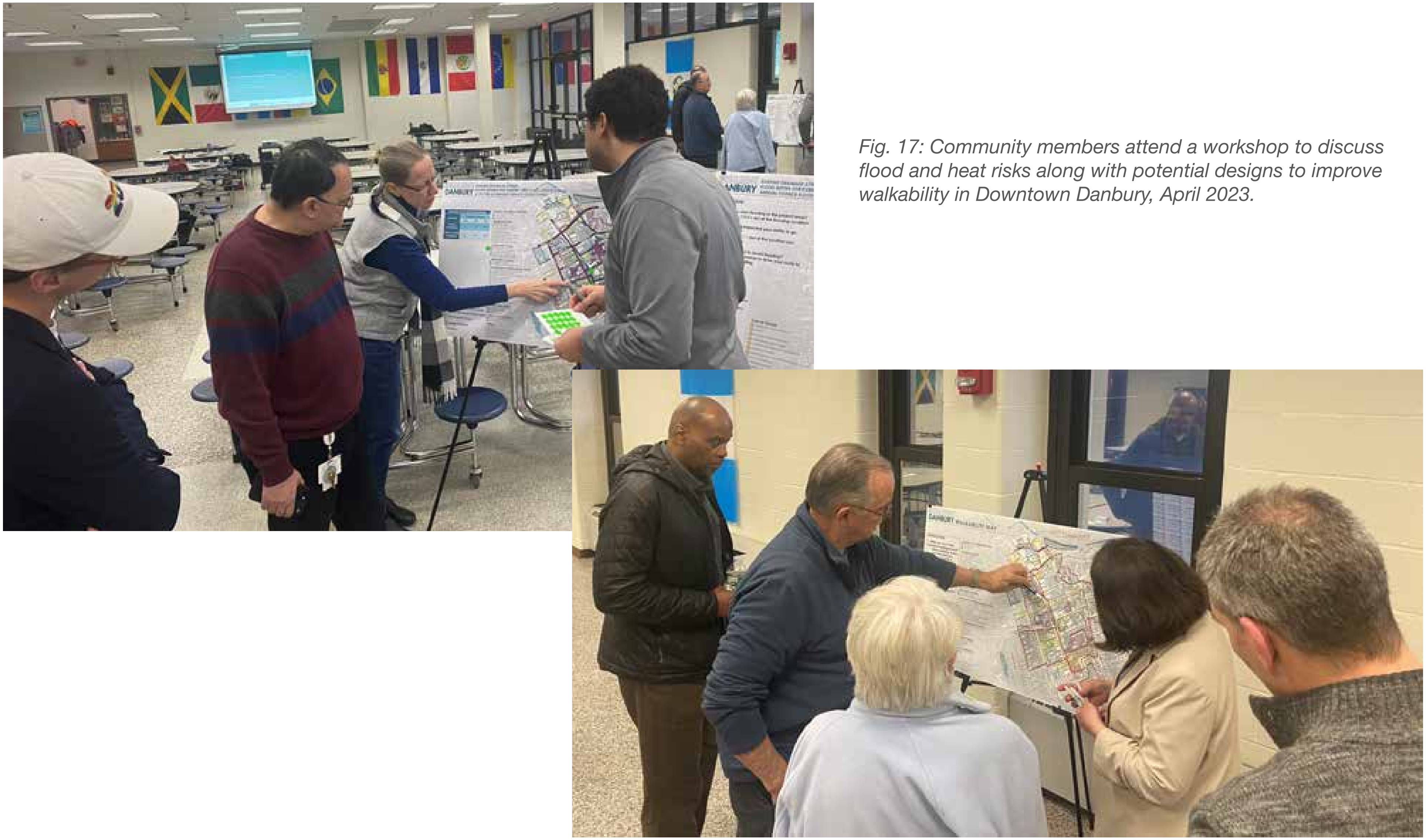


Fig. 17: Community members attend a workshop to discuss flood and heat risks along with potential designs to improve walkability in Downtown Danbury, April 2023.

RESILIENT DANBURY

EXISTING DRAINAGE SYSTEM: FLOOD EXTENTS FOR CURRENT & FUTURE 1% (100-yr) ANNUAL CHANCE FLOOD EVENTS

The maximum flooding extents for each recurrence interval were determined through PCSWMM modeling. The maximum flood extents for the 1% (100-year) annual chance of exceedance storm under current and future climate conditions are shown to the right.

The model results show major areas of surface flooding at the following locations:

- Center Street
- State Street
- Park Place
- The parking lot within the affordable housing complex just south of Park Place
- Southern Main Street
- Wooster Street near the Main Street Intersection
- Liberty Street Near the intersection with Pahquioque Avenue

Number of Inundated Buildings	
Scenario	Annual Chance of Storm (Return Period)
	1% (100-Year)
Current Climate Conditions	99
Future Climate Conditions	137

LEGEND

- Current 1% Annual Chance Flood
- Future 1% Annual Chance Flood
- Watershed Boundary
- Roadways

Fig. 18: Flood model showing current and future 1% annual exceedance probability flooding in the East Ditch watershed, Downtown, Danbury, CT.

Visioning sessions were held to develop a Concept Diagram of Potential Mitigation Options, shown below. This Concept Diagram depicts the range of recommended mitigation options. Fuss & O'Neill worked with CIRCA and the City to develop project alternatives based on the mitigation options identified in the Concept Diagram. These alternatives were developed with consideration given to reduction in flood impacts, viability of green infrastructure, property ownership, and community benefits. Three (3) mitigation alternatives were developed. The primary benefit from the mitigation options comes from drainage system improvements. Green Infrastructure, streetscape improvements, and tree plantings provide additional heat, water quality, and other community benefits.

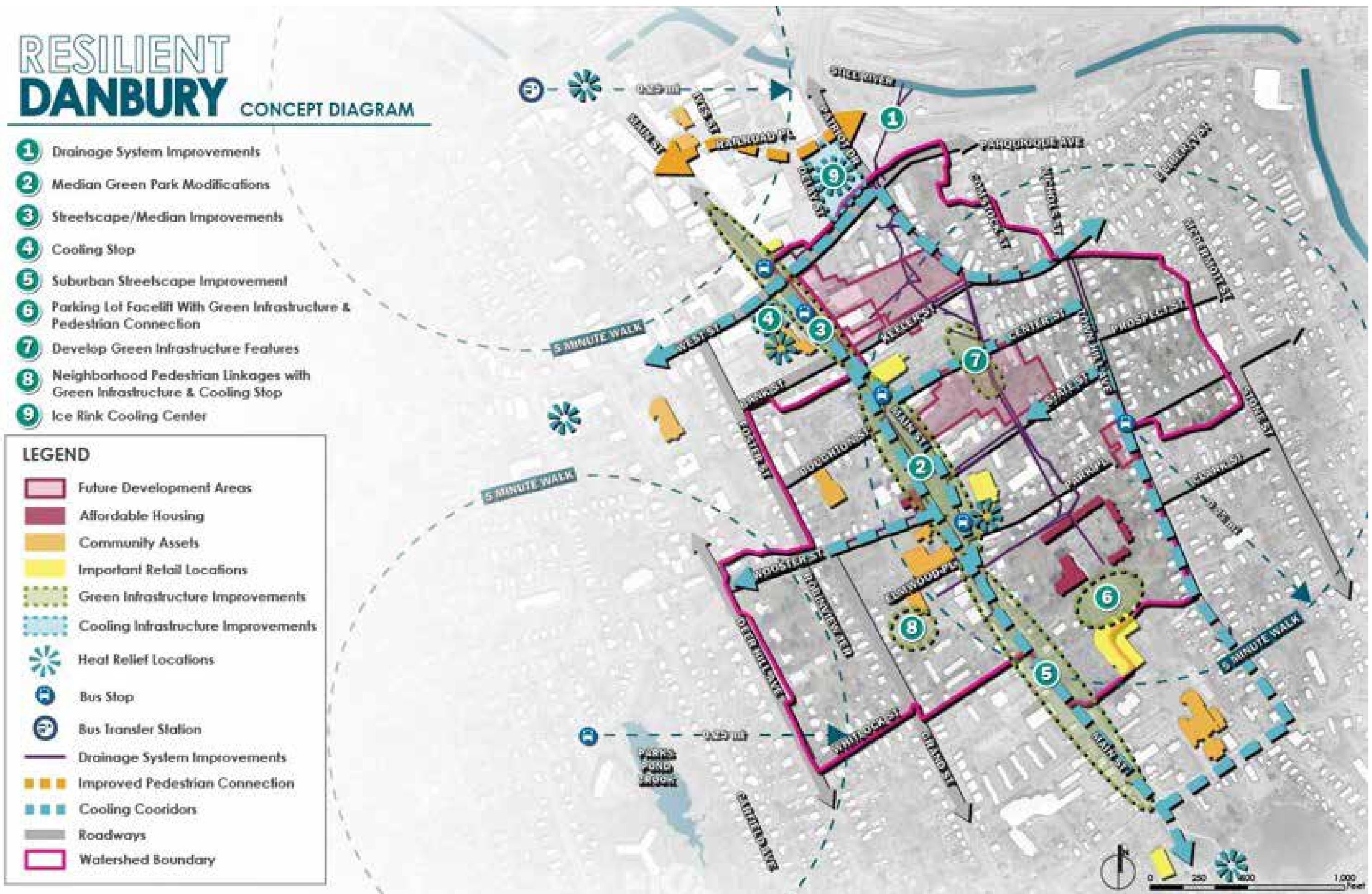


Fig. 19: Concept plan showing different potential strategies to reduce flood risk and extreme heat impacts to residents in Downtown Danbury.

An Implementation Roadmap was developed to guide coordination between the City and various agencies and organizations, including City of Danbury departments – Engineering, Economic Development, Emergency Management – and other organizations including CT DOT and private property owners. The proposed flood and heat resilience improvements along Main Street and on privately owned property will require more detailed planning and engineering, substantial funding, and partnerships between the City, CT DOT, and private property owners. These projects are envisioned to be implemented over the next 10+ years. Green infrastructure and cooling strategies should be implemented along the proposed cooling/resilience corridors as stand-alone retrofit projects or in conjunction with planned capital improvements such as roadway and streetscape projects as funding allows.

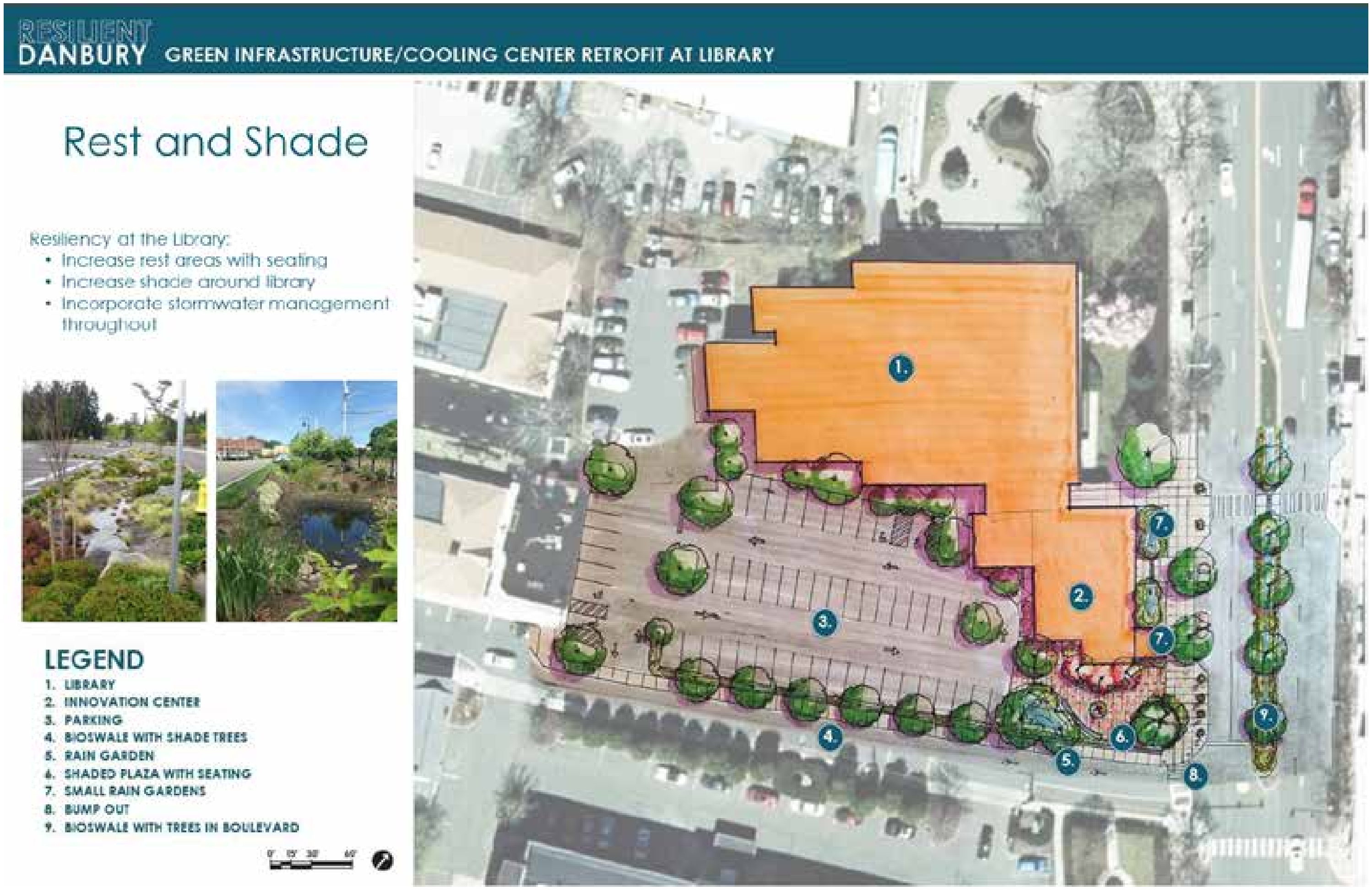


Fig. 20: Concept design for increasing urban tree canopy, reducing impervious surface and stormwater runoff through green infrastructure at Danbury Public Library in Downtown Danbury, CT.

Additionally, the Danbury Ice Arena was identified as a potential cooling center and emergency resilience hub for community residents. Initial discussions were held, and an MOU was drafted in Summer 2023 to formalize the relationship between the city and the arena owner for use of the ice rink during emergencies. Additional work to develop emergency operations plans, as well as assessment of backup power alternatives, and other resiliency site improvements should be done through partnerships between the City of Danbury, Danbury Ice Arena, and community-based organizations serving the greater Danbury community. Additional planning and technical support may be provided by West COG, CIRCA, the CT Green Bank, CT DEEP, and others.

#	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Drainage System Improvements	City of Danbury, Private Property Owners	Secure remaining easements	0-3 yrs	$	FEMA Building Resilient Infrastructure and Communities (BRIC) – $1 billion nationwide for community resilience projects that address flooding and extreme heat.
			Complete preliminary design	0-3 yrs	$$	
			Secure construction funding	3 yrs	$	
			Final design, permitting, and construction	3-5 yrs	$$$	
2	Median Green Modifications	City of Danbury, CT Department of Transportation (CT DOT)	Conduct detailed planning & refine concept	0-3 yrs	$$	
			Coordinate w/DOT	3-5 yrs	$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$$	
3	Streetscape / Median Improvements	City of Danbury, CT Department of Transportation (CT DOT)	Conduct detailed planning & refine concept	0-3 yrs	$$	CT DECD Community Investment Fund (CIF) – up to $175 million annually for capital projects that support economic and community development in underserved municipalities.
			Coordinate w/DOT	3-5 yrs	$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$$	
4	Parking Lot Improvements w/Cooling Stop	City of Danbury	Conduct detailed planning & refine concept	0-2 yrs	$	
			Secure funding	2-3 yrs	$	
			Design, permitting, and construction	3-5 yrs	$$	
5	Suburban Streetscape improvements	City of Danbury, CT Department of Transportation (CT DOT)	Conduct detailed planning & refine concept	0-3 yrs	$$	
			Coordinate w/DOT	3-5 yrs	$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$	
6	Parking Lot Facelift w/Green Infrastructure & Pedestrian Connection	City of Danbury, Private Property Owners	Coordinate w/Private owners of Price Rite & affordable housing	0-3 yrs	$	
			Conduct detailed planning & refine concept	3-5 yrs	$$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$	
7	Develop Green Infrastructure Features	City of Danbury, CT Department of Transportation (CT DOT)	Coordinate with private property owner between State Street & Center Street	0-3 yrs	$	CT DEEP Climate Resilience Fund (DCRF) – approximately $10 million annually for planning and development of flood and heat resilience projects. EPA Community Impact Grants.
			Conduct detailed planning & refine concept	3-5 yrs	$$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$	
8	Neighborhood Pedestrian Linkages with Green Infrastructure & Cooling Stop	City of Danbury, Community	Conduct community engagement, planning & refine concept	0-2 yrs	$	
			Secure funding	2-3 yrs	$	
			Design, permitting, and construction	3-5 yrs	$$	
9	Ice Rink Cooling Center	City of Danbury, private owner	Secure MOA for use as City cooling center	0-1 yrs	$	
			Secure equipment and supplies	1-2 yrs	$$	
			Develop operational procedure	2-3 yrs	$	

Table: 1: Recommendations and next steps for Resilient Danbury. For more detailed information please see the final report:
Appendix G - Resilient Danbury Adaptation Options Final Report

4.2 South Norwalk

South Norwalk is a diverse and vibrant neighborhood along the Norwalk River and harbor in Norwalk, CT. The South Norwalk area contains a major railroad station with regional connections (South Norwalk Metro North station), numerous critical facilities, historic resources, and regional tourist attractions. Flood risks from storm surge and tidal flooding, as well as precipitation and stormwater induced flooding, present public safety challenges to residents both from nuisance flooding as well as impeding access to lifelines, and evacuation during moderate and major coastal storms. Much of the South Norwalk area is also vulnerable to extreme heat, as a result of dense commercial/industrial coverage along the waterfront with high amounts of impervious surfaces, and dense residential development west of the railroad, as well as relatively high social vulnerability among community residents. This project focused on developing a series of resilient corridors that include project designs that will help mitigate the impacts of climate induced flooding to key neighborhood and community assets while also mitigating the impacts of extreme heat for the community.

Woodward Avenue

Meadow Street

Longshore Drive

Fig. 21: Residents provided photos to the project team documenting flooding during Tropical Storm Ida along key road corridors in South Norwalk.

Fig. 22: CIRCA flood modeling shows the extent and depth of future flooding in the South Norwalk area with the addition of a 20" sea level rise.

Current and future conditions for flooding and heat within the study limits were analyzed; existing city infrastructure systems were reviewed; previous city planning reports were examined; site visits were conducted; and meetings were held with the City of Norwalk Planning staff and Advisory Committee, comprised of members of the city government and the community. Flood modeling was developed for the South Norwalk area to understand existing and future flooding conditions. Several key road corridors have experienced recent flooding from major storms as well as, tidal and nuisance flooding. The team analyzed potential flood pathways to understand what opportunities exist to elevate key road corridors and mitigate flooding at key intersections.

Three (3) public workshops, including a walking tour, were conducted to engage the community in the planning process, soliciting feedback to hear the concerns and needs, needed to assist the planning team in establishing the priorities for concepts. The first workshop, held in January 2023, introduced the project and presented the present-day and future flood and extreme heat conditions. The second workshop, held in June 2023, presented preliminary adaptation options, introducing the Resilient Toolkit which is a project-wide strategic concept. The third and last workshop was held in October 2023, included a walking tour of the Concord Street and Water Street section of the project. The preferred alternative, Elevated Roadways at Concord Street and Woodward Avenue, were presented to the community for discussion and comments.

In response to the unique challenges of increased flooding and extreme heat, the adaptation options for South Norwalk were designed under a Resiliency Toolkit Framework. This approach of projects of varied scales, provides flexibility for prioritization and implementation for the South Norwalk study area. It also provides guidance for replication throughout other areas of the city. Within the Toolkit Framework and based upon input from the city, stakeholders, and public, several strategies within the Toolkit were set as priorities for Resilient South Norwalk and prioritized for recommendations for concept design.

Fig. 23: Community stakeholders join the design team for a walking tour of South Norwalk, to discuss road flooding and resilient corridors. Photo credit: The Hour.

In response to the unique challenges of increased flooding and extreme heat, the adaptation options for South Norwalk were designed under a Resiliency Toolkit Framework. This approach of projects of varied scales, provides flexibility for prioritization and implementation for the South Norwalk study area. It also provides guidance for replication throughout other areas of the city. Within the Toolkit Framework and based upon input from the city, stakeholders, and public, several strategies within the Toolkit were set as priorities for Resilient South Norwalk and prioritized for recommendations for concept design.

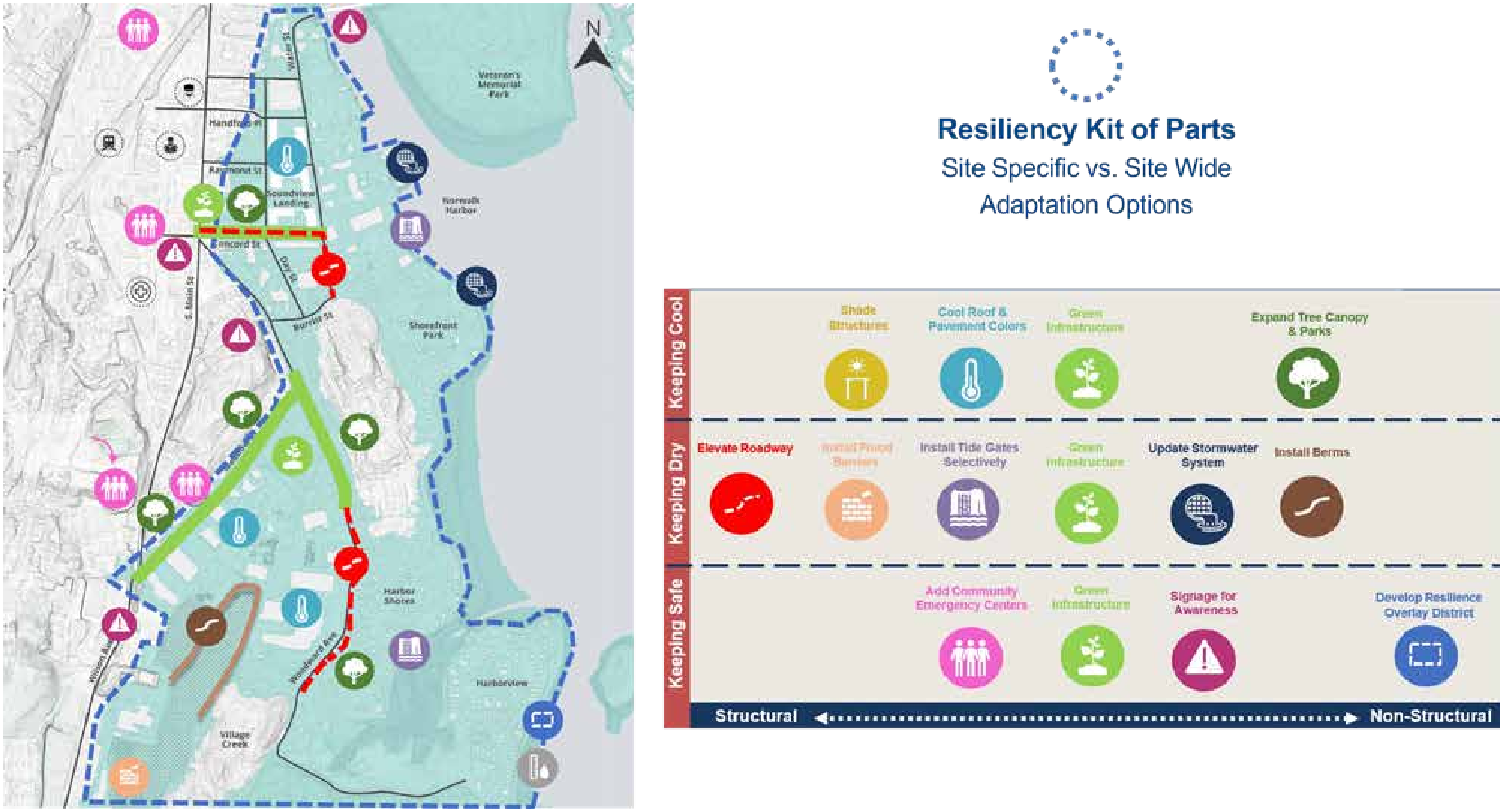


Fig. 24: Resilient South Norwalk resiliency tool-kit with recommendations for specific locations.

Two key roadway sections were selected to further develop concept designs with the goal of creating a resilient corridor extending throughout the project area. Raising Concord Street and Water Street to the Burritt Avenue intersection at the base of the Quintard Avenue to elevation 9.5 would create a continuous Resilient Corridor above the 2050, 10-Yr. projected flood level with sea level rise. (see Area 1). To the south, raising Woodard Avenue from Sable Street northward to Lowndes Avenue to elevation 9.5 would create a second section of a continuous Resilient Corridor. (see Area 2). These two raised roadway sections, with an existing elevated section of roadway at Quintard Avenue, creates a Resilient Corridor from Sable Street at Harbor Shores and Village Creek neighborhoods through to the intersection of Concord Street and South Main Street, outside of the projected flood limits.

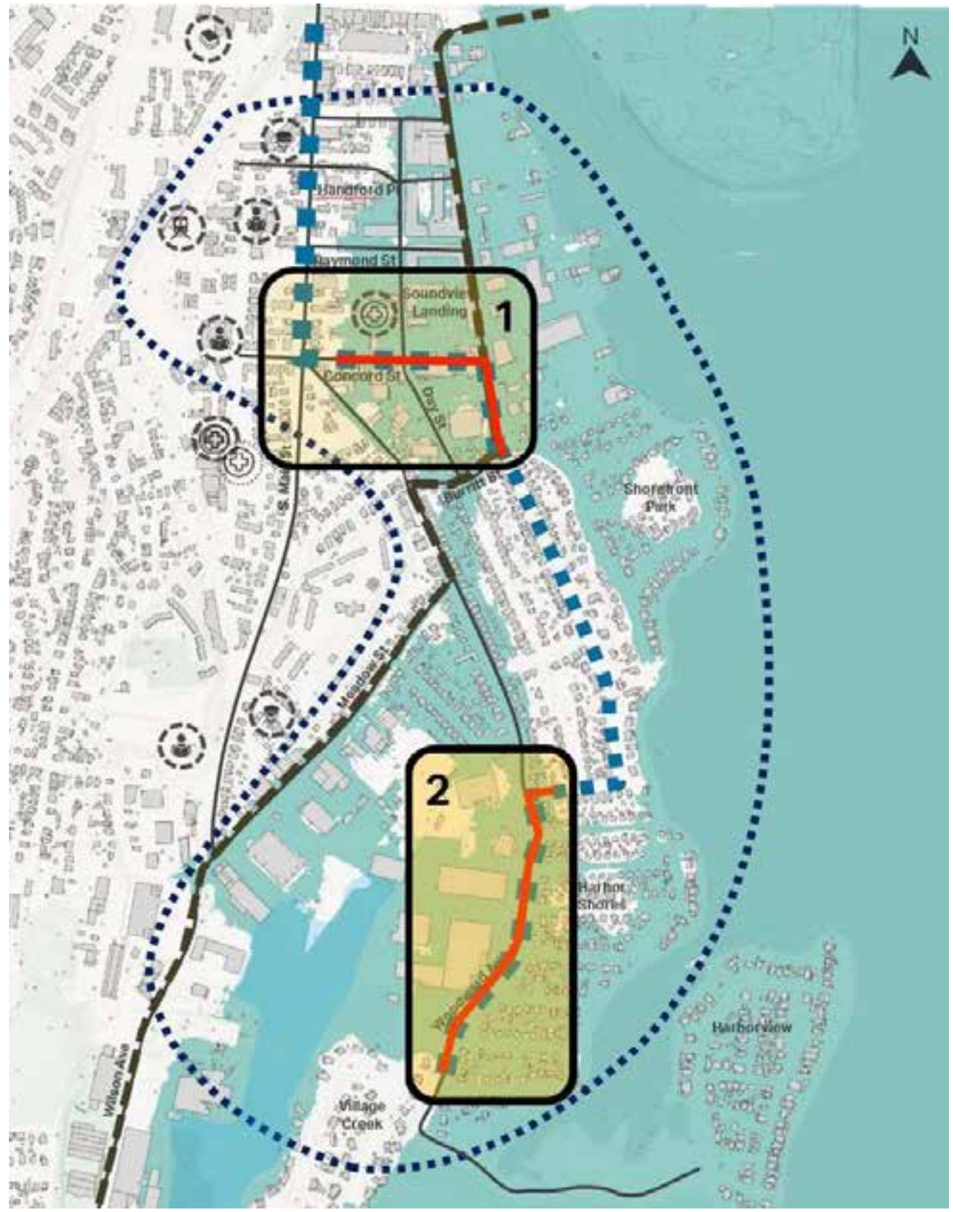


Fig. 25: Two areas were selected for further evaluation of road elevation concept designs to create a resilient corridor in South Norwalk.

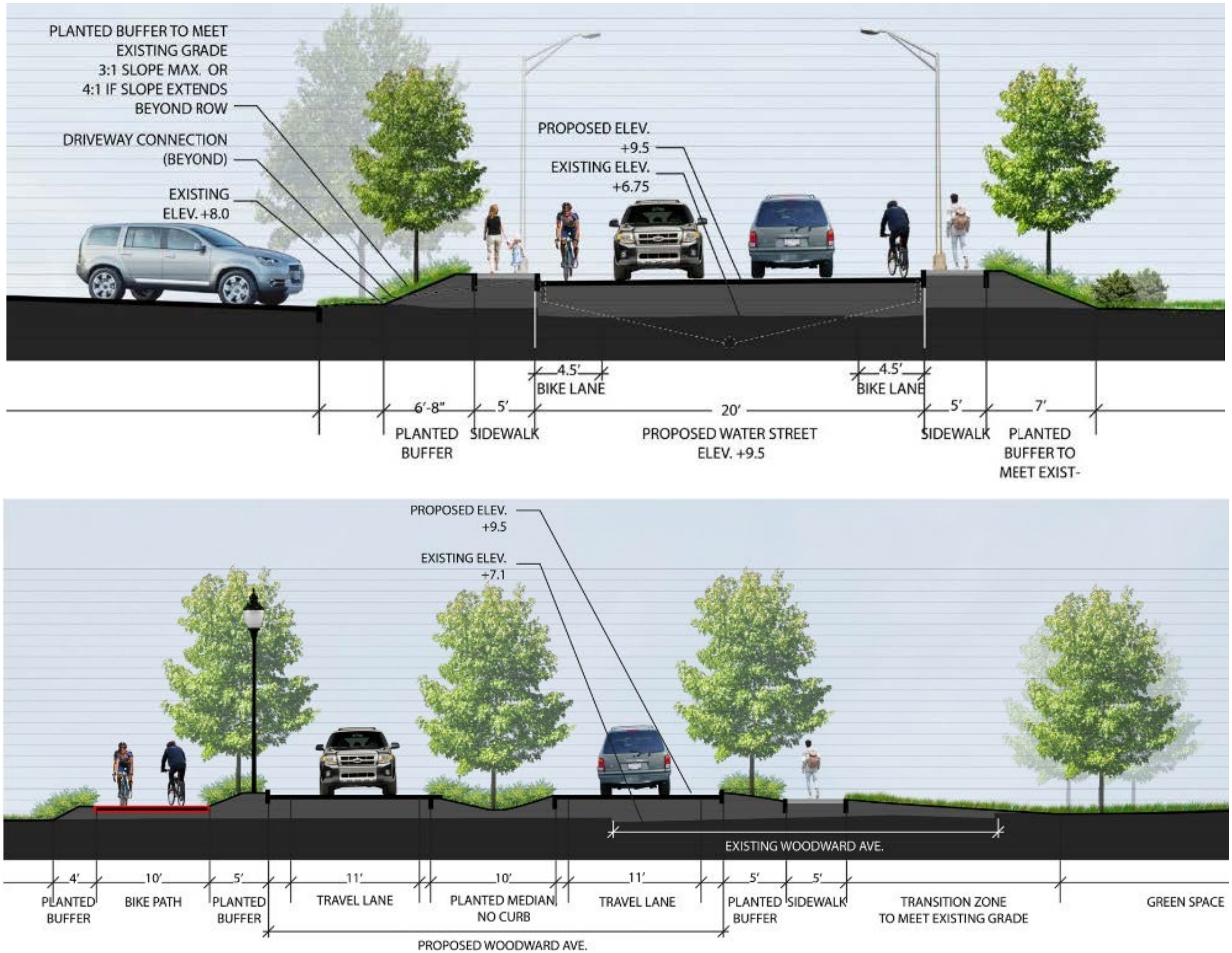


Fig. 26: Road elevation concept designs for Water Street and Woodward Avenue in South Norwalk.

In response to the unique challenges of increased flooding and extreme heat, the adaptation options for South Norwalk were designed under a Resiliency Toolkit Framework. This approach of projects of varied scales and levels of complexity provides flexibility for prioritization and implementation for the South Norwalk study area. It also provides guidance for replication throughout other areas of the city. Within the Toolkit framework and based upon input from the city, stakeholders, and public, several strategies within the Toolkit were set as priorities for Resilient South Norwalk. These recommended actions will need further study to determine feasibility and precise costs but have the potential to assist in protecting the community from some of the effects of climate change.

#	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Elevate Roadways	City of Norwalk, CT DOT	Maintain vehicular and emergency connections to areas within the study. The planning development of this option will need to include modeling of the flood limits.	3-5yrs	$$$	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Planning Grant (USDOT), (0% non-federal match) Design and Construction (10- 20% non-federal match depending on projects listing in CTDOT Resilience Improvement Plan) DEEP Climate Resilience Fund (Design) and National Coastal Resilience Fund (Design and Construction) for Natural and Nature Based Features (NCRF form NOAA and NFWF).
			Conduct detailed planning & refine concepts	0-3 yrs	$$	
			Coordinate w/DOT	3-5 yrs	$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$$	
2	Update Stormwater System	City of Norwalk	Update flood modeling, address upland flooding, pipe system backups, and restricted outfalls.	1-2yrs	$$	DEEP Climate Resilience Fund, Clean Water Fund, local capital improvement funding.
			Conduct detailed drainage study for area that includes South Main St., Day St., and Water St.	1-2yrs	$$	
3	Incorporate Green Infrastructure	City of Norwalk, CT DOT	Provide additional strategies to manage stormwater through permeable paving, stormwater planters, and curb extensions.	3-5yrs	$$	Long Island Sound Futures Fund, NFWF National Coastal Resilience Fund, DEEP Climate Resilience Fund, FEMA Building Resilient Infrastructure and Communities (BRIC).
			Coordinate with private property owners	0-3 yrs	$	
			Conduct detailed planning & refine concepts	3-5 yrs	$$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-10 yrs	$$	
4	Expand the Urban Tree Canopy	City of Norwalk	Provide comfortable corridors for pedestrians and bicyclists, providing a healthy and safe environment for the community.	Ongoing	$	DEEP Urban and Community Forestry Grants, EPA's Environmental and Climate Justice Community Change Grants. EPA is accepting applications on a rolling basis for $2 billion in Inflation Reduction Act funding available to support community-driven projects that build capacity for communities to tackle environmental and climate justice challenges, strengthen their climate resilience, and advance clean energy.
			Conduct community engagement, planning & refine concepts	0-2 yrs	$	
			Secure funding	1-2 yrs	$	
			Design, permitting, and construction	2-3 yrs	$	
5	Add Signage	City of Norwalk	Establish and mark limits of climate impact zones and increase the opportunities to educate the public about heat and flood.	1-2yrs	$	Local capital improvement funding.
6	Establish a Resiliency Hub	City of Norwalk, CIRCA, Community-Based Organizations	Promote development of flood and heat resistant corridors to support future resilient design planning.	Ongoing	$$	EPA's Environmental and Climate Justice Community Change Grants. DEEP Climate Resilience Fund. FEMA BRIC.
			Engage community stakeholders around needs for back up power, services, and recovery support.	0-1 yrs	$	
			Assess potential sites for resiliency hub	1-2 yrs	$	
			Design and permit resiliency improvements	2-3 yrs	$	
			Implement resiliency projects at hub sites	3-5 yrs	$$	
7	Develop a Resilience Overlay District	City of Norwalk, CIRCA	Define the areas that are most impacted by flooding and provide a roadmap for future developers to consider.	1-2 yrs	$	DEEP climate Resilience Fund, Local municipal funds.
			Develop flooding and heat resiliency design guidelines for new construction.	1-2 yrs	$	
			Adopt resiliency overlay district.	2-3 yrs	$	

Table: 2: Recommendations and next steps for Resilient South Norwalk. For more detailed information please see the final report:
Appendix H - Resilient South Norwalk Adaptation Options Final Report

4.3 Downtown Fairfield

Downtown Fairfield is the economic hub of the Town of Fairfield, CT and an important regional asset in Fairfield County. The downtown area is situated on relatively higher ground surrounded by a broad coastal floodplain to the south, the 0.2% annual chance floodplain along the Mill River to the west, and the 0.2% and 1% annual chance flood plains associated with Turney Creek to the east. Although the downtown area (Carter Henry Drive, Miller Street, Sanford Street, Unquowa Road, Unquowa Place, and the adjacent section of the Boston Post Road) is not directly mapped in a FEMA flood zone, it has experienced flash flooding during heavy precipitation events due to the extensive impervious surfaces and the limited capacity of the stormwater management system. Evacuation routes and arterial/collector roads from areas of flood risk such as Reef Road, Beach Road, and the Boston Post Road converge in downtown Fairfield. Although these roads converge outside a FEMA flood zone, stormwater flooding often occurs. This creates a unique situation where the downtown cannot function as a resilient hub for the community. Flood risks from storm surge and tidal flooding, extreme precipitation, and riverine flooding occurring simultaneously would present significant public safety challenges to residents, hinder the use of transit, and impair numerous small businesses in the downtown area. This project focuses on adapting to current and future climate induced flooding impacts to transportation routes and major corridors within the neighborhood.

A review of the existing conditions at the four underpasses and within downtown confirmed the vulnerability echoed by the community. The underpasses currently experience flooding due to intense rain events, and the flooding can be further exacerbated when a storm system is accompanied by a storm surge, which further hinders the functionality of the existing drainage network. Of note, stormwater throughout the downtown area is collected by drainage systems which outlet to nearby waterways. The drainage systems used by the key underpasses drain to waterbodies south of the rail line, which are already taxed during an intense rain event. Mapping of the existing drainage system was overlayed with future flood conditions to better understand the various contributing factors to flooding at each underpass, and how those factors may worsen with sea-level rise.

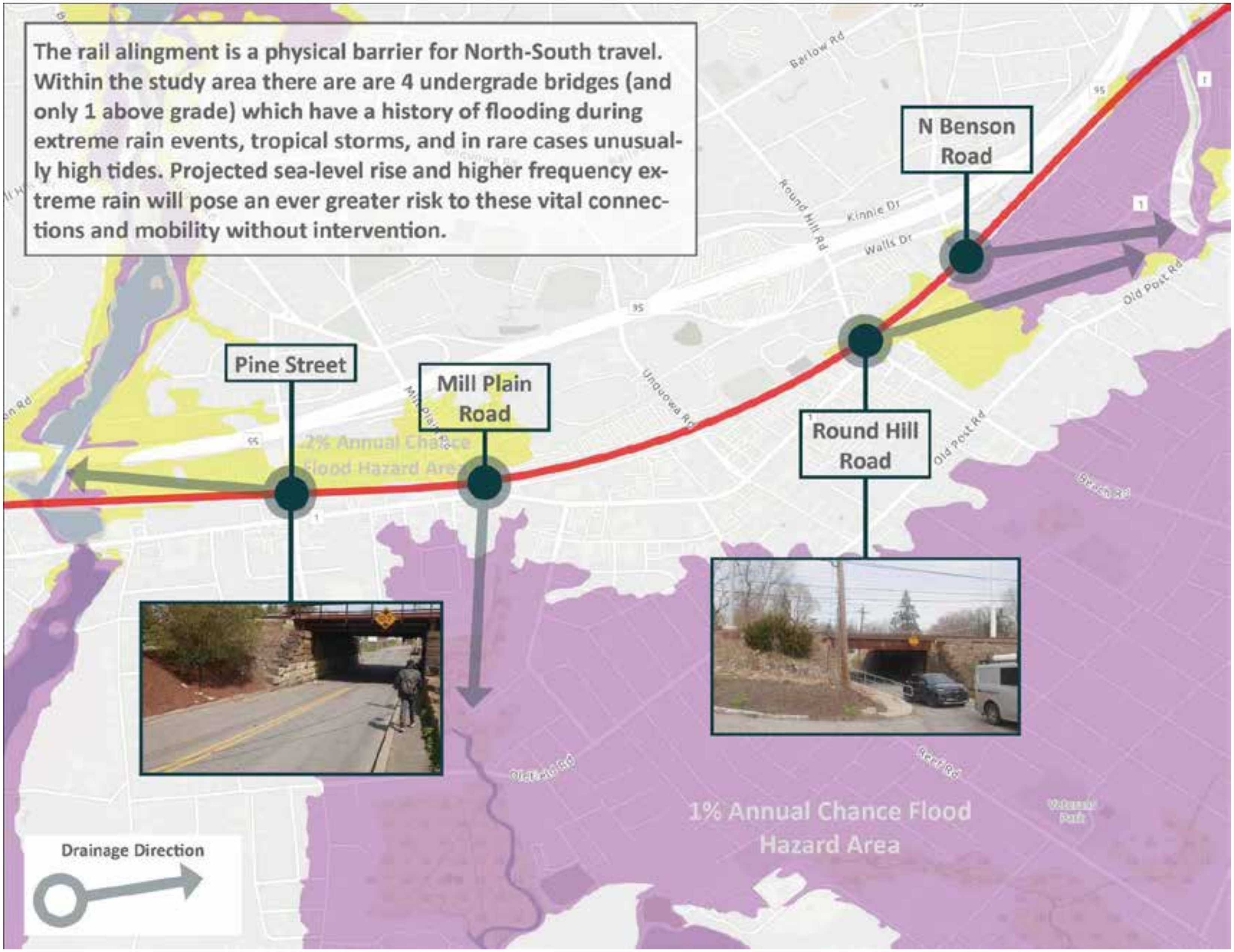


Fig. 27: Four underpasses in Downtown Fairfield are subject to flooding due to combinations of factors such as high intensity precipitation events and tidal storm surge.

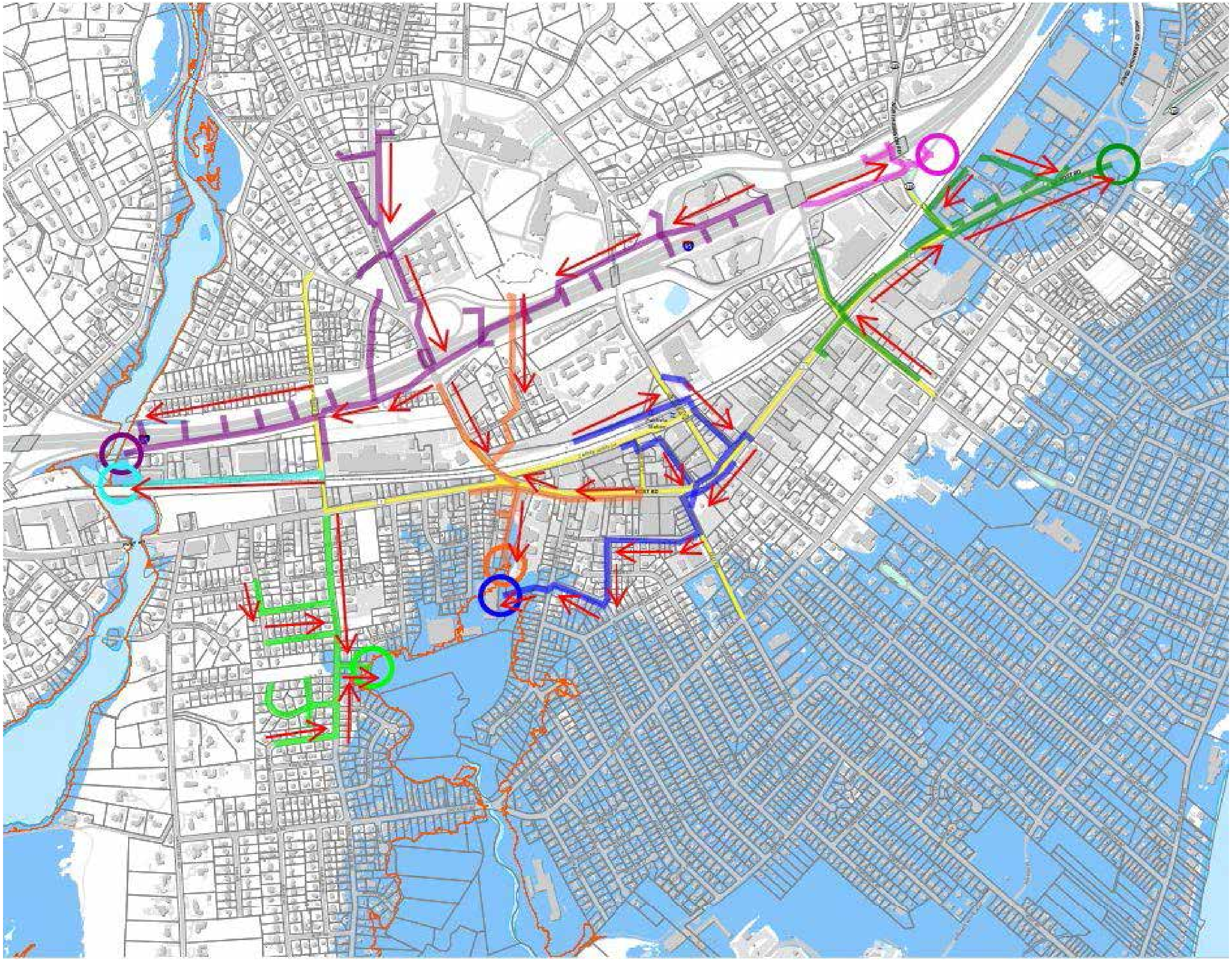


Fig. 28: Drainage networks for each underpass in Downtown Fairfield, overlayed with the extent of projected future 1% annual chance coastal flooding conditions with 20" of sea-level rise. Future tidal flooding conditions will continue to reduce the capacity of the existing drainage system to manage stormwater at the underpasses.

An initial set of adaptation options was developed encompassing three primary types of treatments: green infrastructure, flood control, and infrastructure modifications. These alternatives were used to discuss potential actions and projects with the advisory committee and through community engagement activities. Each adaptation strategy was analyzed using the PERSISTS framework to better understand their viability moving forward. A Benefit-Cost Analysis (BCA) was performed to examine viability. The preliminary analysis was conducted using the USDOT Guidance for Discretionary Grant Programs, then, a custom model was developed to estimate the future costs and benefits for the proposed project over a 20-year analysis period. The alternatives listed below had reasonably high benefit-cost ratios, which resulted in recommendations to further investigate for possible implementation.

Fig. 29: Potential strategies considered for each underpass in Downtown Fairfield.

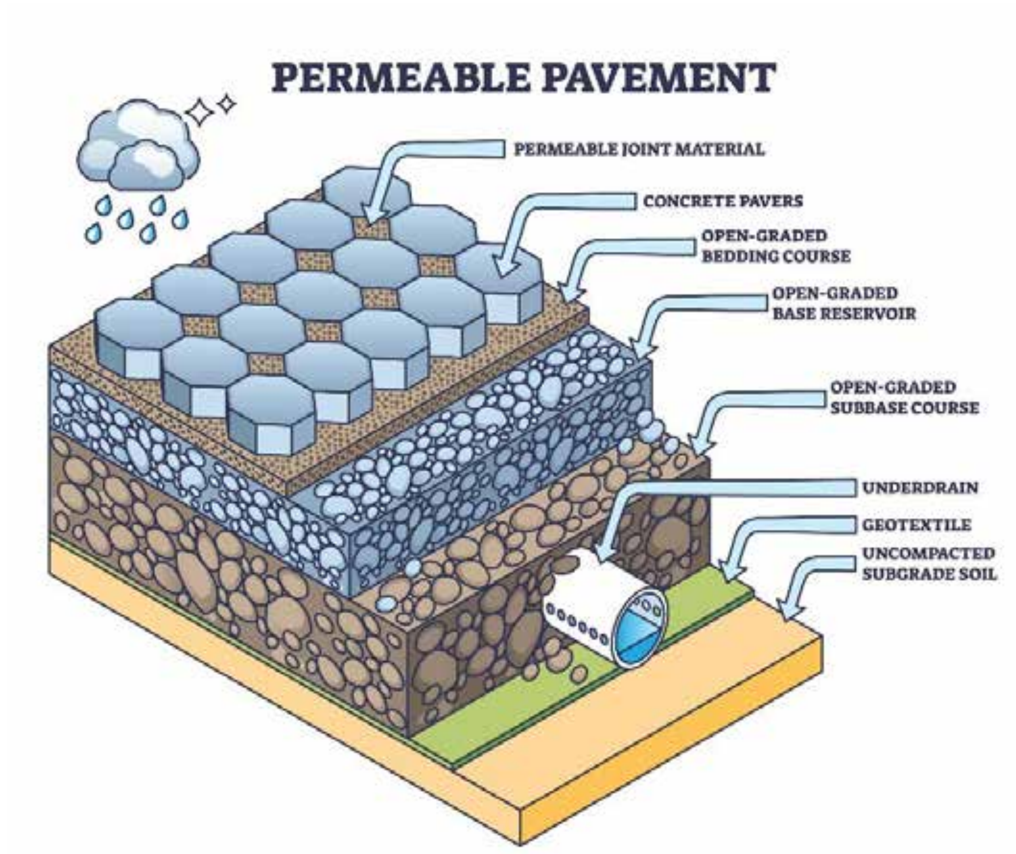


Fig. 30: Permeable pavement and green infrastructure retrofits proposed for the I95 northbound on-ramp median at North Benson Road in Downtown Fairfield.

In addition, green infrastructure (GI) retrofits to the I95 northbound on-ramp median are recommended to increase infiltration of stormwater from the highway entering the drainage system on North Benson Rd. This alternative proposes the construction of a bio-swale and/or a bio-infiltration basin to be deployed near the ramps on North Benson Rd, reducing the rate and volume of stormwater entering the existing drainage network. A bioswale could help mitigate peak flows, while a bio-infiltration basin could help promote stormwater runoff retention, storage, and infiltration from smaller, more frequent storm events.

Warning & Monitoring:

For North Pine Creek Road, Mill Plain Road, Round Hill Road, North Benson Road in the event of flooding at an underpass, a flooding warning system would automatically detect a flooded roadway and deploy barriers to close the road. This alternative is responsive to community concern around getting stuck at underpasses and would prevent people from attempting to cross a flooded roadway. Sensing of water can be accomplished by cameras or weight-based sensors that report water accumulation above a certain level. Once activated, the sensor triggers flashing signage and lowers a gate that physically prevents drivers from passing.

Fig. 31: Example of a traffic gate that could be triggered by flood sensors deployed at underpasses in Downtown Fairfield, CT.

Drainage Improvements:

Mill Plain Road, Round Hill Road Upsizing stormwater piped below the underpasses and parts of the downstream systems may help reduce localized flooding issues due to stormwater. Pipe sizes should be increased to remove constrictions in pipe runs that have been identified in the existing system. Upsizing the drainage system will increase the capacity within the pipes, which will prevent water from backing up and flowing back out of the catch basins during a storm event.

Mill Plain Road - Widened Underpass

Assessment of a Widened Underpass at Mill Plain Road Using PERSISTS Decision Support Criteria:

PERMITTABLE: This alternative would require significant coordination between state agencies and rail operators.

EQUITABLE: This alternative would provide significant resilient corridor benefits through enhancing bike and pedestrian connectivity in addition to its flood mitigation potential.

REALISTIC: This alternative presents some engineering and staging challenges given its impacts to an active rail corridor.

SAFE: The alternative would significantly improve the safety of the corridor for cyclists and pedestrian moving through the area.

INNOVATIVE: This alternative addresses the flooding concern from a new direction and focuses on alternative modes and views the road flooding mitigation as a secondary concern.

SCIENTIFIC: This alternative responds to the 'resilient corridor' focus of CIRCA by improving safety for multimodal users.

TRANSFERABLE: The New Haven Line extends the length of the Connecticut shoreline; many communities face similar flooding concerns and underperforming bike and pedestrian networks.

SUSTAINABLE: There has been public support for alternative pedestrian/bicycle facilities. It is considered sustainable since it benefits the surrounding environment and society.

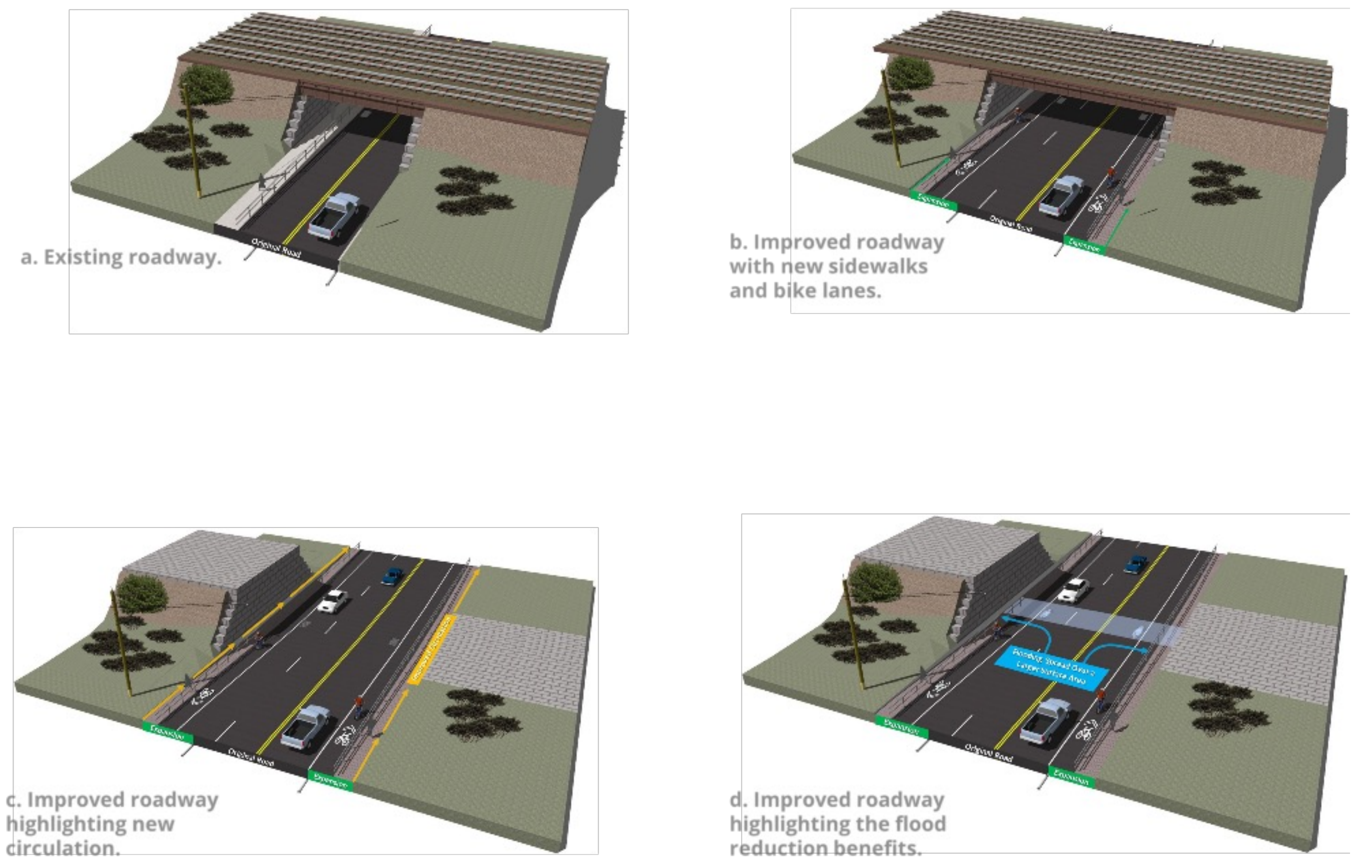


Fig. 32: Summary of PERSISTS analysis of underpass widening alternatives at Mill Plain Road in Downtown Fairfield, CT.

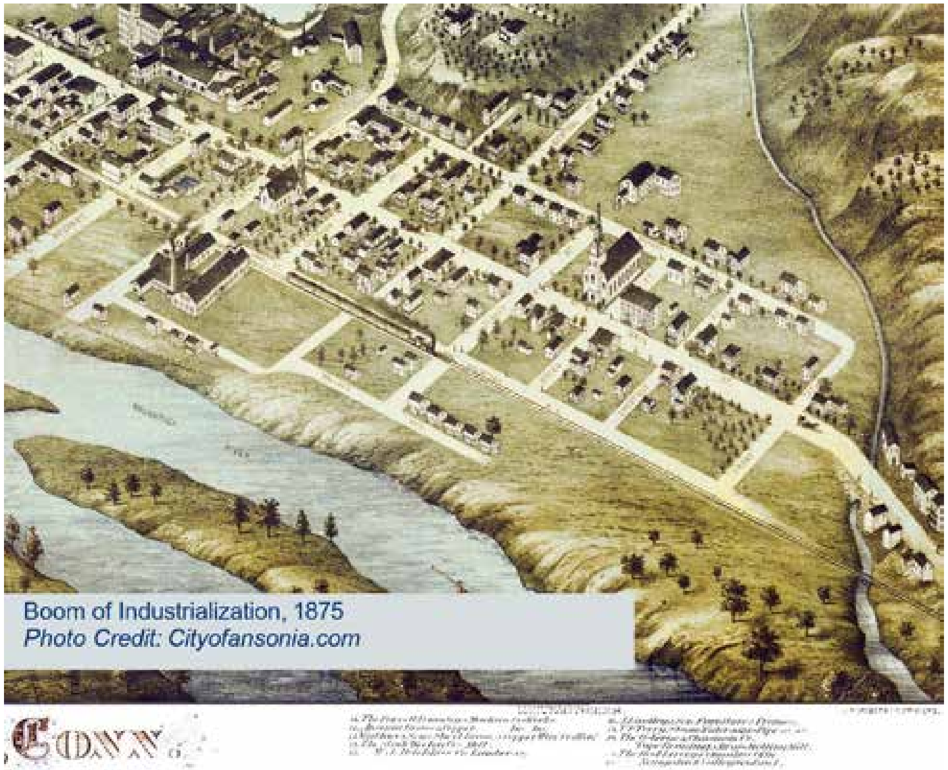
#	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Install Flood Warning & Monitoring Systems at North Pine Creek Road., Mill Plain Road, Round Hill Road, North Benson Road	Town of Fairfield, CT DOT	In the event of flooding at an underpass, a flooding warning system would automatically detect a flooded roadway and deploy barriers to close the road. This alternative is responsive to community concern around getting stuck at underpasses and would prevent people from attempting to cross a flooded roadway.	1-3 yrs	$	Building Resilient Infrastructure and Communities, FEMA. Building Resilient Infrastructure and Communities (BRIC) supports states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. The program's guiding principles are supporting communities through capability and capacity building; encouraging and enabling innovation; promoting partnerships; enabling large infrastructure projects; maintaining flexibility; and providing consistency.
			Conduct detailed planning & refine concepts	0-1	$	
			Coordinate w/DOT	1-2 yrs	$	
			Secure funding	1-2 yrs	$	
2	Green Infrastructure Improvements: Mill Plain Road	Town of Fairfield	Green infrastructure (GI) retrofits to the Fairfield Rail Station parking lot are proposed as part of the strategy for Mill Plain Rd to mitigate runoff entering the drainage network.			
			Conduct detailed planning & refine concept	2-3 yrs	$$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-7 yrs	$$	
3	Green Infrastructure Improvements: North Benson Road	Town of Fairfield, CT DOT	green infrastructure (GI) retrofits to the I91 northbound on-ramp median are recommended to increase infiltration of stormwater from the highway entering the drainage system on North Benson Rd.	2-5 yrs	$$	
			Conduct detailed planning & refine concept	2-3 yrs	$$	
			Secure funding	3-5 yrs	$	
			Design, permitting, and construction	5-7 yrs	$$	
4	Drainage Improvements: Mill Plain Road	Town of Fairfield, CT DOT	Upsizing stormwater piped below the underpasses and parts of the down stream systems may help reduce localized flooding issues due to stormwater.	3-5 yrs	$$$	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT), Federal Highway Administration. The vision of the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Discretionary Grant Program is to fund projects that address the climate crisis by improving the resilience of the surface transportation system, including highways, public transportation, ports, and intercity passenger rail. Projects selected under this program should be grounded in the best available scientific understanding of climate change risks, impacts, and vulnerabilities. They should support the continued operation or rapid recovery of crucial local, regional, or national surface transportation facilities. Furthermore, selected projects should utilize innovative and collaborative approaches to risk reduction, including the use of natural infrastructure, which is explicitly eligible under the program.
			Conduct field survey and detailed modeling of upstream drainage networks.	1-2 yrs	$$	
			Complete preliminary design	2-3 yrs	$$	
			Secure construction funding	3 yrs	$	
			Final design, permitting, and construction	3-5 yrs	$$$	
5	Drainage Improvements: Round Hill Road and North Benson Road	Town of Fairfield, CT DOT	Upsizing stormwater piped below the underpasses and parts of the down stream systems may help reduce localized flooding issues due to stormwater.	3-5 yrs	$$$	
			Conduct field survey and detailed modeling of upstream drainage networks.	1-2 yrs	$$	
			Complete preliminary design	2-3 yrs	$$	
			Secure construction funding	3 yrs	$	
			Final design, permitting, and construction	3-5 yrs	$$$	
6	Policy Recommendations	Town of Fairfield	A range of policy options may help to increase onsite retention and reduce stormwater from entering the system, affecting underpasses.	2-5 yrs	$	
			Engage stakeholders on implementing a Stormwater Authority.	1-2 yrs	$	
			Feasibility assess,emt and data collection for stormwater fee.	1-2 yrs	$	
			Create a zoning overlay for properties that directly contribute stormwater to the underpasses.	1-2 yrs	$	
			Implement a stormwater authority ordinance	2-3 yrs	$	

Table: 3: Recommendations and next steps for Resilient Fairfield. For more detailed information please see the final report: *Appendix I – Resilient Fairfield Adaptation Options Final Report*

4.4 Ansonia

Ansonia, Connecticut is a city in New Haven County located inland along the Naugatuck River just North of Derby. Ansonia is also a member of the Naugatuck Valley Council of Governments (NVCOG), which is a metropolitan planning organization based along the Naugatuck River. The city is also served by the Connecticut Transit Bus Carrier and the Metro-North Railroad commuter rail service that connect residents to cities on the coast such as New Haven, Bridgeport and Stamford. Additionally, state Route 8 serves Ansonia Northbound on exit 19 and southbound on exit 19. Ansonia, has a commitment to transit and supporting passenger rail, along with existing affordable housing, but also has high social, heat, and flood vulnerabilities. The city currently supports 15% low to moderate income housing which is subsidized. To remain resilient, Ansonia will need to ensure that redevelopment is not at risk of flooding, that people have access to options for mitigating extreme heat, and that transit remains available and viable during extreme events that may be exacerbated by climate change. The Resilient Ansonia project focuses on adapting to current and future climate induced flooding impacts in the downtown area and mitigating extreme heat impacts for residents.

Key questions under consideration within Ansonia are whether, and how, future flooding could overtop or otherwise adversely affect the existing flood protection system along the Naugatuck River; whether 0.2% flood zones along Olson Drive parcels could face increasing flood risks; and whether future redevelopment and a new connector road can foster connectivity in the TOD area while providing opportunities for extreme heat relief and mitigation.



Boom of Industrialization, 1875
Photo Credit: Cityofansonia.com

Fig. 33: Overview of downtown Ansonia with key transportation corridors and assets highlighted.

Once a thriving riverside community, Ansonia is now largely detached from the river's edge with only a small section of the east bank free of the flood barrier protecting the city from riverine flooding events. Yet, the impacts of industrialization remain, with dense development and large areas of impervious surfaces still pervasive throughout the downtown landscape. With climate change projected to bring about more extreme heat and precipitation, the city is poised to intervene again and make changes that will ensure a more resilient future.

As part of the analysis of existing conditions, maps were reviewed showing land surface temperatures within the greater context of Connecticut's coastline, as well as a more detailed view of relative temperature increase within the project area. Heat vulnerability maps were generated using data derived from Landsat-8 Thermal Infrared Sensor data and help identify areas of concern for heat stress within the downtown area. The study compared temperature increase with population count to help inform the correlation between urban density and heat island impact. This analysis revealed that Ansonia is heating at twice the rate as nearby communities, despite having comparable population sizes. The data also revealed that Ansonia's downtown area seasonally experiences an increased temperature of 8-to-16 degrees Celsius relative to surrounding areas. To address these issues, the planning team looked more closely at some of the contributing factors on a localized scale to identify potential strategies and projects to reduce heat vulnerabilities.

In addition, a future precipitation event was modeled, indicating the existing flood protection system is likely high enough to prevent overtopping of the Naugatuck River into Downtown Ansonia, although the capacity of pumping stations that manage stormwater flows behind the levy should be more closely evaluated under future conditions to inform stormwater management over time.

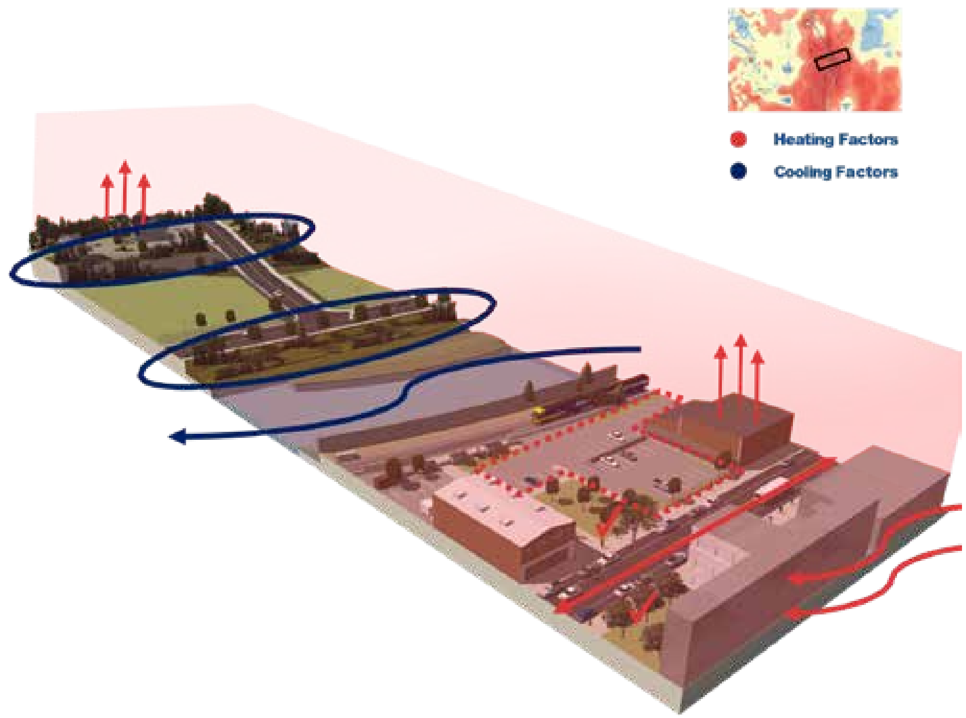


Fig. 34: Landscape features in Downtown Ansonia that contribute to heating and cooling. Large areas of impervious surfaces in and around the Ansonia Metro North train station radiate heat into the surrounding environment resulting in an urban heat island for pedestrians downtown.

A Resilience Planning “Kit of Parts” was created to organize and group green design strategies into overarching themes, which all contribute to the area’s ability to adapt to changing climate demands. These parts are designed to inspire swift problem-solving with long-term resiliency in mind. Themes that were incorporated into concept designs for Ansonia included:

- Link: Link and enhance existing public parks through green infrastructure improvements and integration into green corridors.
- Accessibility: Bike path enhances accessibility and creates missing link in Naugatuck River Greenway path network; Planted bump-out and crossings for improved visibility and accessibility.
- Multi-use: Multi-use spaces in ROW & flexible public parks encourage vibrant and resilient downtown.
- Infrastructure: Maintain existing flood protection system; Solar infrastructure and EV changing stations promotes green Ansonia.
- Engage: Engaging with river’s edge creates opportunity for new amenities, educational programing, and events; Outlooks embrace Ansonia’s relationship to the Naugatuck River; Signage for public amenities & education.

The following locations in Ansonia were chosen to demonstrate how these resilient design strategies could be applied throughout the downtown. The first location on Main Street by the train station is in the heart of historic downtown. Main Street is subject to pluvial flooding risk, which is worsened by abundant impervious surfaces throughout the industrial landscape. East Main Street is also significantly paved, however the existing wide roadway and the large parking lot across from the Veterans’ Memorial Park, offers the opportunity for additional green infrastructure and energy innovation. On the other side of the river, Olson Drive and Riverside Drive are associated with plots that are marked for future development, such as Nolan Field to the south and The Copper and Brass Facility to the North. These are also opportune locations to continue the Naugatuck River Greenway biking network that connects the region.

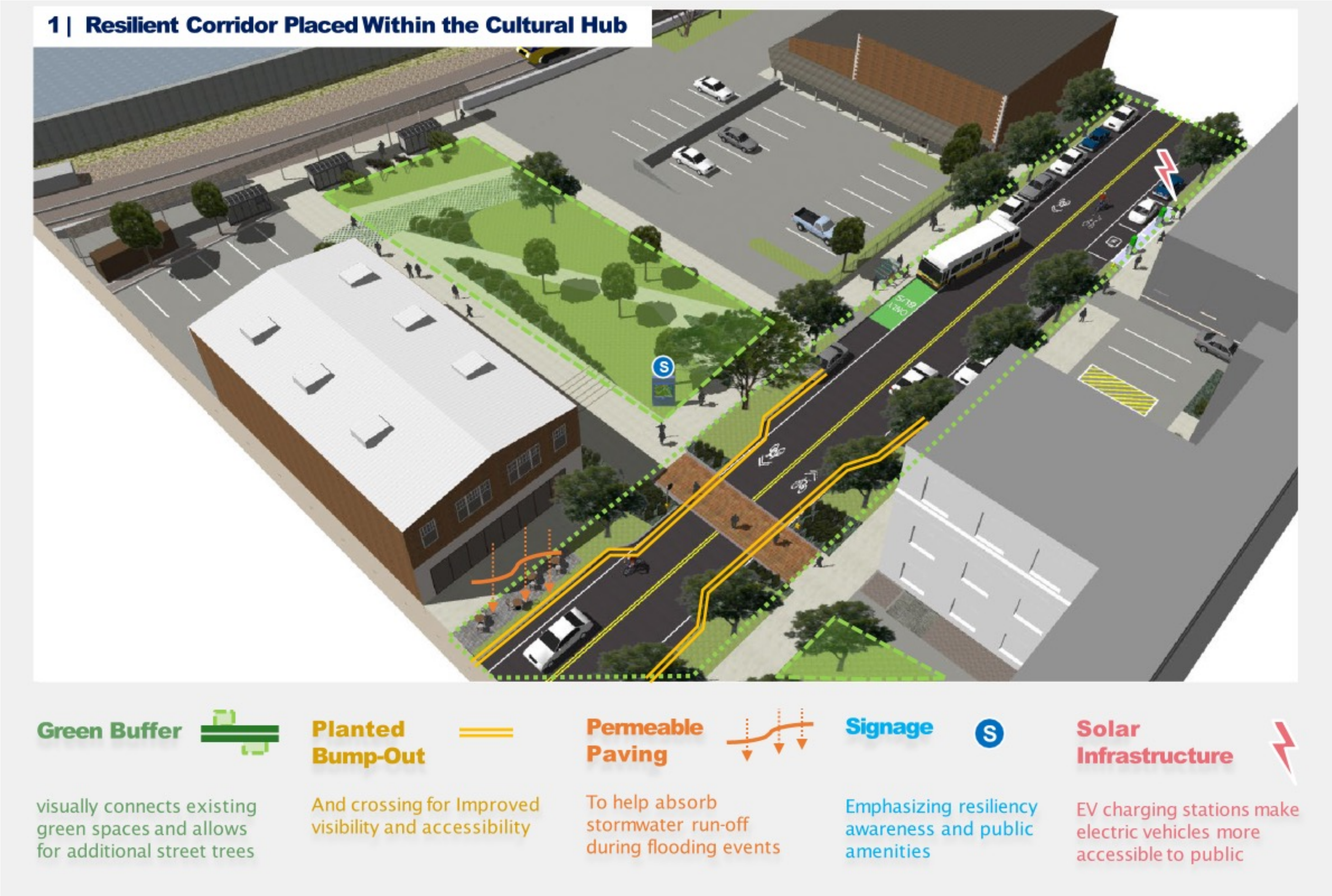


Fig. 35: Concept plan for Main Street Downtown Ansonia, featuring green infrastructure for stormwater management and cooling as well as solar infrastructure to support renewable energy deployment.

Several concepts were developed as potential projects or strategies that can be incorporated into Ansonia's redevelopment, roadway, and capital improvement planning. The need for additional cooling strategies also revealed the potential for a new cooling center which could act as a "resilience hub" for residents in Ansonia. The Ansonia Armory was identified as an ideal location, accessible by public transportation, and strategically situated among Ansonia's vulnerable populations. A resilience hub can provide cooling, clean air, backup power during outages, and provide services and support before, during and after a natural hazard event. An initial concept for the Armory resilience hub was developed looking at issues such accessibility, square footage, potential backup power considerations, and others.

NAME	AREA (sqft)	AREA RANKING	PARKING LOT AREA (sqft)	PARKING RATING	DISTANCE FROM NEAREST BUS STOP	BUS ROUTE RANKING	HEAT VULNERBILITY RANKING	CULTURAL NEUTRALITY RANKING	FINAL RANKING
Ansonia High School/Middle School	97326	5	46037	5	750	3	3	5	4.2
Ansonia Armory	14250	5	22042	5	0	5	4	5	4.8
Ansonia Arms Department	8981	4	103966	5	0	5	4	4	4.4
Senior Community Center (Ansonia Police Department)	24642	5	41054	5	0	5	4	3	4.4
Clinton AME Zion Church	1750	3	14406	4	250	5	3	3	3.6
St. Joseph's Parish	3944	3	3063	2	750	3	4	3	3
Three Saints Orthodox Church	6064	4	5553	3	250	5	3	3	3.6
The Boy's & Girls Club	4288	3	28497	5	250	5	3	5	4.2
Saint Peter & Saint Paul Ukrainian	8357	4	14549	4	0	5	3	3	3.8
Team, Inc. Early Care & Education Center	7257	4	15923	4	0	5	3	5	4.2
Liberty Hall	5290	4	0	1	1000	2	3	5	3
Macedonia Baptist Church	2313	3	9640	3	0	5	3	3	3.2
Ansonia Public Library	6669	4	0	1	500	4	4	5	3.6
City Hall	11171	5	95231	5	0	5	4	5	4.8
Derby Police Department	15138	5	68918	5	1250	1	5	3	3.8
Walnut Hill Community Church Valley	12125	5	9651	3	0	5	4	3	4
St. Mary St Michael School	15027	5	26348	5	0	5	4	5	4.8
Derby Public Library	4294	3	0	1	0	5	4	5	3.6
St. Mary's Church	9018	4	21827	5	0	5	5	3	4.4
Irving School	30781	5	11485	4	0	5	4	5	4.6

Table: 4: Potential cooling center locations accessible to Downtown Ansonia were ranked using different indicators of site suitability.

Number	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Develop clean and accessible energy sources	Town of Ansonia, Eversource	Support development of solar energy and electric vehicle charging facilities throughout project area	1-2 yrs	$$	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Planning Grant (USDOT), (0% non-federal match) Design and Construction (10- 20% non-federal match depending on projects listing in CTDOT Resilience Improvement Plan) DEEP Climate Resilience Fund (Design) and National Coastal Resilience Fund (Design and Construction) for Natural and Nature Based Features (NCRF form NOAA and NFWF).
2	Resilience Center Development	Town of Ansonia, Community Service Organizations, CIRCA	Update public building to accommodate vulnerable members of the community during a climate emergency	1-2 yrs	$$	
3	Incorporate Green Infrastructure	Town of Ansonia, CT DOT	Provide additional strategies to manage stormwater through permeable paving, stormwater planters, and curb extensions.	1-2 yrs	$$	
4	Expand the Urban Tree Canopy	Town of Ansonia, Community Service Organizations	Provide comfortable corridors for pedestrians and bicyclists, providing a healthy and safe environment for the community.	Ongoing	$	
5	Add Signage	Town of Ansonia	Establish and mark limits of climate impact zones and increase the opportunities to educate the public about heat and flood.	1-2 yrs	$	
6	Expand the Resiliency Hub	Town of Ansonia, CT DEHMS, CT DOT	Promote development of core roadways to support key evacuation routes and future resilient design planning	Ongoing	$$	
7	Develop a Resilience Overlay District	Town of Ansonia, CIRCA	Define the areas that are most impacted by flooding and provide a roadmap for future developers to consider.	3-5 yrs	$	

Table: 5: Recommendations and next steps for Resilient Ansonia. For more detailed information please see the final report:
Appendix J - Resilient Ansonia Adaptation Options Final Report

4.5 Stratford South End

The South End neighborhood of Stratford was assessed to have high current and future flood risks and identified as a critical priority for the Town of Stratford in its community resilience plan (2016). As Stratford has moved forward with implementation of the recommendations from the plan, several flood protection projects have been pursued towards the goal of creating a town-wide flood protection system. However, challenges and barriers to implementation have stalled some strategies from the plan. In particular, potential interactions between the Great Meadows saltmarsh, key state road segments managed by CT DOT, and operations related to Sikorsky Airport, have created permitting and negotiation challenges for identifying consensus solutions that would allow the town to move forward with a flood protection strategy. The Phase III planning project focused on detailed review of the proposed flood mitigation strategies from Stratford's community resilience plan, provided an assessment of ongoing implementation challenges, and recommended updated or alternative strategies that can be developed as implementable projects, to maximize the town's resilience goals for the South End community. These alternative strategies included revisions or alternative alignments of key flood protection segments; site-scale flooding accommodation strategies for critical community assets; additional road and infrastructure elevations to support the creation of resilient corridors; green infrastructure or nature-based strategies to improve open space for flood management; and/or combinations of the above to create buffers and multiple layers of resilience for the continued long-term viability of the South End.

The initial phases of the project focused on assessment of the previously identified strategies from the coastal resilience plan, and conversations with the South End community related to the previously proposed projects. A workshop was held in December 2022 to engage with residents and stakeholders about flooding issues in the South End. The workshop was a gallery-style event. Participants circulated among seven stations which presented information and solicited input from attendees. Participants included South End residents, business owners and employees from the South End, local officials and staff, state officials and staff, active citizens and members of various Stratford boards. The workshop helped to reintroduce the town's planning efforts to date, reiterate community priorities regarding both coastal and stormwater induced flooding in the South End, and inform the direction of the project.

Fig. 36: Community members from the South End of Stratford review and discuss resilience strategies from the Town of Stratford Coastal Resilience Plan, at a Resilient Connecticut Phase III workshop on December 5th, 2022.

Orange Street Greenway (wider)

Multifunctional Landscape

A One vehicular route
B Multi-use path
C Stormwater storage areas with native plantings
D Crosswalk improvements

Greenway with Stormwater Storage
Orange Street
R.O.W + voluntary pre-disaster buyouts

Fig. 37: Concept for stream daylighting and green infrastructure retention basin for stormwater management along Orange Street in the South End of Stratford.

#	Recommendation	Organization	Action	Timeline	Cost	Funding Source
1	Project A Commercial Industrial Area Levee Segment/Reach	Town of Stratford	Assess the performance of this segmant with a 2D Hydrodynamic Overland Flood Model.	1-2 yrs	$	DEEP Climate Resilience Fund for assessing the performance of the individual segments with a 2D Hydrodynamic Overland Flood Model and FEMA Building Resilient Infrastructure and Communites (BRIC) 25% non-federal match if BCA for Individual Segment is greater than 1.0.
			Conduct detailed planning & refine concept.	2-3 yrs	$$	
			Coordinate with private properties and secure any needed easements.	2-3 yrs	$$	
			Secure funding.	2-3 yrs	$	
			Design, permitting, and construction.	5-7 yrs	$$$	
2	Project B Lordship Boulevard (State Route 113) and Marine Basin Levee Segment/Reach	Town of Stratford , CT DOT, City of Bridgeport	Assess the performance of this segmant with a 2D Hydrodynamic Overland Flood Model.	1-2 yrs	$	DEEP Climate Resilience Fund for assessing the performance of the individual segments with a 2D Hydrodynamic Overland Flood Model and Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Planning Grant (USDOT) for Access Road and Route 113 Feasibility Study (0% non-federal match) Design and Construction (10- 20% non-federal match depending on projects listing in CTDOT Resilience Improvement Plan) DEEP Climate Resilience Fund (Design) and National Coastal Resilience Fund (Design and Construction) for Marine Basin Natural and Nature Based Features (NCRF form NOAA and NFWF).
			Coordinate with CT DOT, Sikorsky Airport, and City of Bridgeport and conduct detailed planning and feasability assessment.	2-3 yrs	$$	
			Secure funding.	2-3 yrs	$	
			Design, permitting, and construction.	5-7 yrs	$$$	
3	Project C Access Road Levee Segment/Reach	Town of Stratford	Assess the performance of this segmant with a 2D Hydrodynamic Overland Flood Model.	1-2 yrs	$	
			Conduct detailed planning & refine concept.	2-3 yrs	$$	
			Coordinate with private properties and secure any needed easements.	2-3 yrs	$$	
			Secure funding.	2-3 yrs	$	
			Design, permitting, and construction.	5-7 yrs	$$$	
4	Project D Orange Street Stormwater Flooding Area	Town of Stratford	Conduct detailed drainage analysis & refine concept.	2-3 yrs	$$	DEEP Climate Resilience Fund, NFWF National Coastal Resilience Fund, Long Island Sound Futures Fund, local funding.
			Coordinate with private properties and secure any needed easements.	2-3 yrs	$$	
			Secure funding.	2-3 yrs	$	
			Design, permitting, and construction.	4-5 yrs	$$	
5	Implement townwide flood protection system	Town of Stratford, CT DOT, CT DEEP, State and Federal delagation, USACE	Engage US Army Corps. of Engineers to continue more detailed planning of townwide flood protection system.	10+ yrs	$$$$	DEEP Climate Resilience Fund for assessing the performance of the individual segments and the complete flood levee system with a 2D Hydrodynamic Overland Flood Model. U.S. Army Corps of Engineers' (USACE) Connecticut Coastal Storm Risk Management (CSRM) feasibility study and civil works program, Water Resources Development Act (WRDA), Feasibility Study 50% non-federal match. Construction 0-35% non-federal match depending on project's criteria.

Table: 6: Recommendations and next steps for Resilient Stratford South End. For more detailed information please see the final report: *Appendix K – Resilient Stratford South End Adaptation Options Final Report*

4.6 Fair Haven

The Fair Haven neighborhood is home to nearly 14,000 residents, within the City of New Haven, along the south-central coast of Long Island Sound. The neighborhood forms a peninsula bounded by the Mill and Quinnipiac Rivers, which flow into the tidal estuary of New Haven Harbor. Flood risks from storm surge and tidal flooding, as well as precipitation and stormwater induced flooding, present public safety challenges to residents as nuisance flooding as well as impeding access to lifelines, and evacuation during storms. According to the City Planning Department, the neighborhood has a high percentage of residents that are either essential workers or cannot work from home. Therefore, transportation and transit are critical lifelines for the neighborhood. Fair Haven is also highly vulnerable to extreme heat. This is attributed primarily to the high social vulnerability within the community, combined with dense housing, extensive impervious surfaces, disconnected green spaces, and long distances to potential cooling centers and/or shelters. This project focuses on developing adaptation strategies to mitigate current and future climate induced flooding impacts to community assets and transportation corridors, as well as developing strategies to help mitigate the impacts of extreme heat for community residents.

Fig. 38: Aerial image of the Fair Haven neighborhood of New Haven, CT.

Community engagement was an essential part of the planning process. The project team actively sought community feedback during the planning process, working to identify, reach out to, and incorporate feedback from diverse groups of people throughout the community. A Citizen + Technical Advisory Committee was also formed towards the start of the project to help guide the development of the plan. The committee was comprised of community members, Board of Alders representatives, and local organizations. In addition a local community liaison was identified and brought on to the project team to guide engagement and connect with other community organizations in Fair Haven.

Flyers and other notices were also used throughout the project to make community members aware of the plan and related activities (e.g., flood risk mapping, community surveys, etc.). The project team set up a table at several community events throughout the duration of the project, including festivals and other events that brought out large numbers of community members. At these events, the project team spoke with community members about their experiences with flooding and heat in Fair Haven, shared project information, and led activities with community youth to help them understand critical issues like flooding and water quality.

Fig. 39: Outreach materials for a community survey to gather information about resident experiences during flooding and heat events was distributed in English and Spanish throughout the neighborhood. Members of the project team attending several community events including Fair Haven Day, to exchange with community members and get feedback on community priorities and experiences.

The Fair Haven neighborhood is vulnerable to coastal and drainage related flooding. Coastal flooding is caused by storm surge, high tides, sea-level rise, and heavy rainfall as water from the tidally influenced Mill and Quinnipiac Rivers inundates low lying portions of the Fair Haven Shoreline. Drainage-related flooding occurs when stormwater runoff from heavy precipitation exceeds the capacity of the existing drainage systems or combined storm and sanitary sewers due to the imperviousness of the landscape, topography, drainage problems, and tidal influence. Coastal flooding occurs on the Western shore of the Quinnipiac River along Front Street and Quinnipiac River Park, as well as portions of the Fair Haven waterfront and commercial/industrial district along River Street and the lower Mill River from Criscuolo Park north to Grand Avenue and Humphrey Street. Areas of regular drainage-related flooding during high intensity rainfall include Middletown Avenue, railroad underpasses at Humphrey Street, James Street, Clinton Avenue, and Front Street, and areas along John Murphy Drive.

Present-day and future coastal flood extents and depths were modeled and used to assess flood risks to community assets and transportation routes. This included an evaluation of which roads, bridges, underpasses, and evacuation routes can be considered "resilient corridors" under future flooding conditions. In addition, an assessment of potential resilience hub locations was conducted to inform the development of additional emergency support locations for vulnerable community-members during climate disruptions including air quality events, extreme heat, extended power outages, and other weather-related hazards. Feedback from the community and advisory committee as well as City of New Haven staff informed the prioritization of potential locations for adaptation concept development.

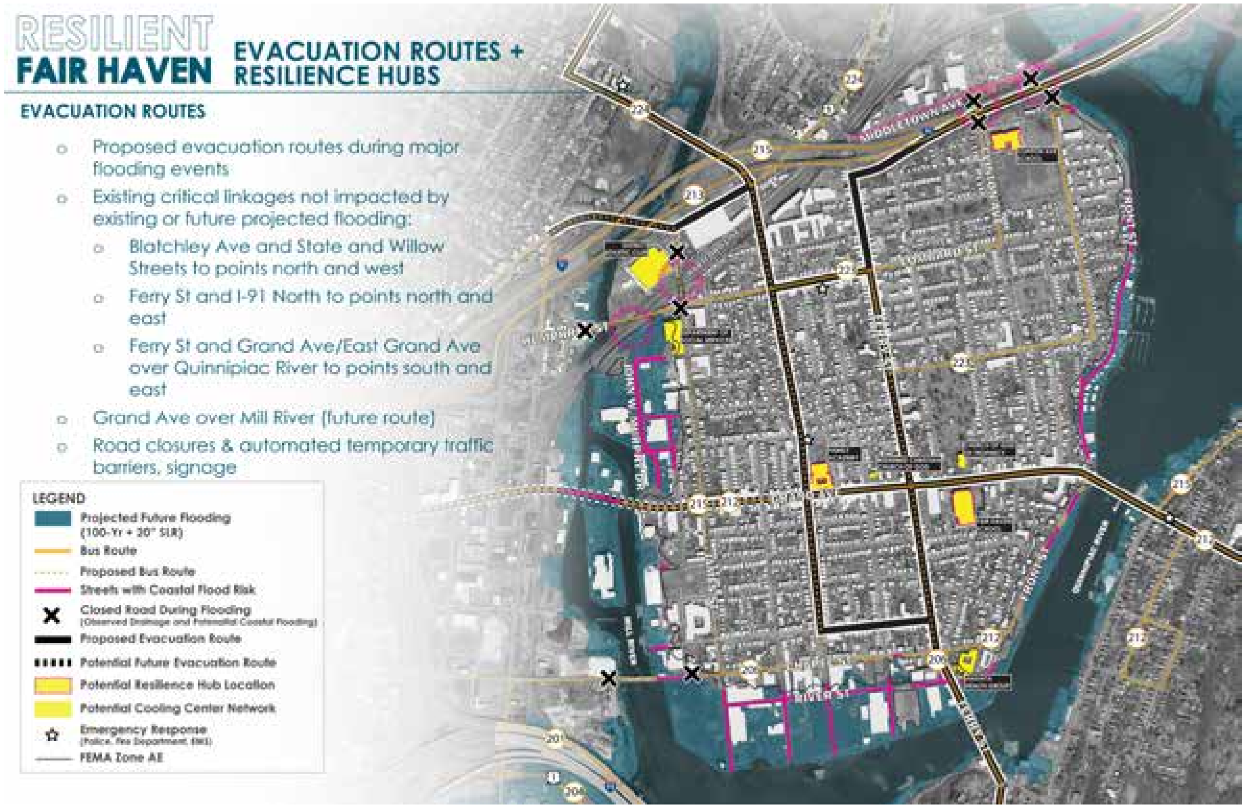


Fig. 40: Areas of current and future flood risk overlayed with potential resilience corridors and resilience hubs in Fair Haven.

Grand Avenue over the Mill River is a future potential evacuation route to access downtown New Haven and points west pending future elevation of Grand Avenue and the two Mill River bridges above the coastal base flood elevation. Road closures and automated temporary traffic barriers, similar to railroad crossing gates, are recommended for roads that regularly flood during coastal storms or heavy rainfall (shown as black Xs), preventing traffic from accessing these areas during flooding and reducing the incidence of stranded vehicles and the need for rescues. This system could be operated by and coordinated between New Haven Emergency Management and/or Public Works, along with signage throughout Fair Haven and community outreach and notifications through existing on-line, social media, and other media outlets.

Several specific areas of focus were identified throughout the Fair Haven peninsula for development of climate adaptation strategies and implementable project concepts. These "focus areas" reflect portions of Fair Haven that are most vulnerable to flooding and extreme heat but also provide opportunities to mitigate climate impacts and enhance community resilience. The identified focus areas include most of the Fair Haven shoreline, as well as critical roadways and corridors that connect the Fair Haven community to the rest of the City and enhance connections within Fair Haven and can serve as cooling corridors using shading strategies and green infrastructure. Recommendations and strategies for each focus area were developed and included in the project report, while two areas were selected for the development of concept designs and benefit/cost analysis.

John W. Murphy Drive Area – encompasses John W. Murphy Drive and adjacent flood prone commercial and residential areas in addition to the critical community connections at Grand Avenue (including the Grand Avenue bridges over the Mill River) and the Humphrey Street underpass. The focus area also extends to the west, encompassing portions of Clay Street, Grand Avenue, and the Family Academy of Multilingual Exploration (FAME) school at the corner of Blatchley and Grand Avenues.

Clinton Park Area – includes Clinton Park, the Clinton Avenue School, English Mall, the Quinnipiac Terrace public housing complex, and Dover Beach along the Quinnipiac River. The area also encompasses the flood prone highway underpasses at Clinton Avenue and Front Street, as well as the important Middletown Avenue connection to commercial shopping areas across the river in Quinnipiac Meadows.

Concept plans that include several strategies that could be implemented individually and standalone projects or through larger scale projects, were developed and refined through stakeholder feedback.

Fig. 41: Concept plan for the John Murphy Drive area of Fair Haven, along the Mill River. The concept includes several elements including elevation of John Murphy Drive and the Grand Avenue Bridge, expansion of open space for flood storage, ecological restoration, and improved public access along the Mill River Trail, and development of cooling corridors through enhanced urban tree canopy.

This project identified site-specific and Fair Haven-wide resilience recommendations in addition to the recommendations for the John W. Murphy Drive and Clinton Park Areas. These include several physical, programmatic, and policy-related actions that the City and other organizations can take over the next few years to make Fair Haven more resilient to existing and future flooding and extreme heat. Implementation of these recommendations will require coordination between various City of New Haven departments – Engineering, Emergency Management and Public Safety, Parks & Public Works – and other organizations including CTDOT, Fair Haven Community Management Team (CMT) and community service organizations, and private property owners.

The suggested resilience hubs and evacuation route and road closure system are near term actions ("low-hanging fruit") that should be pursued within the next 3 years. Coordination will be necessary between the City and CTDOT (CT transit), the Connecticut Department of Emergency Management and Homeland Security (DEMHS), and private owners of possible resilience hub facilities.

Implementation of the recommendations for the John W. Murphy Drive and Clinton Park areas will require coordination between various City of New Haven departments – City Plan, Economic Development, Engineering, Parks & Public Works, Public Schools – and other organizations including CTDOT, Mill River Trail and Watershed Association, Fair Haven Community Management Team (CMT), and private property owners. The flood and heat resilience and shoreline improvement concepts between Grand Avenue and 370 James Street will require more detailed planning and engineering, substantial funding, and partnerships between the City and private property owners. These projects are envisioned to be implemented over the next 10+ years.

Green infrastructure and cooling strategies should be implemented along the cooling/resilience corridors as stand-alone retrofit projects or in conjunction with planned capital improvements such as roadway and streetscape projects as funding allows. The FAME School parking cooling improvements could be pursued independently of the other recommendations and could serve as a pilot for public schools throughout New Haven.

Improvements at Dover Beach, the nearby public housing, Clinton Avenue School, Clinton Park, and English Mall are envisioned to be implemented over the next 10+ years, with detailed planning (including community engagement) to be completed in the next 3 years.

#	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Resilience Hub & Cooling Center Network	City of New Haven, State/Private Facility Owners, Community Service Organizations, Fair Haven CMT, CIRCA	Outreach to existing community service providers to discuss needs related to resilience hubs in Fair Haven, and detailed facility evaluation & selection.	0-1 yrs	$	EPA's Environmental Justice Community Change grants, CT DEEP Climate Resilience Fund (DCRF) – approximately $10 million annually for planning and development of flood and heat resilience projects.
			Develop and execute agreements (MOU) Secure funding.	1-3 yrs	$	
			Implement improvements	3-5 yrs	$$	
2	Evacuation Route and Road Closure System	City of New Haven, CT DEMHS, CTDOT,	Formalize evacuation routes and closure locations.	0-2 yrs	$	DOT PROTECT Grants, FEMA Building Resilient Infrastructure and Communities (BRIC) – $1 billion nationwide for community resilience projects that address flooding and extreme heat.
		Fair Haven CMT	Secure funding for improvements Implement systems.	2-3 yrs	$	
3	Cool and Safe Transportation	City of New Haven, CTDOT, SCRCOG, Fair Haven CMT	Improve access to cool, safe, and accessible routes for walking, biking or using public transit in extreme heat.	0-10 yrs	$$	
4	Efficient Air Conditioning in Schools, Libraries, and Community Centers	City of New Haven	Improve access to air conditioning and healthy energy repairs at public schools, libraries, and recreation centers in Fair Haven and City-wide	0-10 yrs	$	DEEP Climate Resilience Fund, USFS Urban and Community Forestry Grants (USFS) – more than $1 billion nationally for projects that support urban communities through equitable access to trees.
5	Staying Cool and Safe at Home	City of New Haven, Eversource	Energy Efficient Appliances and Home Repairs	0-10 yrs	$	
			Strategic and Inclusive Heat Outreach Year-Round Utility Assistance	0-10 yrs	$	
			Year-Round Utility Assistance	0-10 yrs	$	
6	Urban Forest Enhancement	City of New Haven	Improving access to tree plantings and education about tree care and maintenance for residents in Fair Haven	0-10 yrs	$	
			Expand City street tree list.	0-3 yrs	$	
			Neighborhood greening by improving access to greening and open space.	0-10 yrs	$	
			Formation of GreenCorps local job training program for young adults in Fair Haven.	0-3 yrs	$	
7	370 James Street Parking Lot & Urban Cooling Center	City of New Haven, Private Property Owner, Fair Haven CMT	Engage property owners to assess interest in implementing the resilience concept.	0-3 yrs	$$$	CT DECD Community Investment Fund (CIF) – up to $175 million annually for capital projects that support economic and community development in underserved municipalities.
			Conduct detailed planning & refine concept.	0-3 yrs		
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10 yrs		
8	Mill River Trail, Outfall Improvements, Floodable Park and Gateway Property	City of New Haven, Mill River Trail & Watershed Association, Private Property Owner, Fair Haven CMT	Engage property owner (451 Grand Ave) to assess interest in voluntary acquisition & relocation.	0-3 yrs	$$	Long Island Sound Futures Fund, NFWF National Coastal Resilience Fund.
			Conduct detailed planning & refine concept	0-3 yrs		
			Secure funding.	3-10 yrs		
			Acquisition, relocation, remediation Design, permitting, and construction.	3-10 yrs		

9	John W. Murphy Drive Elevation and Flood Barrier	City of New Haven, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$$$	DOT PROTECT Grants, FEMA Building Resilient Infrastructure and Communities (BRIC) – $1 billion nationwide for community resilience projects that address flooding and extreme heat.
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10+ yrs		
10	Grand Avenue Road and Bridge Elevation	City of New Haven, CTDOT, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$$$	
			Secure funding	3-10 yrs		
			Design, permitting, and construction	3-10+ yrs		
11	Cooling/resilience corridors	City of New Haven, CTDOT (CT transit), Fair Haven CMT	Secure funding.	0-10 yrs	$$	
			Design, permitting, and construction	3-10+ yrs		
12	Family Academy of Multilingual Exploration (FAME) School Parking Lot Cooling Improvements	City of New Haven, New Haven Public Schools, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$	CT DECD Community Investment Fund (CIF) – up to $175 million annually for capital projects that support economic and community development in underserved municipalities.
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10 yrs		
13	Dover Beach Improvements	City of New Haven, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$$	
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10 yrs		
14	Public Housing Open Space Improvements	Housing Authority of New Haven, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$	
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10 yrs		
15	Clinton Avenue School and Clinton Park	City of New Haven, New Haven Public Schools, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$$	
			Secure funding.	3-10 yrs		
			Design, permitting, and construction.	3-10 yrs		
16	English Mall Improvements	City of New Haven, Fair Haven CMT	Conduct detailed planning & refine concept	0-3 yrs	$	

Table: 8: Recommendations and next steps for Resilient Fair Haven. For more detailed information please see the final report:
[Appendix L – Resilient Fair Haven Adaptation Options Final Report]

4.7 Meadow Street Branford

The Meadow Street neighborhood is located in the Town of Branford, along the Branford River. Flooding from the Branford River occurs when the river (a tidally-influenced estuary) overtops its banks and water flows through an Amtrak rail underpass serving a one-way street off Indian Neck Road at the railroad grade. The Town refers to this underpass as "the cattle crossing." When floodwaters pass through the underpass, they cause inundation of Meadow Street and the Hammer Field area. In its Coastal Resilience Plan (2016), the Town evaluated different options for providing a closure structure or permanently sealing the underpass. Members of the public did not support permanent closure. A plan view concept design was prepared with photo renderings of several closure structures, and these were appended to the Coastal Resilience Plan. Significant work would be required to construct a closure structure, requiring coordination with Amtrak and identifying a place to house the movable gate. The Town of Branford plans to reconstruct Meadow Street from Rodgers Street to Church Street in the next few years, providing underground detention under the ballfields to reduce drainage-related flooding. As sea level rise continues, both the frequent flooding that occurs through the cattle crossing, as well as less-frequent flooding that would overtop the railroad grade, are believed more likely. A unique aspect of this study is that it fostered an understanding of the circumstances that create opportunities to engage with Amtrak about using a railroad grade to develop flood protection. The Meadow Street/Hammer Field area contains many residential and non-residential structures, including one of the Town's critical facilities and numerous structures listed as historic resources. Overall, the Branford situation represents a common typology in Connecticut, which may be found in numerous communities.

Along with residential homes and businesses, several municipal assets are located within the Meadow Street neighborhood. The Branford senior center, recreational facilities and municipal offices are part of the recently renovated Community House. A sewer pump station is located on Meadow Street, across from the Cattle Crossing. The section of Meadow Street that is adjacent to Hammer Field is in a low point compared to the surrounding neighborhoods. The lowest point along Meadow Street is at elevation 2.62 feet (NAVD88). According to data available through National Oceanic and Atmospheric Administration (NOAA), the Mean Higher High Water (MHHW) elevation of the Branford River is 2.97 feet (NAVD88).

Modeling completed for this project indicates that the water surface elevations for floods less intense than the 100-year storm (1% AEP) will not overtop the Amtrak embankment. However, there is insufficient information to know whether the embankment would be stable during a flood. As sea level rise continues, flooding that occurs at the Cattle Crossing will likely intensify. For example, the model predicts that the number of structures that would be impacted during a current 100-year storm event (1% AEP) will be consistent with the number of structures impacted during a 10-year storm event (10% AEP) in 2050.

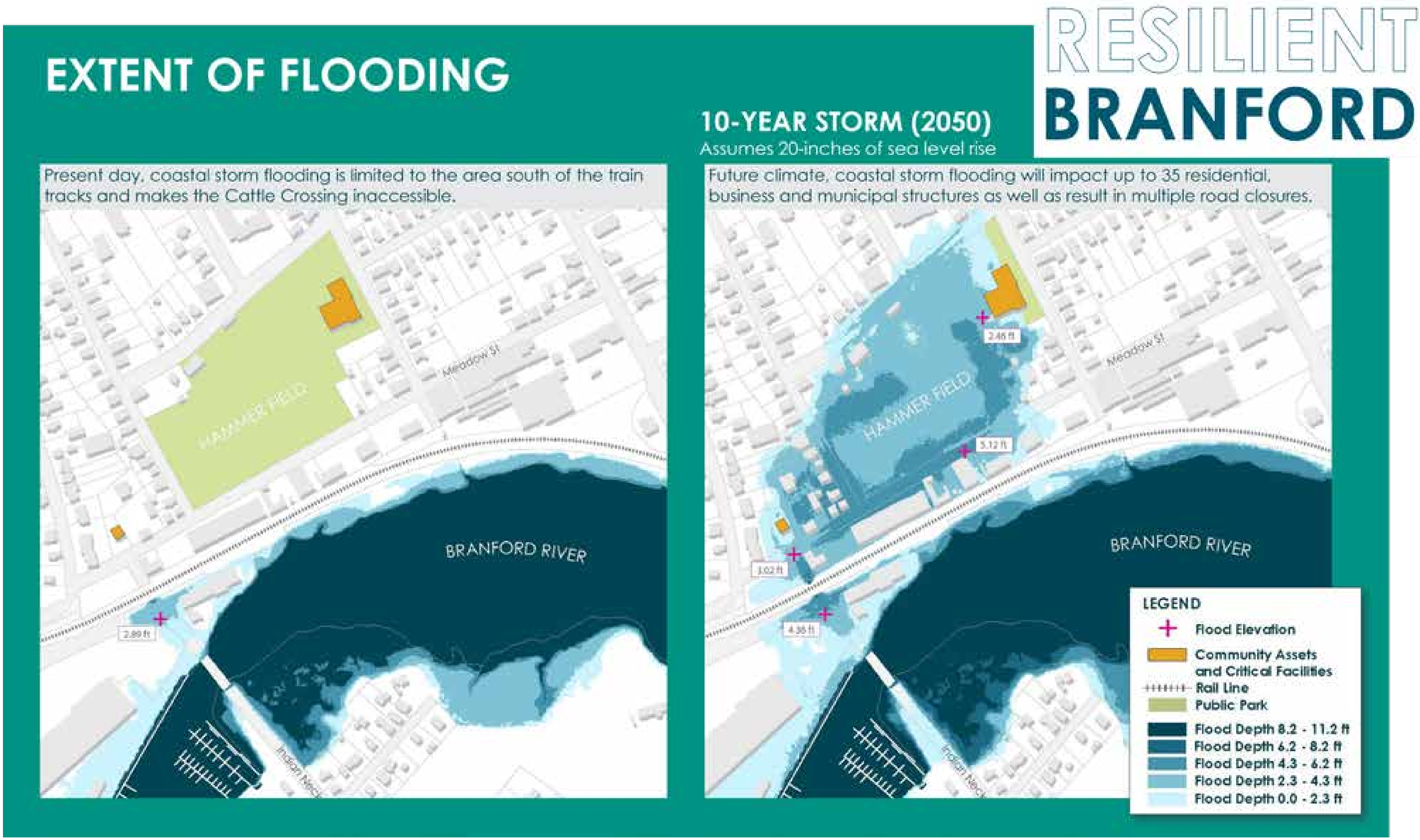


Fig. 42: Flood modeling conducted by the CIRCA team for the Branford River illustrates a significant increase in the area impacted by a future 10-year storm event with the addition of 20" of sea-level rise compared to current conditions.

Four alternatives were evaluated to address flooding at the Cattle Crossing including: installation of a flood gate at the crossing in conjunction with a floodwall adjacent to the railroad embankment; installation of only the flood gate at the crossing; permanently closing of the crossing; and doing nothing. Several criteria were developed to compare the relative pros and cons for each alternative to assist the Town and stakeholders in evaluating the alternatives.

1. Based on long term cost effectiveness (benefits of the project divided by the cost of the project).
2. Amount of coordination with stakeholders required to build the project (i.e., Amtrak, utilities, private property owners, etc.). Including procuring easements for operation and maintenance.
3. Access impacts include car and pedestrian travel access through the Cattle Crossing as well as access to existing utilities (i.e., sewer and drainage).
4. Confidence that mitigation action will act as designed. For example, it is unknown how well the Amtrak embankment will continue to act as a flood control measure. The Amtrak embankment could fail under certain storm conditions. This criteria also considers the ability to apply for a FEMA Letter of Map Revision (LOMR).
5. How quickly project will be constructed.
6. Each of the matrix criteria are weighted based on their priority to the Town of Branford and feedback from project stakeholders.

WEIGHTED COMPARATIVE ANALYSIS MATRIX						
ALTERNATIVE	MATRIX CRITERIA					OVERALL SCORE
	Capital Cost[1]	Impact to Amtrak/Private Property[2]	Access Impacts[3]	Effective Flood Control[4]	Implementation Time Frame[5]	
Criteria Weighting[6]	3	1	2	3	2	
1. Flood Gate with Floodwall	2	1	3	3	1	**2.2**
2. Flood Gate	3	2	3	2	2	**2.5**
3. Closing the Cattle Crossing	3	2	1	2	2	**2.1**
4. Do Nothing	1	3	3	1	3	**1.9**

Fig. 43: Comparative analysis matrix of 4 alternatives of action to reduce flooding through the Meadow Street cattle crossing in Branford.

This table compares all four alternatives based on criteria the Town identified as important. The criteria are weighted on a scale of 1 to 3 based on the importance of the criteria to the Town with 1 being the least important and 3 the most important. Each criteria was comparatively rated for each alternative with 3 being a “positive” rating and 1 being a “negative” rating. The alternative with the highest overall score is the preferred alternative for the Town. Based on the criteria rating, it was determined that Alternative 2: Flood Gate-Only best fit the Town’s criteria and was selected for future phases.

#	Recommendation	Organization	Action	Timeline	Cost	Funding Sources
1	Pursue Flood-Gate Only Scenario	Town of Branford, CT DEEP	Write Proposal For CTDEEP Climate Resilience Fund or Acquire Funding Through Town/Privately	2 yrs	$$	DEEP Climate Resilience Fund, Branford Coastal Resiliency Reserve Fund
		Town of Branford	Secure funding	1 yr		
		Town of Branford, Amtrak, Private Property Owners	Permitting/Amtrak/Engaging Private Property; Get to 70% design	1 yr		
		Town of Branford	Develop Construction Documents, Put Project Out to Public Bid	4 months		
		Town of Branford	Enter Contract with Lowest Qualified Bidder	3 months		
		Town of Branford, Contractor	Construct flood gate	6 months		

Table: 9: Recommendations and next steps for Resilient Meadow Street, Branford. For more detailed information please see the final report: *Appendix M – Resilient Meadow Street Adaptation Options Final Report*

5.0 Lessons Learned and Road Map Recommendations for Connecticut:

The Resilient Connecticut project was developed through a partnership between CIRCA and the State Agencies Fostering Resilience (SAFR) council with support from CT Department of Housing, following the impacts of major coastal flood events in 2011-2012, including Superstorm Sandy and Tropical Storm Irene. The goal of the program was to develop and support climate adaptation planning by increasing coordination across jurisdictions (local, municipal, regional, and statewide) through a climate science informed approach to addressing vulnerabilities at scales that implied shared risks as well as shared solutions. The project also sought to establish a framework for investment and project implementation that integrated risk reduction strategies with economic development framed around transit-oriented development, “resilient corridors”, and critical infrastructure improvements.

Each community in Connecticut is unique with its own social relationships, land uses, socio-economic, ecological, and environmental factors that present different vulnerabilities and frame potential climate adaptation pathways going forward. Resilient Connecticut engaged many different communities in Fairfield and New Haven Counties in a planning process to understand vulnerabilities, develop adaptation options, and identify actions to reduce climate risks that are unique to each community (see sections 3 and 4 of this report). However, several common themes and challenges emerged in the planning process that were shared across the region. In this section we document those common challenges, share lessons learned, and propose recommendations that can serve as a resilience “road map” for the region and Connecticut going forward.

5.1 Common Themes, Challenges, and Lessons Learned:

1. ***Enhanced Planning through Local, Regional, and State Collaboration:*** The Resilient Connecticut Framework was successful at focusing attention on locations with regional assets and infrastructure and urban centers (Downtown Danbury, Fair Haven, Ansonia, South Norwalk) that had been previously neglected in other resilience planning efforts. These areas represented unmet needs in previous planning which face combinations of flooding and heat risks compounded by social vulnerabilities. The Framework concepts (Zones of Shared Risk, Resilient Nodes, Resilient Corridors) were useful spatial planning tools for revealing locations of importance across local, regional, and state domains, and delineating project areas that can be the focus for coordinated action in the coming decade. This represented a change from previous coastal resilience planning in CT which, it could be argued, largely focused on clusters of high value at-risk residential properties in low lying coastal flood plains through more traditional risk identification and cost/benefit approaches; or which prioritized specific adaptation techniques. The partnerships established between municipal, regional (COGs), and state entities can be helpful in developing consistent vulnerability assessment approaches and resiliency strategies to ensure issues receive attention that may not otherwise due to lack of capacity. Favoring one or the other (regional vs. local planning) limits potential outcomes, as the different scales of planning must work together and are needed to support each other.

2. ***Economic Development and Floodplain Management Conflicts:*** Current Federal policies for floodplain management along with local fiscal and economic development incentives remain potent barriers to coherently managing climate risks. In Connecticut's existing "home-rule" approach to land use planning and taxation, municipalities are incentivized to pursue local revenue generating opportunities through economic development and redevelopment. Despite major flooding events such as Superstorm Sandy, coastal areas remain a high value target for commercial and residential development in Fairfield and New Haven Counties, particularly when these areas are close to regional transit such as Metro North. In many cases these areas overlap with FEMA delineated areas of risk commonly known as "floodplains," which can result in intensification of development in areas with high current and future flood risks. In many cases, developers and entities that propose projects in risky areas, sell off these assets once they've been approved and built, transferring the long-term risk to the new property owners, residents, and ultimately, municipalities and the public. At the same time, FEMA floodplains, as delineated on current Flood Insurance Rate Maps (FIRMS), are coarse in their characterization of the actual physical risks. Although FEMA has begun the process of reforming its flood insurance rating methodology with the recent risk rating 2.0 update , the FEMA FIRM remains the most broadly applied and relied upon delineation of flood risks across federal, state, and local regulatory and funding programs . In areas with complex geomorphology such as CT, the mostly static, and coarse delineation of flood risks represented on

FEMA FIRMs does not differentiate between areas of future and/or chronic flood risk, which should be avoided for development, and areas where existing and predicted risks should be effectively managed. This is particularly critical in the assessment of brownfields and underutilized post-industrial sites in coastal areas of Connecticut. No consistent or broadly applicable decision model currently exists for managing tradeoffs between future flood risk, brownfield remediation, and resilient economic development and redevelopment, particularly in EJ communities. In the absence of wholesale retreat from coastal floodplains or relocation of major regional transportation corridors such as the Northeast Rail Corridor and Interstate 95, local planning and zoning decisions are likely to be biased towards short-term economic incentives without an alternative model for creating value.

3. ***Agency Engagement and Coordination:*** The collaboration between state agencies, as envisioned in the original NDRC proposal, did not reach its full potential. The State Agencies Fostering Resilience (SAFR) Council was instrumental in developing the proposal that became Resilient Connecticut. The role of SAFR was to provide a mechanism for interagency collaboration, coordination, and decision-making regarding resilience policies and projects. Early in the project there was a new governor elected, a change in administration, and a new scope created for the Governor's Council on Climate Change (GC3) focusing on climate adaptation. Governor Lamont's Executive Order 3 re-established SAFR as a subcommittee of the GC3 and charged the GC3 with establishing a more comprehensive resilience plan for the state. The committees supporting the GC3 covered a range of sectors and necessitated agency participation in one or more working groups. As a result, the SAFR group's previously anticipated role as a major coordinator for Resilient Connecticut largely took a backseat to other higher profile efforts. The SAFR working group has continued to be a regular forum for informal coordination and discussion of topical issues between agencies. However, the process for more substantive engagement by agencies in planning for projects where jurisdictions overlap and/or time horizons differ (e.g., projects that address state roads and local facilities together) remains unclear, opportunistic and largely ad-hoc. Disruptions in participation are likely to recur across administrations or agency leadership. More formal commitments to interagency participation in planning are needed to create momentum over longer time scales and ensure the most cost-effective solutions can be implemented for large infrastructure investments.

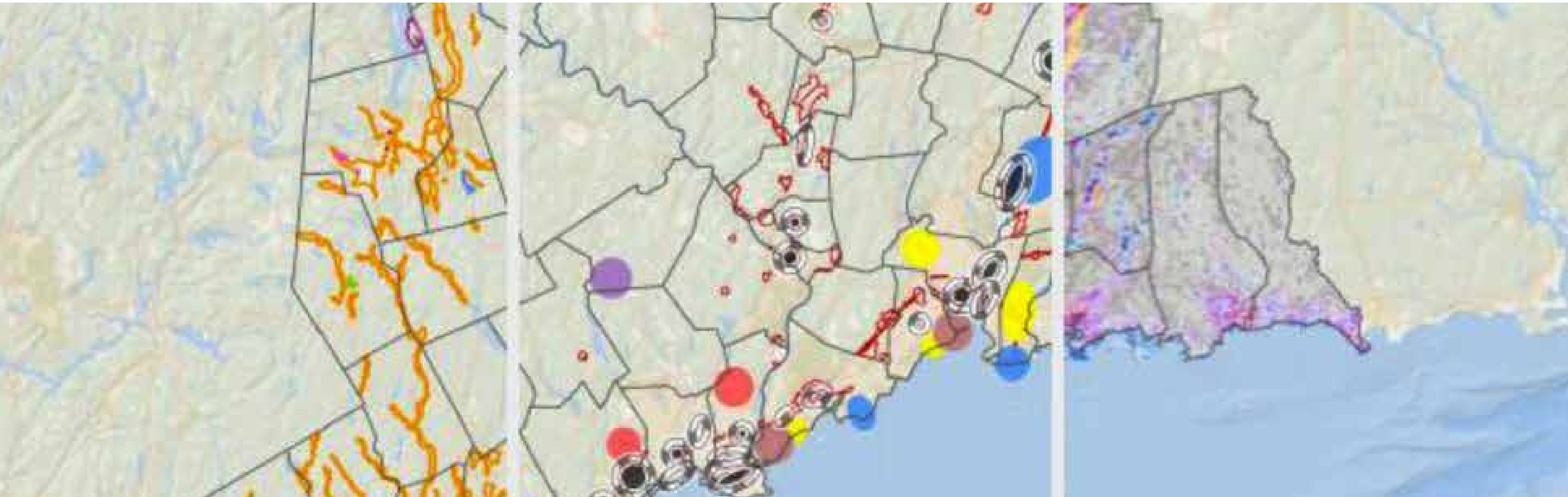
4. ***Challenges Associated with Resources, Staffing, and Sustained Education (aka Capacity):*** Climate change adaptation planning requires technical resources that are difficult for many local governments and resident groups to access. Significant capacity gaps exist between communities. In some cases, towns have chosen not to address climate issues or have lacked a pathway toward consensus on complex problems. In other cases, disparities in property taxes, competing service demands on municipal budgets, and differences among local staff availability and expertise have limited action. Some towns simply won't be able to create or maintain the capacity to implement

long-term, complex adaptation projects. The State of Connecticut should sustain the capacity of CIRCA to provide Municipalities, COGs, and citizens associations with training on planning processes, consensus development, interpretation of risks and maps, project scoping, project budgeting, available grants and funding sources, and support and advice on the effectiveness of technical approaches.

5. ***Integrating Technical Information into Planning:*** In recent years, steps have been taken to ensure climate change is incorporated into local and regional Plans of Conservation and Development and Natural Hazard Mitigation Plans. There has also been the development of resilience tools, future risk maps, and viewers by CIRCA and other groups. Broadening these to include the capacity to assess the potential effectiveness of adaptation strategies should be developed by CIRCA and others with appropriate technical resources. In addition, evidence-based assessments of the effectiveness of innovative solutions (like living shorelines and green infrastructure) are currently limited. Data from demonstration projects and post-construction monitoring of innovative projects are essential to the development of standards that can be used in permit decisions and to provide guidance to municipalities in the development of proposals. Data should be made publicly available, and knowledge dissemination should occur as suggested above in #4.

6. ***Issues of Timing and Readiness:*** Connecticut municipalities differ markedly in their readiness and capacity to take action on climate adaptation and resilience. New programs like the DEEP Climate Resilience Fund can "even the playing field" with funding. Resilient Connecticut identified initiatives that started with political leaders, community groups, and town staff and then advanced to consensus at different rates. Consequently, to be broadly accessible, programs need to be sustained so that communities at different stages of readiness can participate.

5.2 Recommendations for a Resilience Road Map for Connecticut:



1. Take action on existing vulnerabilities, zones of shared risk, and resilience opportunities.

The Resilient Connecticut planning process resulted in the identification of 64 Resilience Opportunity Areas (ROARs) in Fairfield and New Haven Counties. These represent the region's un-met needs for local and regional planning, project development and implementation support. The database of Zones of Shared Risk, Risk Narratives, and ROARs can be found in the Phase II vulnerability assessment report as well as the Resilient Connecticut website.

1.1. Move forward with design and implementation of projects that were advanced during Phase III site planning in Downtown Danbury, Downtown Ansonia, South Norwalk, Downtown Fairfield, South End Stratford, Fair Haven, and Branford. Each of these Phase III locations resulted in specific near and long terms actions, concept design, and project development which can be prioritized for additional state and Federal funding for implementation. See Section 4 for more information on next steps for each of these areas.

1.2. Prioritize engagement and planning support for additional Resilience Opportunity Areas, that were identified in Phase II in other vulnerable locations in Fairfield and New Haven Counties. Local governments and regional planning organizations should work with technical assistance partners such as state agencies, CIRCA, NGOs, and others to move additional ROARs through the site planning process and create specific near-term actions that can be implemented in the next 5-10 years (see recommendation 2.1 below).

1.3. Assign responsibility to a lead agency or office to maintain a statewide inventory of climate resilience plans, actions, and projects as references for previous, existing, and ongoing resilience planning work. This should be integrated with the Statewide Resilience Project Pipeline in recommendation 7. This inventory can become a central resource and reference point for the emerging community of practice of climate service providers and help to prevent duplication of previous work.

1.4. Strengthen the role of regional Councils of Governments (COGs) to conduct monitoring and progress updates on Natural Hazard Mitigation Plans (NHMPs), Coastal Resilience Plans (CRPs), Climate Adaptation Plans (CAPs), and Plans of Conservation and Development (POCD), to evaluate whether towns are acting on plans and identify barriers and ongoing challenges to implementing actions and projects. This can help to position plans as iterative, living documents that continuously inform projects and investments rather than mandatory reports that only receive attention every 5-10 years.

2. Improve agency coordination and take advantage of existing programs and capacity.

Climate adaptation and resilience planning in Connecticut has evolved over the past decade. Today there are many different programs and partners that have built a solid foundation of knowledge, plans, data, and tools to support communities in planning for and adapting to climate change impacts. Going forward, existing programs and partners will need to better coordinate and work together to leverage this foundation for the benefit of communities across the state. This includes leveraging staff capacity and expertise across different state agencies to incentivize more collaboration.

2.1. Expand the Resilient Connecticut Program statewide and designate roles and responsibilities for state planning and technical assistance partners with a lead coordination entity (CIRCA). Provide technical resources to towns to move plans and projects down the resilience project pipeline through a state program that integrates the informal relationships between climate service providers and agency initiatives that are currently engaging communities in an ad-hoc or opportunistic way. That includes integrating data sources, mapping, and stakeholder engagement support for municipalities to conduct vulnerability assessments, conditions analysis, concept development, design, permitting, benefit/cost analysis, implementation, monitoring, and adaptive management of the full range of climate resilience actions. This would be an opportunity to integrate the work of multiple partners including CIRCA's Resilient Connecticut program with the DEEP Climate Resilience Fund, DPH, DOT, CT Insurance Department, and the CT Green Bank's new authorities to invest in environmental infrastructure, among others.

2.2. Refresh the State Agencies Fostering Resilience (SAFR) Council. A more formal structure for SAFR is required and a coordinating entity is necessary. CIRCA has been serving this function in recent years. We recommend the development of a mission statement (To ensure effective cooperation and coordination among agencies to accelerate adaptation to the effects of climate change), designated representatives, quarterly meetings and monthly meetings of work groups. We recommend the consideration of a chief resilience officer in the state to chair the group and report to OPM.

2.3. Create a planning partners collaborative or council to better organize existing programs and avoid duplication between climate resilience planning service providers. The collaborative should be chaired and facilitated by a neutral entity such as OPM or DEEP. This should be distinct from the GC3 process or could be a specific workgroup under the GC3. Look at the FEMA Coordinating Technical Partners as a model that should include and formally recognize established climate services technical and supporting partners that have already been doing the work and have capacity to continue engaging communities going forward.

2.4. Provide training and application of tools and resources for resilience planning. This should include an easily accessible process for communities to get assistance with training and the use of tools with partners through an expanded Resilient Connecticut program (see recommendation 2.1). Over the past decade many different climate-related "toolkits" have been developed for decision-making and planning purposes. What's needed going forward is application, refinement, and training on the use of existing tools and resources.

2.5. Create a regional working group (New England, or Northeast) to continually exchange ideas and progress updates between technical and planning partner programs. Create a technical exchange between state programs. Recent efforts to regionalize technical support programs between states have lacked coordination and can result in overlapping or duplicative programs.

3. Utilize equitable and inclusive planning approaches.

The entire community must be engaged in the assessment of adaptation needs, priorities, and projects. Broad participation is essential to ensure public support and to identify the needs of the most vulnerable. Communities that have been traditionally marginalized or disengaged from planning must be included from the start in setting priorities and developing solutions to climate resilience challenges. This requires resources to support participation and develop local capacity in EJ communities. The state should continue to build on the GC3's efforts to remove barriers and move towards more equitable participation in the resilience planning process.

3.1. Build on the successful pilot rounds of the CIRCA/DEEP Climate and Equity Grants Program to fund capacity building grants for environmental justice-oriented community-based organizations (CBOs) to lead resilience planning and take action in their communities. This should include the identification of a stable source of funding for the grant program over a longer period. This program should be focused on building up the capacity of CBOs with existing relationships and representation from EJ communities and should be broad enough to allow grantees to make decisions on priority activities within a climate resilience framework. More information about the findings from CIRCA's Climate and Equity Grants Pilot Program can be found on the program website here: https://circa.uconn.edu/environmental-justice/climate-and-equity-grant-program/

3.2. Invest in local community-based resource hubs that can provide a venue and staff to facilitate planning for traditionally overburdened and underserved communities. Many community-based organizations are already playing this role around issues of housing, economic justice, food insecurity, health care, and other needs. These organizations can begin to take more active roles in climate resilience planning with additional resources and assistance from state partners. These hubs should also overlap with resilience hubs described in recommendation 4.1 below.

3.3. Integrate the Connecticut Environmental Justice Screening Tool into state grant programs, projects, and investments. CT EJ Screen 2.0 was created through an extensive process that included engagement with EJ community-based organizations. This resource should be leveraged going forward to direct investments and improve the resilience of EJ communities in Connecticut. A staff position at DEEP should be designated for updating the CT EJ Screen going forward to ensure it remains an accurate picture of pollution burden and sensitive populations across Connecticut.

4. Prioritize emergency preparedness and recovery planning.

Prioritize preparedness for disruptive and extreme weather hazards by incorporating climate change into local and regional emergency planning and identify "Community Lifelines" that must function in the aftermath of a disaster. These are essential to human health and safety and sustain the operation of critical community services, government and business functions.

4.1. Create a network of resilience hubs that can serve as points of contact with local communities, provide services, coordinate with local and state government, and pass through resilience-related grants and technical assistance to residents. Resilience hubs can provide spaces for cooling, clean air, backup power generation, provide a venue for engagement and support for longer-term transformational adaptation through building community capacity, relationships, and "social capital."

4.2. Help communities plan for resilience hubs. Create a planning, technical assistance, and funding program to help communities do the work of establishing resilience hubs. Look at a model that includes multiple state partners including CIRCA, the CT Green Bank, DEEP, DPH, and DEMHS, assisting local governments and community-based organizations to assess sites, make resilience improvements, and train local community-members to staff hubs. This will allow multiple communities to learn from one another through a state program that includes sharing technical resources and building a network of mutual support. This can be integrated into the Resilient Connecticut program in recommendation 2.1, as a specific funded activity for towns and community-based organizations.

4.3. Update the State Emergency Response Framework to include the role of resilience hubs for improving local community capacity to support emergency operations and long-term recovery.

4.4. Establish a network of real-time water level and flood level sensors in coastal communities to support local emergency operations, flood alerts, and evacuations. Many communities have been and will continue to live with more frequent flooding of key roadways and underpasses. Real-time information delivered to decision makers could allow for better coordination of road closures and resilient corridors during flooding events. CIRCA pilot projects are underway in Stamford and Branford to develop protocols for data collection and information delivery to decision makers. Learn from these pilots and expand to a statewide coastal flood alert system informed by real-time data at key sites.

4.5. Work with coastal communities to install traffic gates at railroad underpasses that frequently flood to keep people out of harm’s way during hazard events. These gates can be a relatively lower cost near term solution to manage traffic and prevent the need for emergency rescues at underpasses. Underpass zones of shared risk were identified throughout Fairfield and New Haven Counties as part of the vulnerability assessment in Phase II of Resilient Connecticut 1.0.

4.6. Create a central GIS database of evacuation routes and resilient corridors to support longer term emergency planning that integrates sea-level rise and increased flooding into a coordinated evacuation strategies.

5. Build adaptation into infrastructure investments to avoid future costs.

To minimize future costs and social disruption, municipalities and state agencies should integrate climate change adaptation into all planning decisions and investments immediately. Every town's Plan of Conservation and Development and Hazard Mitigation Plan, for example, should enhance long-term resilience by including an assessment of climate change impacts into plans. Routine repairs and improvements that recognize future risk will yield a high return on investment.

5.1. Add detailed climate vulnerability assessment requirements to local and regional Plans of Conservation and Development (POCD). POCDs should be informed by local vulnerability assessments to a variety of climate hazards including sea-level rise, coastal flooding, extreme precipitation, and extreme heat; and identify resilience challenge areas. This will require training opportunities, reporting examples, and technical support to assist towns and COGs with fulfilling these new requirements (see recommendation

2.1). This should include identification of which local resources (social, ecological, and financial) are impacted or informed by resilience initiatives. A phase-in process can allow towns to transition into the new requirements.

5.2. Plans should clearly identify problems that need external support in addition to local municipal resources and include budget reporting for issues that require state support. Formalize the capital improvement plan process for local, regional, and state investments and indicate which projects are informed by resilience and adaptation strategies.

5.3. Municipalities should consider updating zoning codes to move towards resilient development consistent with the Resilient Zoning library and toolkit. Zoning is one tool communities can use to enhance local resilience to climate change impacts like flooding, sea level rise, and increased heat. As redevelopment occurs, it's imperative that new projects don't create additional vulnerabilities such as increased stormwater, heat, or increasing risks in locations that will face chronic hazards in 2050.

5.4. Encourage and incentivize towns to utilize other local boards with newly established authorities for climate resilience activities like Flood Prevention, Climate Resilience, and Erosion Control Boards which now have infrastructure maintenance, construction authority and can bond to fund projects. Local Conservation Commissions can manage nature-based resilience strategies like restored marshes, wetlands and forest areas. Incentives might include a specific track for cost-sharing projects through the DEEP Climate Resilience Fund for example, that utilize local funding or leverage resources through these new boards.

6. Adapt existing and resist new development in coastal and riverine floodplains.

Higher mean sea levels will increase the frequency of flooding in areas that are currently flood prone. Enforcement and strengthening of existing policies will reduce risk to people, property, and municipal tax bases and make new commercial and residential development less vulnerable. Existing homes and businesses that were previously built in areas of flood risk will need to consider the full range of flood mitigation options including elevation, flood proofing, and voluntary acquisition of repetitive and severe repetitive loss properties, among others. New development should be avoided in areas where coastal flood risks are currently known as these areas will continue to flood more frequently by 2050. If municipalities, developers, and property owners choose to site new buildings and development in areas of known coastal and riverine flood risk going forward, future liabilities and costs should be fully assumed by property owners.

6.1. Promote strategies to encourage existing owners to make their properties resilient to flooding. Programs such as FEMA flood mitigation assistance as well as new programs like the CT Green Bank's C-PACE and Smart-e loan program are available to assist with funding and financing property level resiliency improvements. Existing properties that currently face flooding risks, particularly coastal flooding, will need to become more resilient through a variety of strategies including elevation, flood proofing, elevation of critical systems, improved stormwater management, green infrastructure, and in some cases, voluntary acquisition of repetitive and severe repetitive loss properties.

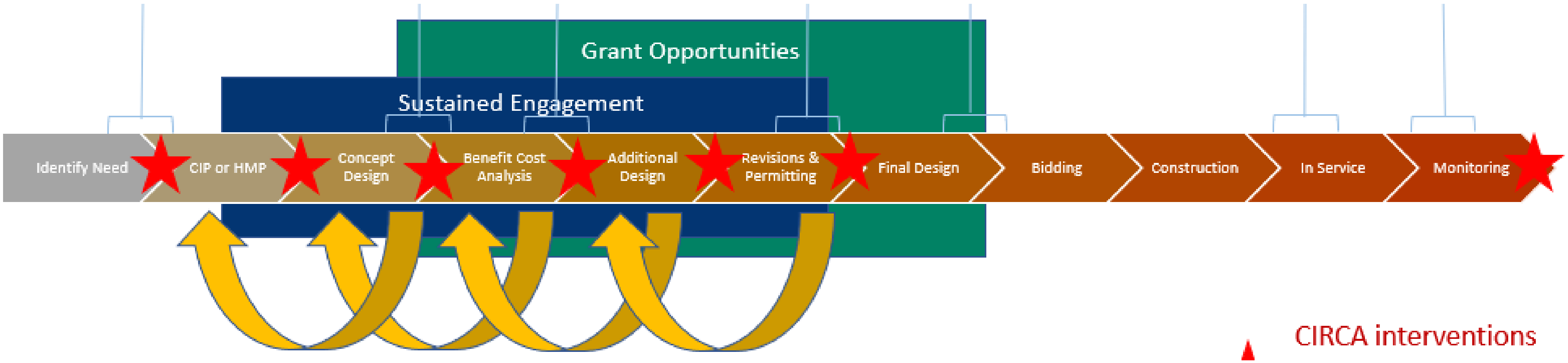
6.2. Create, and make accessible, high resolution, more accurate coastal flood risk maps for the entire coastline that can be used to supplement FEMA risk maps. These maps would be forward looking using actionable science to inform municipal land use and property owners of future risks and guide decision making.

6.3. Municipalities should create resilience overlay zones which designate requirements and design guidelines for existing uses in flood zones. These zones should clarify requirements for meeting state and federal flood risk management standards for freeboard requirements and access. Overlay zones should be conservative and encompass not only areas currently experiencing flooding but also include areas that are anticipated to be vulnerable in 2050 due to sea level rise. This methodology will allow time for property owners to make resilience improvements prior to the onset of problems. Standards and guidelines should be consistent with federal flood risk management standards to avoid ineligibility for federal funding sources.

6.4. Strengthen flooding disclosure requirements for real-estate transactions. Other coastal states have recently made efforts to improve flood related disclosure, such as adding requirements to disclose whether a property is mandated to carry federal flood insurance as well as information about previous flood damage and flood insurance claims. More examples of how Connecticut compares to other states can be found here: https://www.fema.gov/sites/default/files/documents/fema_state-flood-risk-disclosure-best-practices_07142022.pdf.

6.5. Enable the effective use of transferable development rights (TDR's) through legalizing the creation of TDR banks. Property owners in designated vulnerable areas where further development is disincentivized (thereby increasing resilience) then have a mechanism for preserving property value, selling unusable development rights while retaining ownership. TDR banks would eliminate the difficulty of direct transfer between seller and buyer as statute currently requires.

6.6. Consider designating a high frequency or chronic floodplain (e.g. 1–10-year annual exceedance probabilities in 2050) to prioritize help for property owners to equitably access FEMA funding for flood mitigation assistance, including options for property elevations and/or voluntary acquisitions of repetitively flooded properties. Currently, the process for property owners to receive FEMA support for acquisitions is long and administratively burdensome. Local governments must apply for funds on behalf of property owners through a reimbursement model which may be difficult for lower income households to access. State support for acquisition should include requirements for community benefit such as improving public access in coastal areas, preserving open space for community flood management, and the creation of parks and other features that create community-wide benefits.



7. Develop a resilience project pipeline.

In many towns, there are several areas at-risk, and all need attention. Having a series of resilience projects underway will increase the likelihood of winning state and federal adaptation grants and increase support for the local share of matching costs. In addition, state agency resilience projects may need coordination with local projects. The creation of a central project pipeline database will allow for project planning and implementation between and across jurisdictions.

7.1. Conduct and complete the vulnerability assessment of state assets and operations as required b Governor Lamont's Executive Order 3. The vulnerability assessment of state assets and operations should result in coordination and action to ensure state investments are resilient to climate change impacts. Specific projects resulting from the assessment should populate the state resilience project pipeline.

7.2. Update the state resilience strategy based on the assessment of state assets and operations. Develop strategies to inform state and local policies and processes to allow for coordinated action among agencies, regional planning (COGs), and local municipalities. The strategy was reviewed as part of the GC3 process in 2020-21. Given the new information that will be generated by the vulnerability assessments in 7.1, the overall resilience strategy should be renewed through the GC3 or a working group of the GC3.

7.3. Make sure state agency project pipelines are disclosed to COGs and towns. Document challenges and vulnerabilities that require coordination between local and state entities. (e.g. local drainage systems that connect to state drainage infrastructure, or local flooding concerns related to state roads). Clarify the process for towns who wish to initiate engagement with state entities to address these joint challenges. This will allow for opportunities to more effectively and efficiently address problems between overlapping state and local jurisdictions when projects are in the planning stages of development.

7.4. Create a project pipeline database, map, and CIS data portal to track progress on implementing the state resilience project pipeline. This should be coordinated with a state planning inventory and other state data through a centralized data office (see recommendation 1.3). Making the resources for planning more streamlined and less confusing for towns will help with adding new requirements for vulnerability assessments and data creation.

8. Establish and invest in new local funding sources.

Municipalities must begin to develop sustainable funding sources for longer term investments in resilience. A resilience project pipeline receiving federal and/or state support will require local cost-sharing, so a strategy for raising local funds is essential. In addition, many local projects may not qualify or receive significant federal funding. New policy tools in Connecticut have recently been created for this purpose. For example, Public Act 19-77 allows a municipality to create a resiliency reserve fund and PA 21-115, "An Act Concerning Climate Change Adaptation," also provides municipalities with a suite of voluntary tools to fund climate resilience, including enabling of stormwater authorities and a new Environmental Infrastructure Fund within the Connecticut Green Bank.

8.1. Create municipal resiliency reserve funds. Towns should be incentivized to set aside funding for climate resilience and adaptation in budget plans utilizing a climate resilience reserve fund. This acknowledges that every community will be affected by climate change, impacting infrastructure, public health and safety, and that cost sharing will be a necessary component to funding solutions. Examples of actions that could be funded with the resulting revenues should be described for towns to reference, such as upsizing culverts and bridges, providing back-up power to critical facilities, upgrading stormwater infrastructure, and conducting necessary planning studies.

8.2. Create a grant or revolving loan fund for municipalities that want to establish stormwater authorities and Flood Prevention, Climate Resilience, and Erosion Control boards. Prioritize state support for municipalities that want to do the initial engagement, mapping/assessment, and stand-up stormwater authorities, reserve funds, and other local climate resilience funding mechanisms.

8.3. Encourage and enable municipalities to establish “resiliency improvement districts” that utilize a tax-increment financing model to fund improvements in vulnerable areas. This approach can provide more direct financing of projects by those who directly benefit from resiliency improvements. Clear standards and guidance for design flood elevations, freeboard, egress, and other resilience criteria should be included for communities that want to use this option.

8.4. Create a state matching fund to help municipalities with bigger projects. Establish a 50/50 State/local matching fund or other combination that can help municipalities access federal funding for implementation of larger scale projects. This could be done through a specific track of the DEEP Climate Resilience Fund, or other state program.

9. Integrate emissions reductions and renewable energy deployment with adaptation and resilience planning.

Ultimately, the path forward to more sustainable communities includes large investments in reducing greenhouse gas emissions while also reducing risks and vulnerabilities to climate change impacts. It remains a critical goal to ensure these investments are coordinated to maximize our impact with limited resources. In many cases greenhouse gas reduction strategies can meet multiple objectives such as reducing heat risk to vulnerable residents, improving grid resilience, and improving the connectivity of multi-modal transportation.

9.1. Help vulnerable residents make their home more energy efficient and cooler. Prioritize outreach and engagement with building owners, residents, municipalities and utilities to access state and federal incentives for renewable energy programs, in locations of high heat vulnerability. The Climate Change Vulnerability Index for heat can be used as a screening tool to identify and prioritize locations of communities that are particularly vulnerable to extreme heat and air quality impacts. Resilience Opportunity Areas (ROARs) that are characterized by heat and social vulnerability may be good locations for additional planning support for site assessments and investments in renewable energy deployment, efficiency improvements, and other greenhouse gas reduction strategies.

9.2. Improve grid resiliency through targeted microgrid deployment. Work with community-based organizations, municipalities, developers, utilities, and state agencies to implement microgrids in areas that are particularly vulnerable to extended power loss. Not only can microgrids, connected to solar, batteries, and fuel cells generate resilient power during grid outages, they can provide cost savings and emissions reductions during everyday operations.

9.3. Develop a climate resilient standards for multifamily housing that can help to reduce costs for residents and improve resilience to extreme heat, flooding, wind, and other hazards. Many residents who live in affordable housing face high energy costs due to inefficient heating and cooling. Retrofits of existing affordable housing and new affordable housing should be designed to maximize both emissions reduction and risk reduction to climate hazards.

9.4. Invest in climate resilient TOD. Transit Oriented Development (TOD) is an important tool for climate mitigation, as well as climate resilience. Require that transit-oriented development (TOD) plans consider sea level rise and flood hazard areas in planning. Many areas near transit options along the coast in Connecticut are also vulnerable to coastal flooding. It's important that future development of TOD avoids areas where chronic flooding will increase risks and costs to property owners and residents over time. For more on Resilient Connecticut's findings related to climate resilient TOD, visit our research page here: https://resilientconnecticut.uconn.edu/tod/

9.5. Municipalities should consider zoning and land use planning for heat and emissions reductions. Incorporate design standards in zoning regulation to mitigate projected heat increases like green roofs, reflective roofs and pavement, and protections for existing tree canopy cover. Vegetation and landscaping standards can help mitigate both heat and flooding issues using nature-based solutions to provide cooling, process stormwater on site, and absorb CO2.

10. Track changes in climate projections and policy options.

Since 2014, CIRCA's research has provided Connecticut specific guidance on local projections of sea-level rise, precipitation, and temperature due to climate change. This research has been instrumental in helping the state establish planning guidance and policies. As climate science evolves, updated guidance based on the latest findings will be needed to continue informing Connecticut's approach to adaptation and resilience. In addition, efforts to make climate science broadly accessible and understandable to the public will help to enable and inform action.

10.1. Move from "Best available science" to "actionable science." Project designs and decision making on priorities requires information grounded in measurement and data. Connecticut should continue to invest in field assessment and data collection to inform planning and policy guidance.

10.2. Develop resilience metrics and track progress of strategies, actions, and projects. Data from demonstration projects and post-construction monitoring of innovative projects are essential to the development of standards that can be used in permit decisions and to provide guidance to municipalities in the development of proposals.

10.3. Develop a sustained broader public education program to inform the public about climate risks and ongoing progress on strategies.

10.4. Continue to track the evolution of climate science and update state guidance such as PA-18-82, the CT Physical Climate Science Assessment Report, and the Science and Technology working group report of the GC3.

References

An Act Concerning Climate Change Planning and Resiliency. Public Act No. 18-82. (2018).
https://www.cga.ct.gov/2018/act/pa/pdf/2018PA-00082-R00SB-00007-PA.pdf

An Act Concerning Provisions Related to Revenue and Other Items to Implement the State Budget for the Biennium Ending June 30, 2023. Public Act No. 21-2. (2021). https://cga.ct.gov/2021/ACT/PA/PDF/2021PA-00002-R00SB-01202SS1-PA.PDF

Bronin, S. C. (2021). Zoning by a thousand cuts. 50 Pepperdine Law Review 719, 2023.
http://dx.doi.org/10.2139/ssrn.3792544

Buchanan, M., & Abraham, M. (2015). Concentrated wealth and poverty in Connecticut's neighborhoods: Analyzing racially concentrated economic inequality in Connecticut. Data Haven. https://www.ctdatahaven.org/reports/concentrated-wealth-and-poverty-connecticuts-neighborhoods

Climate Central & Zillow (2019). Ocean at the door: New homes and the rising sea.
https://assets.ctfassets.net/cxgxgstp8r5d/6MivIWCUbPf0L5bsN1NCKt/e35b5a4fc1e7cda9b4c8d412ed7c6889/2019Zillow_report.pdf

Connecticut Institute for Resilience and Climate Adaptation (CIRCA), (n.d.). ROARs map index.
https://resilientconnecticut.uconn.edu/roar-maps-index/

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2019a). CDBG-DR funded projects.
https://www.arcgis.com/apps/mapviewer/index.html?webmap=e660068e6ec9433488384fad129605f4

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2019b). Resilient Connecticut workshop summary. https://resilientconnecticut.media.uconn.edu/wp-content/uploads/sites/3830/2019/05/Workshop-summary-final_May-22-2019.pdf

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2019c). Resilient Connecticut climate adaptation summit. https://circa.uconn.edu/nov2019summit/

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2020). Resilient Connecticut planning framework, UConn CIRCA. https://resilientconnecticut.media.uconn.edu/wp-content/uploads/sites/3830/2020/04/Resilient-Connecticut-Planning-Framework-Final-1-30-20.pdf

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2021). Zones of Shared Risk narratives, UConn CIRCA. https://resilientconnecticut.media.uconn.edu/wp-content/uploads/sites/3830/2021/10/Appendix-F.pdf

Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2022). Resilient Connecticut Phase II final report, UConn CIRCA. https://media.circa.uconn.edu//docs/PhaseIIReport/2022.11.21%20Resilient%20CT%20Final%20Report_2022Update.pdf

Cook, S.F. (1973). The significance of disease in the extinction of the New England Indians. Human Biology, 45 (3), 485-508. http://www.jstor.org/stable/41459892

Connecticut Department of Economic and Community Development (DECD). (2022). Distressed municipalities. https://portal.ct.gov/decd/content/about_decd/research-and-publications/02_review_publications/distressed-municipalities

Connecticut Department of Housing (CT DOH). (2015). NRDC Phase 1 application. https://portal.ct.gov/doh/doh/additional-program-pages/ndrc-phase-1-application

Connecticut Department of Transportation (CTDOT). (n.d.). DOT history. https://portal.ct.gov/DOT/General/History/Chapter-2-DOT-History

Daniels, B. C. (1980). Economic development in colonial and revolutionary Connecticut: An overview. The William and Mary Quarterly, 37(3), 429-450. https://doi.org/10.2307/1923811

De Forest, J.W. (1851). History of the Indians of Connecticut, Hartford: Wm. Jas. Hamersley, 65

Federal Emergency Management Agency (FEMA). (n.d.). Individuals - floodplain management resources. https://www.fema.gov/floodplain-management/manage-risk/individuals

Fuller, G.P. (1915). An Introduction to the history of Connecticut as a manufacturing state. Northampton, MA: Smith College, http://archive.org/stream/introductiontohi00full#page/n3/mode/2up

Griffith, J. C. (1983). Connecticut's home rule: the judicial resolution of state and local conflicts. University of Bridgeport Law Review, 4(2), 177-264.

Intergovernmental Panel on Climate Change (IPCC). (2001). Climate change 2001: Impacts, adaptation, And vulnerability: Contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/2018/03/WGII_TAR_full_report-2.pdf

Leslie, D.E., Sportman, S.P. & Jones, B.D. (2020). The Brian D. Jones site (4-10B): A multi-component Paleoindian site in southern New England, PaleoAmerica, 6(2), 1-5. DOI: 10.1080/20555563.2019.1709147

Lewis, R. S., & Stone, J.R. (1991). Late Quaternary stratigraphy and depositional history of the Long Island Sound Basin: Connecticut and New York. Journal of Coastal Research Special Issue No. 11, 1-23. http://www.jstor.org/stable/25735570

Lewis, R. (2013). The geology of Long Island Sound. In Long Island Sound: Prospects for the Urban Sea. Latimer, J.S., Tedesco, M., Swanson, R.L., Yarish, C., Stacey, P., Garza, C. (Eds.) ISBN-13: 978-1461461258. https://doi.org/10.1007/978-1-4614-6126-5_2

Mandell, D. R. (2010). King Philip's war: Colonial expansion, native resistance, and the end of Indian sovereignty. United States: Johns Hopkins University Press.

Miniutti, P. (2019). Resilient Connecticut Climate Adaptation Summit 1, Zones of Shared Risk Charrette.

UConn's Community Research & Design Collaborative. https://circa.media.uconn.edu/wp-content/uploads/sites/1618/2024/07/Zones-of-Shared-Risk-Charette_Peter-Miniutti.pdf

O'Donnell, J., Wilson, R.E., Lwiza, K., Whitney, M., Bohlen, W.F., Codiga, D., Fake, T., Fribance, D., Bowman, M., & Varekamp, J. (2014). The physical oceanography of Long Island Sound. In Long Island Sound: Prospects for the Urban Sea. Latimer, J.S., Tedesco, M., Swanson, R.L., Yarish, C., Stacey, P., Garza, C. (Eds.), ISBN-13: 978-1461461258. https://doi.org/10.1007/978-1-4614-6126-5_3

O'Donnell, J. French, R., Felson, A. & Thompson, B. (2017). The Development of the Connecticut Connections Coastal Resilience Plan. Connecticut Institute for Resilience and Climate Adaptation, Urban Ecology and Design Lab at the Yale School of Architecture, and the CT Department of Energy and Environmental Protection, Project Proposal.

Office of Legislative Research (OLR). (1998). County Government Abolishment.
https://www.cga.ct.gov/PS98/rpt%5Colr%5Chtm/98-R-0086.htm

Ostiguy, L.J., Sargent, T.C., Izbicki, B.J., & Bent, G.C. (2018). High-water marks from Hurricane Sandy for coastal areas of Connecticut, Rhode Island, and Massachusetts, October 2012. U.S. Geological Survey Data Series 1094, 16 p., https://doi.org/10.3133/ds1094.

Rebuild by Design (2015). Rebuild by design.
https://rebuildbydesign.org/wp-content/uploads/2021/12/499.pdf

Regional Councils of Government. Connecticut General Statutes §§ 8-31a to -37b.
https://www.cga.ct.gov/current/pub/chap_127.htm

Resilient Bridgeport (2014). Resilient Bridgeport: Claim the edge, connect the center.
https://resilientbridgeport.com/pdf/RebuildbyDesignProposal.pdf

State Agencies Fostering Resilience (SAFR) Connecticut Connections (2016). NDRC Phase 2 application.
https://portal.ct.gov/doh/doh/additional-program-pages/ndrc-phase-2-application

Schlichting, K. M. (2014). “They shall not pass”: Opposition to public leisure and state park planning in Connecticut and on Long Island. Journal of Urban History, 41(1), 116-142. DOI: 10.1177/0096144214551723

SLR Consulting & Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2021). Resilient Connecticut Phase II: From regional vulnerabilities to resilience opportunities. UConn CIRCA. https://resilientconnecticut.media.uconn.edu/wp-content/uploads/sites/3830/2021/12/Task-4.2-report_final.pdf

Spiess, M. (1935). Connecticut circa 1625: Its Indian trails, villages and sachemdoms. Conn. Soc. Colonial Dames of America. 40pp. https://archive.org/details/connecticutcirca00nati

Stone, J.R., Schafer, J.P., London, E.H., DiGiacomo-Cohen, M.L., Lewis, R.S., & Thompson, W.B. (2005). U.S. Geological Survey Scientific Investigation Map 2784, 2 sheets, scale 1:125,000

Stone, J.R., Schafer, J.P., London, E.H., DiGiacomo-Cohen, M.L., Lewis, R.S., & Thompson, W.B. (2005). Quaternary geologic map of Connecticut and Long Island Sound Basin. U.S. Geological Survey Scientific Investigations Map 2784. (https://pubs.usgs.gov/sim/2005/2784/)

Tilden (1893). Map of the railroads of Connecticut to accompany the report of the Railroad Commissioners. https://www.flickr.com/photos/uconnlibrariesmagic/5529331631/in/photostream/lightbox/

Tondro, T. J. (1999). Fragments of regionalism: state and regional planning in Connecticut at century’s end. St. John’s Law Review, 73(4), 1123-1158.

Town of Branford (2016). Branford coastal resilience plan. https://www.branford-ct.gov/sites/default/files/field/files-docs/branford_crp_draft_reduced_size.pdf

Town of Guilford (2014). Community coastal resilience plan. https://www.cakex.org/sites/default/files/documents/Guilford%20Community%20Coastal%20Resilience%20Plan.pdf

Town of Stratford (2016). Town of Stratford coastal community resilience plan.
https://core-docs.s3.us-east-1.amazonaws.com/documents/asset/uploaded_file/3632/Stratford/4051644/Stratford_Coastal_Resiliency_Plan_-_Final_Report_12-21-2016_Electronic_-_optimized.pdf

van de Plassche, O., (1991). Late Holocene sea-level fluctuations on the shore of Connecticut inferred from transgressive and regressive overlap boundaries in salt marsh deposits: J. Coastal Res. 11, 159-180.

Wu, T., Fragomeni, M., & Minutti, P. (2020). Resilient Connecticut coastal towns Zones of Shared Risk dataset, (v.1), [Maps], University of Connecticut, Connecticut Institute for Resilience and Climate Adaptation, Retrieved from https://resilientconnecticut.uconn.edu/zones-of-shared-risk-dataset/

Zalasiewicz, J., Waters, C. N., Ellis, E. C., Head, M. J., Vidas, D., Steffen, W., Thomas, J. A., Horn, E., Summerhayes, C. P., Leinfelder, R., McNeill, J. R., Gałuszka, A., Williams, M., Barnosky, A. D., Richter, D. deB., Gibbard, P. L., Syvitski, J., Jeandel, C., Cearreta, A., Cundy, A. B., Fairchild, I. J., Rose, N. L., Ivar do Sul, J. A., Shotyk, W., Turner, S., Wagreich, M., & Zinke, J. (2021). The Anthropocene: comparing its meaning in geology (chronostratigraphy) with conceptual approaches arising in other disciplines. Earth's Future, 9(3), e2020EF001782 https://doi.org/10.1029/2020EF001896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