

**Resilient Connecticut Phase II:
From Regional Vulnerabilities to Resilience Opportunities in
Fairfield County and New Haven County
Executive Summary**

1

About Resilient
Connecticut

Phase II of Resilient Connecticut is a dynamic, multidisciplinary planning process to identify and address climate change vulnerabilities in New Haven County and Fairfield County. This Phase of the Resilient Connecticut planning process included progressive technical analysis and robust stakeholder engagement and collaboration, with a goal of identifying opportunities for climate change adaptation through resilience projects throughout the region.

2

Technical Tools &
Resources

The subsequent summary provides a high-level review of the vulnerability analysis and the preliminary identification of areas where climate adaptation opportunities through community resilience tools may be advanced to reduce risks associated with flooding and extreme heat.

3

Vulnerability Mapping

4

Resilience Opportunity
Areas

About Resilient Connecticut

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The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) initiated Resilient Connecticut in 2019 as a component of the National Disaster Resilience Competition award to the State of Connecticut. Funding for this project was provided by the United States Department of Housing and Urban Development through the Community Development Block Grant National Disaster Recovery Program, as administered by the State of Connecticut, Department of Housing. Resilient Connecticut provides the state with a planning framework piloted in New Haven and Fairfield Counties, as these areas were most heavily impacted by Superstorm Sandy in 2012.

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The Resilient Connecticut project focuses on regional resilience and adaptation planning through evaluations and engagement to inform municipal-to-regional scale resilience initiatives and pilot projects. Resilient Connecticut's guiding principle is to establish resilient communities through forward-looking planning that incorporates economic development framed around transit-oriented development (TOD), conservation strategies, and critical infrastructure improvements.



The project will generate recommendations for a Statewide Resilience Road map that includes regional resilience and adaptation planning, policy consideration, and actionable priorities. In addition, science-based regional risk assessments will inform municipal to regional scale initiatives and pilot projects.



3

Resilient Connecticut recognizes that the impacts of climate change to infrastructure, public health, ecology, and other systems are felt at the watershed level and across jurisdictional scales. While much previous planning has been done in Connecticut to understand risks and identify resilience projects town by town, the Resilient Connecticut Phase II planning process analyzed climate risks from a systems perspective, identified vulnerabilities to regional infrastructure, and created a process for shared investment and decision making at scales appropriate to address shared and similar problems among stakeholders.

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Phase II of Resilient Connecticut commenced in mid-2020 and will conclude in late 2021. The central technical component of Phase II of Resilient Connecticut is a regional risk and 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 that have potential for TOD. This vulnerability assessment can be incorporated into both climate-specific and regular planning processes at the municipal, council of government (COG), and state scale.

The results of Phase II of Resilient Connecticut are captured in several public-facing products such as map viewers, an ESRI Story Map, workshops, webinars, and reports. The subject report summarizes the initial assessment of regional vulnerabilities and zones of shared risk, as well as the identification of potential areas of opportunities.

As Connecticut increases its preparedness efforts, the products created during the Resilient Connecticut project could be enhanced to incorporate growing datasets, more precise measurements, and a wider geographic scope.

Technical Tools

1

The vulnerability assessment conducted during Phase II involves the development and use of several technical tools to aid in the assessment of flood and extreme heat vulnerabilities. These tools have been expanded upon using outside resource reviews, stakeholder feedback, and a multitude of environmental, social, and infrastructural datasets. The three major tools include:

- Social Vulnerability (SV) Mapping
- A new “Climate Change Vulnerability Index” (CCVI)
- Mapping of “Zones of Shared Risk” (ZSR)

Each tool presents the vulnerabilities to climate change stressors in a slightly different manner; however, intersections and similarities amongst the three were realized.

Social Vulnerability Mapping

2

The Resilient Connecticut methodology for social vulnerability mapping incorporates 30 social factors into a social vulnerability index, which are then divided into five subgroups. The index is primarily comprised of the latest statewide block group demographic data sourced from the 2015-2019 U.S. Census American Community Survey (ACS).

Climate Change Vulnerability Index

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Building upon CIRCA’s coastal vulnerability index method (refer to <https://resilientconnecticut.uconn.edu/resources/>), the CCVI uses a quantitative index-based approach to characterize flood and extreme heat vulnerabilities throughout the two counties. The index combines social, ecological, and built sensitivities with climate and physical exposures while adjusting for adaptive capacities to characterize vulnerabilities on local and regional scales. The indices acknowledge the ongoing challenges of mitigating flood and heat risks across the region and can aid in identifying the drivers of some of these challenges.

Zones of Shared Risk

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A ZSR can be defined as an area that faces a specific profile of flood-related challenges because of climate change, and therefore the inhabitants of the ZSR share a risk profile. These areas include houses, land, infrastructure, hydrological, ecological, social, and institutional elements. Planning through the ZSR approach is a qualitative means of characterizing vulnerabilities and risks for coastal and inland communities. A ZSR includes the stakeholders that share the specific risks.

ZSR support the concept of “resilient corridors.” These corridors are mechanisms to adapt at-risk areas while supporting infrastructural and economic development. Resilient corridors should connect low lying, vulnerable areas to upland resilient areas. Corridors can be developed between ZSRs for short-term needs such as evacuation as well as long-term movement of services and goods.

Resources

Various sources have been used for data for the technical tools and analyses. The four COGs have played an important role in data acquisition for their respective regions. The four COG stakeholders are Western Connecticut COG (WestCOG), Connecticut Metropolitan COG (MetroCOG), Naugatuck Valley COG (NVCOG), and South Central Regional COG (SCRCOG).

Vulnerability Mapping

In addition, other state and federal resources have been utilized for social, infrastructural, and ecological datasets. Plans of Conservation and Development, Hazard Mitigation Plans, and Community Resilience Building reports have been reviewed in addition to regional scale plans like CIRCA's Drinking Water Vulnerability and Resilience Plan. These provide insights into community needs and highlight intersections between municipal efforts and the goals of Resilient Connecticut.

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Social Vulnerability

The overall social vulnerability calculated from all 30 factors is typically highest in the more urbanized areas in New Haven and Fairfield counties, generally extending along major transportation routes (I-95, I-91, and Route 8). While the SV results may not directly relate to climate change stressors such as flooding or extreme heat, the resulting maps convey which communities may face underlying challenges, and ultimately how these challenges impact disaster response and recover as well as climate change adaptation. Of the municipalities throughout the region, the following have at least one census block group of the highest SV scores:

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<i>Ansonia</i>	<i>East Haven</i>	<i>New Haven</i>	<i>Stratford</i>
<i>Bridgeport</i>	<i>Fairfield</i>	<i>Norwalk</i>	<i>Wallingford</i>
<i>Danbury</i>	<i>Hamden</i>	<i>Shelton</i>	<i>Waterbury</i>
<i>Derby</i>	<i>Meriden</i>	<i>Stamford</i>	<i>West Haven</i>

3

Specific categories or subgroup vulnerabilities can also be assessed using SV maps. The top five most vulnerable block groups for each subgroup category are:

- *Socioeconomic Status*: Bridgeport (2), New Haven, Danbury, Stamford
- *Household Composition and Disability*: Bridgeport (2), Wallingford, Waterbury, Wolcott
- *Minority Status and Language*: Bridgeport (2), Derby, Norwalk (2)
- *Housing Type and Transportation*: Bridgeport (4), Waterbury
- *Labor Force*: Bridgeport, Meriden, New Haven (2), Norwalk

4

Heat Vulnerability

Heat is a concern for vulnerable populations, sensitive ecosystems, and energy concerns (i.e., due to inefficient cooling) found in higher vulnerability areas. Areas throughout the region that are vulnerable to extreme heat according to the CCVI results are primarily found in the more urbanized areas, including:

- Southeast Greenwich along Route 1
- Downtown Stamford, East Side, and Glenbrook
- South and East Norwalk, Eastern side along Route 7 between 15 and Route 1
- Central and Southern Bridgeport
- Downtown Danbury
- Waterbury neighborhoods of Overlook, Hillside, Central Business District, South End, Crownbrook, New Pac, and Bouley Manor

Vulnerability Mapping

In most of these areas, heat vulnerability tends to radiate from these neighborhoods, decreasing outward. However, there are also smaller pockets of high heat vulnerability in neighboring communities. Naugatuck, Ansonia, and Derby have smaller areas that show high heat vulnerability in comparison to those above, while West Haven and East Haven have high heat vulnerability areas along the New Haven boundaries. The CCVI contains the data to dig deeper into these considerations with numerous scored data layers driving these quantitative results.



Flood Vulnerability

The flood CCVI results are generally not as concentrated in urbanized areas as the heat vulnerability mapping. Instead, spatial vulnerability trends are relatively synonymous with rivers, streams, and the Long Island Sound coastline, as one might expect. New Haven, Bridgeport, Stratford, Norwalk, and Stamford have some of the higher coastal vulnerable areas, while inland communities like Danbury and those along the Naugatuck and Quinnipiac Rivers have high riverine flood vulnerable areas. The flood vulnerability mapping takes into consideration different types of flooding such as riverine, storm surge, and ponding in low areas. Other factors playing a role in vulnerability include flood-vulnerable infrastructure, flood-sensitive ecosystems, and populations at risk of flood-related hazards.



As with the heat vulnerability mapping, the important point when evaluating the CCVI results is understanding the underlying contributors; what is *sensitive* in these areas, what is driving *exposure*, and how *adaptive* is the community.

Zones of Shared Risk



The identification and understanding of ZSR is meant to work with SV and CCVI mapping to provide additional insight into the types of vulnerabilities and risks throughout the region. ZSR have been delineated in the municipalities with TOD potential whether the TOD is for an established or planned passenger rail station. ZSR mapped for this project vary greatly in size, with some nested within another ZSR. In general, four types of ZSR were mapped for Resilient Connecticut:



- *Access*: risks derived from flood-related access or egress challenges
- *Location*: risk derived from the area's low-lying location and directly vulnerable to flooding
- *Proximity*: risk derived from adjacency to low-lying, vulnerable lands
- *Natural Protection*: risks to lands that provide natural flood protection or that occupy land that is appropriately flooded in lieu of development

Railroad underpasses have been identified as a separate type of ZSR typology, although the underpasses have characteristics of access and location ZSRs. Many communities have identified ongoing challenges associated with these underpass locations.

The four COGs (WestCOG, MetroCOG, NVCOG, and SCRCOG) provided an important platform for monthly meetings to provide updates about the SVI, CCVI, and ZSRs to chief elected officials and their transportation, planning, and conservation-oriented subcommittees. The following eight pages summarize some of the key findings in each COG planning area, with one page per COG devoted to flood vulnerabilities and one page per COG devoted to heat vulnerabilities.

Vulnerability Mapping

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This region is comprised of three coastal and three inland communities. Flood vulnerability is highest along the shoreline due to storm surge and sea level rise, with additional vulnerabilities along the streams and rivers in the region.

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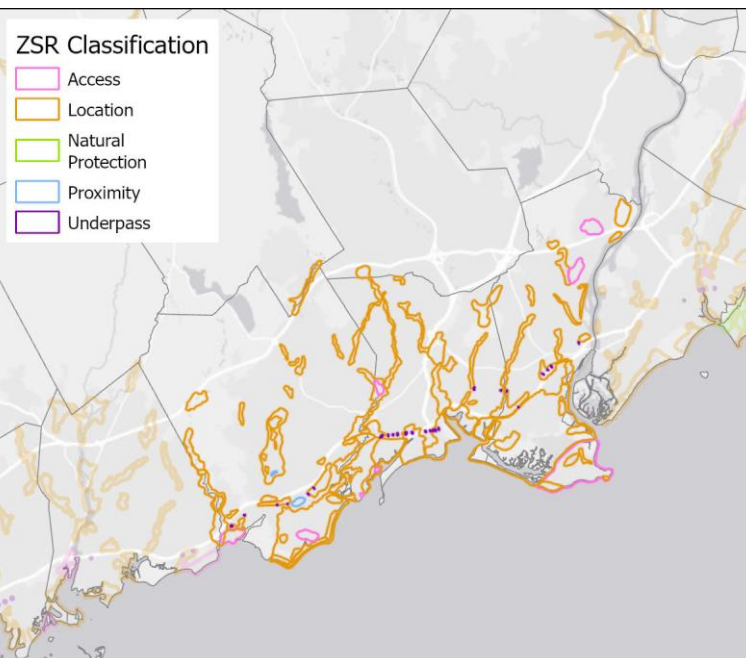
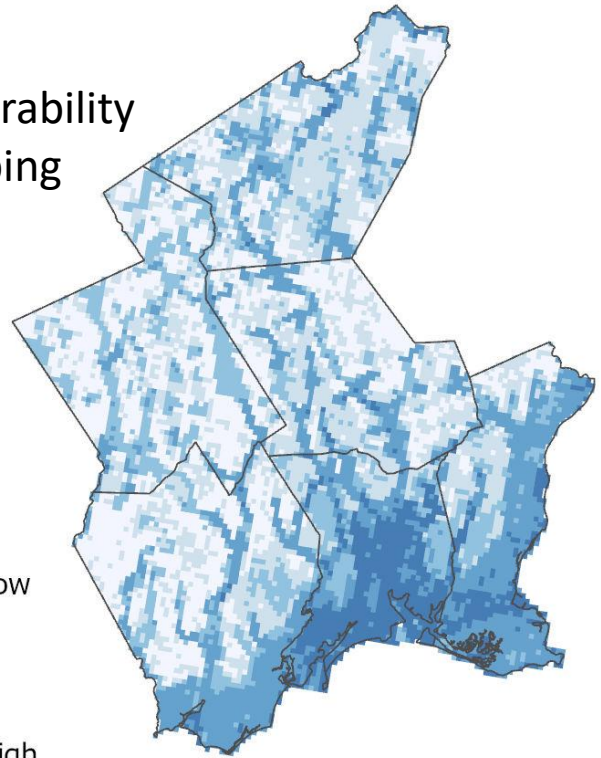
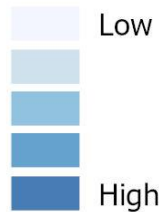
The highest flood vulnerabilities are found along the shoreline and major rivers of the MetroCOG region, although urbanized areas in the three coastal communities

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exhibit vulnerabilities that are not necessarily located along rivers and streams. These may be due to stormwater drainage concerns reflected in the aspects of the CCVI that capture pooling and ponding. Higher social vulnerabilities in Bridgeport and Stratford also lead to relatively high flood vulnerabilities. Flood vulnerabilities in the three northern communities of Easton, Trumbull, and Monroe are aligned with watercourses. The most vulnerable TOD in the MetroCOG region is the Bridgeport TOD. In addition, there are three shelters located in high flood vulnerable areas: Columbus School, Jettie Tisdale School, and Multicultural Magnet School.

4

Flood Vulnerability Mapping



ZSR were primarily delineated along the developed portions of the riverine corridors and shorelines. Numerous nested ZSR were delineated in coastal Fairfield and Stratford to represent areas that can be isolated or affected by multiple scales of isolation during an evolving flood event. Areas of potential isolation in northern Stratford were also identified. Downtown Fairfield was identified due to its frequent flooding caused by stormwater.

MetroCOG

Vulnerability Mapping

1

Heat vulnerability for MetroCOG is highest in Bridgeport; with moderate to high vulnerability throughout Stratford, eastern Fairfield and southern Trumbull. Heat vulnerability is low to moderate throughout Easton, Monroe, and a majority of Trumbull.

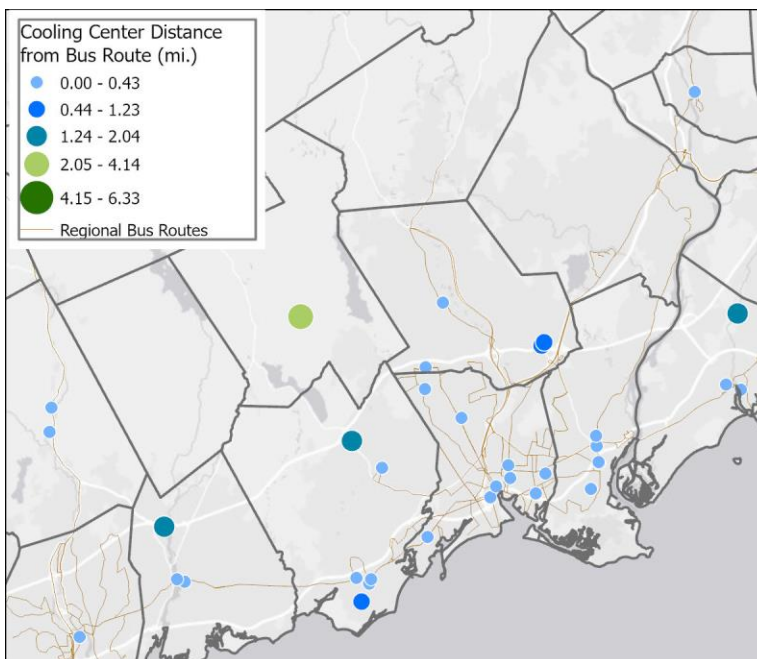
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Bridgeport is almost entirely vulnerable due to social factors. This includes high density of heat vulnerable populations and lower adaptive capacities. This is also true for much of

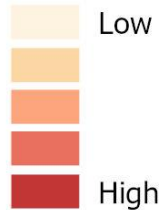
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Trumbull and Stratford; both communities are predominantly vulnerable because of social factors, however both have some locations that are driven by built factors. This indicates high impervious surface density, high emissivity, and lower built adaptive capacity. Easton and Fairfield are both predominantly heat vulnerable as a result of built contributors, with eastern Fairfield having high social concerns. Monroe shares both social and built concerns as the driving factors behind heat vulnerability. While certain areas, such as Bridgeport and southern Stratford, may also have high built related vulnerability (high emissivity or impervious surface density), the social implications

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Heat Vulnerability Mapping



outweigh the built according to the CCVI method. There are likely ways to reduce social sensitivities to heat by way of built adaptation.

The most heat vulnerable TOD in the MetroCOG region is the Barnum Station. While this station is not yet developed, it is important to consider heat vulnerability in the area during future development. Also of note, the Easton Senior Center and Black Rock Church are cooling centers greater than one mile from a bus route, which elevates heat risk.

Vulnerability Mapping

NVCOG

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The NVCOG region is comprised of 19 municipalities; however, only 13 are included in the focus area of Resilient Connecticut as some are located outside of Fairfield and New Haven Counties.

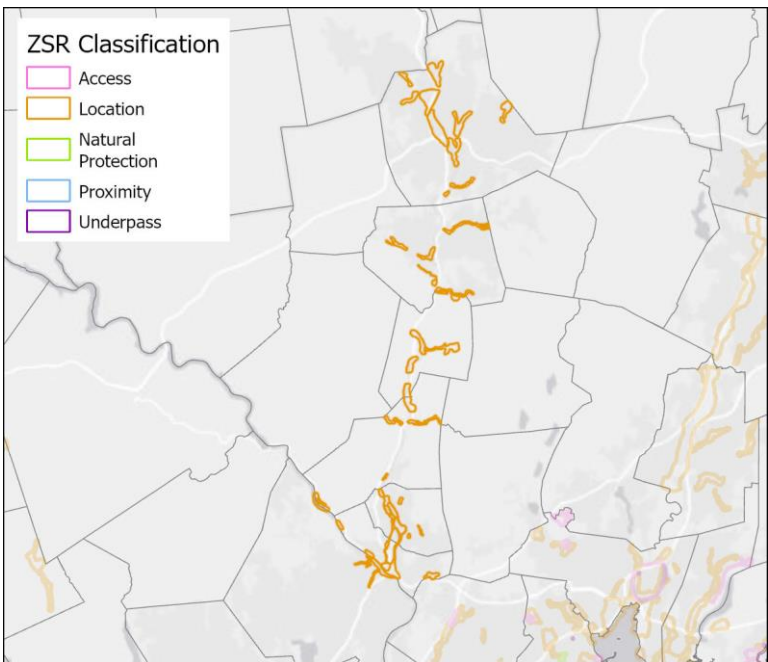
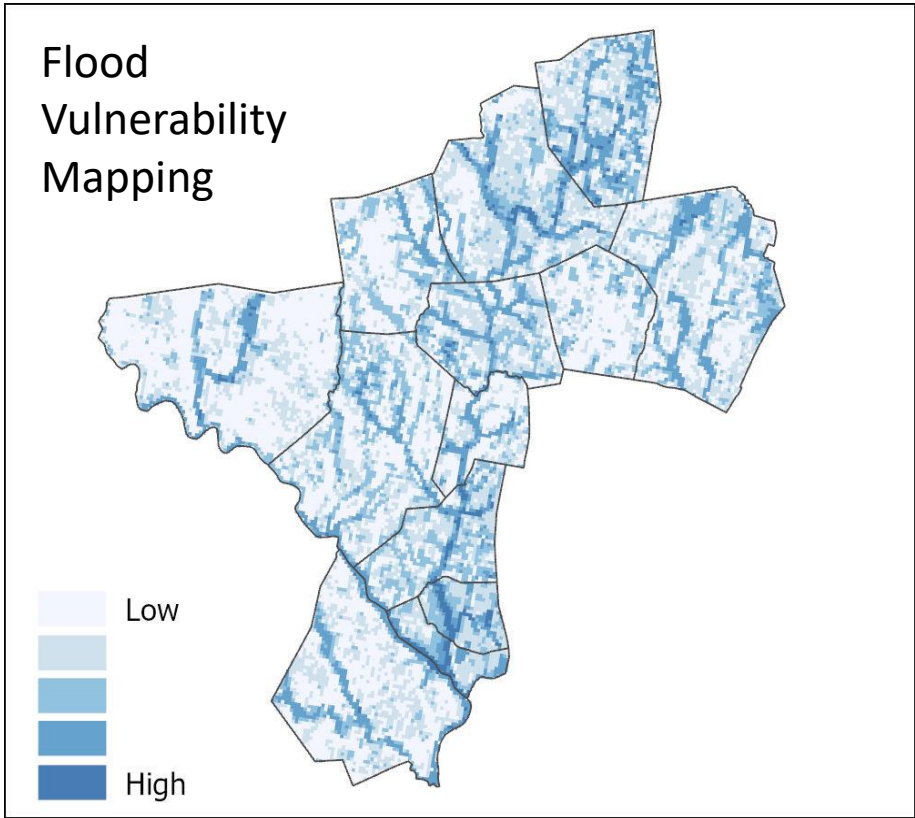
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Flood vulnerability in the NVCOG region is highest along the Naugatuck, Housatonic, Mad, Pomperaug, and Tenmile Rivers. Several tributaries throughout the region contribute to moderate to high flood vulnerability. All of the communities located

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along the Naugatuck River have high flood vulnerability, including those that enjoy flood protection from upstream dams and/or from local flood protection (levee) systems such as those located in Ansonia and Derby. The only NVCOG community that lacks extensive riverine flood vulnerability is Prospect, which is due to its headwaters position. Flood vulnerability drivers vary greatly throughout the region, but it is important to note that Derby, Ansonia, Beacon Falls, Naugatuck, Waterbury, and Wolcott have the highest density of social sensitivity, which may be driving overall flood vulnerability.

4



The Derby/Shelton TOD area along the Naugatuck River has the highest flood vulnerability in the NVCOG region. In addition, the Beacon Falls Town Hall (shelter) is located in a moderate-high flood vulnerable location.

ZSR were primarily delineated along the developed portions of the river corridors. Hazard mitigation plans were critical for locating ZSR that do not follow mapped floodplains, such as ZSR in Waterbury, Naugatuck, and Shelton.

Vulnerability Mapping

NVCOG

1

The highest heat vulnerable areas have been identified in Derby, Ansonia, Waterbury and Naugatuck. These four municipalities have some of the more urbanized communities in the region with high impervious surface, and socially vulnerable population. The remainder of the NVCOG region has primarily moderate to low heat vulnerability.

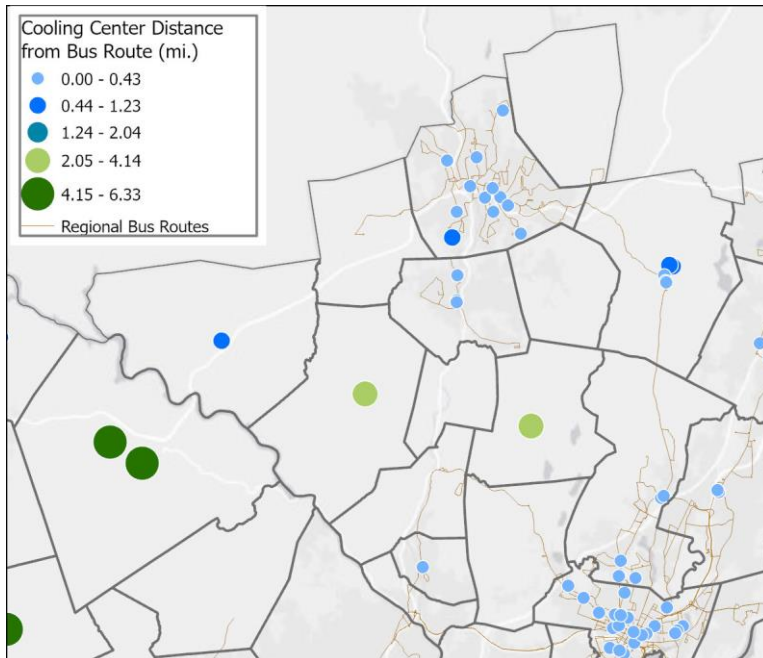
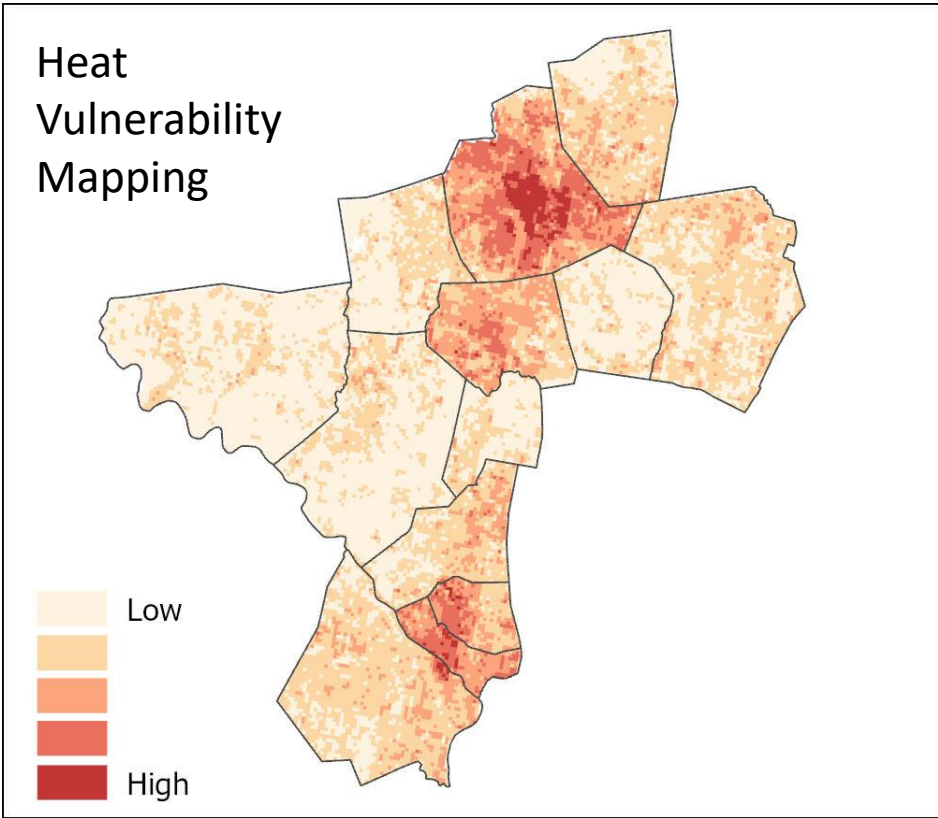
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The factors driving high heat vulnerability in the NVCOG communities

are primarily social. This is also true for a majority of the region. While many communities are low to moderate for heat vulnerability, their driving contributors are associated with socially sensitive populations. Relevant social indicators include heat related health concerns, transportation challenges, living below poverty levels, or populations without health insurance. Built factors are driving vulnerability in Southbury, Middlebury, eastern Prospect, and much of Cheshire and Wolcott, with contributing factors such as high building or impervious surface density, potentially inefficient structures, and high emissivity.

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The Waterbury TOD area has the highest heat vulnerability of all TODs in NVCOG. This indicates high social and built sensitivities within the 0.75 mile radius surrounding the station. These driving factors should be considered during any TOD redevelopment. It is also important to note that of all cooling centers in the NVCOG region, the Oxford Town Hall and Southbury Senior Center are both located over one mile from a bus route, potentially reducing accessibility to these sites.

SCRCOG

Vulnerability Mapping

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The SCRCOG region is comprised of 15 communities; seven are coastal and eight are inland.

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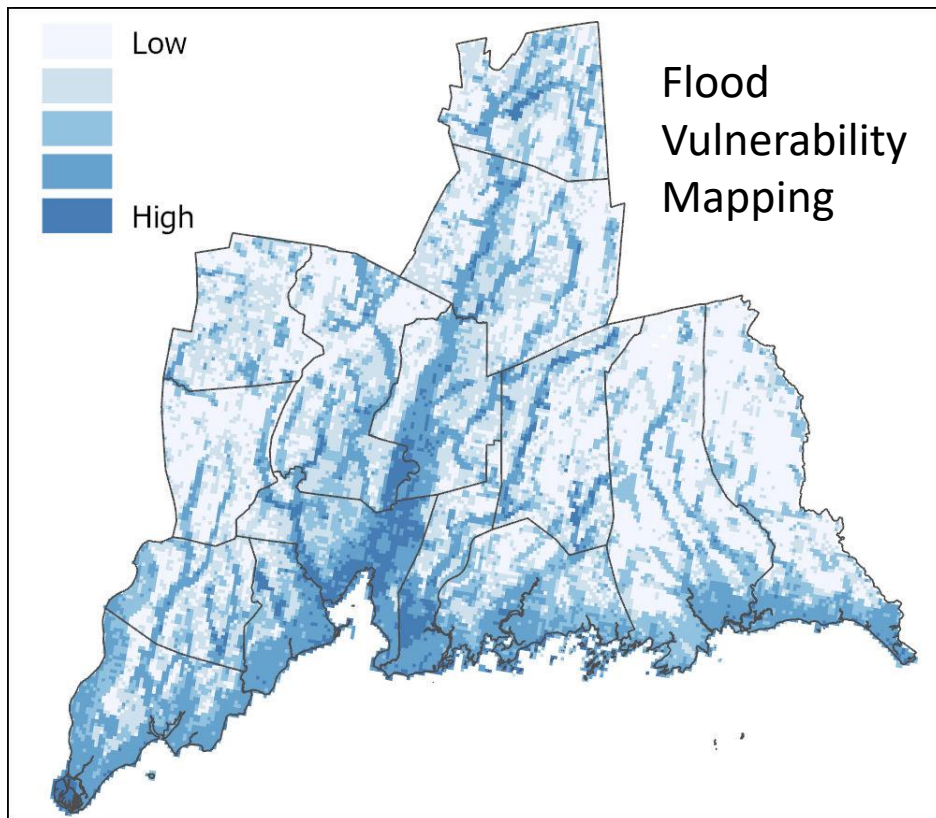
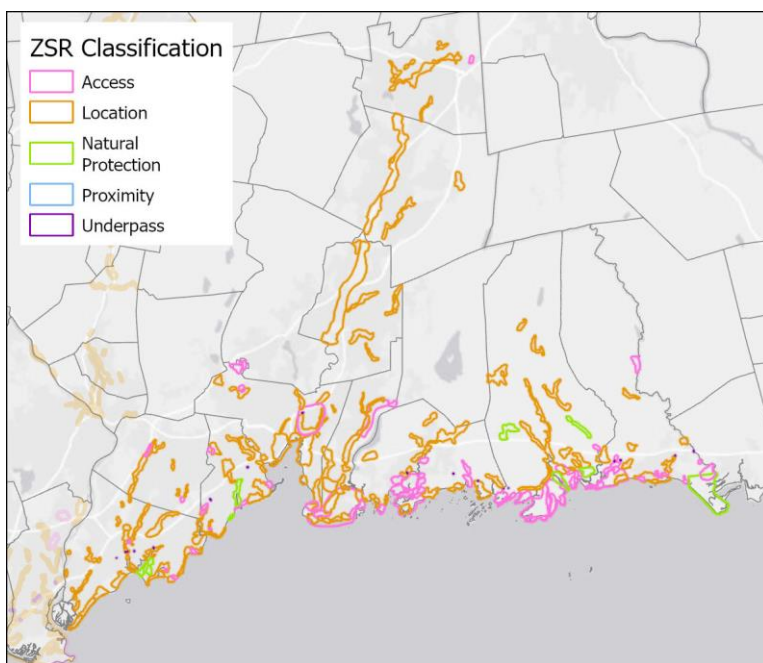
Flood vulnerability is concentrated along the coastline, the Housatonic River, the West River in New Haven, and the Quinnipiac River extending from Meriden to New Haven. Flood vulnerability is primarily driven by social factors in New Haven, Wallingford, and Meriden, sensitive populations reside.

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Union Station in New Haven has the highest collective vulnerability of the TODs throughout the SCRCOG region. Shelters including Branford High, East Haven Senior Center, Hamden High, Muravnick Senior Center, Platt High, and New Haven Fire Academy are in moderate-high flood vulnerable areas.

4

ZSR were primarily delineated along the developed portions of the riverine corridors and shorelines. Numerous nested ZSR were delineated in coastal Milford, East Haven,



Branford, and Guilford to represent areas that can be isolated or affected by multiple scales of isolation during an evolving flood event. Hazard mitigation plans and coastal resilience plans were helpful for locating ZSRs that do not necessarily follow mapped floodplains, such as some of them in Milford, West Haven, Branford, Guilford, and Madison. Stakeholder input also aided in ZSR delineation, such as the Post Mall area in Orange.

SCRCOG

Vulnerability Mapping

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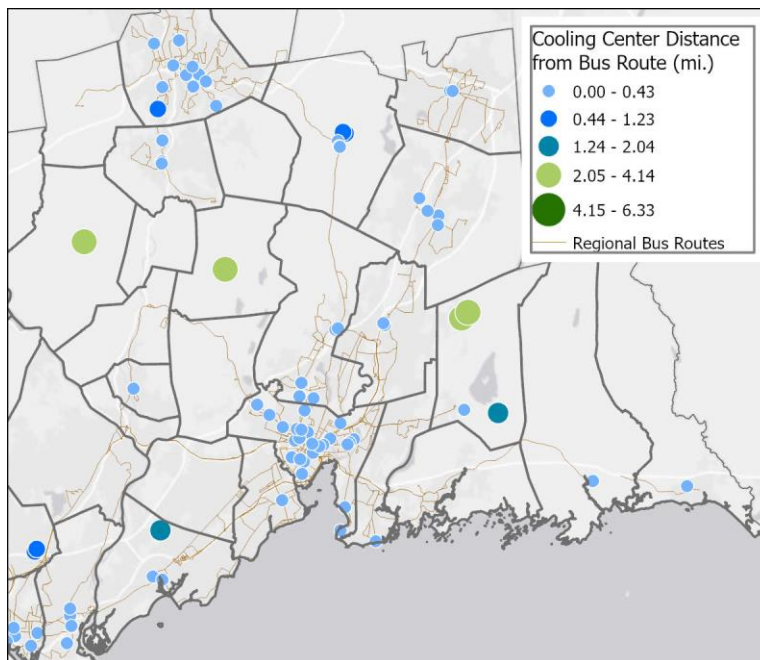
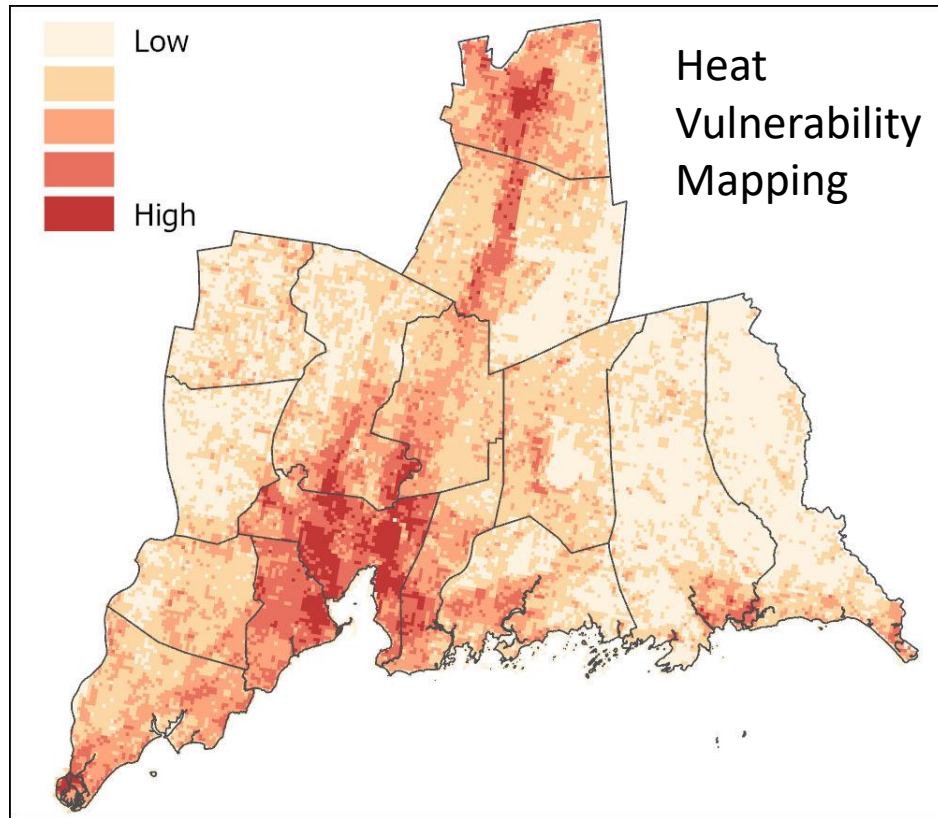
The highest heat vulnerability is concentrated in New Haven in the Port Area and in the Hill area near the West River. High heat vulnerable areas are found in downtown Meriden and in West Haven. Moderately high heat areas radiate from the high heat areas throughout New Haven, a majority of West Haven and Meriden, and along the Route 15 corridor in Wallingford. Smaller moderate heat areas are also along the Milford shoreline, East Haven, southern

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Branford and southeastern Guilford. A majority of the high and moderately-high heat areas are primarily driven by social contributors. This includes heat vulnerable populations that may not have health insurance, have heat-related health concerns, have low income, or high population density. The low to moderate heat areas are primarily driven by built contributing factors. This includes high emissivity and impervious surface density, older structure age, or far from a shelter or cooling center. There are some areas, such as central Guilford, eastern Madison, and northwestern Hamden where built and social factors equally contribute to heat vulnerability.

4



Of all TODs in the region, the Meriden TOD has the highest heat vulnerability. However, the TOD areas in New Haven and West Haven also rank highly. Four cooling centers in the region are further than one mile from a bus route: Bethany Town Hall/Senior Center, Atwater Memorial Library, Edward Smith Library, and No. Branford Rec. Dept. This elevates heat risk in those communities, as residents may not be able to reach cooling centers as easily.

WestCOG

Vulnerability Mapping

1

WestCOG is comprised of 18 municipalities, with 16 in Fairfield County. The highest flood vulnerabilities are along the coastline and along the Still River in Danbury and Brookfield. Moderately-high vulnerable areas can be found along major rivers and streams in the region such as the Norwalk, Mianus, Saugatuck, and the Byram Rivers.

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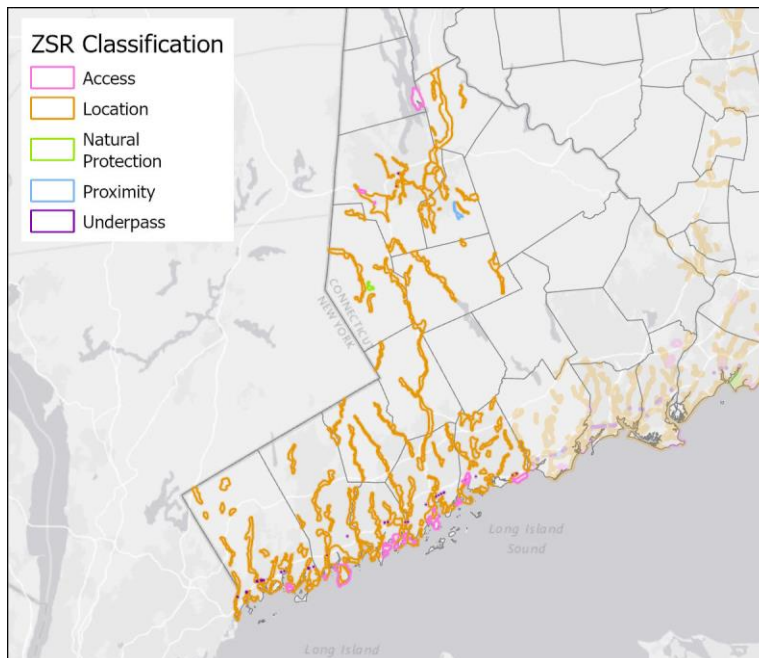
The Stamford TOD has the highest flood vulnerability in the region. Five shelters are

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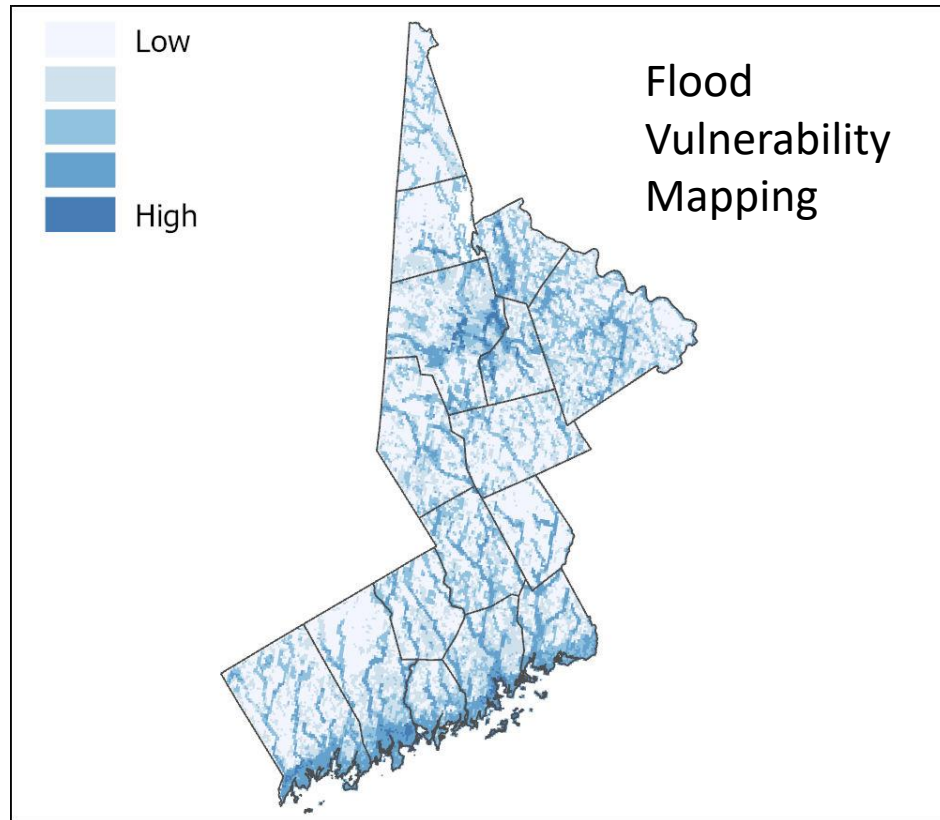
located in moderately-high flood areas: Mather Community Center, Darien Town Hall, John Read Middle School, New Fairfield Senior Center, Stamford Government Center, and Wilton YMCA.

4

ZSR were primarily delineated along the developed portions of the riverine corridors and shorelines. Numerous nested ZSR were delineated in coastal Greenwich, Darien, Norwalk, and Westport to represent areas that can be isolated or affected by multiple scales of isolation during an evolving flood event. Hazard mitigation plans were helpful



for locating ZSR that do not necessarily follow mapped floodplains, such as some of the ZSR in Danbury, Bethel, Ridgefield, and Norwalk. Stakeholder input also aided in ZSR delineation, such as in Danbury.



WestCOG

Vulnerability Mapping

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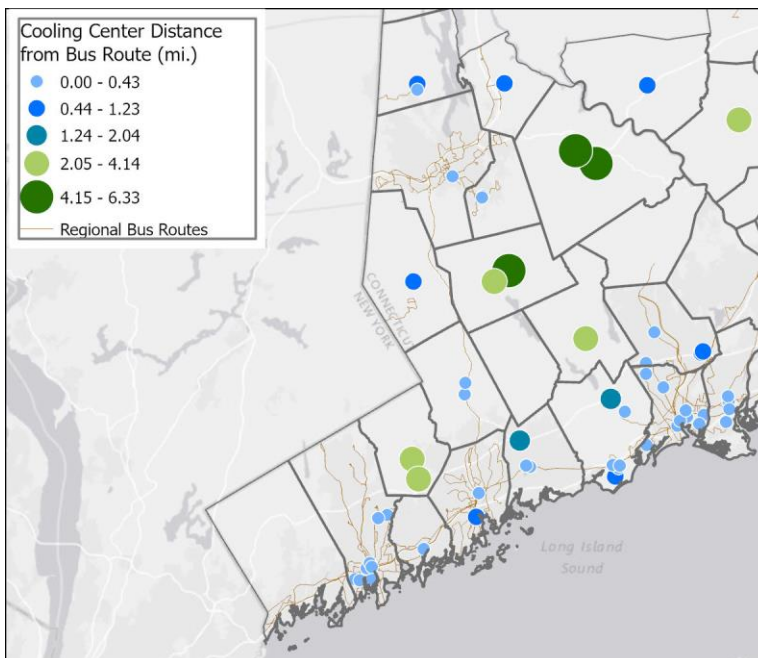
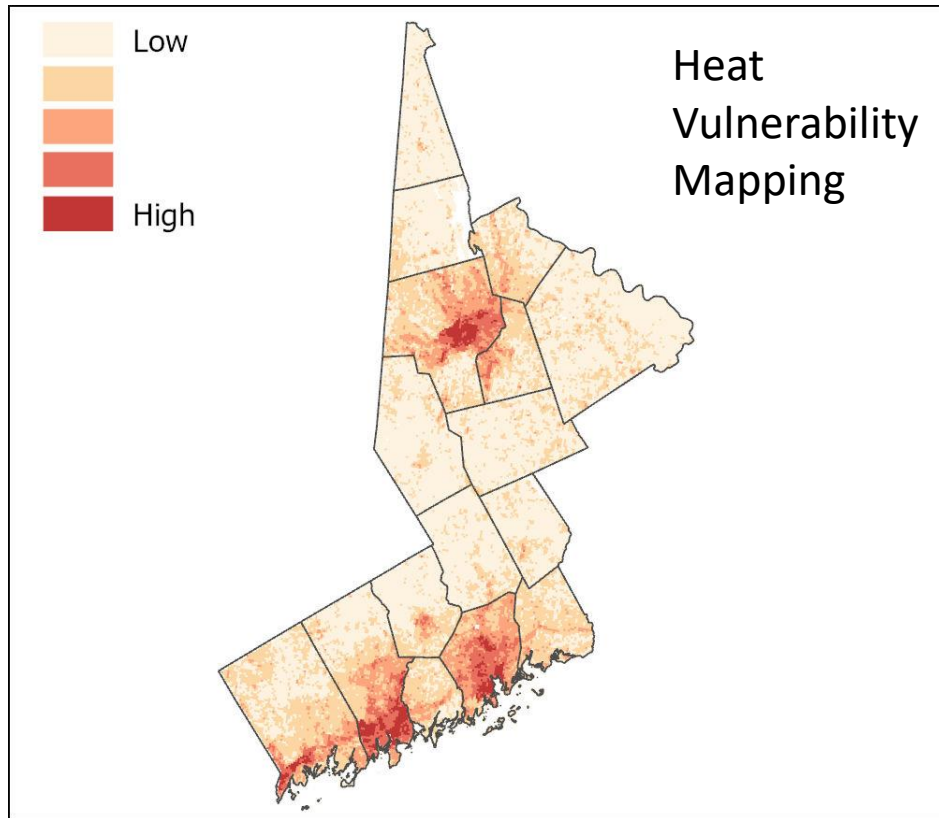
High heat vulnerability areas are located in southern Stamford, southwestern Greenwich along Route 1, south Norwalk, and downtown Danbury. Radiating from these high heat areas in these communities are moderately to moderately-high vulnerable areas. New Canaan center and the Route 1 corridor in Darien also have some heat vulnerability. A majority of the region has low to moderate heat vulnerability. The high and

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moderately-high heat areas are mostly driven by social factors. Contributing factors include high numbers of asthma related emergency visits, low disposable income, and very old or young populations. In addition to the high heat areas already listed, west Redding, northeast Wilton, and southern Ridgefield are driven by social factors. Many of the remaining areas are driven by built factors such as older structure age, longer distance to shelters or cooling centers, and high building density. Some smaller areas are driven by ecological factors including reduced tree and vegetative coverage. There are also several areas throughout the region where vulnerability is equally driven by built and social contributing factors.

4



The Danbury TOD is the highest heat vulnerable TOD area. Relative to the other COGs, WestCOG has the most cooling centers greater than one mile from a bus route: Cyrenius Booth Library, Newtown Municipal Complex, Redding Community Center, Mark Twain Library, Ridgefield Parks & Recreation, Westport/Weston YMCA, New Canaan Library, and New Canaan YMCA. This elevates heat risk in those communities

Vulnerability Mapping

Assets and Infrastructure

As noted by a participant in the Resilient Connecticut workshops, “critical infrastructure supports critical infrastructure.” In other words, even infrastructure that may seem inconsequential may support infrastructure that is more obviously critical. Infrastructure is a necessary component of supporting TOD, resilient corridors, and resilient communities. Therefore, the Resilient Connecticut planning phase included an inventory and analysis of key assets and infrastructure. This analysis identifies the degree of risk that a component is exposed to regarding flooding and extreme heat. The following assets and infrastructure types were included in this analysis:

- Affordable Housing
- Critical Facilities
- Regional Employment Centers
- Economic Assets (including historic and cultural resources)
- Passenger Rail and Bus Service Infrastructure
- Sanitary Sewer Systems
- Public Water Systems
- Areas supported by individual sewage disposal systems (septic systems)

As an example of the types of overlay analysis that were undertaken, affordable housing assets have been cross-referenced with CCVI mapping to identify potential heat and flood risks. A few key conclusions from the assessment of assets and infrastructure are described below.

Critical Facilities

FEMA generally defines a “critical facility” as a facility (or infrastructure) that is critical to the health and welfare of the population and that is especially important following hazard events. Critical facilities of local and regional significance are found throughout Fairfield County and New Haven County. These facilities are within *and* outside of areas of flood and heat vulnerability. Communities have made progress toward increasing resilience as these critical facilities are relocated or replaced. Additional progress is needed to continue reducing risk to climate-related hazards, but methods will vary case by case.

Most of the facilities used in the analysis are not necessarily regional as they typically serve only the municipality they are located in. However, during extreme events any of these facilities and their associated services may support regional functions. In particular, community shelters and cooling centers are important at both a municipal and regional scale. There are 170 municipal shelters throughout the region; 14 are located in a high heat or flood vulnerable area and two are located in a ZSR. In addition, 108 cooling centers have been identified throughout the region.

To characterize accessibility, cooling center proximity to bus routes was analyzed. There are 84 centers within 0.5 miles of a bus route, eight within a mile, and 16 centers that are between one and six miles from a bus route. Facility vulnerability and accessibility is critical to providing safe refuge to all populations during an event.

Vulnerability Mapping

Regional employment centers, economic assets, and historic and cultural resources are often found in areas of high flood and heat vulnerability, as they were historically developed in the State's urban and village centers near water and supporting infrastructure. These assets cannot be easily relocated. Risks must be addressed using comprehensive sets of structural and non-structural tools, from flood protection to building capacity.

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Regional Employment Centers

Approximately 270 major employment centers are located throughout the region. These include sites where employees work, such as a university or manufacturing plant, and sites that serve as the headquarters for large employers, such as offices.

There are 59 locations in a high flood/high heat vulnerable area; 32 of these are likewise in a ZSR. All of these ZSR are classified as the location typology with the exception of one, a Town Fair Tire in East Haven which is located in an access ZSR.

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Some locations in highly vulnerable areas and ZSR include critical service facilities such as New Haven Fire and Police locations, St. Mary's Hospital, and Derby City Hall. Other locations, such as Stop & Shop in East Haven or Shoprite in Stamford may face challenges with maintaining refrigeration during an event, with surrounding communities depending on food from these locations.

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All of the identified employers serve a critical function in some way whether it be a public service, reliable employment, or economic stimulation to the community and region. The identification of vulnerabilities and incorporation of resilience and adaptation strategies in business continuity plans and within opportunity areas is critical to maintaining regional operations and economic stability.

Historic and Cultural Resources

Historic and cultural resources in Fairfield County and New Haven County were geocoded in 2016-2017 through funds provided by the Department of Interior to CT State Historic Preservation Office (SHPO), and represent one of the most recently-developed GIS datasets available for evaluation. Historic resources (typically consisting of historic buildings and homes) and historic districts are located in numerous areas of high flood and high heat vulnerability, as well as many regional ZSR. Refer to the report for more information.

4

Historic resources typically cannot easily be retrofitted to reduce flood and heat risks, and their presence in an area of high vulnerability or risk will point to the need for adaptation and resilience projects that are larger than the site scale. An example is the Hammer Field/Meadow Street area of Branford, where tidal flooding from the Branford River can pass through a railroad underpass and flood historic structures. Flood protection at this underpass would allow protection of historic structures than cannot otherwise be protected through elevations.

Rail Assets

Passenger rail lines and stations are at high risk of flooding. In most cases, these risks must be addressed in place. However, several unique opportunities are on the horizon. New passenger stations are planned in Brookfield, Orange, North Haven, and the Georgetown section of Redding; these can be developed as resilience models. Some stations may be relocated, such as Seymour and Naugatuck; the new

Vulnerability Mapping

locations can be resilience models and the sites that are vacated can be redeveloped to reduce community heat and flood vulnerabilities. Public transportation like rail (or bus, described below) provides transit options for vulnerable populations and bolsters community development. With transit-oriented development (TOD) being a major component, understanding the existing vulnerabilities is key to developing resilient communities and corridors. TOD areas throughout the region have been analyzed to identify flood and heat vulnerabilities and railroad elevations have been identified to determine their relation to the base flood elevation.

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Bus Assets

Bus transit systems are sometimes well-positioned to help move vulnerable individuals to health care, shelter, and cooling facilities. As resilient corridors are identified for future investment, consideration for enhanced transit opportunities should be considered.

While bus hubs may not be fixed-in-place or promote development like train assets, they are critical for equitable transportation opportunities and redundancy when train routes are inoperable. Several bus hubs outside of rail stations have been mapped, and their flood and heat vulnerabilities identified. All 12 hubs have at least moderate flood or heat vulnerability, with the Bridgeport Transportation Center being the only one to have both high flood and high heat vulnerabilities. In addition, six are in a ZSR which signifies a larger scale flood risk to the site and impacts to the community.

2

Affordable Housing Assets

Many affordable housing assets are in urbanized areas and house vulnerable populations. To identify opportunities in creating or redeveloping these locations, HUD and COG data has been used to locate and evaluate housing vulnerabilities as well as their proximity to TOD areas. In total, 443 affordable housing locations have been identified throughout the region. Almost 100 vulnerable housing assets have been identified based combinations of heat and flood vulnerability. While many of these are in urbanized communities such as New Haven, Bridgeport, or Stamford, some vulnerable housing assets are located in suburban communities such as Greenwich, Fairfield, and Stratford.

3

4

Drinking Water Infrastructure

Utility reliability, whether water, sewer, or electric, is a critical component of a resilient community. Public water systems in Connecticut include community water systems served by groundwater supply wells and reservoirs, transient non-community water primarily systems served by wells, and non-transient non-community water systems primarily served by wells. Public water systems are relatively resilient in Connecticut, but several key interconnections should be pursued to bolster regional resilience from droughts and severe weather events. Sources of supply that are vulnerable to flooding should be protected.

To determine the vulnerability of drinking water infrastructure, flood vulnerable community drinking water wells have been identified. This is similar to the extensive review in CIRCA's Drinking Water Vulnerability and Resilience Plan. In total 13 wells have been identified with three of those belonging to a community system, meaning they are used for residential drinking water supply. These community wells belong to Regional Water Authority and Aquarion Water Company. While these wells may be elevated or floodproofed, there are potentially wells in high or moderately vulnerable flood areas that are susceptible to flood waters and debris.

Vulnerability Mapping

Wastewater Infrastructure

Sanitary sewer system components such as wastewater treatment plants and pumping stations will remain vulnerable to flood risks and must be made more resilient over time. These systems either serve multiple communities *or* regional assets and infrastructure, therefore a compromised wastewater system can have regional impacts.

1

Of all mapped wastewater data currently available, five pumping stations are mapped in high flood vulnerable areas, and five water pollution control facilities (WPCFs) are mapped in both high flood vulnerable areas *and* a location ZSR. Of the 31 WPCFs, two are located in an access ZSR (Branford and West Haven) with both sites having moderate-high flood vulnerability. While a location ZSR indicates a flood risk due to a nearby flood source, an access ZSR indicates a challenge of site accessibility during an event.

2

The areas of communities that are supported by septic systems are typically not aligned with TOD and planned development, but one significant outlier is the Guilford-Madison area. These two municipalities are in an area that has traditionally lacked sewer systems. With the significant flood risks in the Guilford TOD area, continued use of septic systems may be incompatible with resilient, adapted development. Individual sewage disposals systems (septic systems) in these towns are located in highly flood vulnerable areas without options for replacement with sewer systems.

3

Critical Habitats

The Connecticut Department of Energy and Environmental Protection (DEEP) has developed critical habitat data which represents 25 types of specialized habitats throughout the state. In addition, the Natural Diversity Data Base (NDDB) has also been evaluated for intersection with the critical habitats. These habitats and NDDB areas identify significant ecosystems that support critical ecosystems and are home to endangered or threatened species.

4

In the high flood vulnerable areas, 34 different locations contain several types of critical habitats. These include habitats such as tidal marshes, floodplain forests, and beaches, all of which are also identified as NDDB areas in specific locations.

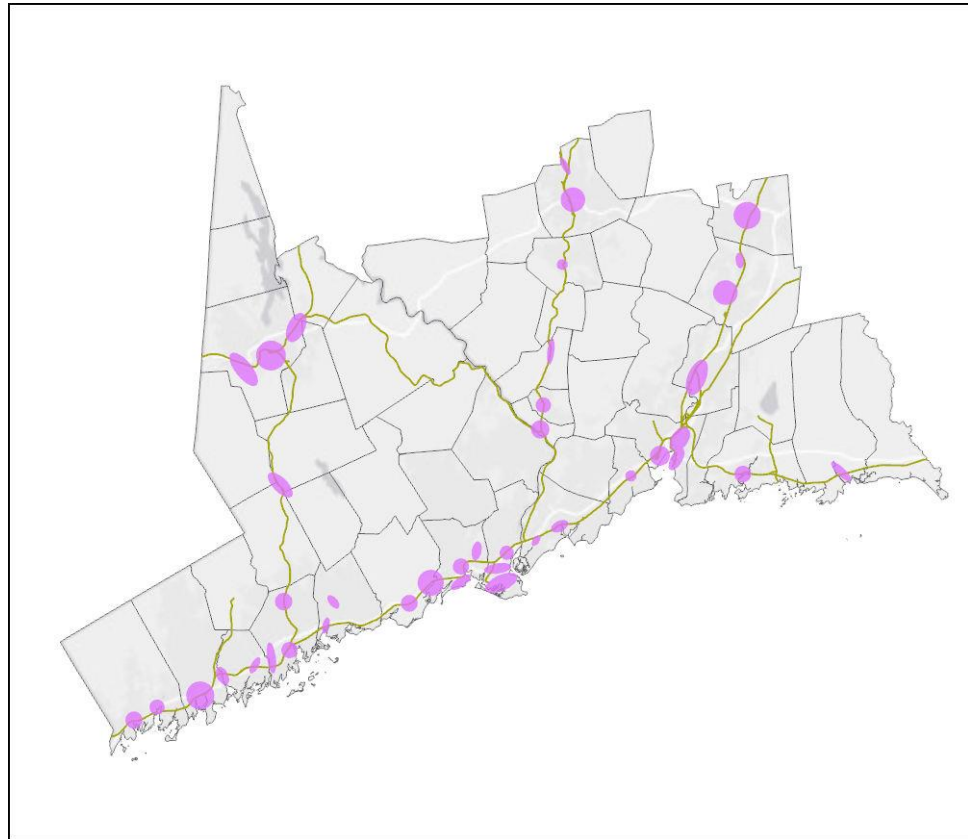
Many of these sites provide services such as critical ecosystem services, shade or water access during a heat wave. They also act as economic stimulators for the region as they serve as major tourist attractions. Conservation or restoration may increase community and regional resilience in multiple ways.

Opportunity Areas

Resilience Opportunity Areas

The technical tools and planning process have been used to evaluate vulnerabilities and identify climate adaptation and resilience opportunity areas that are candidates for climate adaptation scenario development.

The CCVI results for flood and heat vulnerabilities, ZSR, key assets and infrastructure, potential development areas, and TOD areas have been subject to an overlay analysis and evaluated together to locate the areas that are most vulnerable to extreme heat and floods, have a shared flood-based risk, and are candidates for TOD and other planning endeavors. Ultimately, the intersection of these tools and efforts highlights and identifies priority areas that are most vulnerable to climate change, therefore are at risk, and thus should be targeted for climate adaptation efforts. The vulnerability drivers and risk in each area vary, so understanding the characteristics of each is important in developing resilience options.



In total, 40 potential opportunity areas have been identified throughout the region, many of which **contain a passenger rail station and corresponding TOD area**, whereas others contain major regional assets and infrastructure. Refer to the map packet for summary sheets about each.

These areas will be prioritized in fall 2021 based on various characteristics such as connectivity to evacuation routes and ability to support resilience corridors, and ability to support or be supported by resilient assets and infrastructure. Following this prioritization, a subset will be selected for adaptation scenario conceptualization.

1

2

3

4

Opportunity Areas

The many areas of moderate to high flood and heat vulnerabilities in Fairfield County and New Haven County suggest intriguing intersections with other factors that present community and regional risks. Therefore, an additional set of potential regional resilience opportunities were identified in Fairfield County and New Haven County beyond those identified through the overlay of regional infrastructure, planned development, and TOD.

1

One set of additional potential opportunity areas is focused on a variety of methods of characterizing affordable housing risks. Pockets of affordable housing in high flood or high heat *and* high flood vulnerable areas, especially without access to bus or rail transit, suggests that opportunities for resilience exist in a few communities where the 40 infrastructure/TOD-dependent opportunity areas were not already identified. A total of 11 affordable housing opportunity areas were identified.

2

Another set of potential regional resilience opportunity areas is focused on a wastewater infrastructure. Several WPCFs and sewer pumping stations are located in the 40 infrastructure/TOD-dependent opportunity areas that were identified on the prior page, but a handful were not. Of the remaining assets, four sets were located in areas of high flood vulnerability and have been given opportunity area designation.

A final set of potential regional resilience opportunity areas is focused on public water system infrastructure.

3

- First, the State's public water supply reservoir watersheds enjoy strong protections. Nevertheless, four of these watersheds in Fairfield County and New Haven County contain potential toxic or hazardous waste site considerations in locations of high flood vulnerability. The intersection of flood vulnerability, type of site, and location in a public water supply watershed implies an opportunity to reduce risks such as more frequent flooding.

4

- Second, although many of the public water supply wells in the State are appropriately-sited, three areas in Fairfield County and New Haven County are characterized by high densities of wells located in areas of flood and high heat vulnerabilities. This raises questions about whether multiple climate-induced hazards such as flooding and flashy drought could lead to impairment of groundwater supply in areas where many wells are present. The intersection of flood and heat vulnerability and a high density of public water supply wells implies an opportunity to reduce multiple risks associated with climate change
- Lastly, to identify potential public water supply well challenges during a flood event, shelters across the region were cross-referenced with their water supply source and flood vulnerability. Those that rely on a well for drinking water and are located within a high flood vulnerable area present an opportunity for enhancing drinking water resiliency during sheltering events. One area was identified.

Refer to the maps for summary sheets about each area, which can be found at:

<https://resilientconnecticut.uconn.edu/resilience-opportunities/>