SAFR Connecticut Connections

June 22, 2015

TABLE OF CONTENTS

Executive Summary 2

Threshold Requirements 4

Capacity 8

Need 14

Consultation 22

Concept 25

Outcomes 33

Leverage 34

Long-term Commitment 35

Additional Maps and Drawings (Figures 1-64) 37

EXECUTIVE SUMMARY

New Haven and Fairfield counties were designated as most impacted and distressed counties due to Hurricane Sandy, the Qualifying Disaster for this competition. Sandy damaged 2,853 single-family homes in Fairfield County and 1,165 in New Haven County. Unmet recovery needs in these counties total more than $158 million from housing ($135,789,167) and infrastructure ($22,510,508). This unmet need includes eight public housing properties in the 100-year floodplain. If Connecticut were to assess all resilient repair needs the additional need would be in the hundreds of millions of dollars. Coastal communities are home to 60% of the state's population and more than 32,000 homes lie within the 100-year floodplain. Connecticut has the second highest exposure of vulnerable coastal assets on the east coast. With more than $542 billion in assets at risk to coastal storms, only Florida has a greater exposure.

The Applicant, the State of Connecticut's Department of Housing (DOH), is working with the State Agencies Fostering Resilience (SAFR, pronounced safer) to address these risks and prepare and implement the NDRC proposal. SAFR includes representatives from eight state agencies. SAFR is supported by 19 additional partners including the regional Councils of Government, Connecticut Conference of Municipalities, University of Connecticut, Yale, Partnership for Strong Communities, Housing Development Fund, Connecticut Green Bank, the state's largest utility companies, several environmental organizations, The Red Cross, CT Rises, and the Tremaine Foundation. All Partners have incorporated resilience to the impacts of severe weather, sea level rise and climate change into their core mission or programs.

To address Connecticut's vulnerabilities, this proposal outlines a long-term vision for establishing more 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. Increasing investment in identified *resilience zones* provides an opportunity to increase economic resilience by strongly tying back to the regional transportation network and regional economic opportunities. Therefore, these investments represent a 'no regrets' approach to climate adaptation because in addition to providing long-term resilience, they provide a myriad of co-benefits that strengthen communities and economic opportunities in the short term and between storms.

To develop this proposal the team undertook a robust process of public outreach and engagement. This process built upon the lessons learned in Rebuild by Design and numerous other community resiliency processes. The process included over 50 consultations, 3 public hearings and open houses, a project website, site visits, and social media campaigns. This enriched the Phase 1 discovery process, informed the resiliency strategy, resulted in numerous partnerships (with more to come) and will continue to shape the Phase 2 application.

The concept is closely aligned with state spending priorities, including the Governor's priority of a "best-in-class transportation system." As a member of SAFR, Connecticut's Department of Transportation pledged to coordinate appropriate projects in their FY15 $1.7 billion capital budget with the NDRC proposal. Other SAFR partners have committed to exploring similar opportunities during Phase 2, if selected. The state has already committed $500,000 to the CDBG-NDR application, and the team has identified potential sources of leverage funding totally over $2.75 billion.

Connecticut has demonstrated its long-term commitment to building back better through the Connecticut Climate Preparedness Plan, which advanced legally mandated efforts to prepare for climate change. The state has reduced coastal vulnerabilities through the passage of two new laws, the dedication of new resources to the Microgrids program, and the creation of the Connecticut Institute for Resilience and Climate Adaptation and Shore Up Connecticut, a low-interest loan program for flood mitigation.

THRESHOLD REQUIREMENTS

General Section. The State of Connecticut is in compliance with the requirements of the General Section.

Eligible applicant. The Applicant is the State of Connecticut.

Eligible county. The eligible counties in the State of Connecticut are Fairfield (County/in PMSA 1160,1930,5760,8040) and New Haven (County/in PMSA 1160,5480,8880). New Haven and Fairfield counties were both impacted by Disaster Number 4087, incident type: Hurricane, incident title: Hurricane Sandy, incident begin date: 2012-10-27, and end date: 2012-11-08.

Most impacted and distressed target area. The target areas identified as most impacted and distressed (MID) as a result of Hurricane Sandy (DR-4087) are Fairfield and New Haven counties. These counties were previously determined by HUD to be most impacted.

Unmet recovery needs threshold. The State of Connecticut has Unmet Recovery Needs (URN) (needs that have not been addressed by federal, state, or other sources) in excess of $158 million in housing and infrastructure in the MID areas of Fairfield and New Haven counties.

Owner occupied housing. DOH is administering an Owner-Occupied Rehabilitation and Rebuilding program targeted to assist 1-4 unit owner-occupied properties, addressing rehabilitation and mitigation/elevation needs. Tranche 1 (T1) CDBG-DR funding addressed unmet rehabilitation needs, alone or in conjunction with mitigation/elevation needs. Tranche 2 (T2) CDBG-DR funds addressed mitigation/elevation needs of 1-4 unit owner-occupied properties damaged by Hurricane Sandy whose rehabilitation was addressed through insurance proceeds, FEMA assistance and/or SBA assistance. We anticipate awarding and expending all of the available Tranche 1 and Tranche 2 funds allocated for these activities ($44.2M). The Tranche 3 (T3) plan proposes distributing $6,886,050 to owner-occupied housing and the remaining $4,572,950 to multi-family housing, infrastructure, administration and planning, and $10M to *Resilient Bridgeport* RBD. DOH does not anticipate the number of houses damaged by the disaster to go below 20 even after T3 funds are allocated.

Owner Occupied housing Data Source Analysis. In the Dropbox folder Spreadsheet 1 is a detailed breakdown by county of the homeowners currently being assisted or intended to be assisted with an estimated cost of activity, including CDBG-DR, insurance, FEMA and SBA. Spreadsheet 2 is a detailed breakdown of homeowners who have applied for assistance, but for whom funds are not currently available. In order to accomplish this analysis, we made the following assumptions: (1) There is remaining Unmet Need existing among homeowners in both New Haven and Fairfield Counties consisting of those on our current application list; (2) Mitigation/elevation needs exist in both counties consisting of those on our current application list; (3) Cost estimates for Unmet Need

in Spreadsheet 2 were determined using the average cost of assisted or to-be-assisted homeowners in the respective counties from Spreadsheet 1. The Summary Table of Unmet Need Owner Occupied below shows the number of current applicants seeking assistance with remaining unmet rehabilitation or with unmet mitigation/elevation needs, which cannot be addressed with other sources through CDBG-DR, insurance, FEMA, SBA. Table Legend: Avg. Asst = Average Assistance from other sources (Insurance, FEMA, SBA); Total Asst. = Total Assistance from other sources; and URN = Unmet Recovery Need (URN calculated as Total Need minus Total Asst.).

The Summary Table of Unmet Need Owner Occupied Housing						
County	# Houses	Avg. Cost	Total Need	Avg. Asst.	Total Asst.	URN
Fairfield	99	$181,579	$17,976,315	$67,186	$6,651,414	$11,324,923
New Haven	74	$175,325	$12,974,098	$52,139	$3,858,286	$9,115,794
Total URN Owner Occupied Housing after Tranche 3 CDBG-DR allocation = **$13,554,621**						

Multi-family housing. DOH is administering a Multi-family Rehabilitation/Rebuilding and Mitigation program (T1 p. 53), targeted at low and moderate-income (LMI) multifamily properties with unmet need, and emphasizes state or federal public housing. DOH anticipated using leverage (state taxable and tax exempt bond financing, federal Low Income Housing Tax Credits (LIHTC) (both 4% and 9% credits), as well as conventional financing for housing) and thus allocated $26,000,000 in CDBG-DR funding to address these needs. To date, DOH has targeted the majority of the $26,000,000 available on three separate public housing replacement activities (T3, p.9).

The Summary Table of Unmet Need multifamily shows remaining unmet need for rehabilitation or replacement of these units (T3, p.9). T3 proposes to distribute $3,000,000 to multi-family (T3, p.19). Not all of the funds identified in the "Estimated Assistance Other Sources" column have received commitments; therefore unmet need may be greater than estimated. Table Legend: (T.D.C. = Total Development Cost; CDBG-DR = CDBG-DR Assistance; E.A.O. = Estimated Assistance Other Sources (DOH/LIHTC/Other); URN = Unmet Recovery Need, URN calculated from T.D.C minus CDBG-DR minus E.A.O.)

Summary Table of Unmet Need Multi-family Housing					
County	# Units	T.D.C.	CDBG-DR	E.A.O.	URN
Fairfield	911	$315,463,287	$23,230,000	$191,998,787	$100,234,500
New Haven	140	$43,000,000	$0	$18,000,000	$25,000,000
Total URN Multifamily after Tranche 3 CDBG-DR allocation = **$122,234,500**					

Summary of unmet housing need. There is unmet housing need in the MID counties, Fairfield and New Haven, in excess of $135,789,167 after proposed T3 (Figures 1-3).

Infrastructure. In the most impacted target areas there is damage to permanent public infrastructure from the qualifying disaster, Hurricane Sandy, which has not been repaired. The following is the remaining infrastructure repair needs in the target area sent to DOH. The location of damage by county and municipality and a damage summary for each project is as follows: (Dropbox file names: *Town Name_Descriptor*)

Fairfield County: *Fairfield_Pump Station* over two feet of Sandy flood waters stayed behind after storm, flooding one square mile of land and homes; *Greenwich_Point Park* wave and wind damage to park structures and erosion of natural features, living shoreline for damage prevention proposed; *Westport_Bridge* Sandy waves dislodged bridge to island, which was repaired, but not resilient to future storms. *Bridgeport_Marina Village* storm surge flooding damaged housing, proposal to repair incorporates resilience.

New Haven County: *Beacon Falls_WWTP* stormwater flooding at wastewater treatment plant along river; *Meriden_Harbor Brook* stormwater flooding along river; *Milford_Point Beach* coastal storm surge flooding damage of low-lying areas; *Milford_Wepawaug* flooding along Wepawaug river, dredging mitigation proposed; *Oxford_Firehouse* firehouse flooded during Sandy; *West Haven_Tide Gate & Footbridge* tide gates and footbridge damaged from Sandy storm surge flooding; *West Haven_Culvert* culvert vulnerable to extensive flood damage from Sandy and future storms; *Ansonia-Derby_Water Tank* project to prevent loss of water pressure. The Data Sources has the sources and uses for each project listed. The table below shows the total cost of repairs, other sources of funding (ACE/FEMA/municipal) and the funding required to complete repairs.

Summary Table of Unmet Need Infrastructure			
County	Cost of Repairs	Other Funding Sources	Funding Needed
Fairfield	$15,301,536	$4,761,250	$10,540,286
New Haven	$17,322,742	$4,352,520	$12,970,222
Total Unmet Infrastructure Need after Tranche 3 CDBG-DR Allocation = **$22,510,508**			

There are inadequate funds to complete the repairs because CDBG-DR funds have been exhausted. Following Sandy there were 40 infrastructure projects requiring $157.4 million in funding. Of the CDBG-DR funds awarded only $6.2 (T-1) and $30 (T-2) million have been dedicated to addressing these needs. While T-3 proposes dedicating an additional $1 million to infrastructure, there will remain an unmet need in excess of $22 million.

Summary of unmet infrastructure need. Based on the projects listed in the data source and summarized above, there is an unmet infrastructure need of $22,510,508 after proposed T3.

Statement on eligible activity, resilience incorporated, national objective, overall benefit and establish tie-back. Funds will be used solely for necessary expenses related to disaster relief, long-term recovery, restoration of infrastructure and housing, and economic revitalization in the most impacted and distressed areas for which the President declared a major disaster in the aftermath of an event occurring in 2011, 2012, or 2013, pursuant to the Stafford Act. The expectation is to improve the resilience of the most impacted and distressed target area(s) to current and future threat(s) and hazard(s), including effects of climate change. Connecticut has demonstrated taking at least one permanent action to increase resilience in the target area, region or state. With respect to activities expected to be assisted with CDBG NDR funds, the Application has been developed so as to give the maximum feasible priority to activities that will benefit low- and moderate-income (LMI) families. The aggregate use of CDBG NDR funds shall principally benefit LMI families in a manner that ensures that at least 50 percent of the grant amount is expended for activities that benefit such persons.

Benefit-cost analysis. There is no benefit-cost analysis associated with the Phase 1 application.

CAPACITY

General management capacity. The State of Connecticut's Department of Housing (DOH) is the Applicant and will coordinate partners and implement the activities proposed in this application. Under P.L. 113-2, CT received $159,279,000 CDBG-DR funds. Governor Malloy designated DOH as the principal state agency for allocation and administration of this funding. DOH currently maintains a dedicated Sandy recovery staff team that has successfully administered, managed, distributed - with sound financial and procurement processes - two rounds of CDBG-DR funding since the Qualifying Disaster (Sandy). The DOH has prepared and executed a CDBG-DR Action Plan and two substantial amendments to meet the housing needs of communities most impacted by the storm. These needs included the costs of repairs, reconstruction and new construction, which were not covered by insurance, FEMA, or other sources of funding as well as infrastructure repairs, mitigation projects, and planning activities. Through this process DOH vetted contractors, issued invitations to bid, issued contracts, oversaw contract execution, and coordinated with other agencies to obtain the proper permits. DOH also manages and funds Shore Up CT, a low-interest mitigation financing program. DOH's ability to initiate the Sandy program and programs like Shore Up CT show its internal control capacity and ability to quickly launch and implement major projects successfully. In order to provide quality assurance DOH will seek advisory assistance from all Partners, from the interagency workgroup, State Agencies for Resilience (SAFR), which was created to facilitate this application. SAFR members include lead staff from agencies that have supported and committed resources to this application and building overall resilience in the state.

Application preparation. The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) at the University of Connecticut (UConn), a Partner on this application, was contracted to support the development of this application through an MOU with a Partner agency, the Department of Energy and Environmental Protection (DEEP). Through weekly meetings and daily interactions, CIRCA engaged with DOH and SAFR to develop and review this proposal, catalogue unmet needs, contribute technical knowledge, and direct community outreach. CIRCA and UConn worked with Alex Felson Landscape Architects also from the Yale Urban Ecology and Design Lab to develop the design vision. CIRCA will participate in Phase 2 and will continue to advise the state in its primary role as a resilience research and outreach institute. CIRCA also attended the Rockefeller Resilience Academy alongside representatives from DOH, OPM, and DESPP/DEMHS.

Cross-disciplinary technical capacity. The Applicant, DOH, will work across disciplines to achieve project goals, and ensure excellent design quality by partnering with SAFR, faculty and staff experts from UConn and Yale, and the Connecticut Conference of Municipalities and regional Councils of Governments. The Applicant and Partners have experience with interdisciplinary work in the following areas: designing, planning and implementing large, complex and comprehensive projects; benefit-cost and data analysis; public works; affordable housing; environmental quality; community engagement; design and engineering; and economic revitalization.

Applicant capacity. DOH strengthens and revitalizes communities by promoting affordable housing opportunities and has significant experience working on civil rights and fair housing issues. DOH seeks to eliminate homelessness and to catalyze the creation and preservation of quality, affordable housing to meet the needs of all individuals and families. Major initiatives include the Governor's $300 million, 10-year capital investment in state-sponsored Housing Portfolio and the Sandy CDBG-DR program, which includes data analysis of racial or economic disparities in its Action Plan.

Partner capacity.

- **CT Office of Policy and Management** (OPM) is a co-chair of SAFR. OPM functions as the Governor's staff agency and plays a central role in state government, providing the information and analysis used to formulate public policy and assisting state agencies and municipalities in implementing policy decisions on the Governor's behalf. OPM is the coordinator of interagency problem-solving efforts, including Transit-Oriented Development, and is the liaison between municipal and state government for this application.

- **The CT Department of Energy and Environmental Protection** (DEEP) is a co-chair of SAFR. DEEP's mission is to conserve, improve, and protect natural resources and the environment as well as to ensure availability of affordable, clean and reliable energy. DEEP brings its experience co-leading CIRCA, implementing the Coastal Zone Management program, which includes permitting structures for shoreline adaptation, administering CT's Clean Water Fund, developing energy, climate and resilience policy, and running the Floodplain Management and the NFIP.

- **The Office of the Governor** (OTG) ensures coordination between concepts proposed in the application and gubernatorial priorities, including a focus on state-sponsored housing revitalization and a "best-in-class transportation system".

- **CT Department of Transportation** (DOT) strives to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality. DOT's $1.7 billion annual budget (2015) supports many highway, bridge, rail, bus, water, bicycle, and pedestrian capital assets and operations, including many of which are adjacent to waterways and vulnerable to flooding. DOT brings a wealth of experience on Transit-Oriented Development; "Complete Streets" designs; Public-Private Partnerships, Design-Build projects; alternative design concepts; procurement processes; and transportation asset management.

- **The CT Department of Emergency Services and Public Protection/Division of Emergency Management and Homeland Security** (DESPP/DEMHS) advises SAFR on emergency

management and homeland security programs that encompass all human-made and natural hazards, including prevention, mitigation, preparedness, response, and recovery components to ensure the safety and well-being of citizens. This includes administering FEMA's Hazard Mitigation Assistance grant programs and Public Assistance Programs and incorporating climate change risks into the Threat Hazard Identification and Risk Assessment, State Preparedness Report and Connecticut's State Hazard Mitigation Plan Update.

- **The Department of Public Health's** (DPH) vision is for healthy people in healthy Connecticut communities and is charged with protecting and improving the health and safety of the people of Connecticut. The DPH advocates health impact assessments (HIA) be conducted where possible to ensure conditions in which people can be healthy.

- **Connecticut Insurance Department** (CID) provides assistance and information to the public and to policy makers and regulates the insurance industry. Connecticut is one of only a few states to request voluntary climate change disclosure surveys from insurance companies. CID advises SAFR on the impacts of mitigation strategies and policies on insurance in the state and provided key contacts with stakeholders from the insurance and reinsurance industries.

- **The CT Conference of Municipalities** (CCM) is the state's association of towns and cities. CCM brings community engagement and regional policy and planning experience to assist SAFR.

- **The CT Department of Economic and Community Development** (DECD) advises SAFR on comprehensive approaches to economic development and revitalization that incorporate community development, transportation, and productive redevelopment of brownfield properties by promoting smart growth principles and strengthening public-private partnerships.

- **The University of Connecticut. Connecticut Institute for Resilience and Climate Adaptation** (CIRCA) fosters resilience of vulnerable communities along the state's coast and rivers to the impacts of climate change through transferable and replicable adaptation solutions. CIRCA's technical capacity for science-based analysis includes: impacts of climate change, sea level rise, ocean dynamics, future precipitation and hydrology models, weather prediction, environmental law, economics and policy analysis. CIRCA's faculty contribute to the National Climate Assessment and advise state, national and international bodies on climate change.

- **UConn Sea Grant** is the state's component of the NOAA national Sea Grant network and has expertise in research and outreach including the Climate Adaptation Academy workshops and the NOAA Sea Grant Coastal Storm Awareness Program.

- **UConn Center for Land Use Education and Research** (CLEAR) provides information and assistance to land use decision makers to balance growth and natural resource protection.
- **Yale Urban Ecology and Design Laboratory** (UEDLAB) provides landscape architecture expertise. The UEDLAB was a member of the *Resilient Bridgeport* Rebuild by Design team and has contributed to green infrastructure and coastal planning projects in Connecticut.
- **The Regional Councils of Government** (COGs) serve the vital role of regional planning, as Connecticut does not have county governments. The South Central Regional COG (SCRCOG), Western Connecticut COG (WCCOG), and Greater Bridgeport Regional Council (GBRC), facilitate regional initiatives and represent all municipalities in our MID-URN counties.
- **Partnership for Strong Communities** is a statewide housing policy organization that works to prevent and end homelessness, create affordable and mixed-income housing (including in communities that have little or none) and foster community development solutions.
- **The Housing Development Fund, Inc.** (**HDF**) is a nonprofit organization dedicated to financing the development of affordable housing and will work with SAFR to apply lessons learned from existing lending programs including Shore Up CT, the state's resiliency loan fund. HDF in partnership with Yale is conducting an analysis of housing needs in 80 low-income census tracts, which will assist in the analysis of unmet needs in the target area.
- **The Emily Hall Tremaine Foundation** has been a key funder of state-level climate and energy initiatives in Connecticut, including the state's Climate Action Plan, and is looking to fund resiliency innovations at the community scale. In addition, the foundation will utilize its national funder affinity group involvement to raise the visibility of Connecticut's efforts.
- **The Long Term Recovery Committee for the State of Connecticut** will help coordinate through its participation in a number of joint working groups related to coastal resilience.
- **Connecticut Chapter of the American Red Cross** and **CT Rises** have been extensively involved in Sandy recovery efforts in Connecticut and will provide vital insight into unmet need not identified through government channels.
- **EPA Long Island Sound Study, Save the Sound, and Audubon Connecticut** will provide guidance on coastal adaptation measures, wildlife protection, and conservation opportunities.
- **Connecticut Green Bank**, the nation's first state green bank, leverages public and private capital to drive investment and scale-up of clean energy and energy efficiency in Connecticut. Their staff will provide important expertise on potential financing mechanisms for projects.

- **East Coast Greenway Alliance** is developing a public trails network in the target counties as part of a 2,900-mile system of paths, to connect communities from Maine to Florida.
- **UIL Holdings** and **Eversource Energy** serve most electric and natural gas customers in the state and will work closely with SAFR to coordinate electric and gas infrastructure modifications to support the designed project and further enhance critical infrastructure resiliency.

Maintaining partner capacity and obtaining future capacity. We have secured Partners with a wide array of diverse and overlapping capacities and expertise. This redundancy provides security, as well as great team depth and strength should Partner commitments change. All Partners are committed to this application and have incorporated one or more aspects of resilience to the impacts of severe weather, sea level rise and climate change into their core mission or programs. Moreover, the Applicant, DOH, has run a CDBG-DR program for the past three years, and will continue to do so if funds are awarded. In a Phase 2 application process, the state would engage additional partners particularly at the local level and in the private sector. Many of the Partners have existing contracts with firms that could provide additional technical (i.e. engineering) expertise. For example, DOT has a pre-approved list of 135 consultants who could be used for engineering, design, and planning.

Cost-benefit analysis. Our Partners have extensive experience with various cost-benefit analytical (CBA) tools, and will be able to perform or contract for such analysis. DEMHS utilizes FEMA's BCA software to evaluate projects submitted to FEMA's Hazard Mitigation Assistance programs. DOT has an active Transportation Asset Management program with the capacity to inventory, inspect, monitor and prioritize facilities for maintenance and capital project programs. DOT routinely practices scenario planning including no-build alternatives, BCA and other advanced management techniques to constrain its ongoing work program to available revenue.

Community engagement capacity. DOH has a commitment to resident and community engagement with established programs detailed in an Action Plan and two substantial amendments for the CDBG-DR program. DOH and SAFR have engaged CIRCA, an institute dedicated to research and outreach for communities impacted by climate change, to support DOH's application and identify the communities most vulnerable to future hazards. CIRCA's Director of Community Engagement is coordinating the application team. The community engagement processes is being led by an AIA, LEED-AP nationally-recognized community design and developer who is working with the Yale UEDLAB and a multidisciplinary team of highly qualified scientists, practitioners and educators. All state agency partners, CCM and the regional councils of government, have extensive experience with community engagement and planning. Partners have extensive engagement experience through multiple projects including Rebuild by Design, local and international landscape architecture projects, rebuilding in New Orleans, national resilience charrettes and leading a Community Development Corporation that rehabilitated over 1,500 buildings.

Process for incorporating community feedback. Phase 2 would include the continued involvement of Phase 1 stakeholders; however, as the projects move closer to implementation engagement would shift to direct engagement of community members, neighborhood associations, and municipalities. The process to identify unmet needs and means of addressing these needs includes: early and frequent consultation; documentation and response to comments and suggestions; participatory workshops. Many partners worked with Rebuild by Design in Bridgeport to engage the community through a variety of methods including the All Scales Workshop where leaders from more than 40 organizations, including many based in the impacted community, worked alongside a cadre of professionals developing proposals for resilient community development. This engagement model will serve as a precedent for future engagement. DPH is exploring the potential to integrate a rapid Health Impact Assessment (HIA) into the community engagement process.

Empowering community leaders. DOH supports a number of initiatives to build community leadership, such as the CT Housing Coalition's Connecticut Emerging Leaders Network and the Affordable Housing Academy. As an example, the Yale UEDLAB has worked for over four years with residents from Bridgeport's vulnerable South End neighborhood to build, maintain and adapt a community-driven flood management and green infrastructure project in the floodplain. UConn's Climate Adaptation Academy is educating officials about adaptation measures.

Harmonizing contributions from diverse stakeholders. The Partnership for Strong Communities has an extensive record of bringing together diverse constituencies to find solutions reaching beyond the specific interests of housing advocates, developers and human service providers typically involved in housing policy. Other partners, including the COGS, which provide regional planning support, have extensive experience with community development through participatory activities. This includes research and publication about the use of social media in community development, development of the first website used as a tool for community comment, and development of open house techniques that positively engage divergent voices.

Regional and multi-governmental capacity. DOH is the lead agency making all final allocations of funding; however, the DOH will coordinate and plan all projects with Partners, specifically those of the interagency task force SAFR, which was created for the purposes of this application. DOH and the SAFR representatives have extensive experience working on multi-agency projects and through public private partnerships including work specific to Sandy recovery. DOH and agency partners work on a statewide and regional basis and are approaching this proposal as an opportunity to develop best practices that can be applied strategically in other locations throughout the state, region, and nation, where appropriate. Many SAFR partners, including the Connecticut Council of Municipalities, the regional Councils of Governments, The Partnership for Strong Communities, and Long Island Sound Study bring significant regional planning experience and are similarly working to replicate best practices regionally.

The state's proposed approach builds directly on the physical features shared among coastal communities. The approach details vulnerable coastal typologies, or common conditions that repeat along the state's coastline. The state's vulnerabilities have been framed in this way so that solutions can be more easily replicated and implemented in communities that may not have been as hard hit by Sandy, but are nevertheless highly vulnerable to the future storms.

The state has also considered how addressing vulnerabilities to climate change can be used to reduce economic disparities and improve opportunities for low- and moderate-income families using transit-oriented development with options for affordable housing as a means to improve economic resilience. By integrating climate resilience efforts into ongoing economic and community development initiatives will increase the state's ability there is a greater potential to address class-related disparities that exacerbate the vulnerabilities of low- and moderate-income families at risk in the floodplain.

NEED

Summary of the most impacted and distressed target area. The target areas identified as most impacted and distressed as a result of Hurricane Sandy (DR-4087) are Fairfield and New Haven counties. These counties were previously determined by HUD to be the most impacted.

Summary of unmet need.

Housing vulnerability. Flooding and rising sea level will significantly affect coastal communities, which are home to 60% of the state's population. More than 32,000 homes lie within Connecticut's 100-year floodplain (CT Natural Hazard Mitigation Plan, 2010), which, according to FEMA, places more than $18 billion in assets at risk. Sandy damaged 2,853 single-family homes in Fairfield County and 1,165 in New Haven County (Figs. 1-3). There are still 99 homes in Fairfield and 74 homes in New Haven Counties seeking assistance post-Sandy. After the Tranche 3 CDBG- DR allocation is spent, there will be a remaining unmet need of $13,554,667 for owner-occupied housing. A more substantial investment is required to adapt the state's housing stock to new conditions. Where homeowners have maintained equity in their homes as their only major financial asset, there is a risk of severe financial impacts from flooding. Much of the vulnerable housing stock was originally built as seasonal beach cottages before 1990, the first year when provisions for wind and flooding damage were included in state law, and therefore is not able to withstand strong storms or new flood risks (CT NHMP Update, 2014).

Damage to multi-family housing developments from Sandy was concentrated in Fairfield and New Haven Counties (Fig. 4). In total, 1,298 units sustained damage. Three public housing

properties (581 units) sustained the most damage. In total, eight public housing properties in the FEMA 100-year floodplain need to be elevated, rehabilitated or relocated, at a total cost of $358 million with an unmet need of $125 million. The state faces a shortage of affordable housing and many existing affordable housing units need mitigation measures to protect against the effects of climate change (Figs. 5-6). Maintaining economically diverse communities and availability of affordable housing options is a high priority for the state.

Unmet infrastructure and resiliency needs. Bridgeport has significant unmet resiliency needs identified during Rebuild by Design (RBD). The *Resilient Bridgeport* project outlines an innovative and comprehensive approach to protecting the city's vulnerable South End, Black Rock and downtown neighborhoods from climate hazards and to supporting economic revitalization. While the state was awarded $10 million, there is a substantial unmet need for implementation. The initial proposal estimated a cost of $291 million; however, through subsequent planning the estimated cost to provide essential flood protection and remediation has been revised to $302,714,000. This leaves an unmet need of $292,714,000. The project design may be scaled back; however, providing essential flood protection requires a contiguous network of flood defenses, which will cost more than $65 million for the South End alone.

Impacts to infrastructure. Aging infrastructure is an overarching challenge, which will be exacerbated by extreme weather events. There is damage to permanent public infrastructure following Sandy that has not been repaired and CDBG-DR funds have been exhausted. The total unmet need for infrastructure is $22,510,508; however, this represents a small fraction of the total mitigation needs for the infrastructure in the state.

Transportation. The east-west transportation corridor is particularly challenged as it runs through the coastal towns and suffers from high traffic volumes. The coastal east-west corridor is a critical travel link for the Northeastern U.S. because there is no alternative passenger rail route between Boston, New Haven, and New York City. In several locations the rail line roadbed is the first line of coastal flood defenses as it acts as a berm on the inland edge of the floodplain. I-95 & CT-15 are the primary highway links between New York City and Boston. During storms, vulnerable points, hindered by drainage systems designed for a pre-climate change world, along these routes hinder the movement of residents and emergency vehicles. Designed for a different era, much of the drainage infrastructure has insufficient capacity to handle increases in storm runoff and surge.

Water. The water infrastructure is similarly vulnerable. Sandy impacted local drinking water systems. Most systems lost street power; smaller public water systems lost water supply due to the lack of emergency power. In some cases street power was lost for 5-7 days, which made large

water system generators vulnerable to failure. Further interconnections between public water systems do not exist in most situations, making it impossible to share drinking water during emergency events like Sandy. Sewer and wastewater treatment systems, including those in Fairfield and Stratford were also impacted. By design, wastewater treatment plants are located close to receiving waters at the low points so sewage can be cost-effectively fed to the treatment facility without pumping.

Power. Many plants were inches away from extensive damage during Sandy. Had storm characteristics been slightly different, they could have been severely disabled. A rise in sea level may have serious repercussions on the functioning of treatment plants and sewer networks. A DEEP study found that up to 10% of sewer service areas and up to 5% of pumping stations could be affected by a 1m rise in sea level. Both sea level rise and erosion can undermine private septic systems in the coastal zone. Norwalk, Bridgeport, and New Haven still have combined sewer systems, which are often overwhelmed during times of heavy rain, leading to discharge of untreated, or partially-treated waste, which negatively impacts the Sound. Existing flood defenses, such as berms and surge barriers, were designed for historical storm events; they will become vulnerable to overtopping and offer reduced protection as precipitation events become more intense and sea levels rise.

Power. The state's power generation and supply infrastructure is particularly vulnerable; a significant percentage is in need of retrofitting to protect facilities from flooding. For example, despite protective barriers, a Bridgeport electrical facility has begun to experience flooding at high tide (McCarthy, 2013). Substations are similarly vulnerable.

Characteristics of Fairfield and New Haven counties. The demographic information for the two counties is contained in (Figs. 7-8); however, it is important to note that minorities (8-67%) and the elderly (13-27%) make up a significant percentage of the population in many of the impacted communities (Many of the areas most impacted by Sandy are also areas with a high percentage of low- and moderate-income (LMI) residents (Figs. 9-10). This clustering of low-income neighborhoods near the coast indicates that there may be disproportionate effects on low-income communities. The Social Vulnerability Index (SoVI®) highlights a clustering of socially vulnerable areas in the floodplain, particularly in urban areas (Figs. 11-12). Hurricane surge data overlaid on the SoVi map demonstrates that highly vulnerable populations are specifically vulnerable to flooding (Figs. 13-14). A CCM report on disproportionate burdens shows that 4 out of the 25 towns categorized as "distressed" were among those Sandy seriously affected (Fig. 15). Sandy inundation and the anticipated flooding from a Category 3 Hurricane were mapped for each municipality (Figs. 16-30). Coupled with 12" of sea level rise, flooding will be devastating at the local scale (Fig. 31). As a result, Connecticut has the second highest exposure of vulnerable coastal assets on the east coast. With more than $542 billion in assets (or 64% of properties) at risk

to coastal storms; only Florida has a greater exposure. Since 1950 NOAA has recorded over 600 severe floods in Connecticut. Although a number of flood control measures exist, as the FEMA Hazard Maps show, most of the coast remains directly exposed to flooding (Fig. 32-33). Moreover, anticipated inundation from future hurricanes along the shores of New Haven and Fairfield Counties is extensive (Figs. 34-35).

This exposure will be exacerbated by climate change. As described in the U.S. National Climate Assessment, New England saw more than a 70% increase in the amount of precipitation falling in very heavy events between 1958 and 2010 (Fig. 36). By 2050 it is estimated that the Connecticut coast will see a rise in sea levels between 27 and 50 cm (Kopp et al., 2014) and has been rising at an approximate rate of 2.85 mm a year in Bridgeport, CT (Fig. 37). Nor'easters, which have been striking with greater frequency and intensity since the 1970s (New England Aquarium, 2009) have contributed to more frequent flooding in Connecticut.

Comprehensive risk assessment approach- mapping physical vulnerabilities. The U.S. Army Corps of Engineers (USACE) recently completed the North Atlantic Coast Comprehensive Study Report, which included a detailed analysis of the state's shoreline. USACE identified areas vulnerable to inundation using SLOSH modeling conducted by NOAA. USACE established an exposure index to describe population and infrastructure density, social vulnerability, and environmental and cultural resources. These were combined to identify areas with a higher flood risk (Fig. 38-45). This assessment identified 15 areas meriting further analysis, 8 of which fall within the Most Impacted and Distressed counties (Fig. 46-47).

Our science-based risk assessment therefore focuses on a more detailed analysis within these identified areas to help guide eventual project selection (Fig. 48). Vulnerable areas are being mapped based on the following factors: 1) within the 100-year flood zone, 2) expected to be affected by sea level rise by 2050, 3) have the least topographic change, 4) are built on glacial deltas or filled wetlands, and 5) areas that become isolated due to limited or impassable egresses during times of flooding (Fig. 49). Next, areas of historic flooding were identified using 1) individual properties damaged by Sandy (Fig. 50-51), 2) areas with repetitive and severe repetitive loss properties (Figs. 52-55), and 3) areas with the greatest damage during Sandy and Irene (measured by expenditure through FEMA's IHP grants (Figs. 56). Third, areas of social vulnerability were identified by 1) the Social Vulnerability Index (SoVI®) composite score (Figs. 11-12) and 2) low or moderate income areas (identified by HUD for FY2014) (Figs. 9-10).

Vulnerable coastal typologies. Connecticut's complex geology means flooding risk is closely tied to a high occurrence of glacial delta deposits, which are inherently more erodible (Figs. 57-58). The variegated character of the coast makes large-scale collective coastal engineering works, designed to prevent floodwaters from entering, technically challenging and costly. Because of the

site variability, each community will need to determine how they choose to respond to a changing environment. Despite the apparent physical heterogeneity, the most vulnerable communities share many common physical characteristics and land use patterns (Fig. 59). These typologies, vulnerable due to land use patterns and physical geography, repeat along the state's coastline (Fig. 60). Understanding the shared characteristics between these areas will help develop transferable solutions. Each typology is described briefly below.

- **Critical infrastructure on the banks of estuaries**. These areas are vulnerable to both riverine and coastal flooding. Relocating critical facilities to higher ground can be difficult or expensive. Disruption of these facilities has cascading impacts on public safety and recovery.
- **Dense urban areas in low-lying floodplains**. Many of the state's largest cities, e.g. Stamford, Norwalk, Bridgeport, and New Haven, include areas vulnerable to riverine and coastal flooding due to their low elevation and proximity to Long Island Sound and impervious surfaces.
- **Potentially isolated peninsulas and impounded marshes**. Many areas are connected to higher ground inland by low-lying causeways that routinely flood, leaving residents isolated and limiting emergency vehicle access. These roadways often cut across marshes, and this disrupts the flow and drainage of stormwater. These restrictions to flow may exacerbate flooding in times of heavy rain and may disrupt local ecology. Over time these areas could become increasingly isolated and inaccessible as sea levels rise.
- **Low-lying, low-density developments.** Many developments on the fringe of wetlands or built on fill are vulnerable due to their low elevation, gently sloping ground, and high groundwater levels, all of which create drainage challenges. Constructing typical coastal defense structures in these areas can be difficult due to the technical challenges with drainage and ecological concerns (i.e. inhibiting marsh migration). These projects may also be relatively more expensive as the low-density development increases the proportional cost.
- **Exposed beach backed by marsh**. These areas are highly vulnerable due to the risk of flooding both from the tidal wetland behind and directly from the Sound. At the nexus between two dynamic environments, the ground between them is vulnerable to more dynamic changes as sea levels rise. These narrow areas of land (often a sand barrier) are also critical to protecting the marsh, which in turn protects the larger community further inland. Structural interventions are more challenging in these sensitive sites that suffer when water flow is restricted, ground water levels swell and the dynamic landform is stagnated.

Project selection process. The process for selecting specific projects will be determined by the SAFR committee during April and May. This selection process will build on precedents from other state-run selection processes including, but not limited to, those used to disperse previous Sandy related funding. The selection process will be informed by reviewing the best and most current scientific data related to vulnerabilities with a variety of experts and community

members. We will explore opportunities for specific projects based on an extensive planning process. This process will rely on a more in-depth and comprehensive assessment of social, infrastructure, and economic vulnerabilities. It will also be informed by studies of impacts on community health, recent publications from ACE outlining suitability of coastal infrastructure, CIRCA's modeling of combined riverine and coastal flooding potential, a study on long-term land cover changes expected due to rising sea levels in Fairfield and New Haven counties, as well as planned transportation, energy, water, communications and municipal infrastructure projects.

Disproportionate impacts. We know from Sandy and Irene that storms can cause acute social disruptions. A recent Yale study explored reasons why residents chose not to evacuate and found 23% felt they need to stay to protect their home and belonging, and 17% understood the risks of not evacuating but felt they couldn't because of lack of knowledge, transportation, money, poor health or inability to transport pets. Storm impacts to the elderly and those with disabilities or limited resources can be particularly serious. For example, among Medicare recipients in Connecticut 16,240 people currently rely on medical equipment such as ventilators, oxygen concentrators, dialysis, and enteral feeding (CT DESPP, 2015). For transit-dependent residents, evacuation may be more difficult and interruptions in public services may have cascading impacts if the interruption causes lost wages, or in some cases loss of a job because a person cannot get to work. When interruptions of key public services persist or recur frequently people may choose to move, which can lead to lower home values or "checkerboard" communities. When disasters cause residents to relocate, they lose connection to their immediate community. These disruptions are particularly difficult for lower income demographics (Weiss, 2012).

Exacerbating conditions. The state's vulnerability to flooding is exacerbated by several characteristics outlined below:

- **Extensive brownfields:** Connecticut's industrial history along rivers and the coastline left a legacy of contaminated properties. These contaminants can be quickly mobilized during floods or more gradually as water tables rise and shorelines erode (Fig. 61).
- **Environmental justice concerns:** Several municipalities with unmet needs have state-defined environmental justice communities and traditionally disenfranchised groups.
- **Large income disparities and a shortage of affordable housing in communities of economic opportunity.** Many of the most vulnerable citizens are in need of quality affordable housing. In order to address these needs in an era of constrained resources it is important to add new housing as well as to preserve existing affordable housing. Connecticut has the second most unequal household income distribution in the country and has had the greatest growth in household income inequality (Hero, 2009). Connecticut's highest-income households (top 5%) received a quarter (24.9%) of all the income in the state. The poorest 20% received 3.3% of all

income. The Gini Index (a measure of inequality) for Fairfield County in 2007 was 0.534, one of the highest in the nation (Figs. 62-64).

- **Challenged but improving inter-municipal coordination**: The home-rule tradition has limited inter-municipal planning for transportation, water management, and flood control.
- **Heavy reliance on transportation networks in flood-prone areas**: The state's densest transportation corridor is along the coastline. Low to moderate income neighborhoods often depend on public transportation for access to work and for egress during emergencies. During storms, floodwater can inundate critical transportation infrastructure such as rail line underpasses, making evacuation difficult or impossible and hampering recovery efforts.

Direct and indirect economic impacts. Between 2010 and 2050, the impacts of climate change could cost Connecticut $9.5 billion in GDP and approximately 36,000 jobs (Sandia Report, 2010). Using FEMA HAZUS10 loss estimation methodology it is estimated that a 100-year flood in Connecticut would incur over $4.9 billion in residential property damages, $13.6 billion in other property losses, and $101 billion from business interruptions (McCarthy, 2013). Insurance claims data indicate that disruptions in business operations, including supply chains, are frequently a direct result of failures in infrastructure networks and are often more costly than direct property damages (Brandes *et al.* ULI, 2013). Economic disruptions in the state's coastal communities have cascading impacts on the state and regional economy. The maritime and tourism sectors are particularly vulnerable to sea level rise, flooding and increased storm activity (Conn. Climate Adaptation Subcommittee, 2010). The maritime sector, with several deep-water seaports, accounts for nearly $7 billion of gross state product (Apex, 2010) and employs about 400,000 people (Pomeroy, 2013).

Barriers to more resilient solutions. Based on data gathered from 154 municipalities, a recent study identified the top barriers to adaptation as a lack of funding, lack of public information, and prioritization of other issues (Boyer, *Sea Grant Law and Policy*, 2012). Connecticut is a home-rule state where municipalities are self-governing with only planning oversight at the county level. The creation of SAFR, and the corresponding planning process has already improved state and regional coordination. Financing the needed investments and communicating risk remain substantial barriers. If awarded, our proposal will further a regional approach, prioritize extensive education initiatives, and increase the ability of residents to understand and prepare for climate change.

Financing improvements to public and private properties and infrastructure will be challenging because of the increased cost of the building techniques required to construct an insurable property in areas where risks are so high. Furthermore, financial incentives between the federal, state, local governments and private entities are currently misaligned and do not encourage resilient building in the flood zone.

Insurance coverage. Another major barrier is the lack of adequate insurance coverage. One of the largest barriers to adequate coverage is the perception that it is too expensive or unnecessary. Many property owners, including local public housing authorities in the MID counties, have reported that when faced with a tight budget they choose to neglect insurance coverage. Other homeowners allow their insurance to lapse after their mortgage is paid off.

Connecticut's repetitive-loss buildings, many of which are insured by NFIP, have incurred $218 million dollars in damages (CT Natural Hazard Mitigation Plan update, 2014). The highest concentrations of these are found in Milford, East Haven, and Westport. Recent changes to the NFIP have begun to affect the market and this is likely to contribute to increased costs of living and a decrease in affordable housing in shoreline areas vulnerable to flooding.

Actions taken to address this vulnerability. After experiencing Irene, Sandy and Nor'easter Alfred back to back, Connecticut invested in preparedness, recovery and mitigation. HUD CDBG-DR Sandy Recovery funds ($159,279,000) are being used to rebuild and elevate homes, protect the coastline and critical infrastructure, raise roads, install microgrids and backup generators, and plan for coastal resilience. Bridgeport received $10 million in Rebuild by Design to fund the *Resilient Bridgeport* plan. New programs have been established and funding mechanisms have been created or augmented. The State Legislature passed *An Act Concerning Connecticut Global Warming Solutions* (2008), which called for the Climate Preparedness Plan, finalized in 2013. The SCRCOG and the GBRC partnered with the Connecticut Nature Conservancy (CT TNC) to develop a coastal resiliency framework. CT TNC and Connecticut Sea Grant/CLEAR conduct workshops on resilience for municipal staff.

Eversource and United Illuminating, two major utility companies and Partners on this application, have invested in preventing future outages. Eversource Energy is engaged in resiliency projects totaling over $442 million is Fairfield and New Haven counties. USACE Sandy Recovery projects in Connecticut include beach restoration (Prospect Beach and Woodmont Beach), breakwater repair (Bridgeport and New Haven), flood protection investigations (Fairfield, Milford and East Haven), hurricane barrier repairs (Stamford) and erosion control (Morris Cove).

Opportunities for recovery and revitalization. Our proposal describes how forward-looking development strategies are essential to help maintain socially and economically diverse shorefront communities. Using economic development along transportation corridors as a driver of economic revitalization will provide for a more resilient economy and will provide additional housing for low- and moderate-income residents.

CONSULTATION

Consultation process. The NDRC team undertook a robust process of outreach and engagement. This process built upon the lessons learned in Rebuild by Design and numerous other community resiliency processes in Connecticut. The process included over 50 consultations, 3 public hearings and open houses, a project website, site visits, and social media campaigns. This enriched the discovery process, informed the resiliency strategy, resulted in 28 partnerships (with more to come) and will continue to shape the Phase 2 application.

Stakeholder identification and engagement. State Agencies For Resilience (SAFR) forms the core team for NDRC working with Yale, CIRCA and partners. Members actively shaped the application through internal and external consultation on resiliency needs and strategies for the environment, water, health, transportation, housing, relief services and energy. This team reached out to the chief elected officials of all impacted communities and held interagency calls with most. Members exchanged knowledge about vulnerabilities revealed during Sandy, continuing recovery needs, and opportunities to leverage federal funds. Team members met with town engineers, planning staff, and other representatives such as the Bridgeport Neighborhood Trust and toured areas affected by Sandy. During these meetings local representatives reviewed infrastructure and housing assets damaged in past storms and detailed ongoing and planned projects to address these issues. A myriad of resources were mined for creative and cost-effective approaches to build and maintain communities that are physically, socially, environmentally and economically resilient.

Design and collaboration. Our process built upon a substantial number of previous Sandy-recovery and resiliency engagement initiatives, many of which involved deep participation by vulnerable populations. These include: 1) Rebuilding by Design (with bike tours, an All Scales Workshop and many stakeholder meetings), 2) State Sandy Recovery programs, CDBG-DR and Shore UP outreach, 3) The Nature Conservancy's (TNC) Coastal Resilience Planning (including the Tool Kit and technical assistance to planning agencies), 4) the Regional Plan Association's SustainableNYCT Plan, 5) the Sea Grant Climate Adaptation Academy 6) community-based green infrastructure and living shorelines projects such as the Seaside Village community rain garden and 7) the Shoreline Preservation Task Force's year-long investigation based on public hearings and expert consultations on the impact of sea level rise and storms on the state. Also consulted were: 1) Local and State Conservation and Development and hazard mitigation plans, 2) plans for adjacent areas such as the Eastern CT Sustainability Plan and the Sustainable Knowledge Corridor Plan for the Capital Region and 3) other state and agency plans. A design charrette was held with regional planning organizations at the South Central Regional Council of Governments where an outline of the proposal was presented, critiqued and refined by representatives from CIRCA, CTDOT, DEEP, Yale UEDLAB, the Greater Bridgeport Regional Council, the Shoreline Task Force, TNC and the Western CT COG. These initiatives revealed the need for planning and infrastructure solutions to support resilient redevelopment connected by fortified infrastructure to serve impacted areas

including public housing in the floodplain.

Vulnerable populations. Team members consulted with organizations representing and/or composed of members of vulnerable populations including the CT Publicly-Assisted Housing Resident Network, the Fairfield Co. Environmental Justice Network, CT Coalition for Environmental Justice the Partnership for Strong Communities and other advocacy groups. Input from housing authorities, lenders, insurers including the Housing Authority Insurance Group, neighboring tribal nations and states, individuals, and employers were also sought to help build solutions to identify problems and as well as to foster understanding of regional impacts.

Public outreach. Outreach to the public and residents of impacted areas included publication in the state's primary newspaper, the *Hartford Courant* and the Spanish language *La Voz*; flyers distributed to libraries, public housing, town halls, and houses of worship; Twitter and blogs; and use of multiple existing listservs from groups such DOH, the CT Association of Conservation and Inland Wetland Commissions, and TNC. We also created a dedicated webpage with information, resources, the proposal, and synopses of the public hearings and open houses, and a method for submitting comments on the proposal and process. This process of expanding stakeholder contacts and review of existing initiatives is ongoing and will inform Phase 2.

Three public hearings and open houses provided opportunities for comment on the draft proposal and brainstorming about Phase 2. Participants were engaged through interactive activities such as mapping and preference surveys. Posters supported exploration of broad concepts: unmet needs, vulnerabilities, coastal typologies, resilient landscapes, the approach (strategies for solutions to unmet needs), and a comment and idea station. These meetings were accessible by public transportation and held in the MID counties, Fairfield and New Haven, as well as the State Capitol. 71 individuals signed into the hearings and provided extensive comments. Materials were also available on the website thereby creating a virtual open house.

The cumulative impact of the risks and vulnerabilities identified include losses experienced by individuals, families, neighborhoods, municipalities and the state. Sandy resulted in lost homes, jobs, personal possessions and business stock. Lack of power, transportation, access to health care and services in turn caused lost days of school, work, commerce and progress. Flooding of exit routes and fear of looting trapped residents. Relocation for short and long periods of time led to loss of vital connections to family and commercial support. As witnessed in team community tours, destroyed neighborhoods require rebuilding and reknitting social fabrics as well as securing safe exit routes and plans for resilience. Municipalities experienced loss of business revenue and tax base. These cumulative losses will have deep long-lasting impacts on the state's economy and culture. However, they also generated a multitude of studies and initiatives designed to make Connecticut more resilient, some of which are already underway.

Unmet needs reported are extensive, including everything from the need for an emergency

generator for an elderly housing facility to larger and longer-term social vulnerabilities such as unsafe, unhealthy neighborhoods to the need for fortification of railways and roads. Of particular importance is the need to develop resilient solutions for public housing. Residents and housing authorities report the need for rebuilding almost two thousand units located in the floodplain.

Indirect risks and vulnerabilities disproportionately impact low-income households, which have fewer resources to endure disruptions, thus potentially increasing inequality. The target area includes unfortified brownfields, wastewater treatment plants and other sources of contamination that constitute health hazards. Rents have increased due to the loss of housing stock, thereby increasing the number of families experiencing rent burdens. Uninsurable losses in property value and quality-of -life are widely experienced as is the stress and time expended coping with the storm and its aftermath.

Influence on the proposal. Stakeholders, partners, and citizens have shaped this proposal by identifying unmet needs; revealing scientific and planning research; proposing structures that network existing initiatives; cataloging capacity for implementation; advocating for addressing needs for resilient community development including examining health impacts; proposing financing and insurance mechanisms; and building replicable solutions for future funding especially in meeting the needs of public housing and its neighbors located in the floodplain.

Future plans. Plans for collaboration, outreach, and communication for Phase 2 include continuing to work with identified stakeholders and their representatives and extensive collaboration with proposed project communities. In Phase 2, direct engagement with residents, particularly from the most vulnerable communities, will be expanded. This participation will be held in conjunction with regular meetings of residents' and neighborhood associations and other identified constituent groups. Stakeholder involvement will continue to include framing issues, determining priorities and communicating preferences. Shared learning will facilitate growth in the ability to fully engage stakeholders in discussions. Workshops and charrettes will allow deep engagement in design. Advocacy groups will continue to advise on engaging vulnerable populations and participate alongside individuals impacted by proposals. The Department of Public Health will explore the potential of integrating a rapid Health Impact Assessment (HIA) into the Phase 2 planning process.

CONCEPT

Approach to addressing risk. Due to Connecticut's complex geology and topography (Fig.65) the areas most vulnerable to flooding (shown in blue) occur in patches along the coast. This geography complicates the response to flooding and makes collective, engineered flood control measures (i.e. storm surge barriers, reinforced dunes) more technically challenging and costly. However, the state's topography also creates opportunities because ridgelines often extend down to the coastline. These elevated corridors can become a critical connection and safe way back to the inland areas (Fig. 66). This unique physical environment also means that all of the communities impacted by Sandy have areas of high ground (often the historic center of the community), which can serve as resilience zones (Fig. 67). By identifying these resilience corridors and zones and strategically investing in their long-term functionality, the state can enhance the safety and livability of shorefront communities. By connecting these corridors to regional transportation networks, the state can strengthen economic resilience while adapting to future flooding.

Figure 65

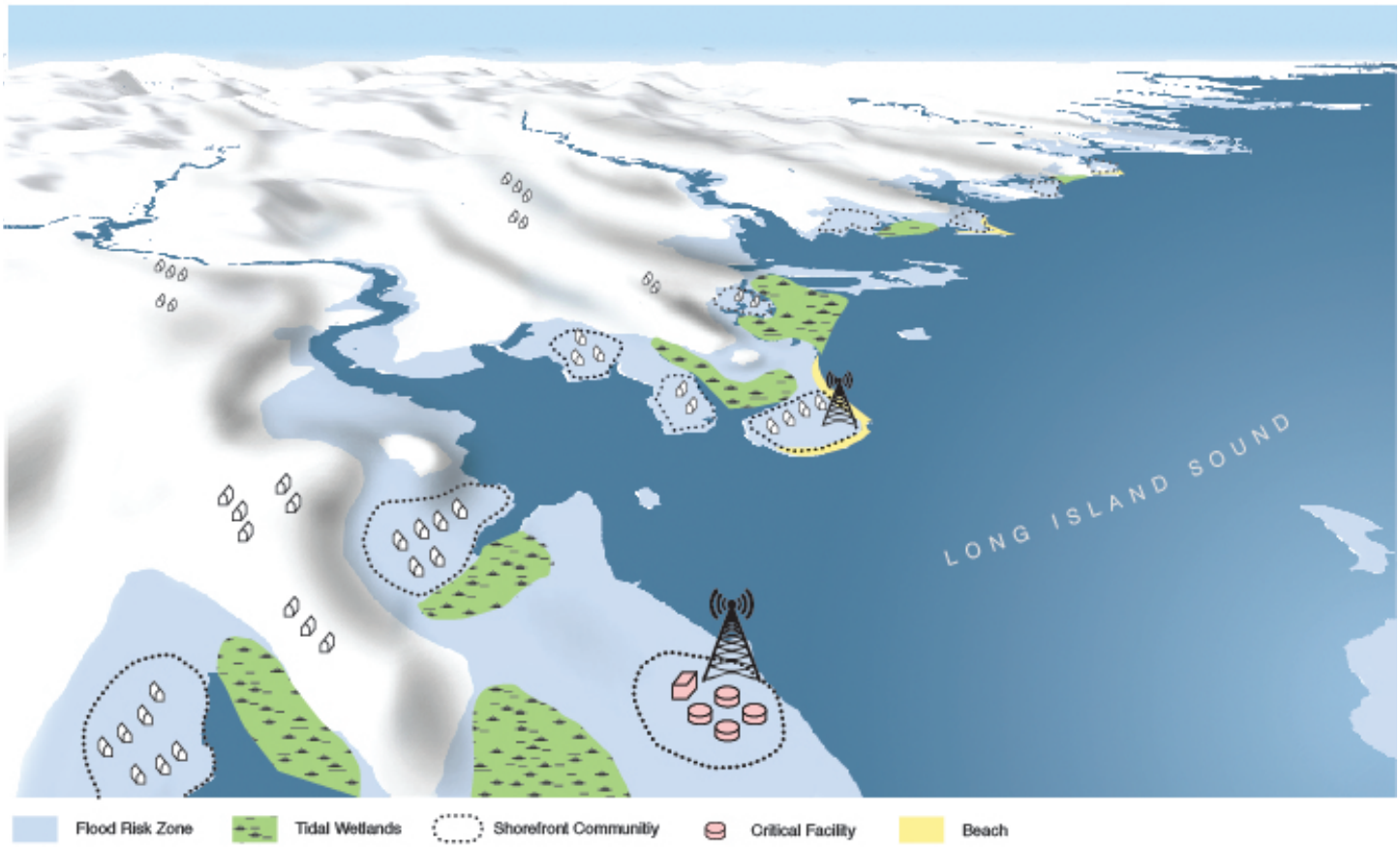


Figure 66

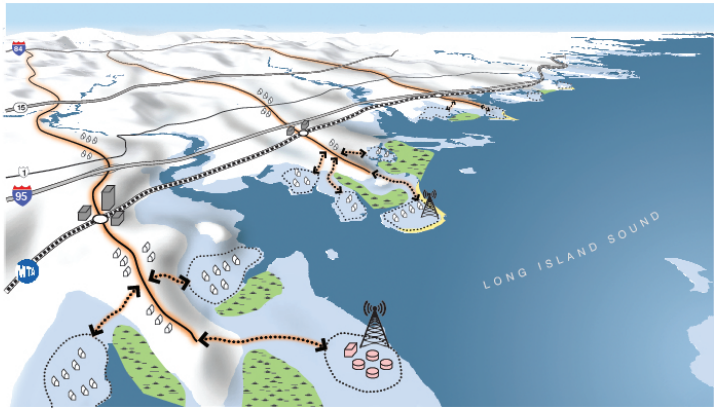


Figure 67

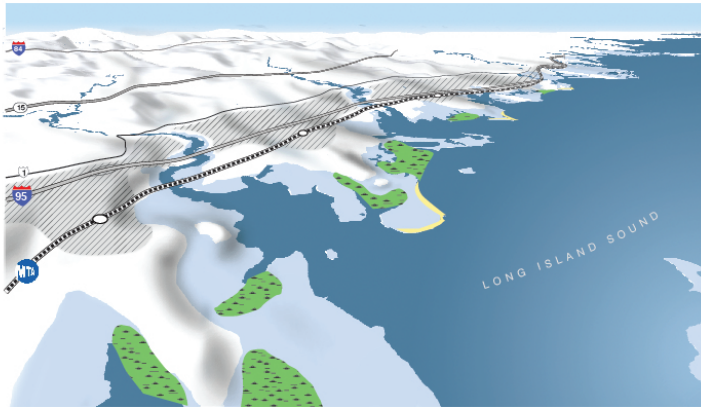


Figure 68

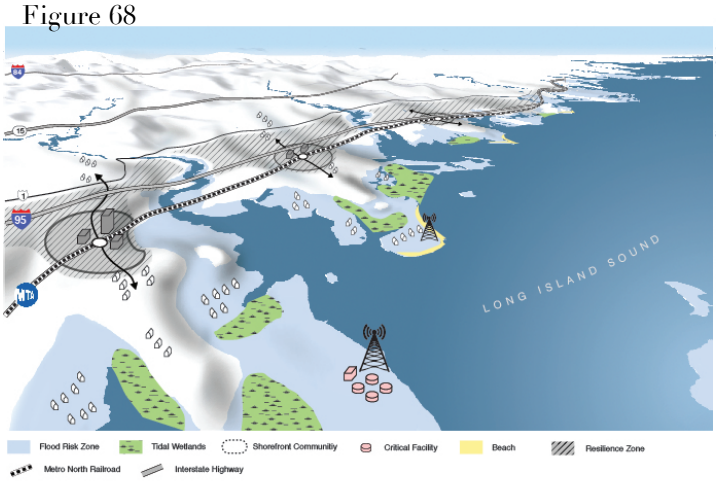
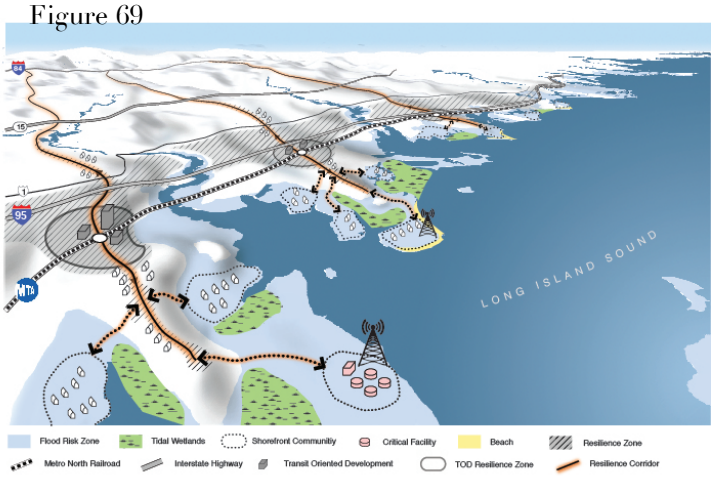


Figure 69



Resilience zones. These areas of high ground can over time be adapted to house the most critical facilities, resilient housing, and to provide key services and shelter during storms (Fig. 68 & 70). Increasing investment in these resilience zones provides an opportunity to increase economic resilience by strongly tying back to the regional transportation network and regional economic opportunities (Figs. 69 & 70). Therefore, these investments represent a 'no regrets' approach to climate adaptation because in addition to providing long-term resilience, they provide a myriad of co-benefits that strengthen communities and economic opportunities in the short term and between storms.

Figure 70



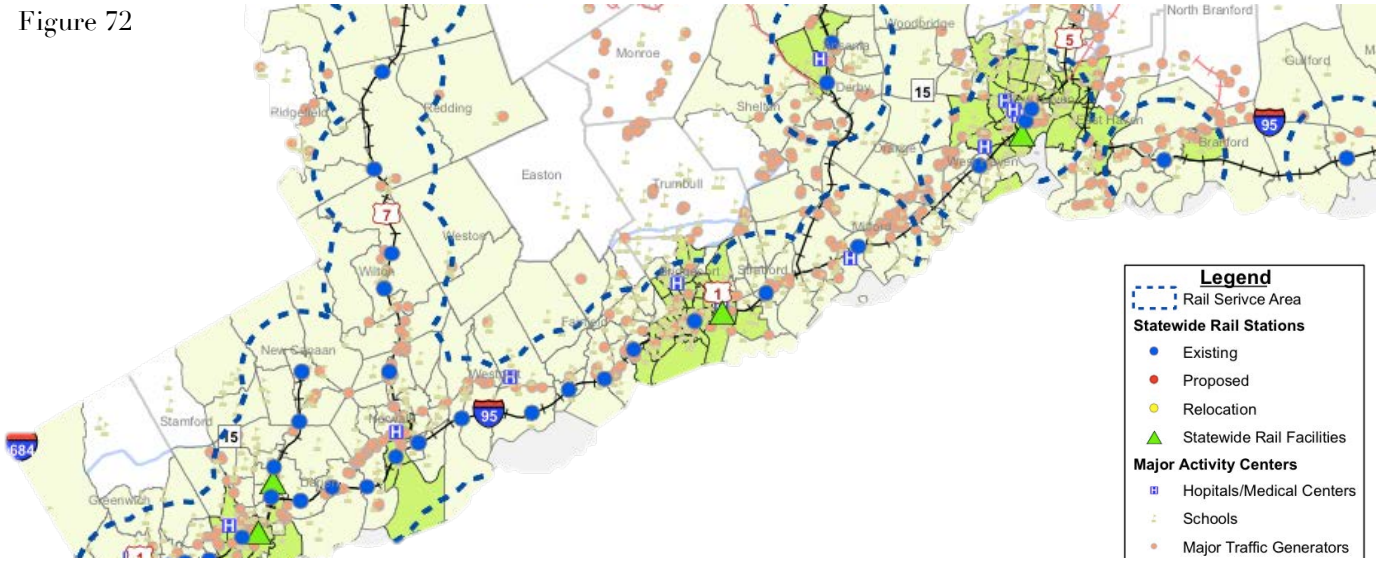
Figure 71



The Sandy-impacted communities are closely linked to the regional transportation network, which provides a unique opportunity to encourage more resilient redevelopment. Many of the most impacted communities are home to the most vulnerable populations, including areas of West Haven, Bridgeport, Norwalk, and Stamford (Fig. 72). DOT previously identified many of these same locations as areas with both high rates of poverty and served by rail service. DOT's map highlights areas where more than 11.6% of the population is living below the poverty line (shown in green). These areas present opportunities to simultaneously support economic development while building more resilient communities.

Connecticut faces an acute shortage of affordable housing and many of the existing affordable units are vulnerable due to their location within the floodplain and this vulnerability is expected to

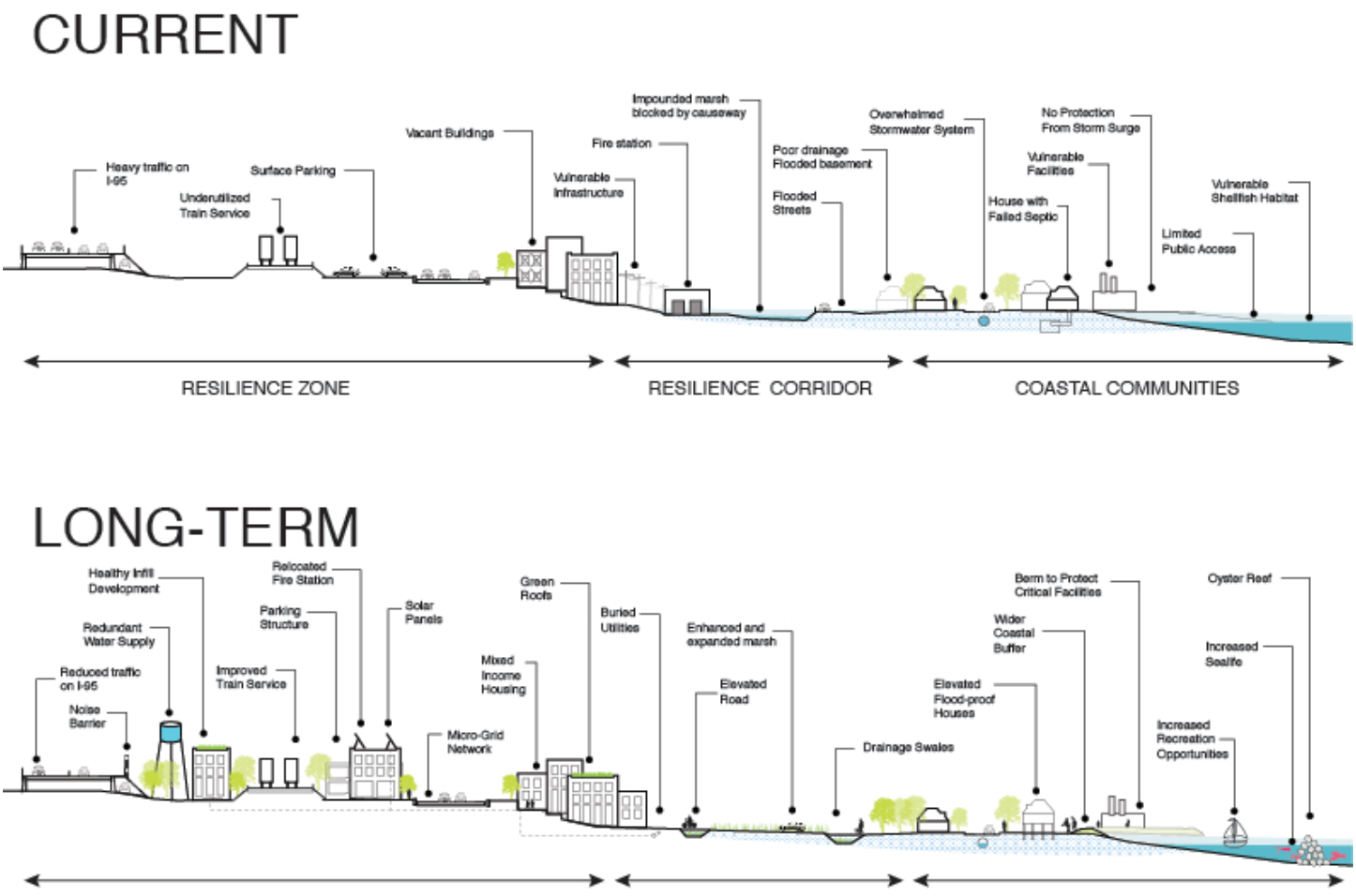
Figure 72



increase as sea levels rise. As regulations regarding development in the floodplain and near sensitive ecosystems become more stringent, it may become more challenging and costly to modify these low-lying properties. We propose addressing these needs by creating new incentives that support the development of mixed-income, transit-oriented developments within these resilient zones (Figs. 70 & 73). Creating new affordable housing in mixed-income developments would create new opportunities to access desirable job markets and educational institutions in Fairfield and New Haven counties. Encouraging this development would contribute to creating more economically and socially diverse communities and create opportunities to leverage public-private partnerships that address the state's housing needs. Encouraging transit-oriented development also aligns closely with the Governor's new investments in transportation. Connecticut's economy is closely tied to the northeast regional corridor and demographic and market trends suggest that demand is rising among younger demographics for housing in more compact, walkable communities with access to multiple modes of transportation. Retaining younger residents is an important contributor to the state's long-term economic health.

Creating more resilient centers and providing more housing options will also provide families with more housing choice within their own communities. In the most vulnerable neighborhoods there is

Figure 73

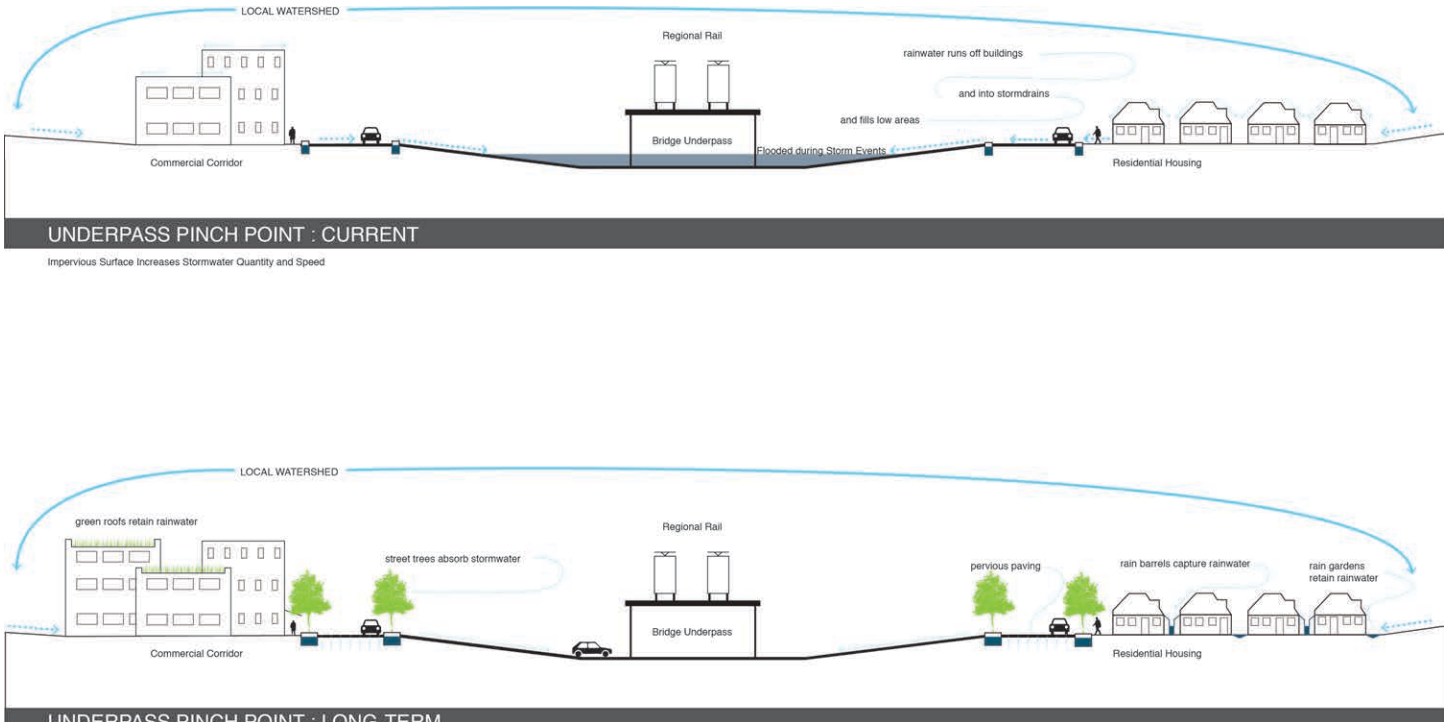


the potential that following a disaster some families may not have the financial resources or may choose not to risk future loss or disruption by rebuilding in place. Providing alternative housing within the same community and school district will help maintain cohesion and ensure their continued diversity. Socially cohesive communities have also been shown to be more resilient in the face of disaster (Weil F., 2011).

Resilience corridors. The state's transportation network is vulnerable to flooding; at the local level many egresses become partially flooded or impassable at low-lying points. Such pinch points often occur in underpasses beneath the rail line and causeways over creeks, rivers, and wetlands. As these transportation networks lose functionality, they increase the risk to residents and increase demands on emergency workers during a storm. Following a storm (and moving forward as sea levels rise) these flooded egresses may impact home values as neighborhoods that become isolated during storms may come to be seen as riskier and less desirable places to live.

As an extension of transit-oriented developments in the resilience zone the team proposes to support resilient transportation and economic development corridors that connect the resilience zones down to shorefront communities. The resilience corridors provide support and ensure the livability of more vulnerable shorefront communities and reduce perceived risk. The corridors will link critical facilities (hospitals, fire stations, power generation) and provide greater continuity of service to the lower-lying communities. Currently, shorefront communities are accessible by a network of roadways, many of which become impassable during bad weather; however, these vulnerable points have not been systematically mapped and prioritized at the state level. We

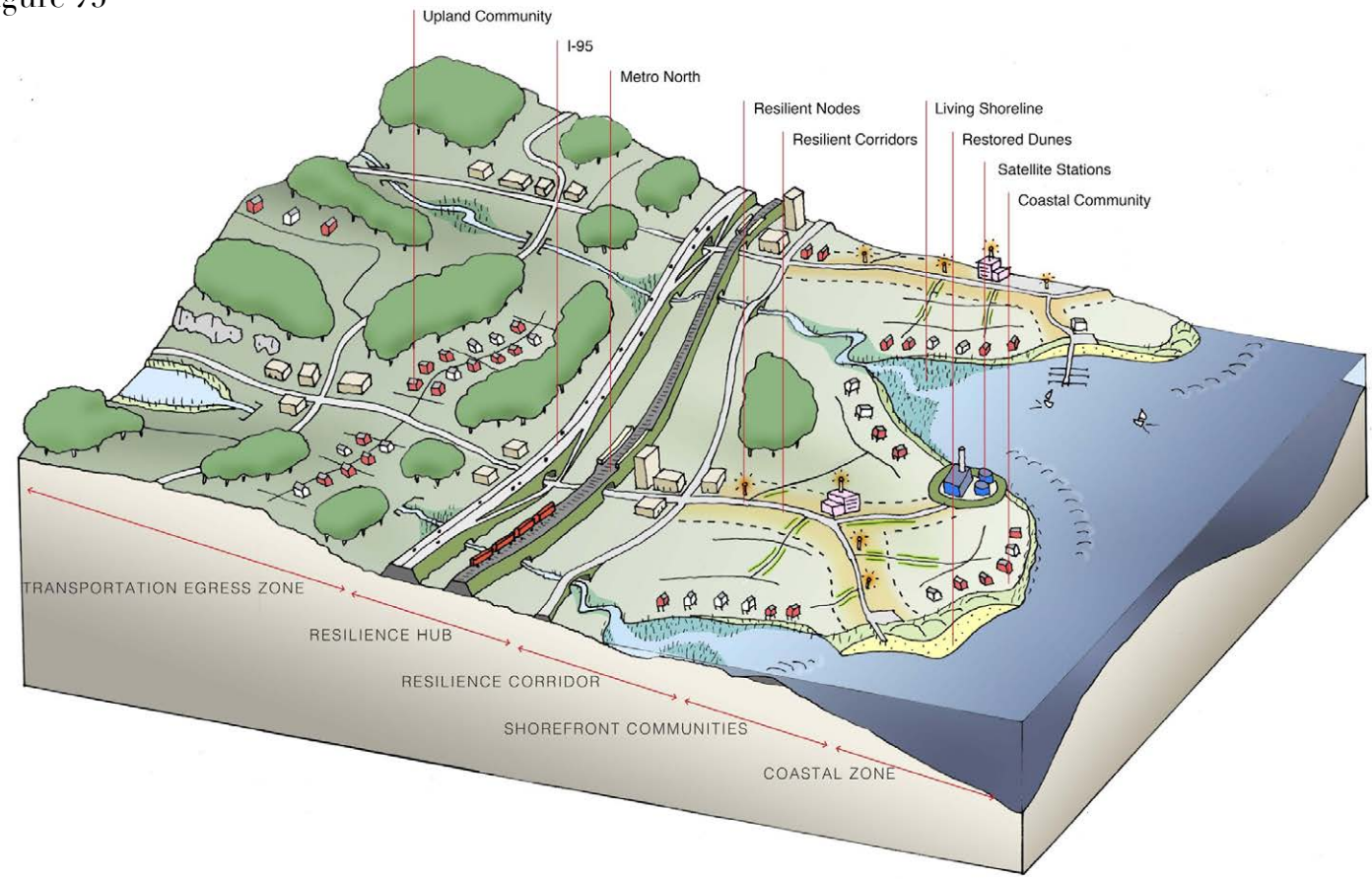
Figure 74



therefore propose prioritizing investment along strategic ridgelines to ensure that communities have at least one secure egress.

Components of these resilience corridors will gradually be raised above the floodplain to ensure emergency access and evacuation. Strategic land use and other infrastructural changes will support this strategy. For example, these corridors could provide additional services to intermittently flooded properties including community parking, debris removal staging sites, reinforced infrastructure (such as water mains) and water infiltration or storage. For highly urban areas these can become reinvestment corridors providing new commercial services and more resilient housing close to desirable waterfront areas but outside of the floodplain. These retrofits can be combined with other initiatives such as providing enhanced drainage and water storage using green infrastructure, increasing the resiliency of the electrical grid and establishing microgrids, and integrating other modes of transportation, such as expanding walking trails and bike paths (Fig. 74). Providing this lifeline will enhance the safety of residents and may help stabilize the long-term property values. More importantly, strategically mapping the vulnerabilities and prioritizing urgently needed investment along key roads will help infrastructure funds go farther. Investment

Figure 75

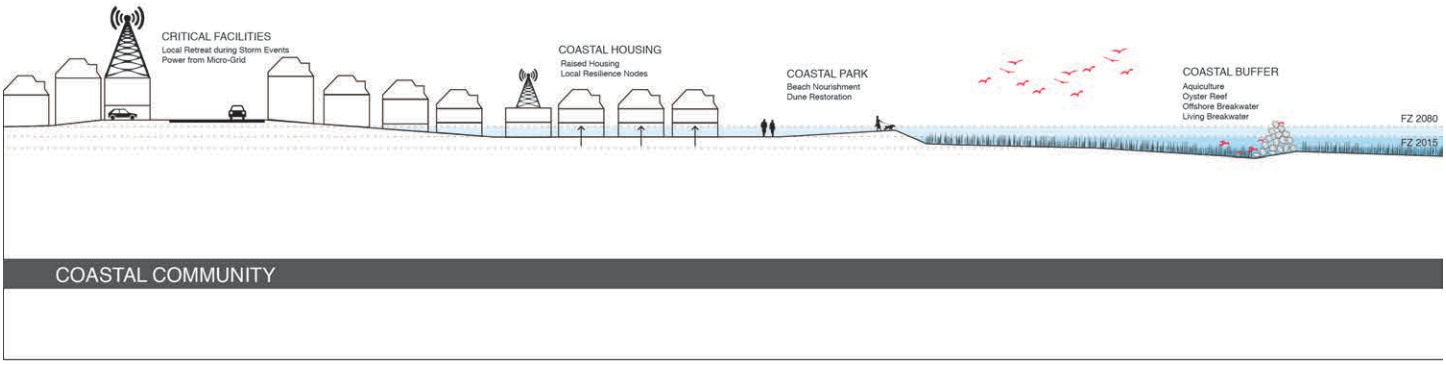


along these corridors, which directly link with regional and local level transportation networks, will maximize the immediate co-benefits for residents. These corridors can also enhance connections

within neighborhoods by making it easier to access public beaches and transit stations via improved bike paths and walkways. These corridors would also be designed to connect critical facilities, given that many (including regional power generation facilities) are located in the floodplain (Fig. 75). Ensuring access to critical facilities during times of flooding can limit the potential damage, shorten recovery time and reduce the costs of storms. The creation of distributed power and emergency centers will further expedite recovery. Infrastructure investment within this zone can be further refined to reflect physical conditions and the level of future risk.

Shorefront communities and the coastal zone. Additional investment is needed in the most vulnerable shorefront communities and along the coastal zone to protect and gradually reduce flood risks in existing neighborhoods (Fig. 76). More proactive management is also needed for buffering ecosystems and drainage networks to support the continued livability of shorefront communities.

Figure 76



Due to the variegated coastline and the close connection between risk and local physical features, each community will need to determine how they choose to respond to a changing environment. However, there are shared characteristics between vulnerable coastal typologies. The following proposed interventions have the potential to benefit many coastal areas and typologies.

- **Expand access to financing for mitigation measures to adapt the built environment.** The financing mechanisms described subsequently will support elevation, flood-proofing, and floodwater management to support longer-term transition to resiliency.
- **Prioritize safe access along a resiliency corridor.** This will ensure emergency access to and from the shoreline and reduce the potential for loss of life and property.
- **Create resilience nodes that can serve as a refuge during flood events**. Nodes within low-lying communities can provide safe places for emergency operations, parking and access to key goods and service within walking distance from flood-prone neighborhoods.

- **Enhance green infrastructure**. Green infrastructure networks can simultaneously improve stormwater management, create recreational and open space amenities, enhance ecological resilience, and link regional recreation trails. These enhancements can be leveraged in conjunction with roadway reconstruction and sewer separation investments.

- **Encourage mitigation through participation in the Community Rating System** (**CRS**). Only three communities in Fairfield and New Haven counties currently receive discounted insurance premiums through their participation in the CRS. Expanding participation has the potential to save shorefront communities $3.9 million dollars annually. Currently the administrative burden is too high for many municipalities; therefore the feasibility of providing assistance through the state or regional entities will be explored.

- **Enhancing or creating naturalized storm buffers**. Greater protection is needed along the coast to ensure that existing buffer areas such as dunes and wetlands continue to provide protection as environmental conditions change. There are many opportunities to construct, enhance, or restore protective areas both onshore and offshore while enhancing public access, biodiversity, and the aesthetic value of coastal recreational areas. Potential projects such as dune reinforcement, beach nourishment, or the creation of living breakwaters have been shown to reduce the risk of wave damage, erosion, and stabilize the shoreline.

Financing resilience. We intend to lower barriers to investment in resiliency projects through a public private partnership modeled on Connecticut's Green Bank. The CT Green Bank is the most successful example in the country of project underwriting and financing for investing in renewable energy and energy efficiency projects. The proposed resiliency program, which may build directly on existing Commercial Property Assessed Clean Energy (C-PACE) or Shore Up CT financing initiatives in the state, will be designed to provide a combination of private financing, government grants, insurance vouchers and low interest loan options for low and moderate-income homeowners and renters, neighborhood associations, taxing districts, municipalities and small businesses who invest in retrofitting structures including critical infrastructure to lower the risks of damages due to flooding and extreme storms. Using a mix of vouchers, grants and low interest loans assessed to a property instead of a property owner can help address gaps in existing mitigation grant programs. The program would be designed to incentivize low- and moderate-income residents who may not participate in other programs due to the financial hardship required to provide the up-front soft costs or who may be reticent to incur additional debt. The details of how the financing mechanism would be designed will be outlined in Phase 2 and Connecticut is very well positioned to take on these challenges. Connecticut's innovative PAR financing model was presented at the national conference for the Association of State Floodplain Managers (ASFPM) in 2014 and will be presented in more detail at the ASFPM national conference in 2015. Connecticut is known across the country as a center for financial businesses and insurance, and draws on the experience of the Green Bank and the operation of three

resilience financing programs: the nation's first microgrid program, Shore Up CT and the Clean Water Fund.

Coherence with existing policy goals. This proposal is closely aligned with the growth management principles outlined in the state's Conservation and Development Plan including their goals to 1)"Redevelop and revitalize regional centers…with existing or currently planned infrastructure" 2) "Expand housing opportunities…to accommodate a variety of household types and needs" and 3) "Concentrate development around transportation nodes and along major transportation corridors." The plan also outlines "priority funding areas" where development is actively encouraged. There is very clear coherence between the "priority funding areas" and the areas identified by this proposal as key resilience zones. Furthermore this proposal is closely aligned with the Department of Housing's 2010-15 Consolidated Plan for Housing and Community Development. This plan outlines a vision where "Housing developments will be clustered around pedestrian-friendly areas, in close proximity to employment and commercial centers, schools, public transportation, and around established infrastructure. Connecticut will revitalize its urban and regional centers with mixed-use, mixed-income housing and community development, providing a safe and clean environment to attract an economically and socially diverse workforce." This proposal would also be closely aligned with the work underway for the Transit Oriented Development working group. Additionally, the coastal components of this proposal are closely aligned with the Long Island Sound Study's Comprehensive Conservation and Management Plan.

OUTCOMES

Outcomes - Long-term solutions. This proposal outlines a long-term vision for establishing more 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. By leveraging other ongoing and planned projects it is possible to make substantial progress in selected communities. This proposal outlines interventions throughout coastal communities, but primarily focuses on the expansion of opportunities and supporting infrastructure to create mixed-income, mixed-use, transit-oriented development in resilient centers. The proposal includes multi-phase projects with some components requiring upfront funding for construction and others that will require longer-term maintenance. The innovative funding mechanisms, including the provision of the long-term maintenance and programmatic costs, will be described for each project in Phase 2.

Co-benefits. Promoting development oriented toward transit networks will reduce climate and air quality impacts from transportation and relieve pressure on undeveloped land. Expanding housing choice within resilience zones will expand access to regional economic opportunities and help to

support economically and socially diverse communities. Providing additional housing opportunities within the community also supports long-term community resiliency and social cohesion as residents affected by flooding will have ample housing choices that allow them to stay within their own communities. Mitigating flood risks with green infrastructure and living shorelines presents numerous opportunities to improve environmental quality.

Measuring success. Project-specific metrics will be developed for each program component in Phase 2. These metrics are likely to include: the increased number of affordable housing units created outside of flood zones or benefiting from mitigation measures; the increased number of housing units and amount of commercial building space built or renovated within a half mile of a rail or bus station; the increased number of property owners with access to affordable financing for mitigation measures; the increased number of towns participating in the Community Rating System; the increased capacity of green infrastructure to manage surface run-off; the reduction in the number of households with limited egress from their homes during times of flooding; and reduction in the number (or value) of properties exposed to flood risk.

LEVERAGE

Leverage - Partners and stakeholders. The Applicant's partners include state agencies that are involved in major infrastructure projects being undertaken on a multi-decadal time scale. CTDOT has committed to coordinating applicable activities in its Capital Infrastructure Plan with this proposal. Other SAFR partners have committed to exploring similar opportunities during Phase 2. The regional partners, CCM and the COGs, as well as selected municipalities will be key to the implementation and maintenance of projects and have been active in developing this application. CIRCA Advisory Committee members, have voiced their support for this application. The recent redevelopment and flooding mitigation project in Meriden demonstrates the state's ability to work cooperatively and draw upon diverse funding sources to support complex and large-scale redevelopment projects.

Financing resilience. The Applicant has consulted with CIRCA's advisory committee, Connecticut Green Bank (a public private partnership, which is approaching $100 million in value for private financing for climate mitigation), the CDI, Munich Reinsurance America Inc., State Farm, the Housing Authority Insurance Group, and on the potential opportunities to finance the mitigation investments needed in Connecticut. These discussions on opportunities to use cost savings and other incentives to support mitigation will continue to be a priority for the state.

Co-benefits as leverage. Enhancing the resilience of the transportation network will result in cost savings from reduced business interruption, stabilized property values, and most importantly improved emergency access which reduce the loss of life and property. Using TOD as a tool for

economic resilience creates the potential to leverage private investment as well as public funding from the Governor's second-term priority of a "best-in-class transportation system" and funding to support smart growth. Green infrastructure can improve storm water management and reduce the investment needed to upgrade sewer infrastructure and improve water quality.

Committed and potential leverage. The state has already committed $500,000 to prepare the CDBG-NDR application. Potential sources of leverage have been identified for projects in Phase 2, which have the potential to extend the reach of this approach beyond the MID counties. This leverage totals approximately $2.75 billion including: Connecticut DOT 2015-2019 Capital Infrastructure Program ($1.7 billion FY 2015); State-Sponsored Housing Portfolio revitalization plan ($300M); Clean Water Fund ($480M 2015 with $103M set-aside for green infrastructure and adaptation); Drinking Water State Revolving Fund ($133.6M SFY 2014&2015); Connecticut Microgrid Grant and Loan Program ($23.1M); Shore Up Connecticut loans ($25M); bond funds under the state's Hazard Mitigation Buyout Assistance Program ($4M); Bond Funds for Beach Erosion or Flood Control Project; and the Connecticut Institute for Resilience and Climate Adaptation with a seed budget of $2.5M, but also actively pursuing research grants from NOAA, USDA, EPA, NSF and USAID. The state's TOD workgroup has also identified and shared with SAFR 30 potential funding sources (over $50M) to support TOD planning and implementation. The Governor's proposed budget has allocated new spending for green infrastructure ($20M) and resiliency projects ($20M). The EPA Long Island Sound Study and Connecticut Sea Grant also provide hundreds of thousands of dollars annually to support to research on coastal issues and climate change. With the support of the Tremaine Foundation, the Applicant will continue reaching out to the philanthropic community including the Fairfield County Community Foundation and the Community Foundation for Greater New Haven.

LONG-TERM COMMITMENT

The Connecticut Climate Preparedness Plan, released in 2013, advanced legally mandated efforts to prepare for climate change. The Connecticut Long-Term Recovery Committee and the Shoreline Preservation Task Force laid the foundation for two laws passed since Sandy: *An Act Concerning the Permitting of Certain Coastal Structures by the Department of Energy and Environmental Protection* and *An Act Concerning Climate Change Adaptation and Data Collection*. The first law required the consideration of sea level rise in the state's civil preparedness plan, applications to the Clean Water Fund, state and municipal plans of Conservation and Development, as well as in municipal evacuation or hazard mitigation plans, and also required the development of best practices for coastal structures. The second law led to the creation of the Connecticut Institute for Resilience & Climate Adaptation, a UConn-DEEP partnership, which was established to support adaptation to rising sea levels.

Improving the built environment. One year after Sandy, the Shore Up CT program was created and supported with $25 million in bond funds. Shore Up CT, administered by CT DOH, helps property owners located in flood zones VE or AE finance or refinance property elevations and retrofits for flood and wind proofing. Eligible properties include those not otherwise eligible for assistance programs such as second homes, commercial properties, and owner-occupied multi-family units. The program elevates all residential properties higher than the minimum standard to the 500-year flood height +1' which adds 3' of protection on average. Shore Up's goal is to complete 20 loans in the first 12 months. Applications correlate well with the areas hit hardest by Sandy, which demonstrates that the program is reaching target areas. As the average loan is approximately $125,000, the initial $25 million investment has the potential to improve around 200 homes. The program is a revolving loan fund so it can assist homeowners well into the future.

Easements. In areas impacted by Irene and Sandy, some residents have chosen to relocate outside of the floodplain. In the Old Field Creek area of West Haven, floodplain easements will be acquired on 33 properties through the Natural Resources Conservation Service Emergency Watershed Protection Program. The easements will be converted to open space in perpetuity and will prevent future damages and risks to public safety and improve critical habitat.

Building codes. Several communities enacted regulations providing an additional safety margin for vulnerable structures. Darien, Greenwich, Stamford, and New Haven all require an additional foot of freeboard for all new residential, non-residential, and manufactured homes in the VE, A, AE flood hazard zones. Stratford requires an additional foot for structures in the VE zone. Bridgeport recently added additional amended zoning regulations to facilitate elevations.

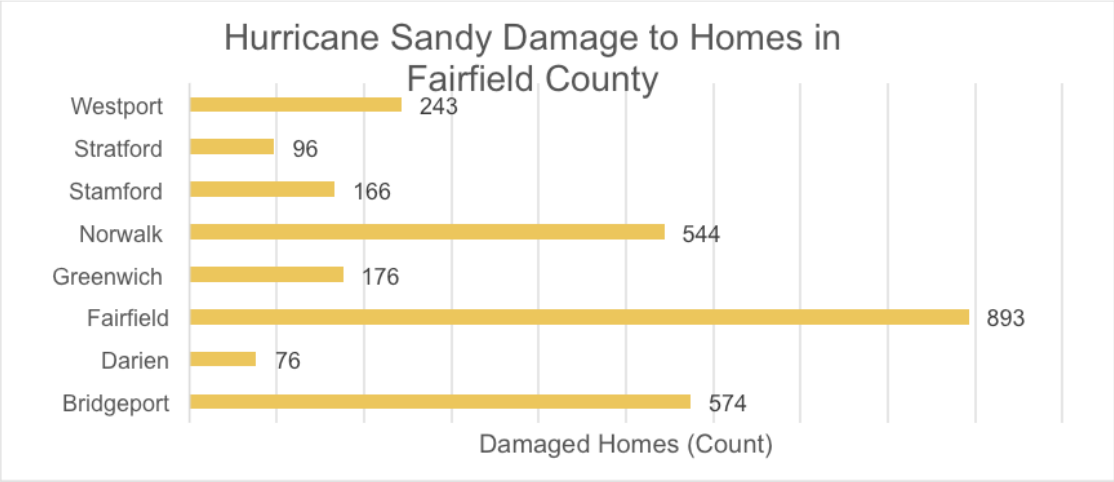
Floodplain management. Connecticut's Flood Management statutes extend beyond FEMA's requirements. All activities must comply with the requirements of CGS 25-68d(b) and Section 25-68h-I, and through 25-68h-3 of the Regulations of CT State Agencies, and this includes any projects using public funding (whether state actions or federal passed through a state agency). Any activity within the floodplain must be in compliance with the National Flood Insurance Program (NFIP). All critical facilities must be elevated 1' above the 500-year flood elevation. Furthermore, proposals must promote long-term non-intensive floodplain uses and have utilities located to discourage floodplain development. The Connecticut Coastal Management statutes seek to ensure that coastal development protects natural resources like living shorelines, minimizes risks to life and property, and minimizes shoreline armoring.

Microgrids. The state has dedicated an additional $15M to the Microgrid Pilot Program. Two of the initial projects will benefit Bridgeport and Fairfield, communities heavily impacted by Sandy. The Bridgeport project will help prevent critical infrastructure (City Hall, Police Headquarters, Senior Center) from going offline during major events. The Fairfield Public Safety Microgrid project will benefit the town's emergency operation center, fire department headquarters, police station, a cell tower and the homeless shelter at Operation Hope.

SAFR Connecticut Connections

Additional Maps and Drawings
Figures 1-64

Figure 1. Number of homes damaged by Hurricane Sandy for coastal municipalities in the most impacted and distressed target areas (Analysis of Communities Impacted by Hurricane Sandy in Connecticut; HUD: PD&R; March 7, 2013).



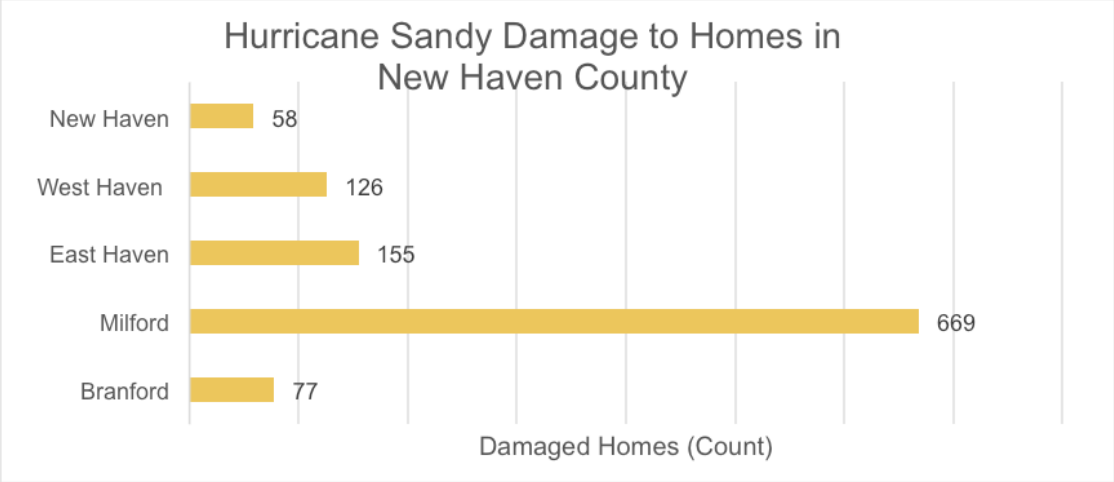


Figure 2: Hurricane Sandy Impacts total unmet housing needs

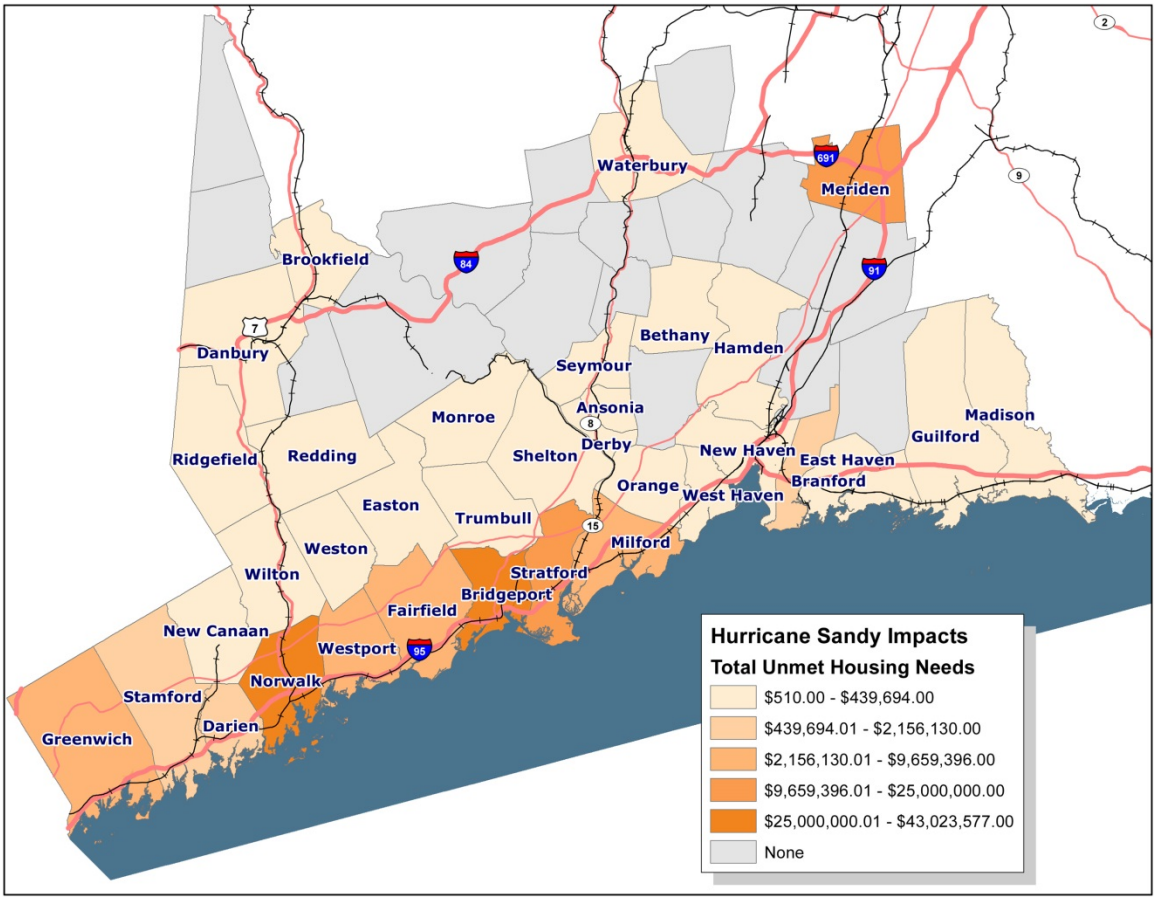


Figure 3: Hurricane Sandy Impacts unmet needs for owner-occupied housing

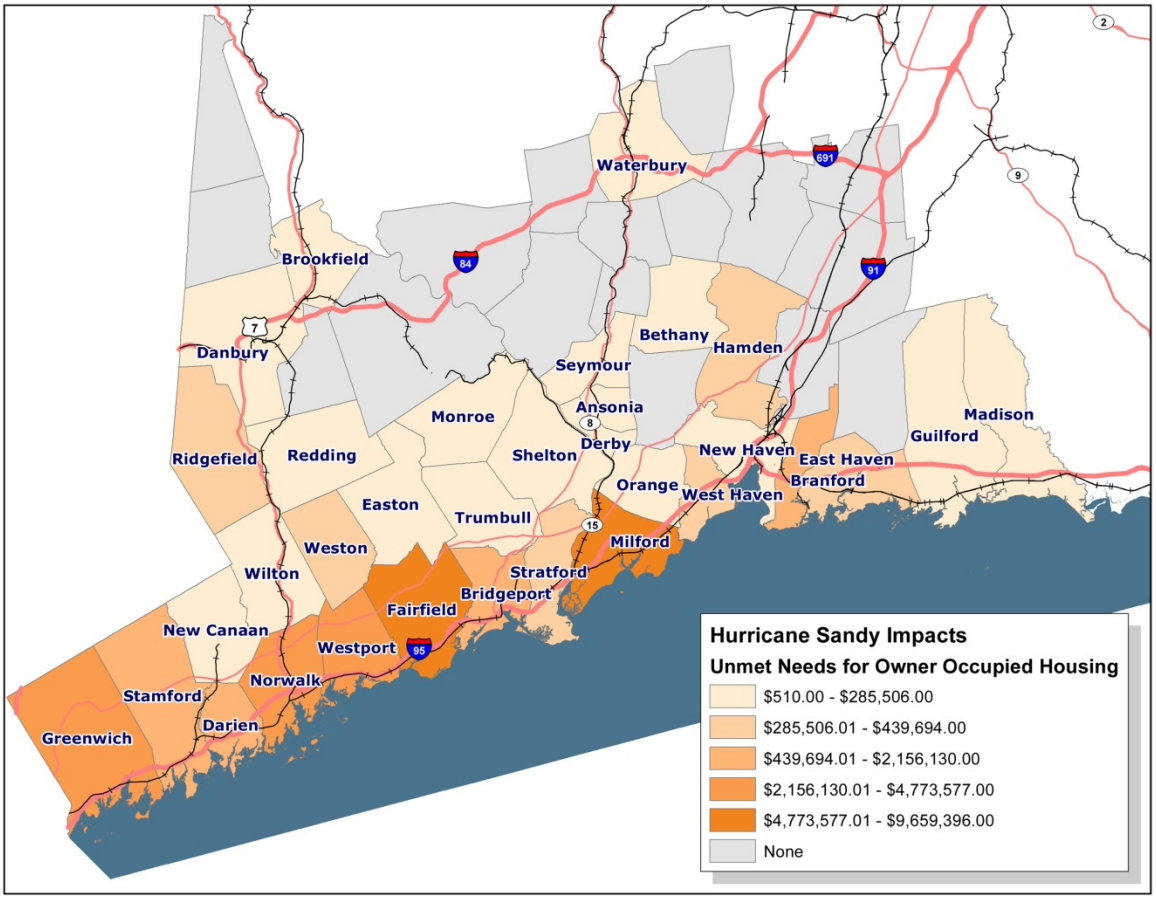


Figure 4: Hurricane Sandy Impacts unmet needs for multi-family housing

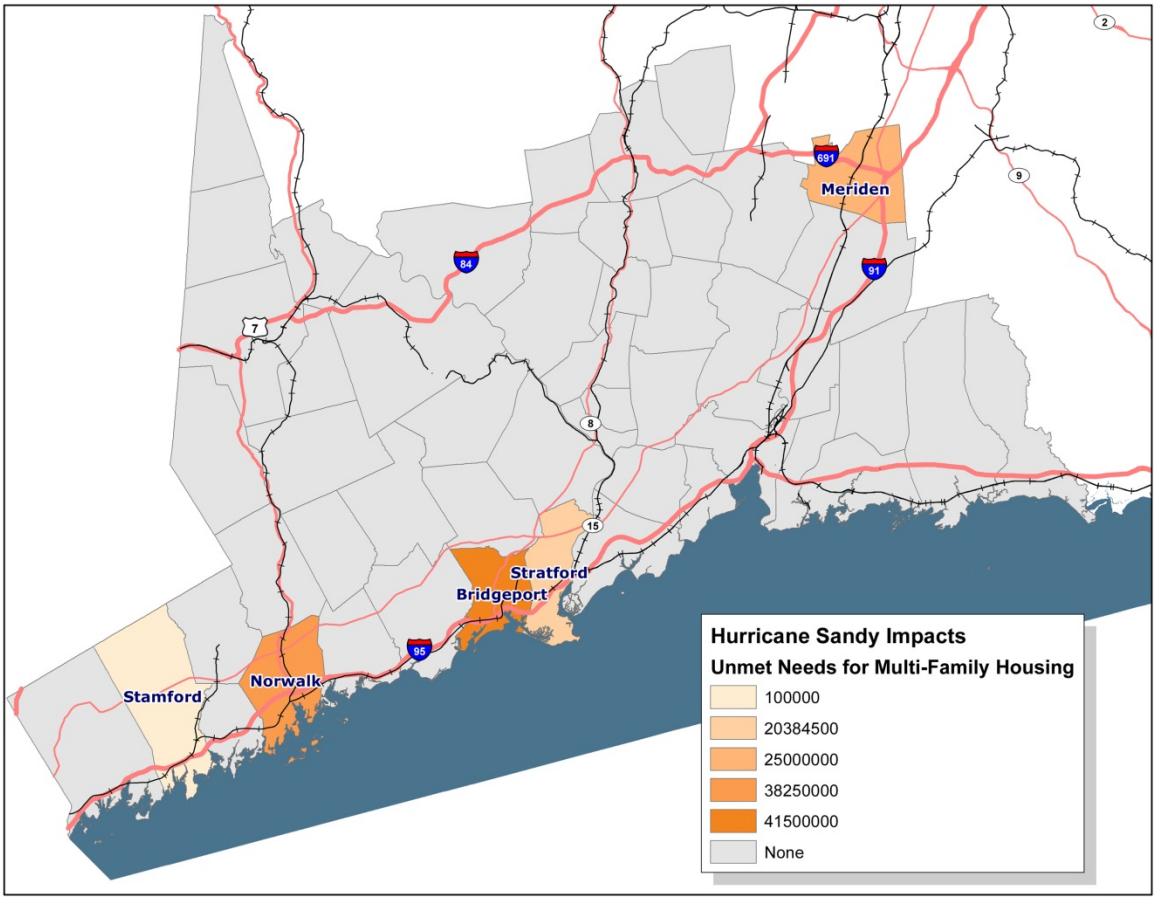


Figure 5. Average rent for coastal municipalities in the most impacted and distressed target areas (Zillow Rent Index, April 29, 2013).

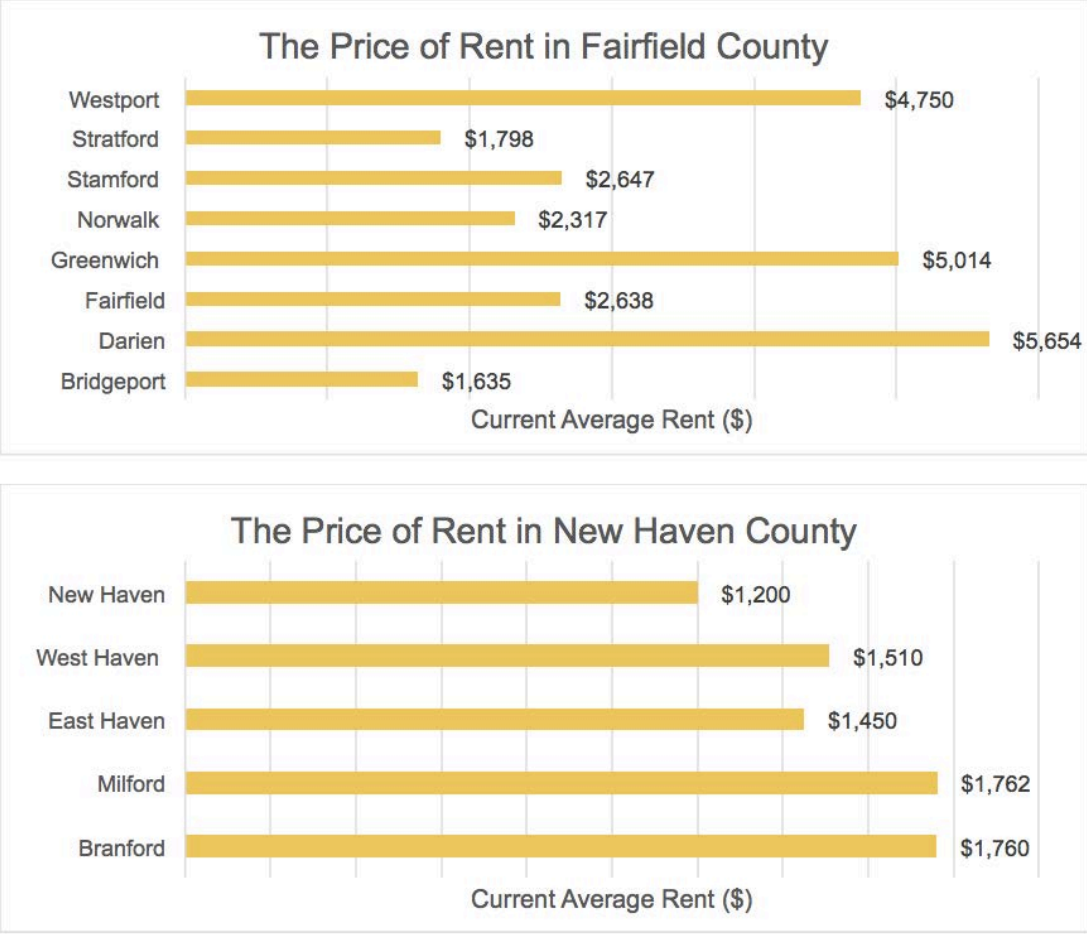
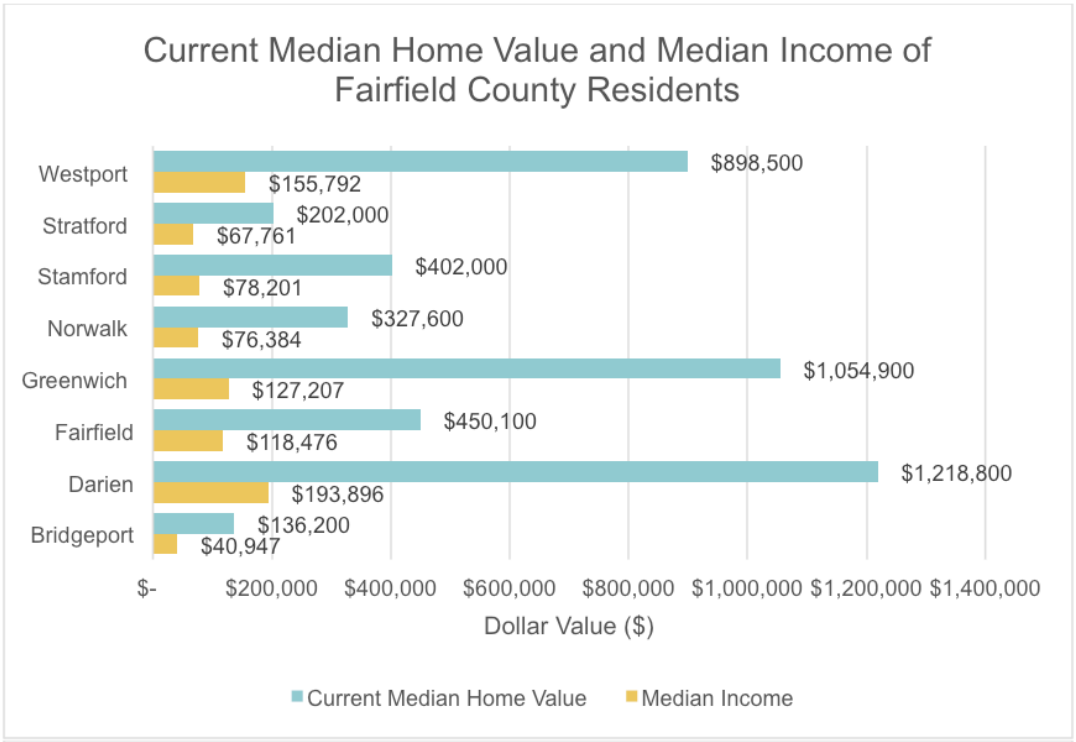


Figure 6. Current median home value and median income of residents in the most impacted and distressed target areas (Zillow Home Value Index, April 29, 2013; CT CDBG-DR Sandy Action Plan, June, 2013).



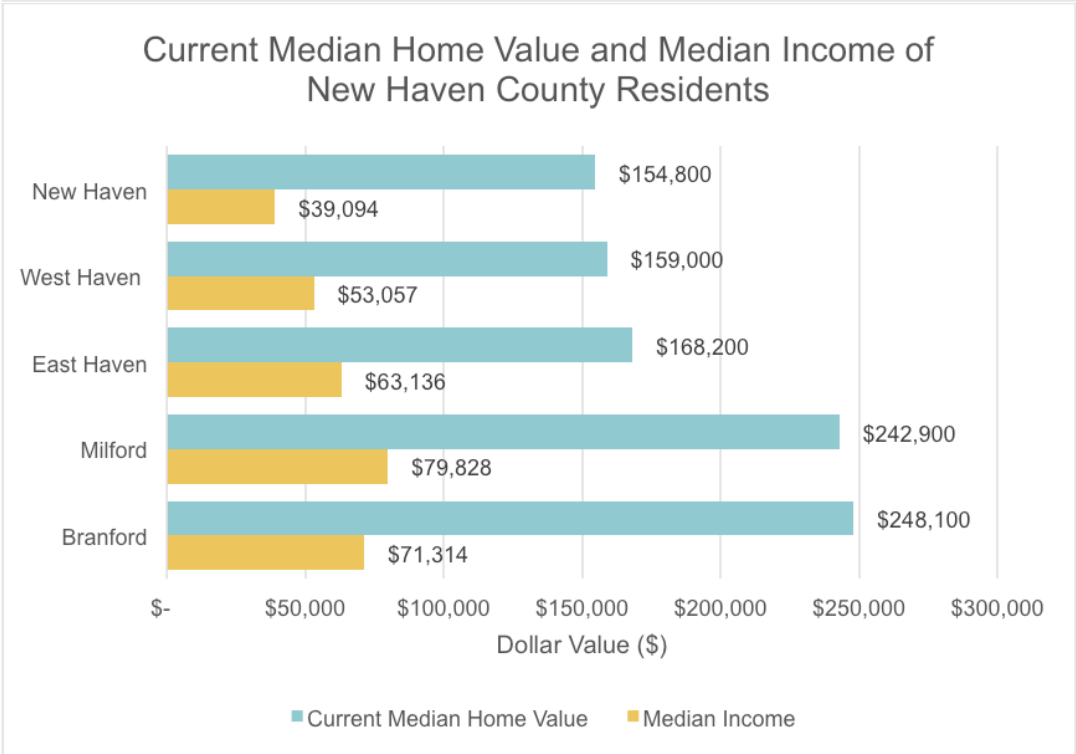
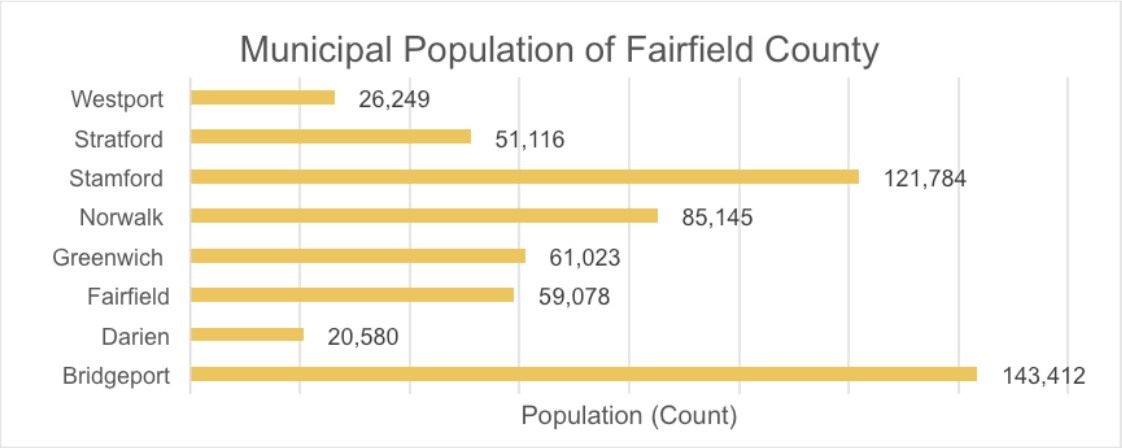


Figure 7. Population of coastal municipalities in the most impacted and distressed target areas (American Community Survey 2007-2011 Five Year Survey).



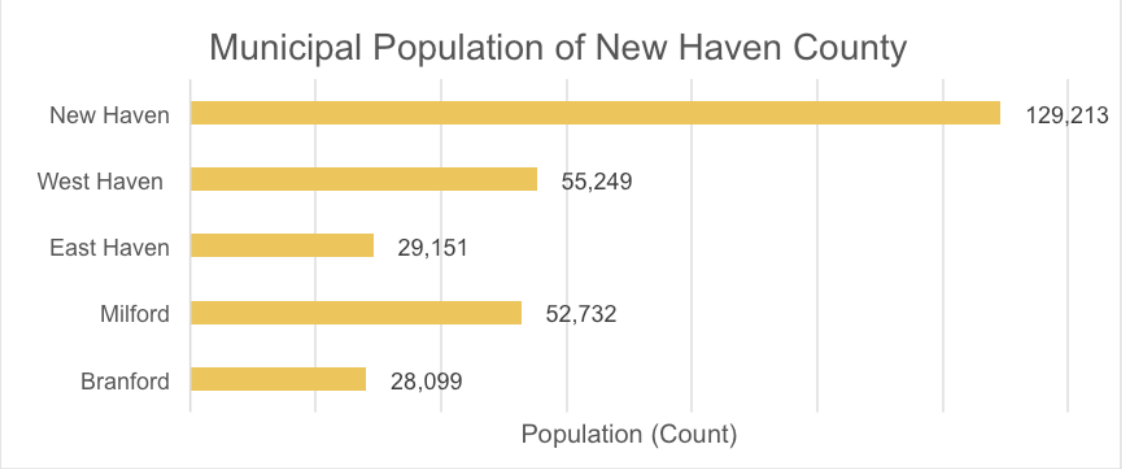
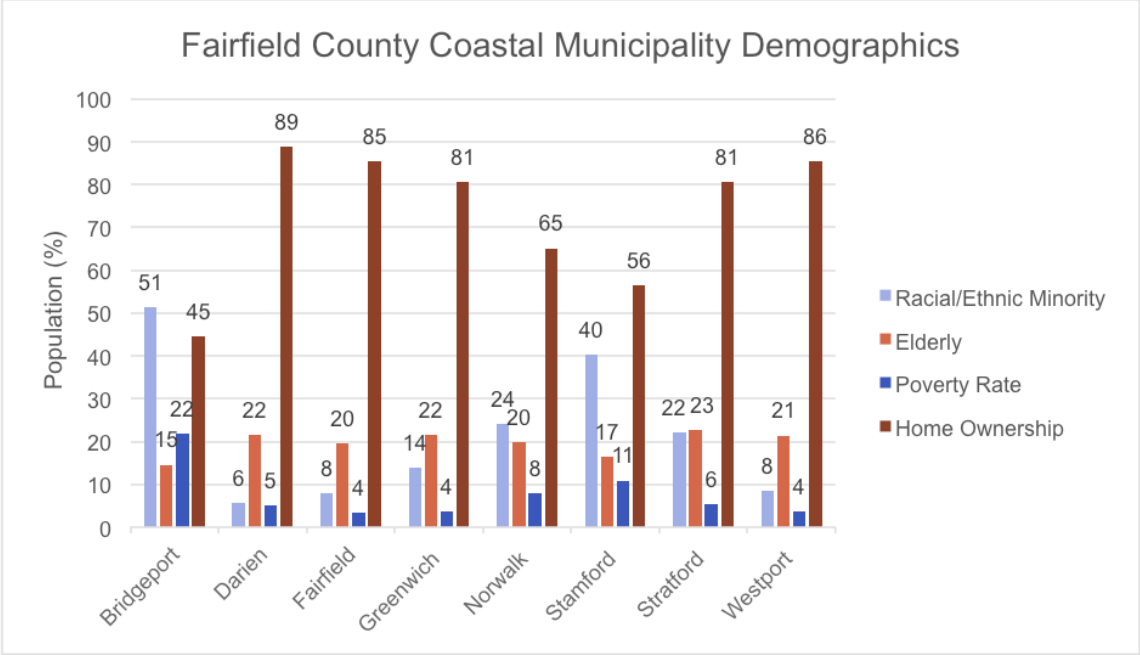


Figure 8. Percentage of the population that is a racial/ethnic minority and elderly and the poverty rate and home ownership rate for coastal municipalities in the most impacted and distressed target areas (American Community Survey 2007-2011 Five Year Survey; CT CDBG-DR Sandy Action Plan, June, 2013).



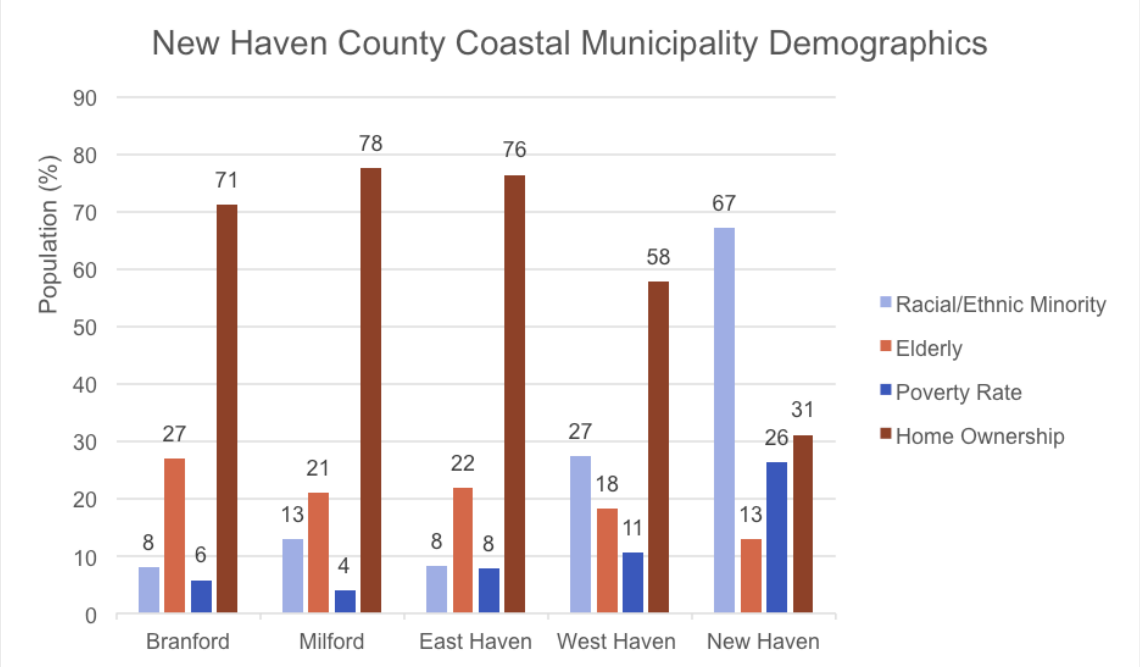


Figure 9: Percentage of persons with low or moderate income in Fairfield County

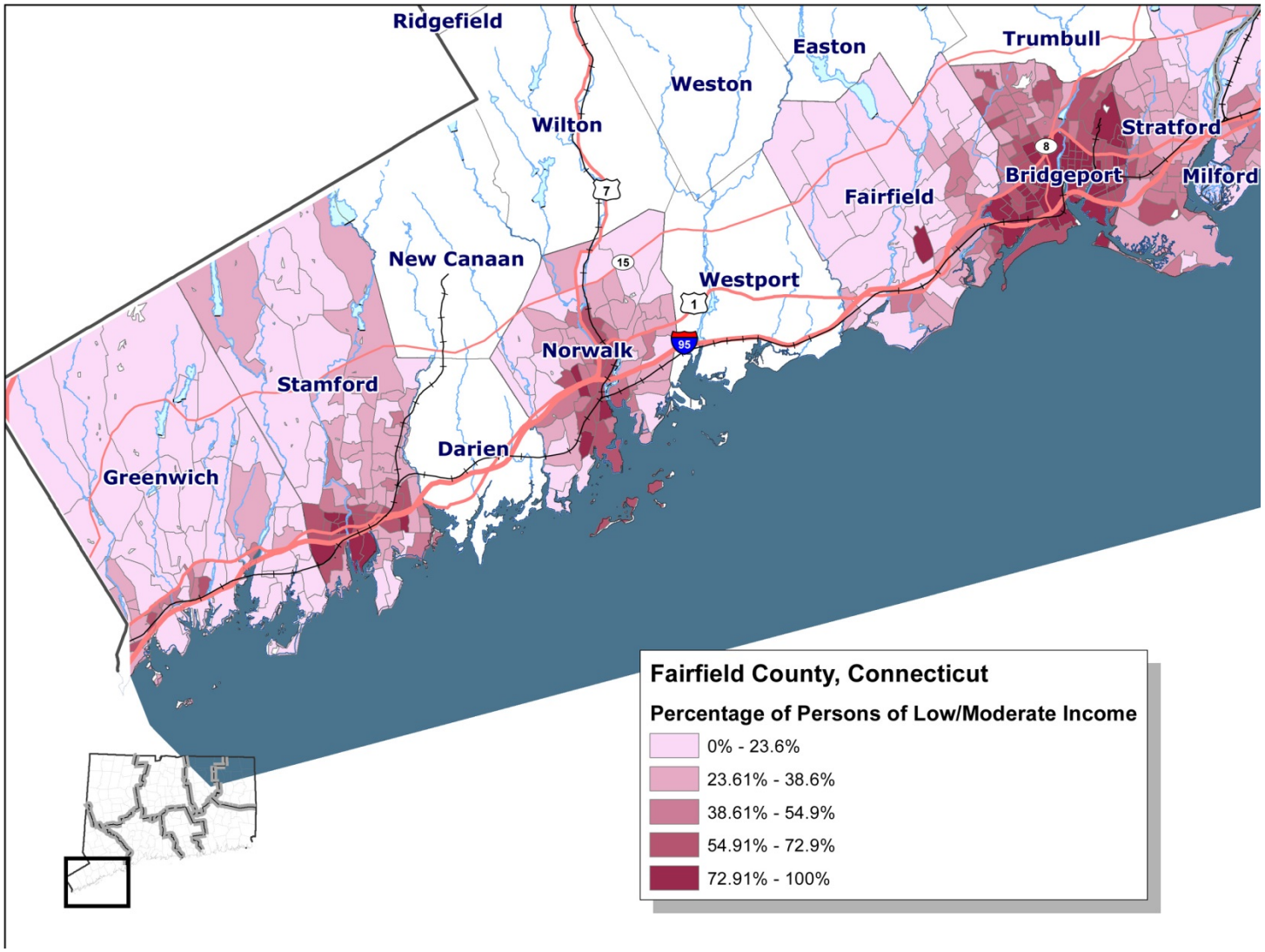


Figure 10: Percentage of persons with low or moderate income in New Haven County

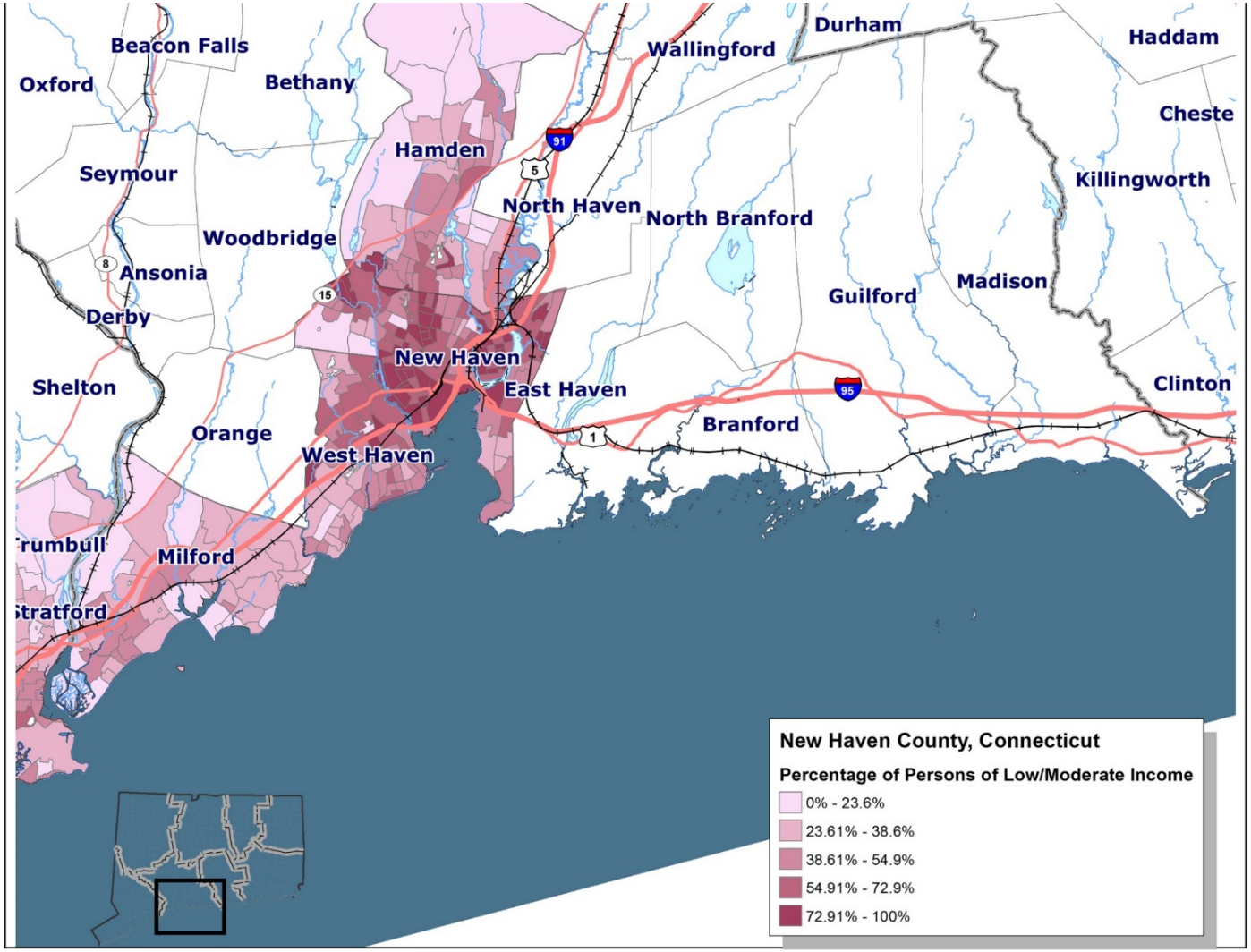


Figure 11: Social Vulnerability Index for Connecticut at the census track level in Fairfield County (2010)

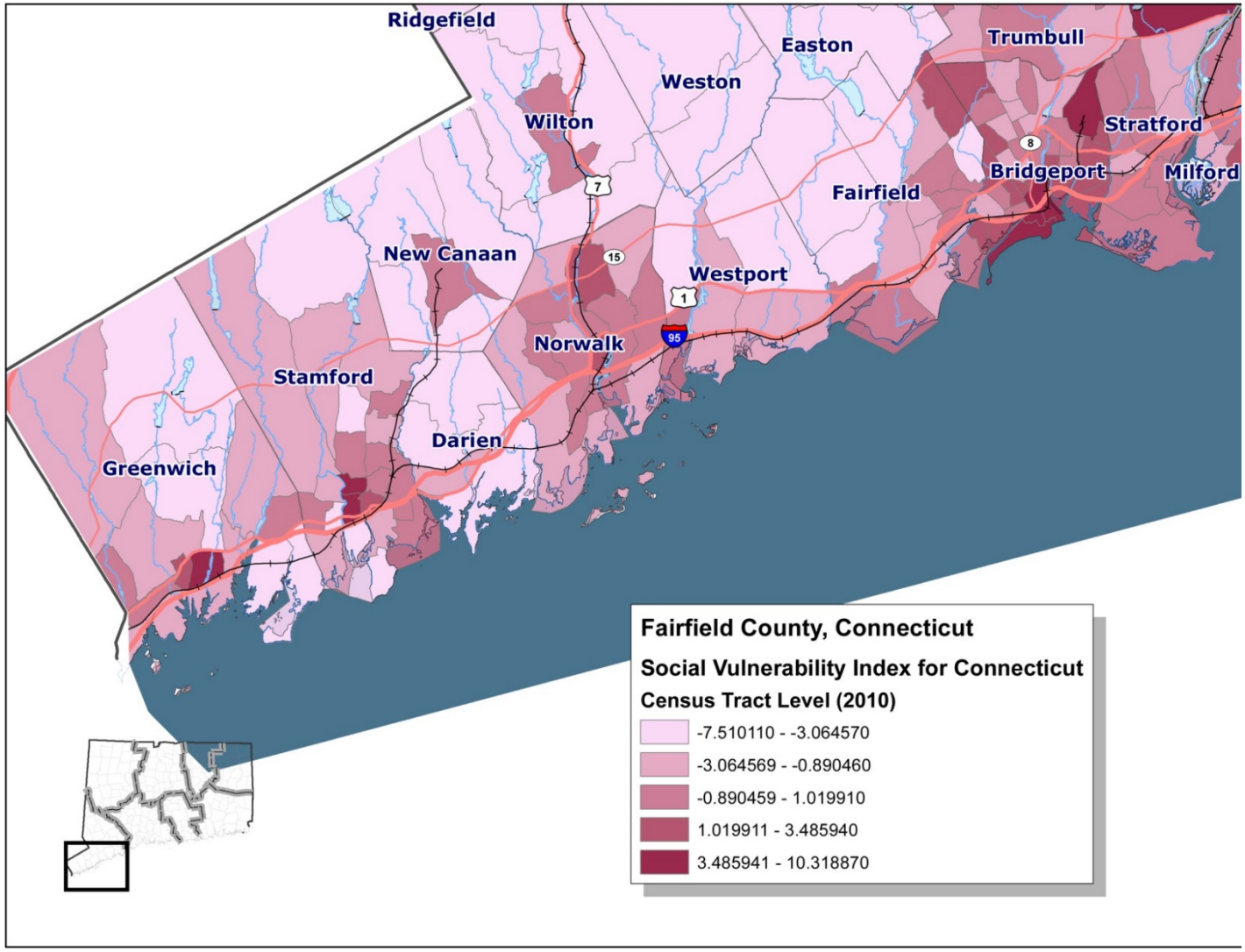


Figure 12: Social Vulnerability Index for Connecticut at the census track level in New Haven County (2010)

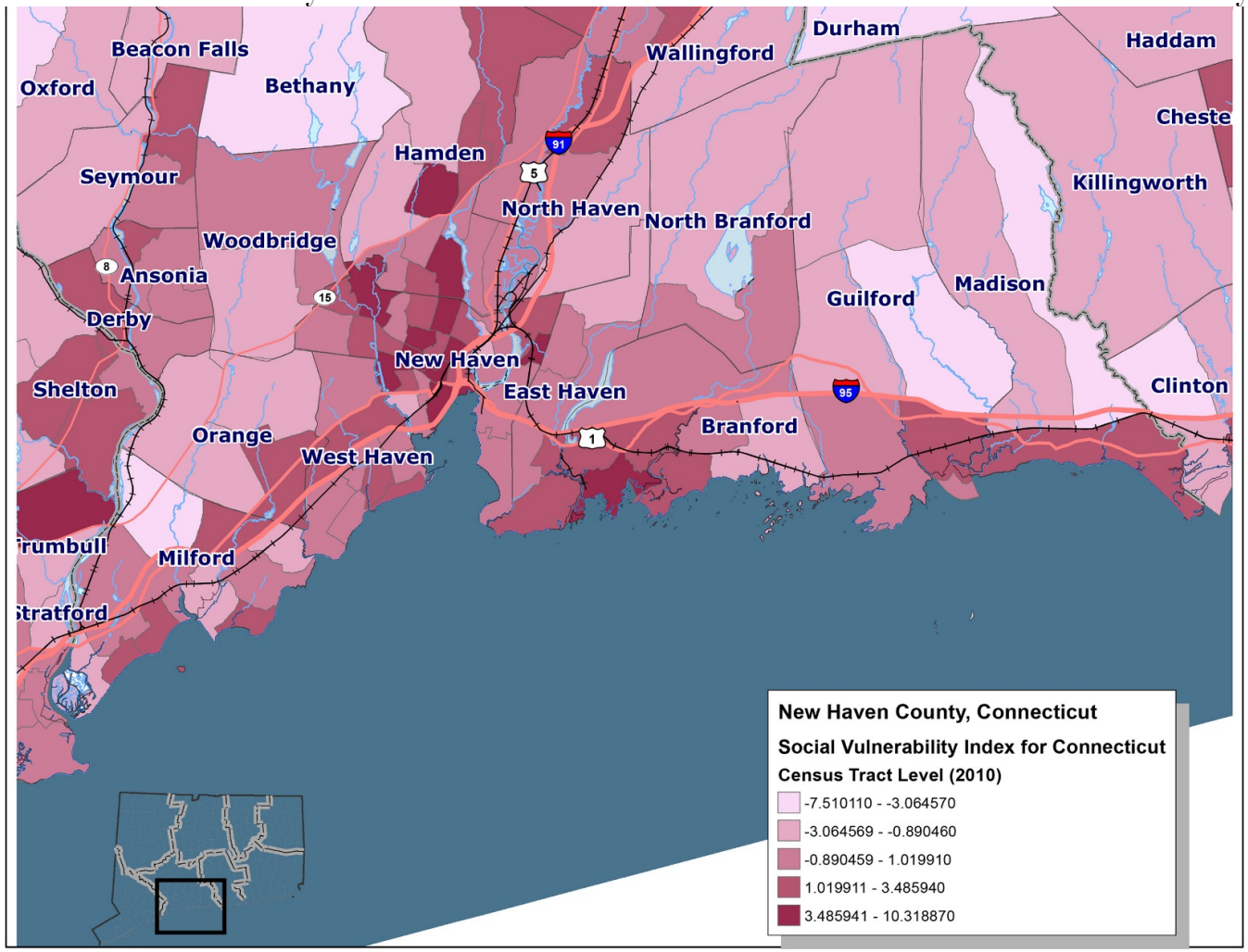


Figure 13: Social Vulnerability Index with Hurricane Surge overlay in Fairfield County

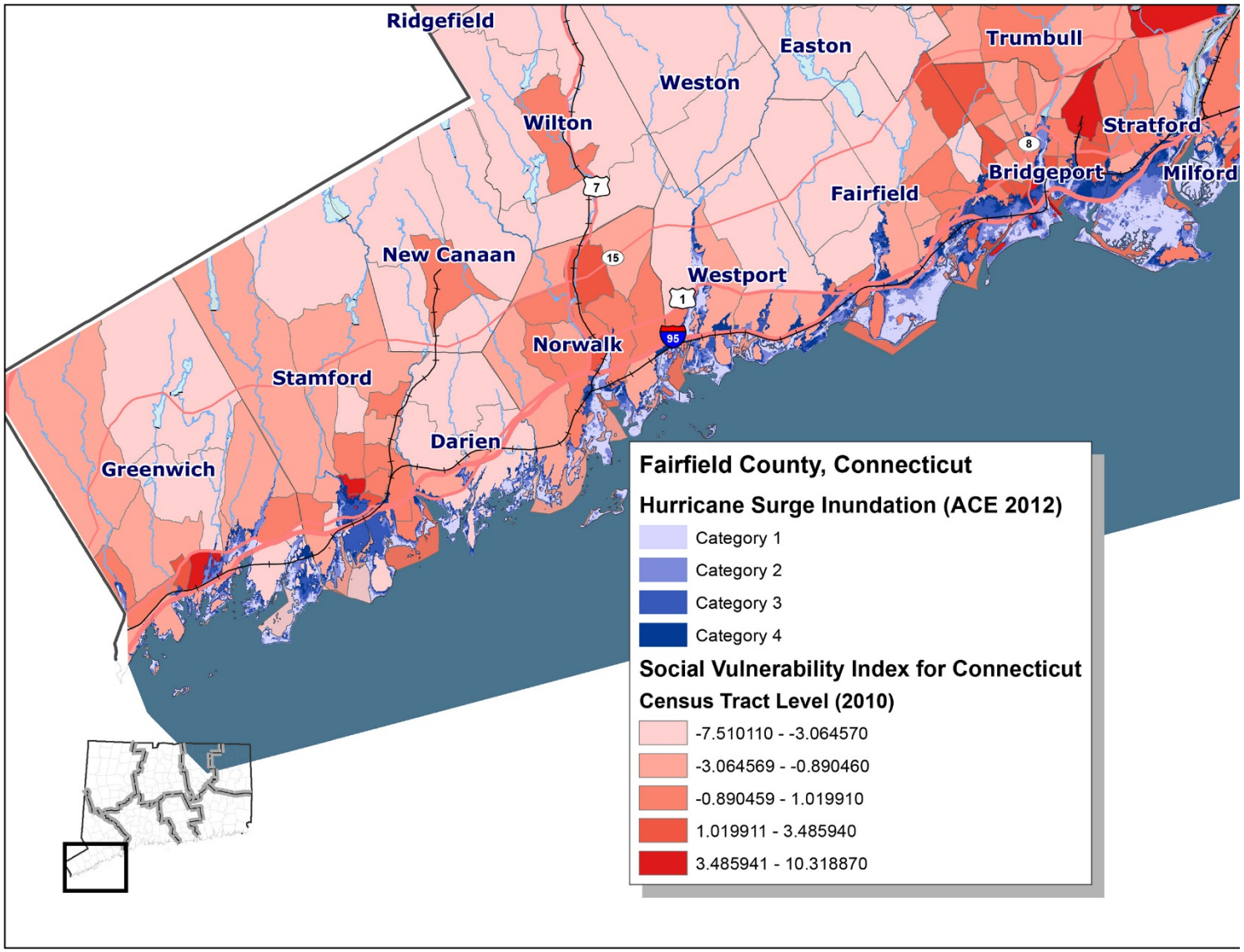


Figure 14: Social Vulnerability Index with Hurricane Surge overlay in in New Haven County

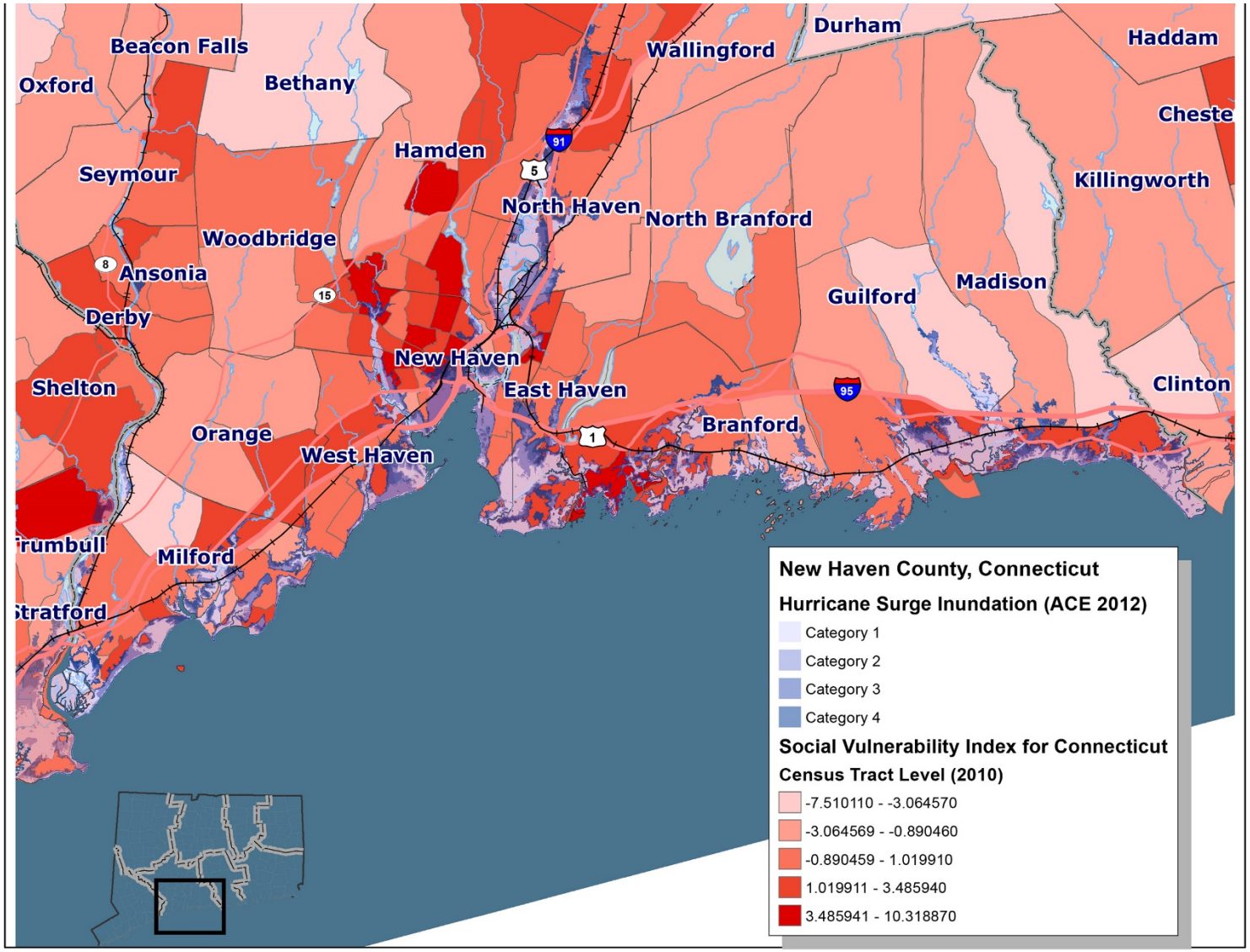
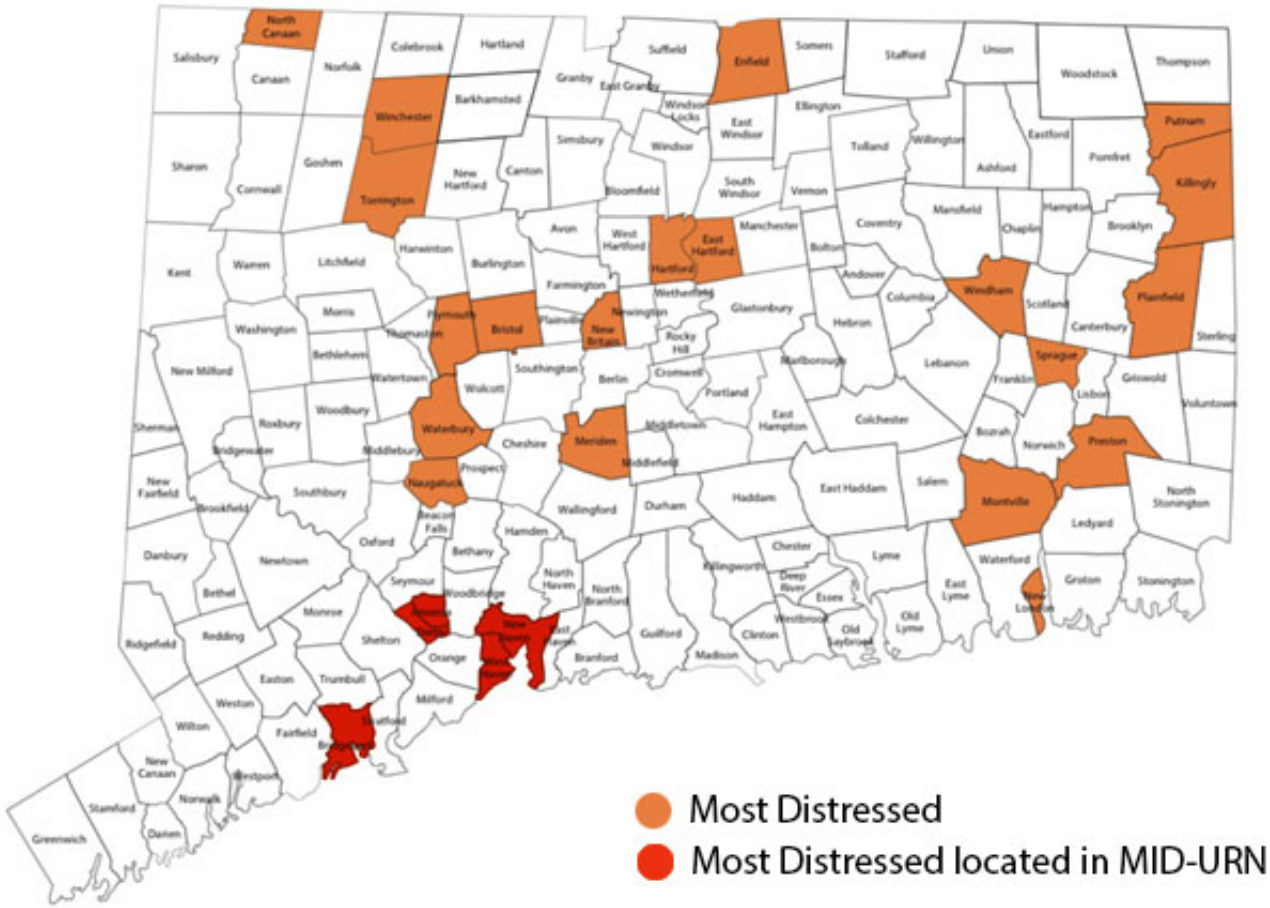


Figure 15. The most distressed 25 municipalities in the State of Connecticut as ranked by the Connecticut Department of Economic and Community Development based on high unemployment and poverty, aging housing stock and low or declining rates of growth in job creation, population, per capita income, percent of population with a high school degree and higher and per capita Adjusted Equalized Net Grand List (Connecticut Conference of Municipalities, Disproportionate Burdens: Major Challenges Facing Connecticut's Poorer Communities, November, 2014; © Copyright 2014 Connecticut Conference of Municipalities)



Legend Enlargement for Figures 16-30

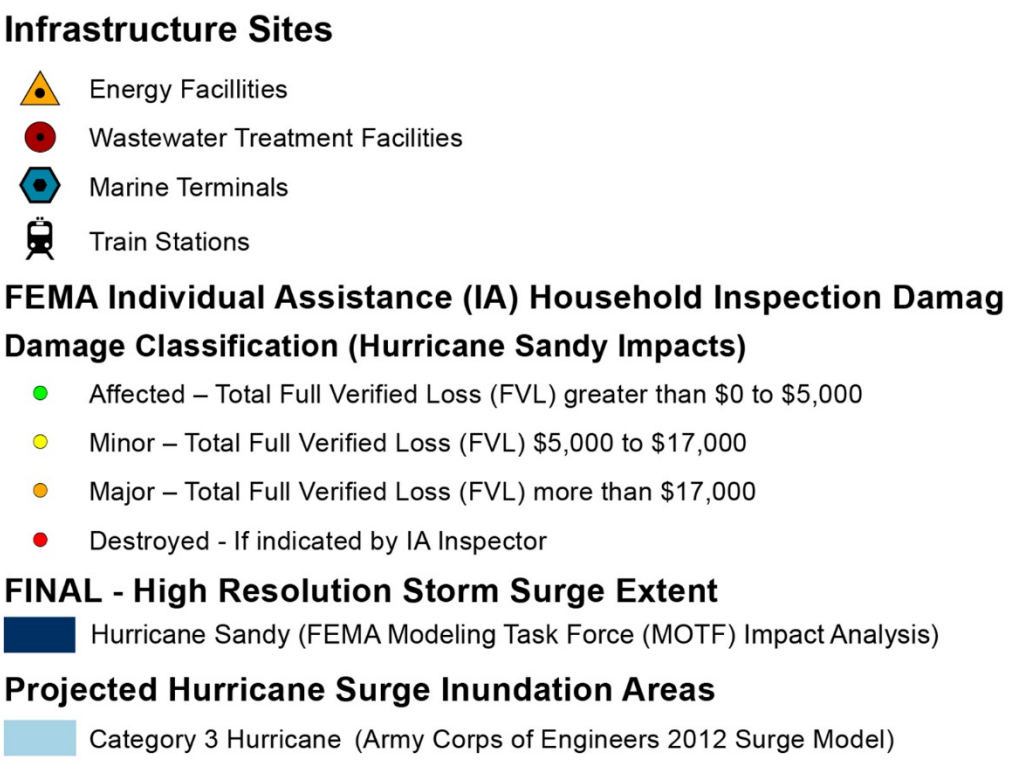


Figure 16: Hurricane Sandy and Anticipated Category 3 Inundation Town of Greenwich

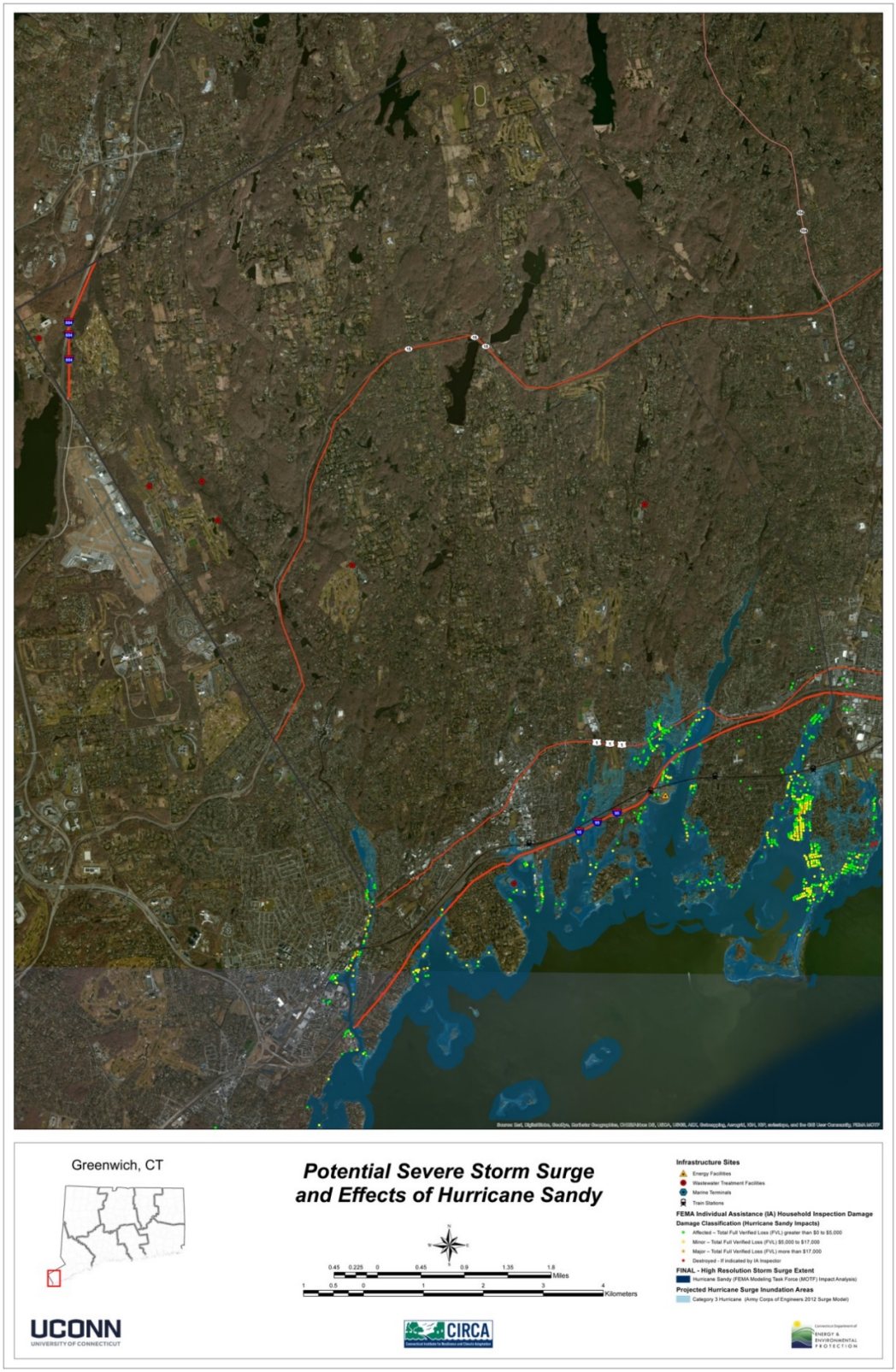


Figure 17: Hurricane Sandy and Anticipated Category 3 Inundation City of Stamford

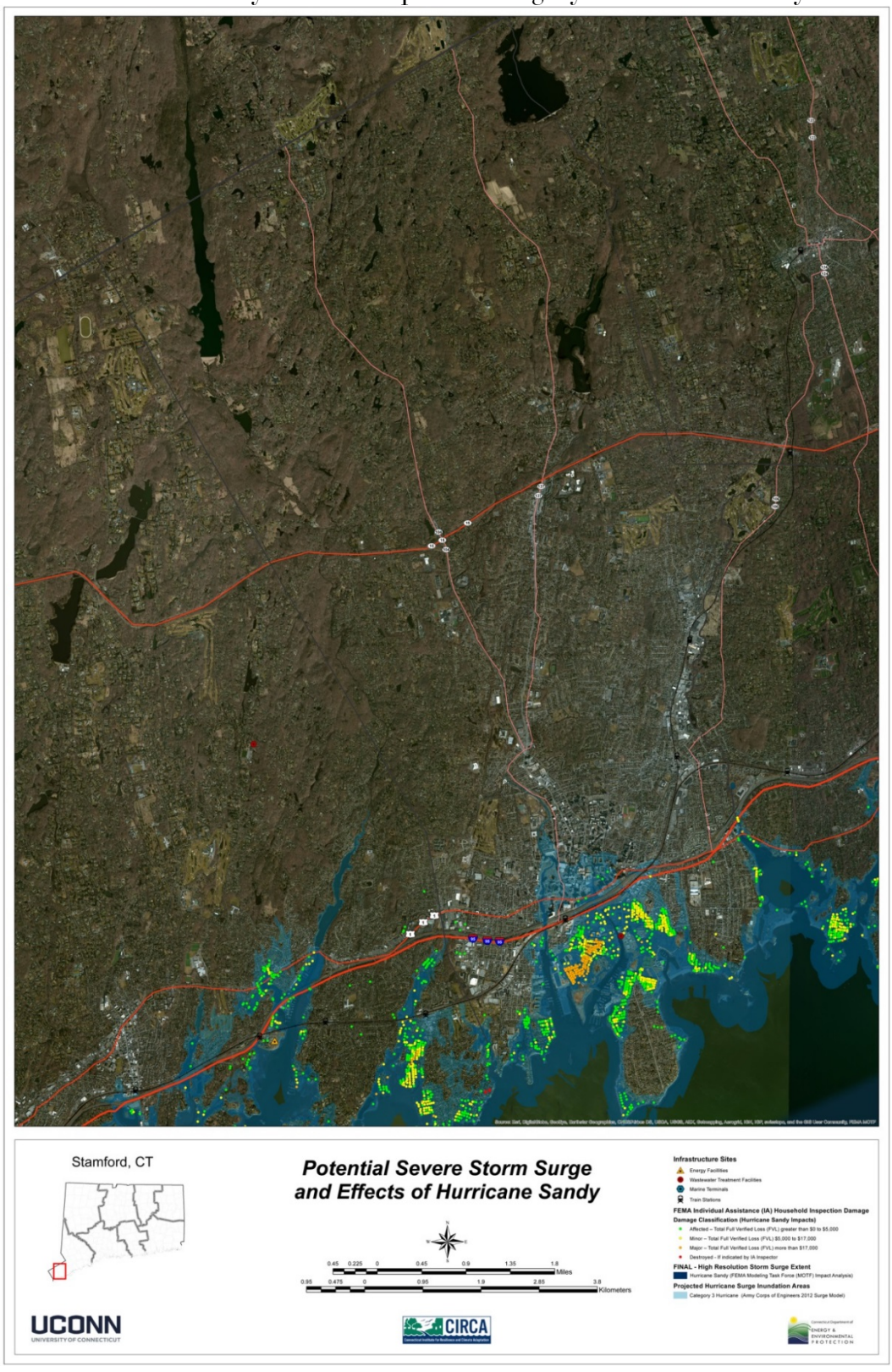


Figure 18: Hurricane Sandy and Anticipated Category 3 Inundation Town of Darien

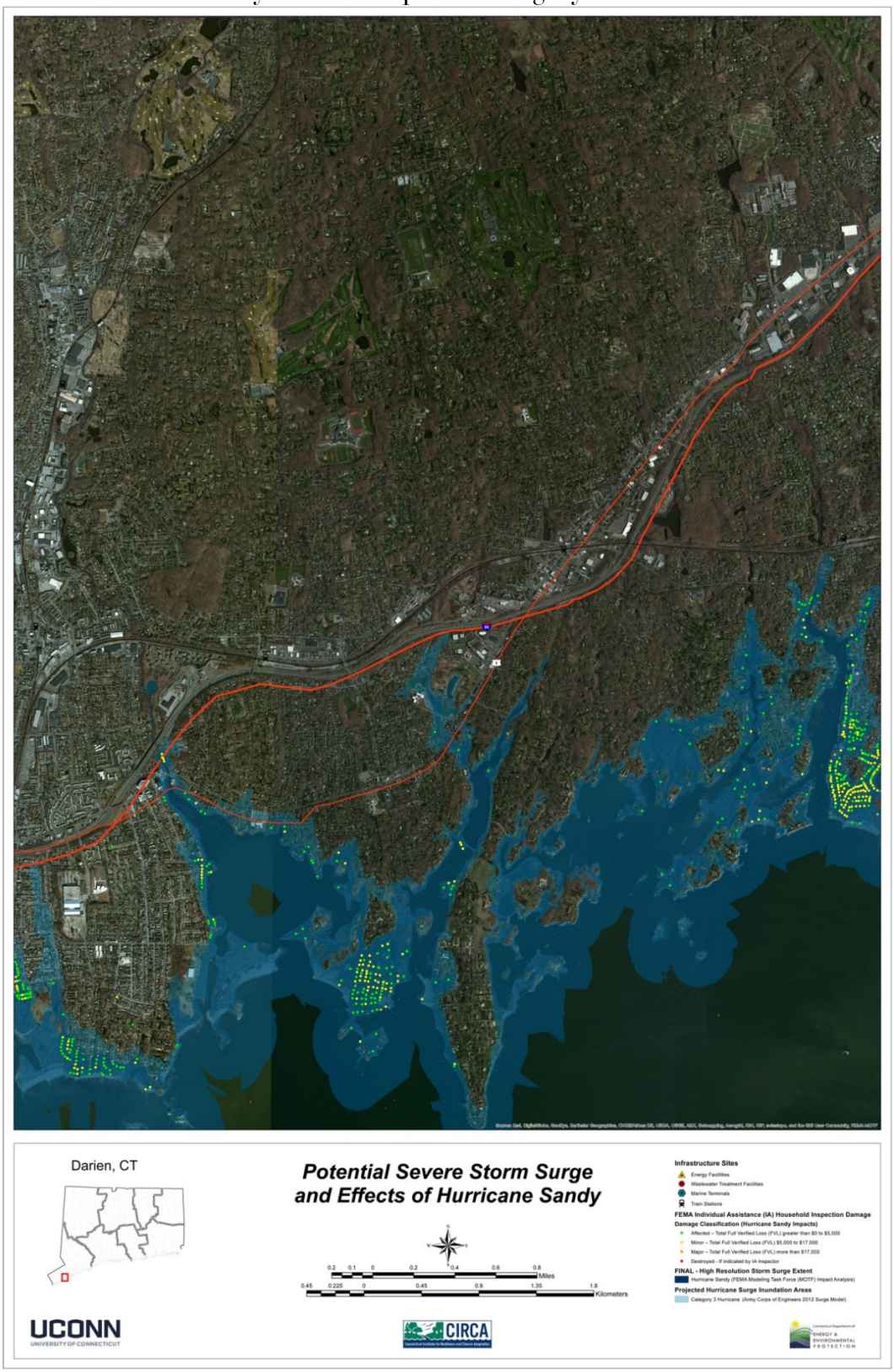


Figure 19: Hurricane Sandy and Anticipated Category 3 Inundation City of Norwalk

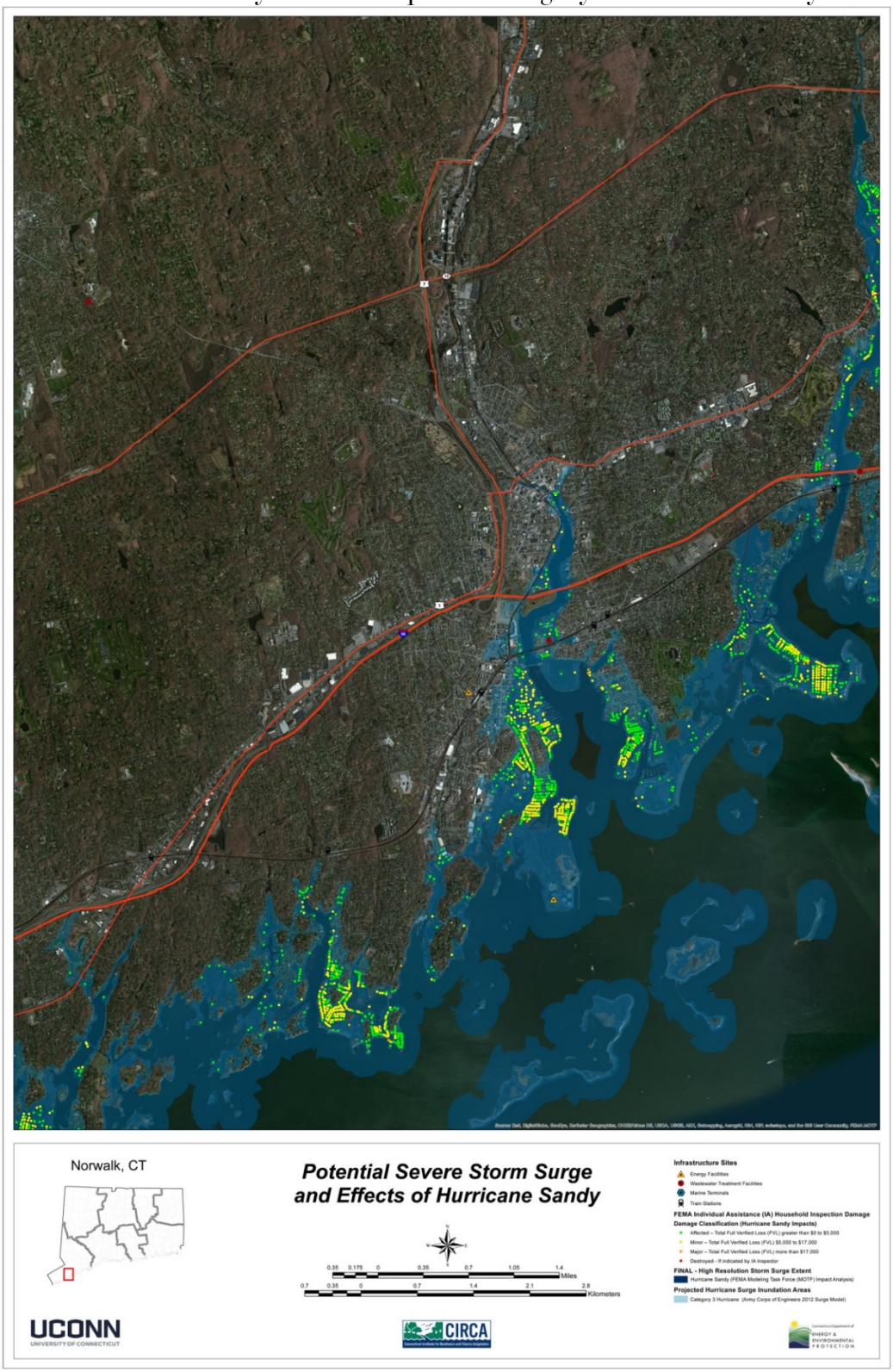


Figure 20: Hurricane Sandy and Anticipated Category 3 Inundation Town of Westport

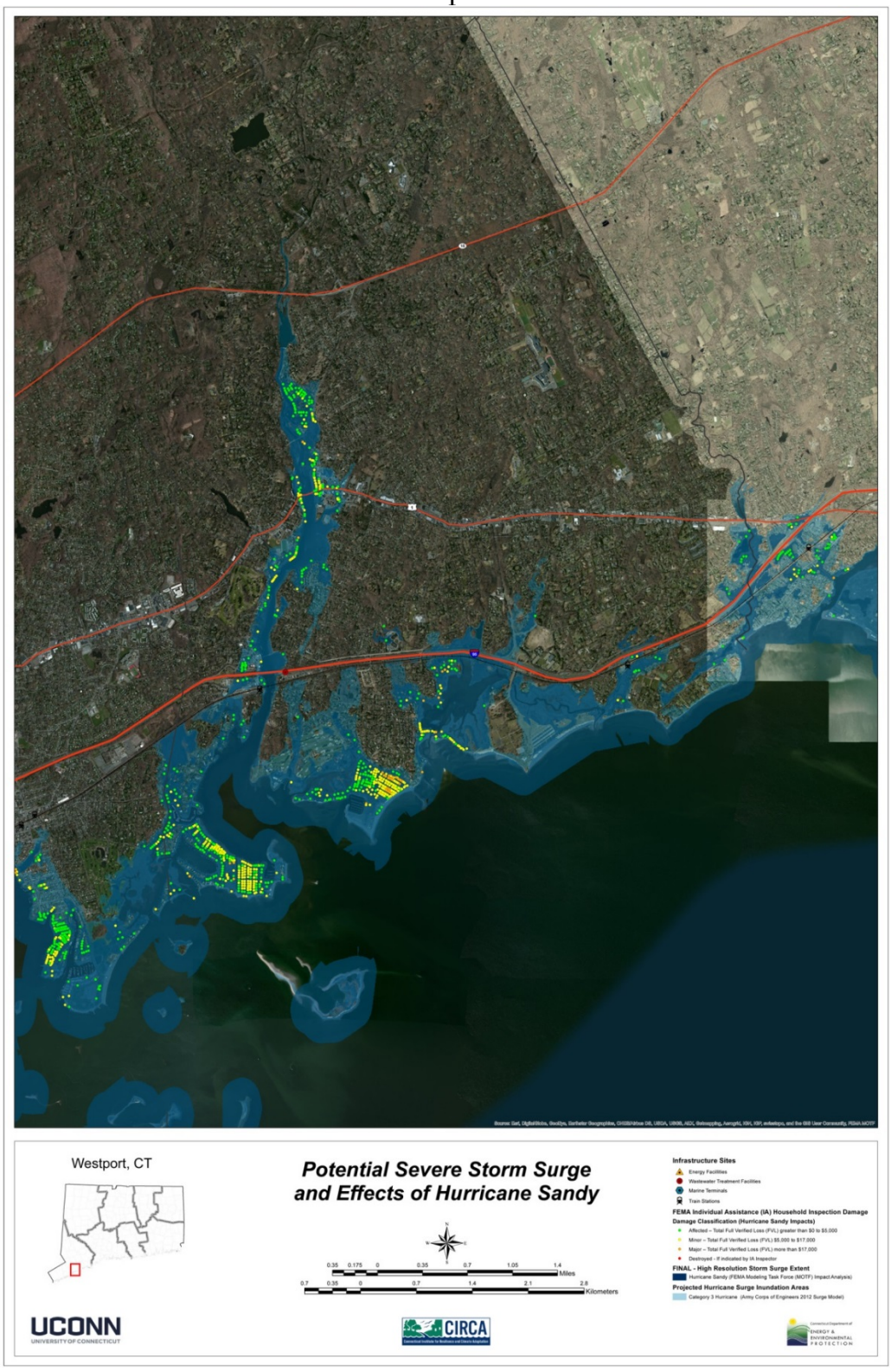


Figure 21: Hurricane Sandy and Anticipated Category 3 Inundation Town of Fairfield

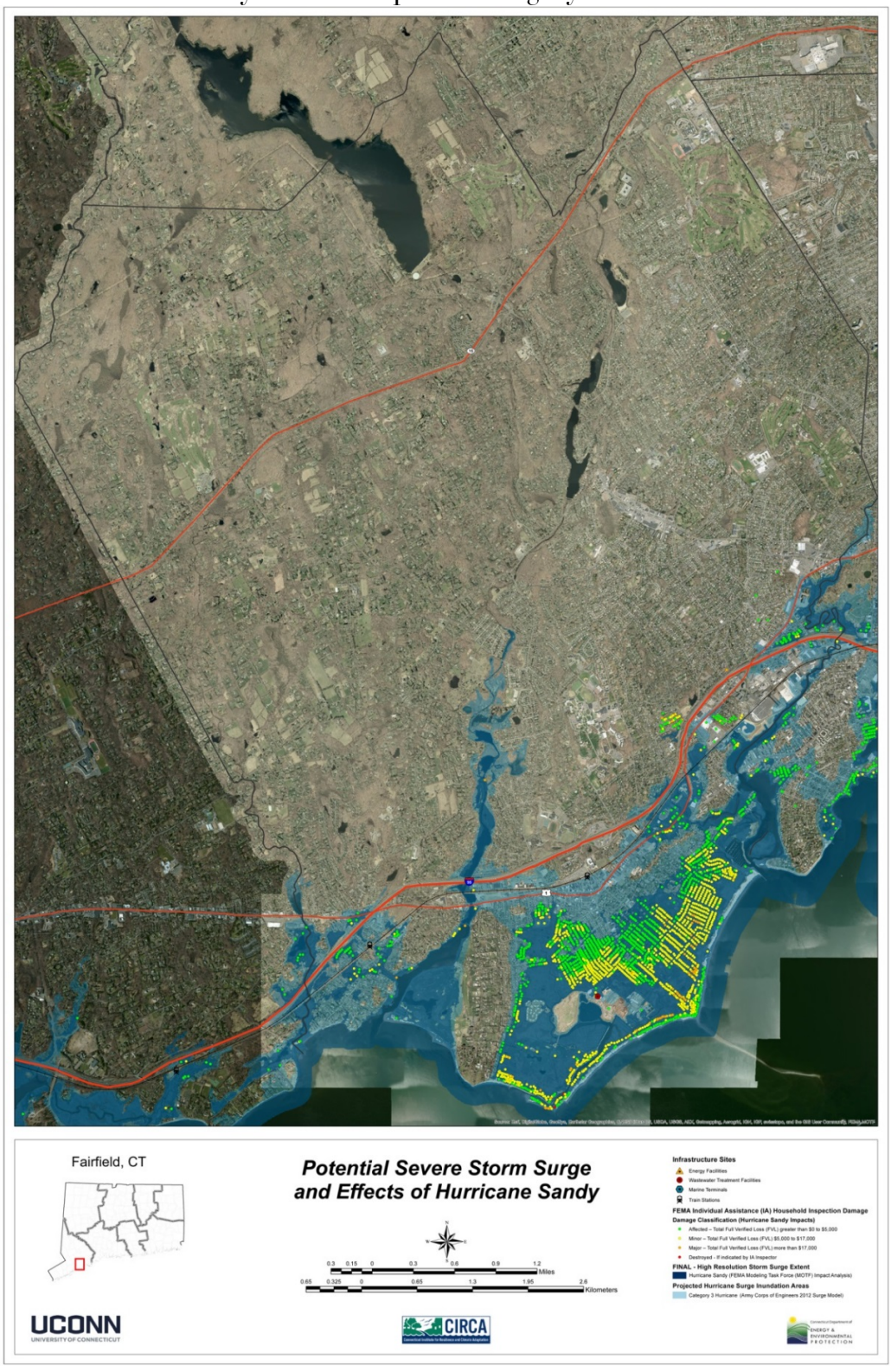


Figure 22: Hurricane Sandy and Anticipated Category 3 Inundation City of Bridgeport

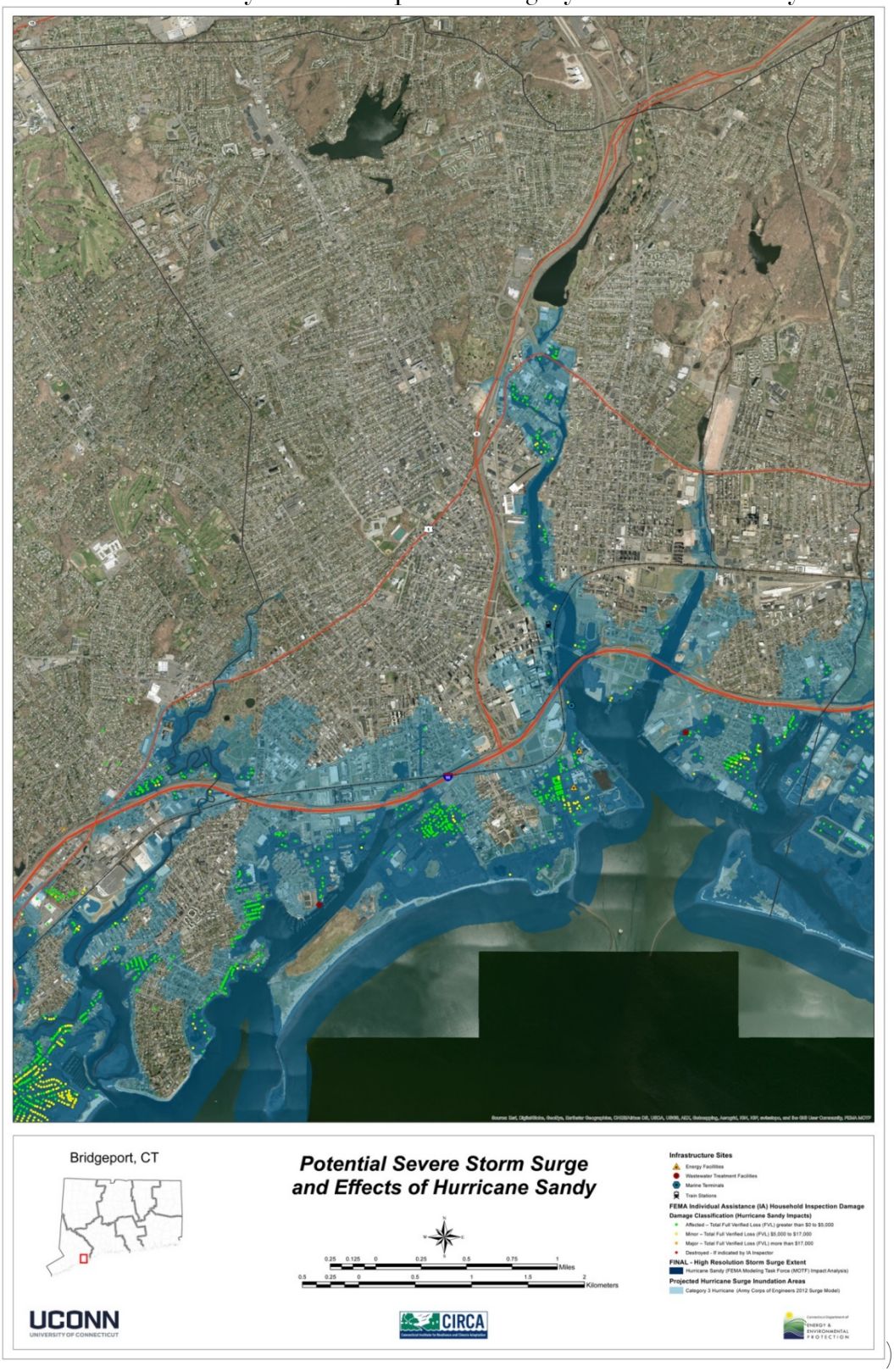


Figure 23: Hurricane Sandy and Anticipated Category 3 Inundation Town of Stratford

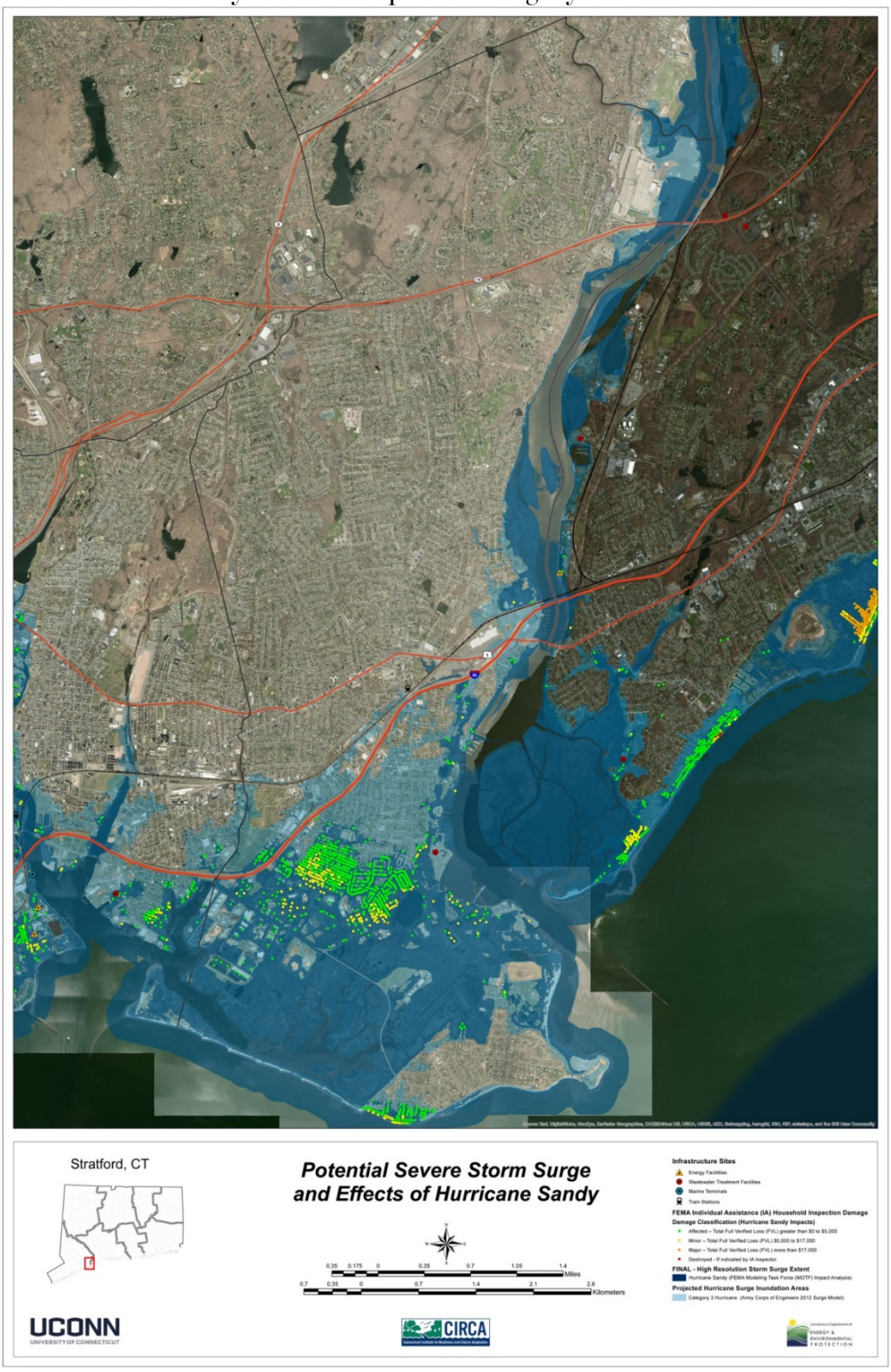


Figure 24: Hurricane Sandy and Anticipated Category 3 Inundation City of Milford

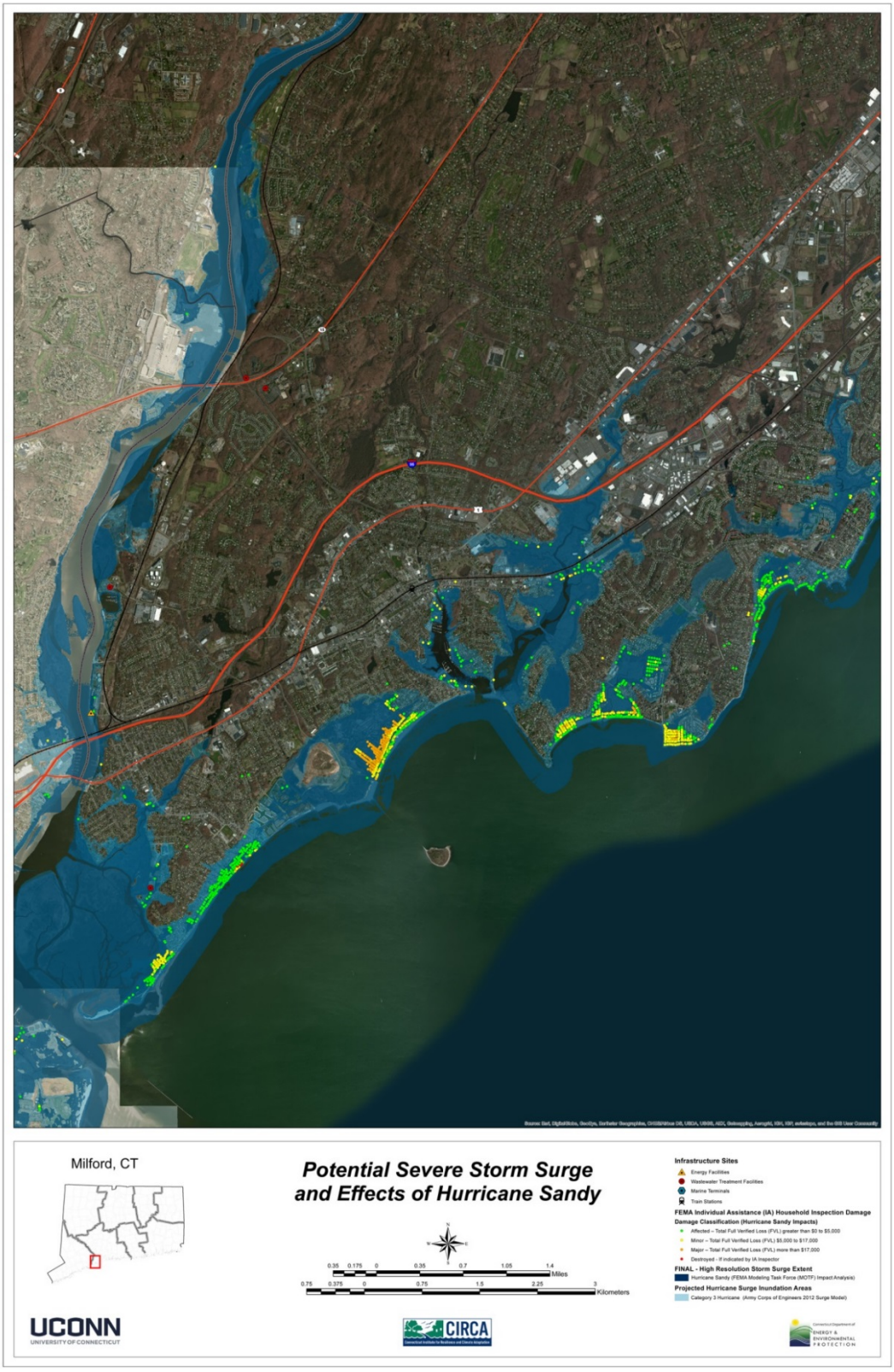


Figure 25: Hurricane Sandy and Anticipated Category 3 Inundation
City of West Haven



Figure 26: Hurricane Sandy and Anticipated Category 3 Inundation City of New Haven

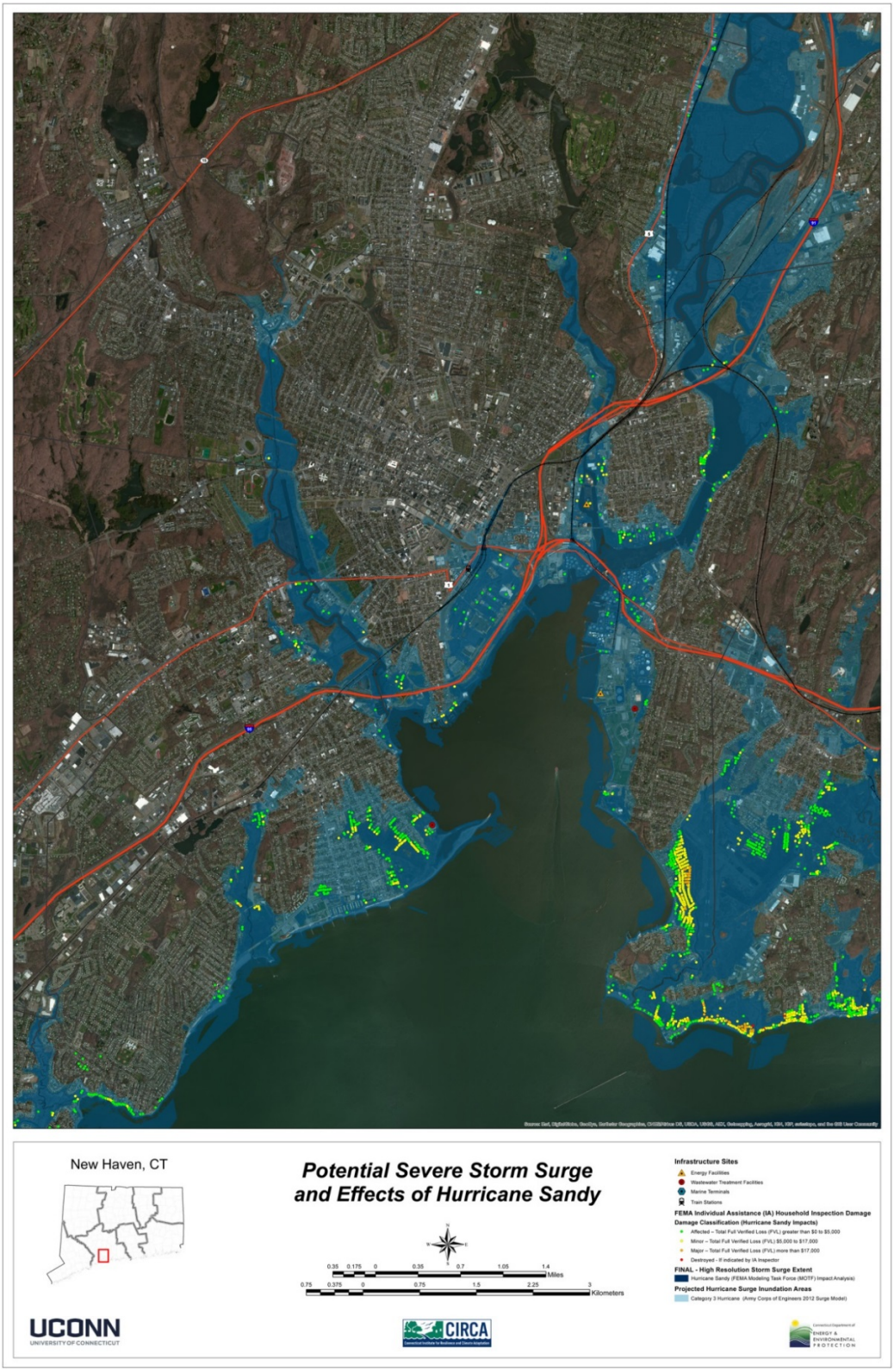


Figure 27: Hurricane Sandy and Anticipated Category 3 Inundation Town of East Haven

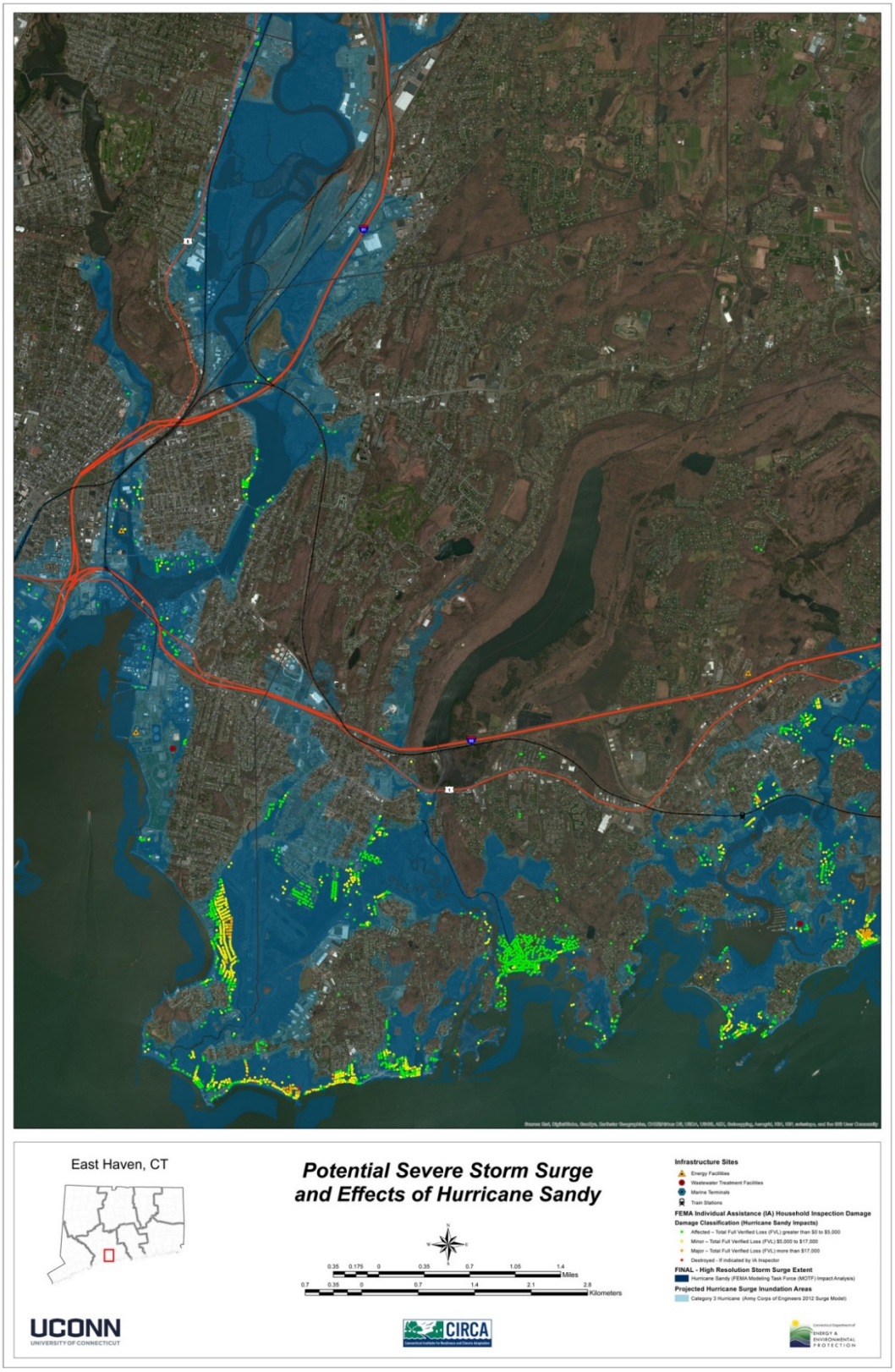


Figure 28: Hurricane Sandy and Anticipated Category 3 Inundation Town of Branford

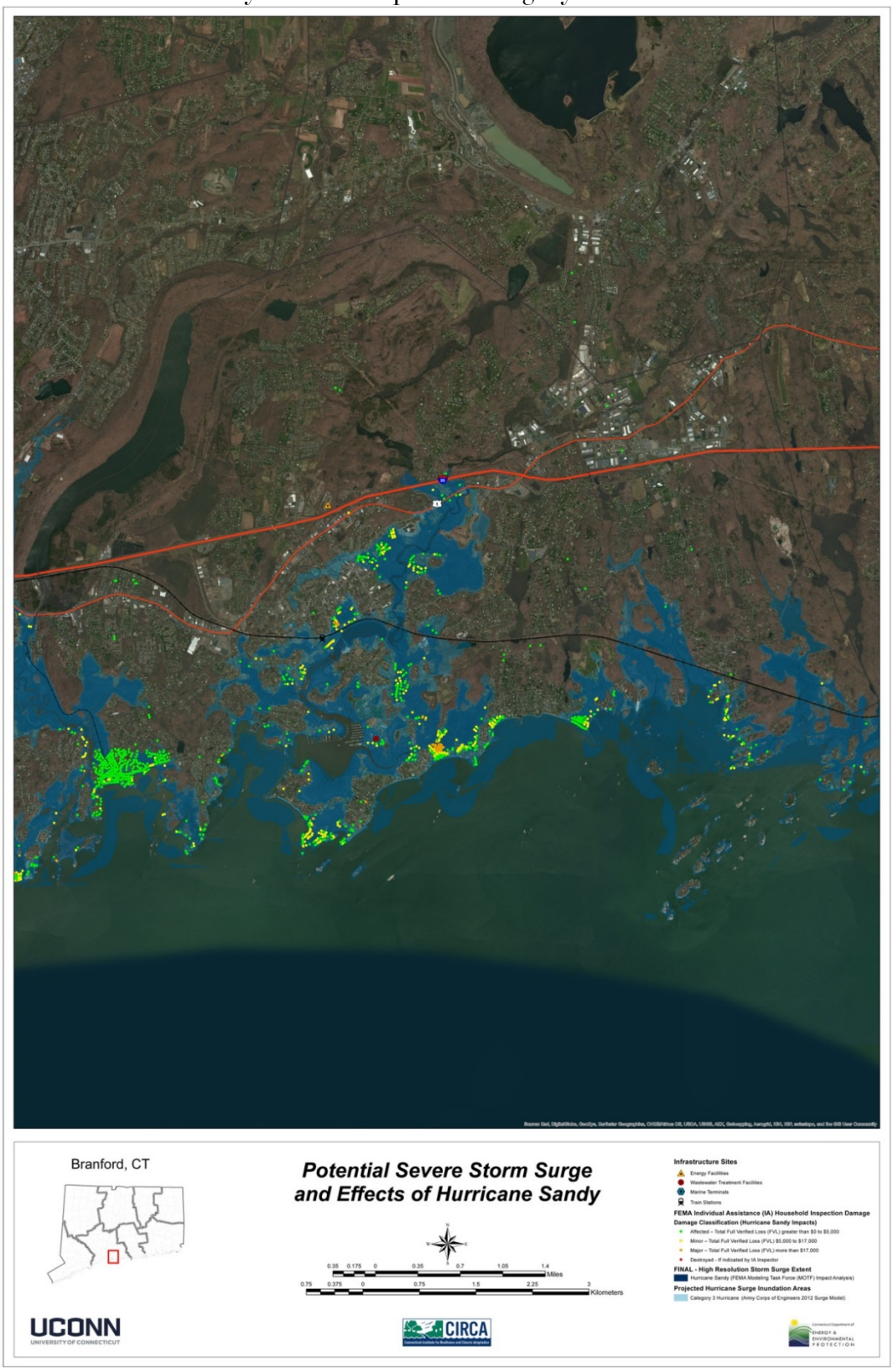


Figure 29: Hurricane Sandy and Anticipated Category 3 Inundation Town of Guilford

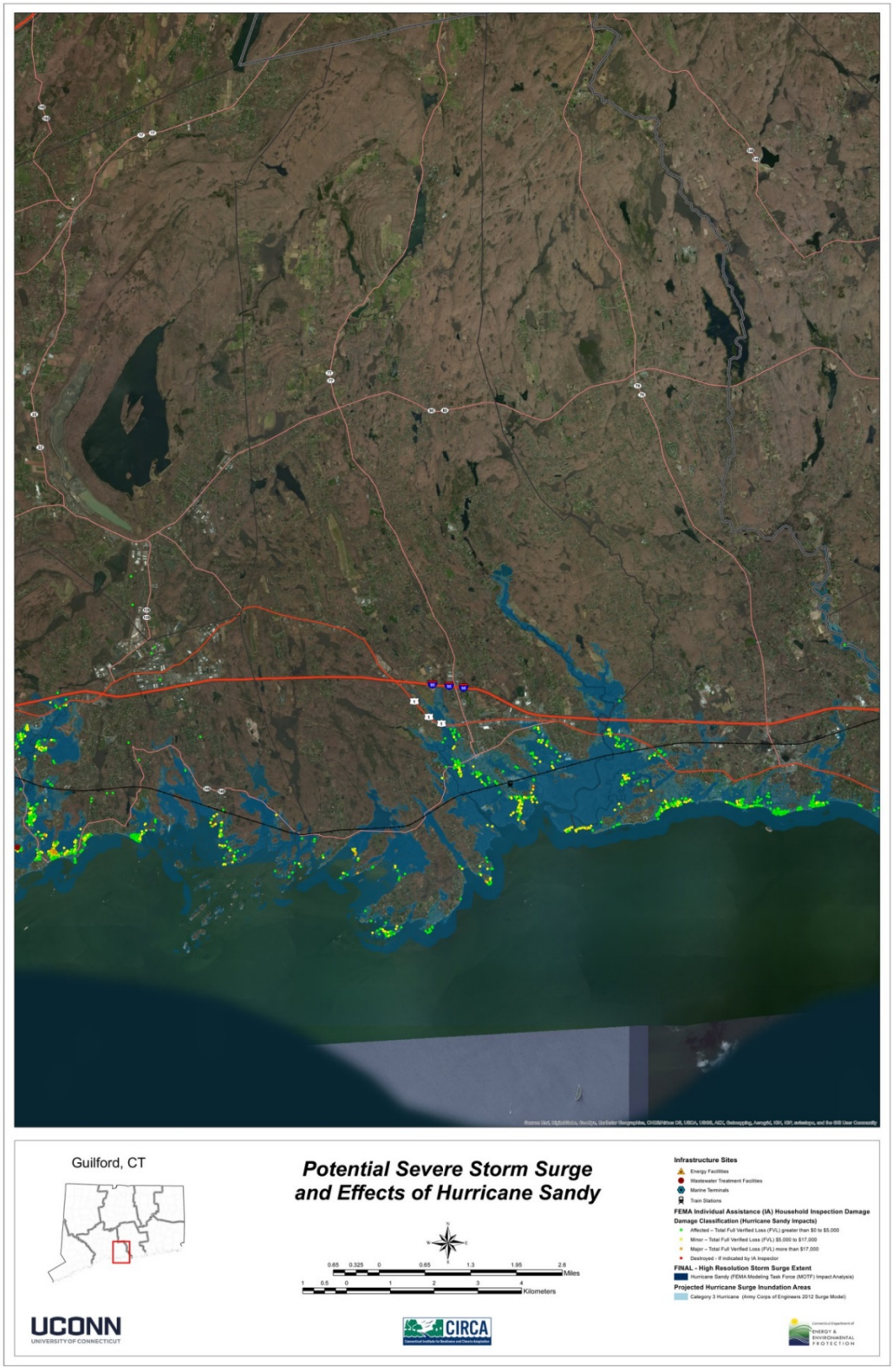


Figure 30: Hurricane Sandy and Anticipated Category 3 Inundation Town of Madison

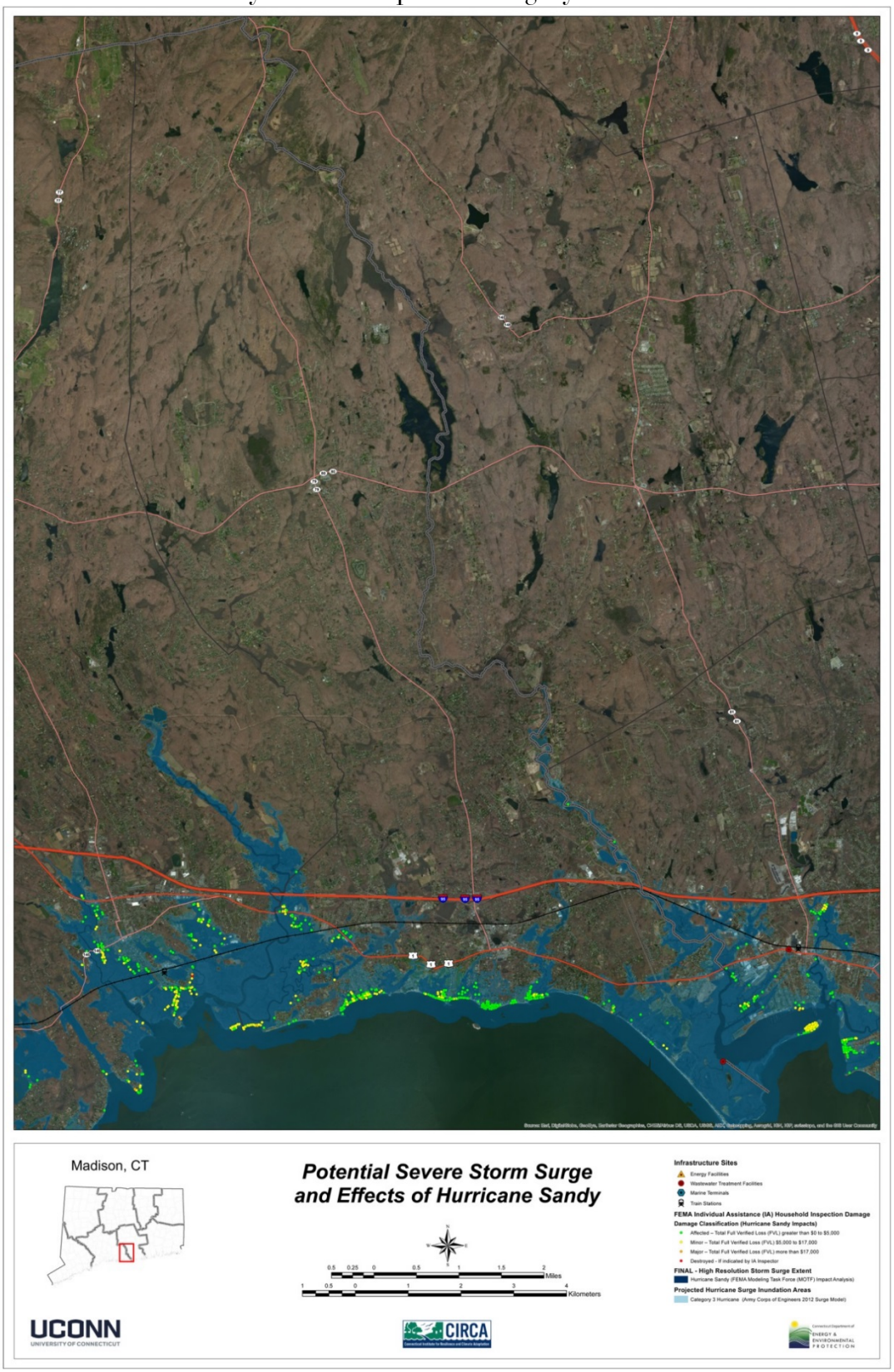


Figure 31: An example of an area expected to be affected by sea level rise (12")

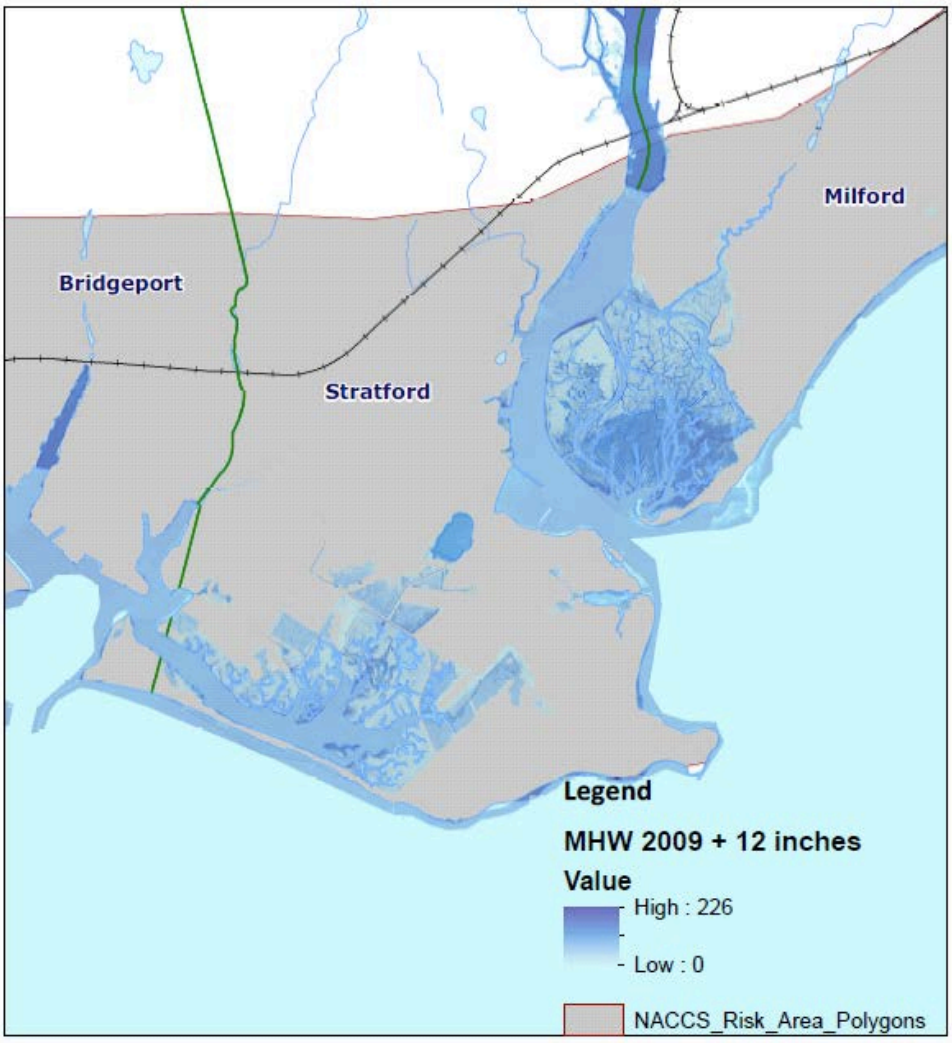


Figure 32: FEMA Flood Hazard Areas for Fairfield County

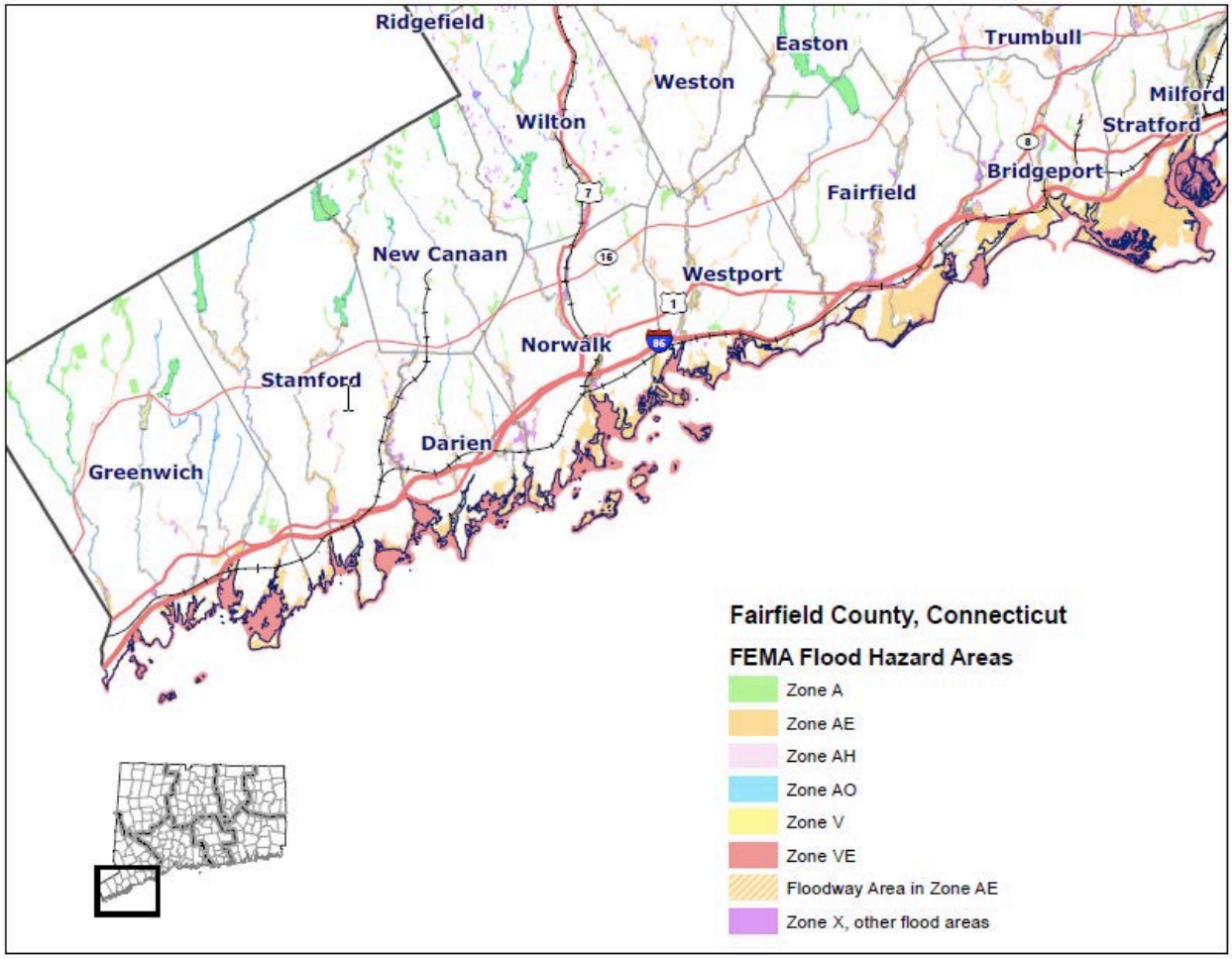


Figure 33: FEMA Flood Hazard Areas for New Haven County

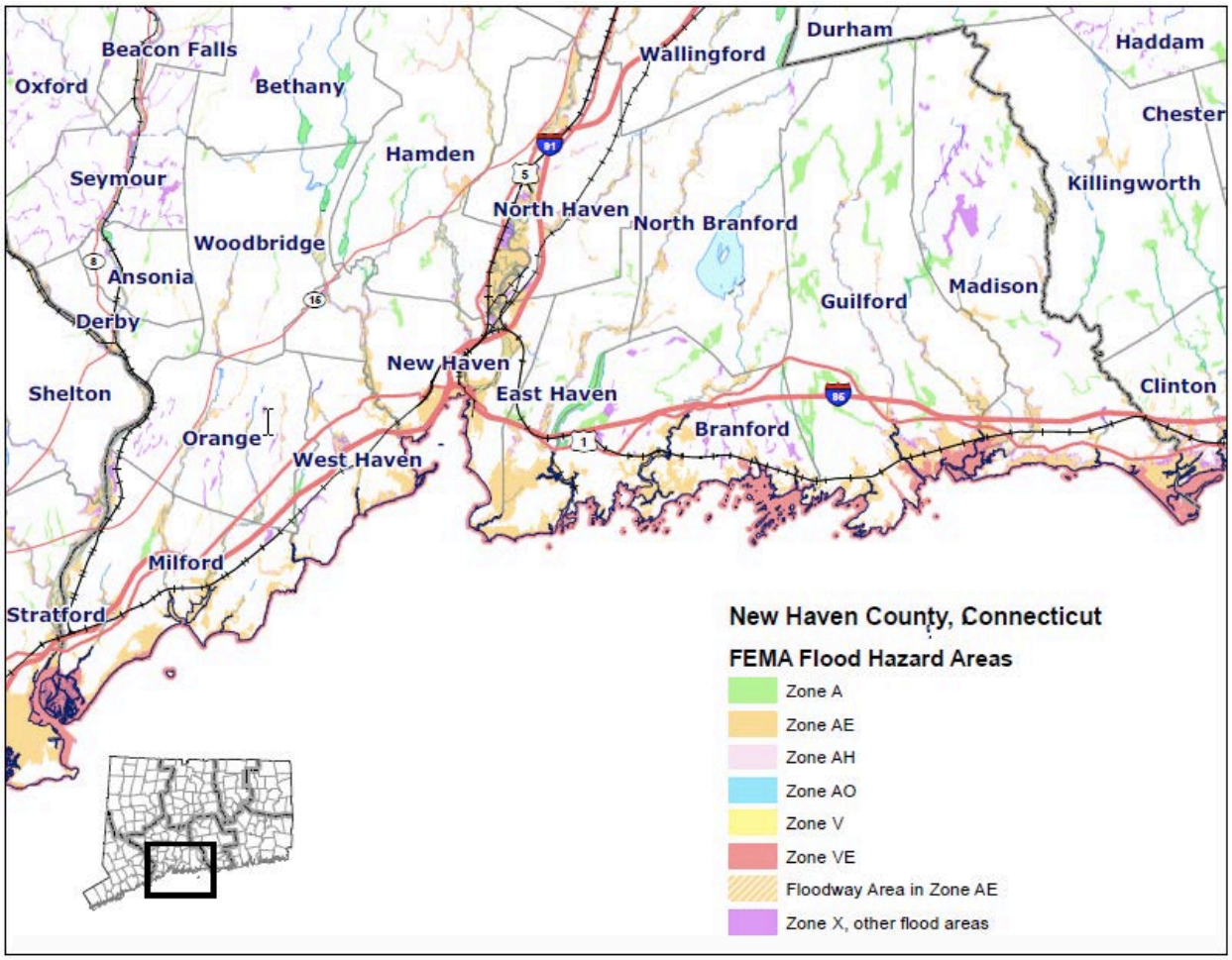


Figure 34: Hurricane Inundation Areas as predicted by the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model in Fairfield County

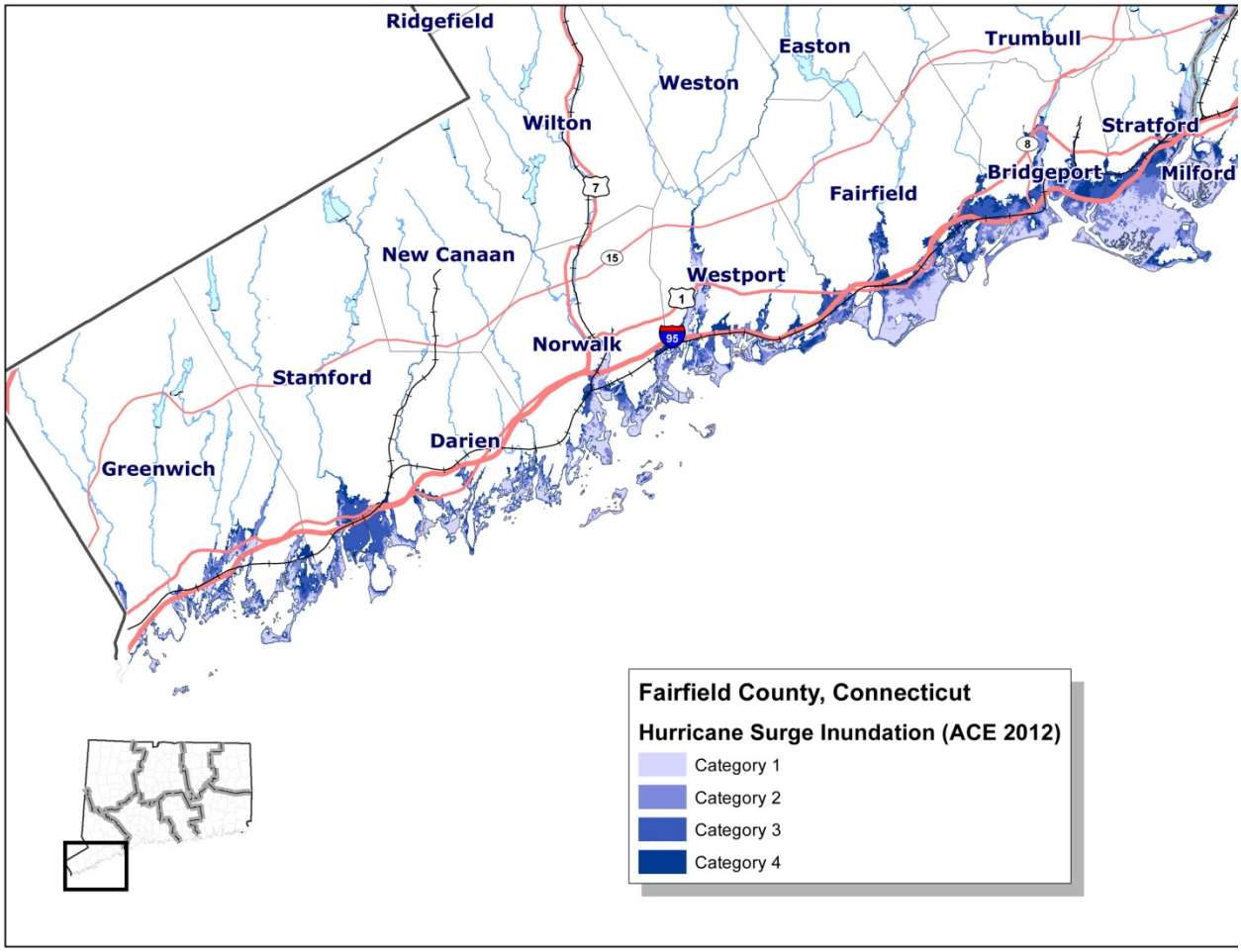


Figure 35: Hurricane Inundation Areas as predicted by the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model in New Haven County

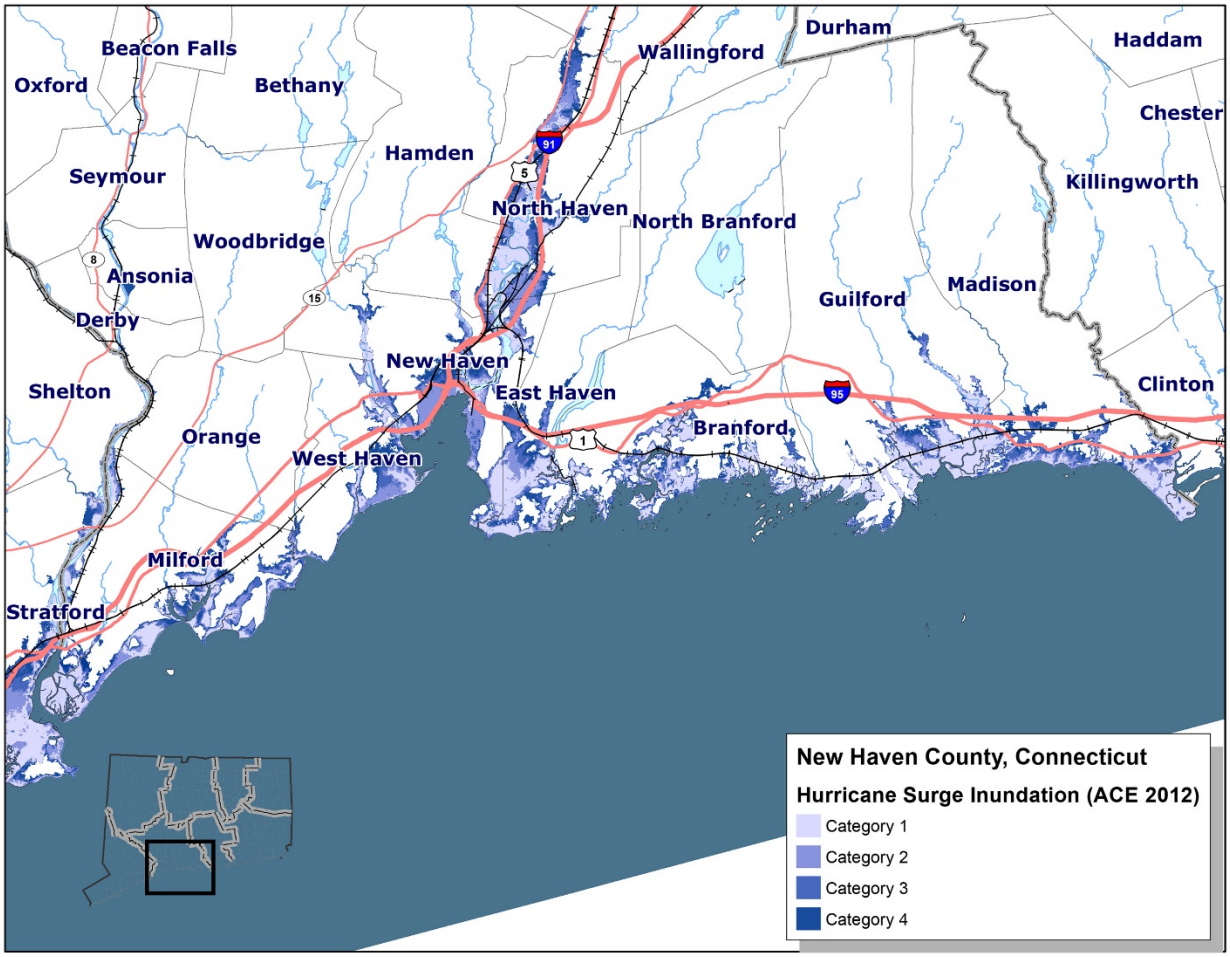


Figure 36. Observed Change in Very Heavy Precipitation. (Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville, 2014: Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19-67. doi:10.7930/J0KW5CXT

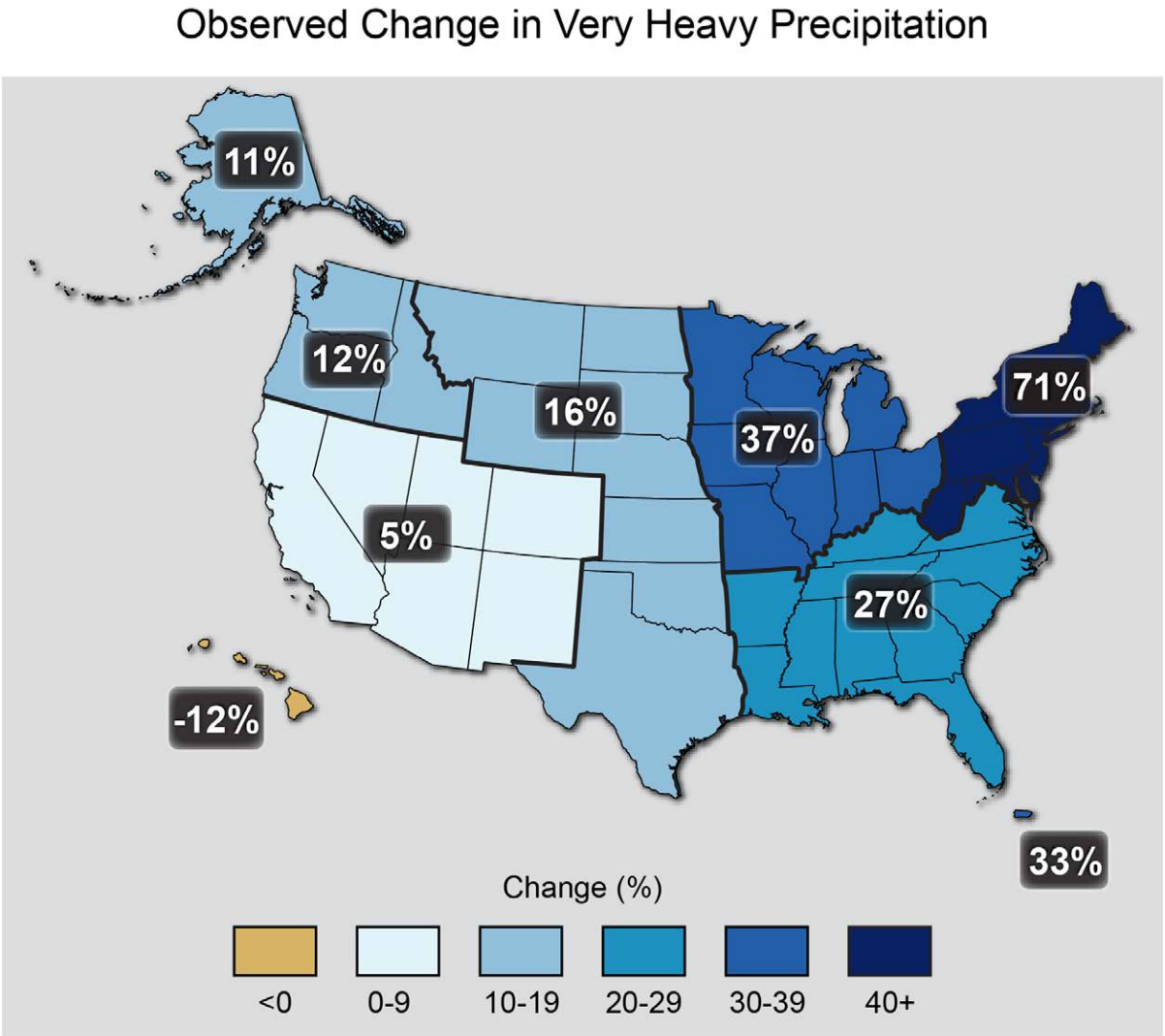


Figure 37: Mean Sea Level trend for Bridgeport, CT

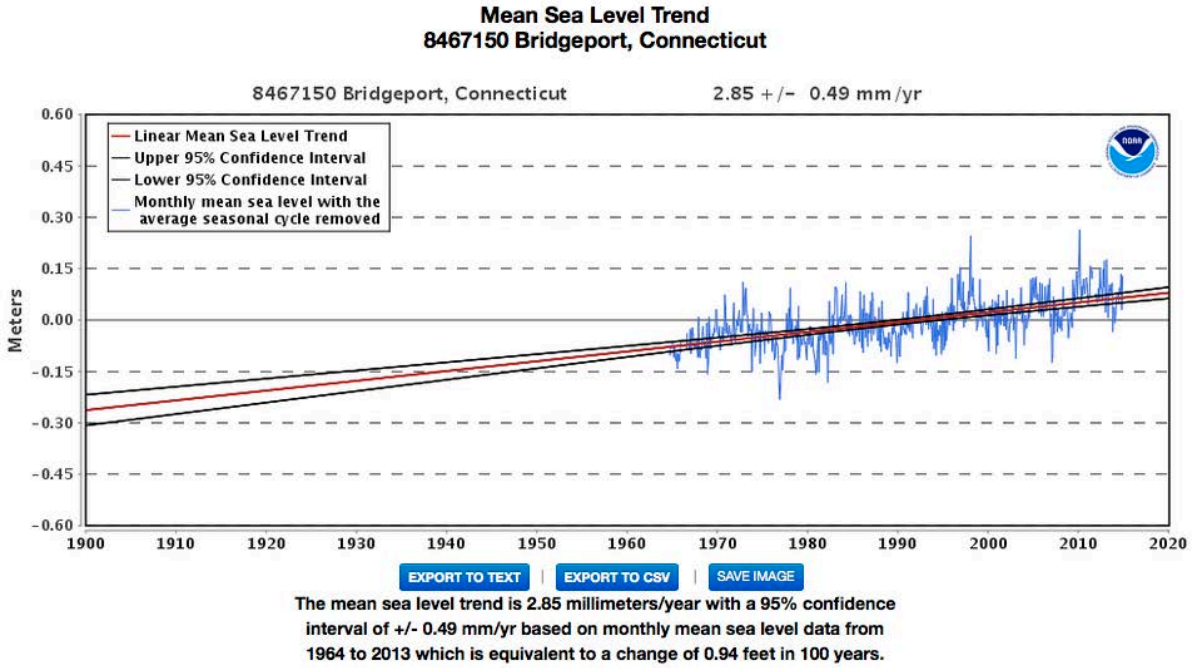


Figure 38: Army Corps of Engineers Environmental Risk Index for Fairfield County

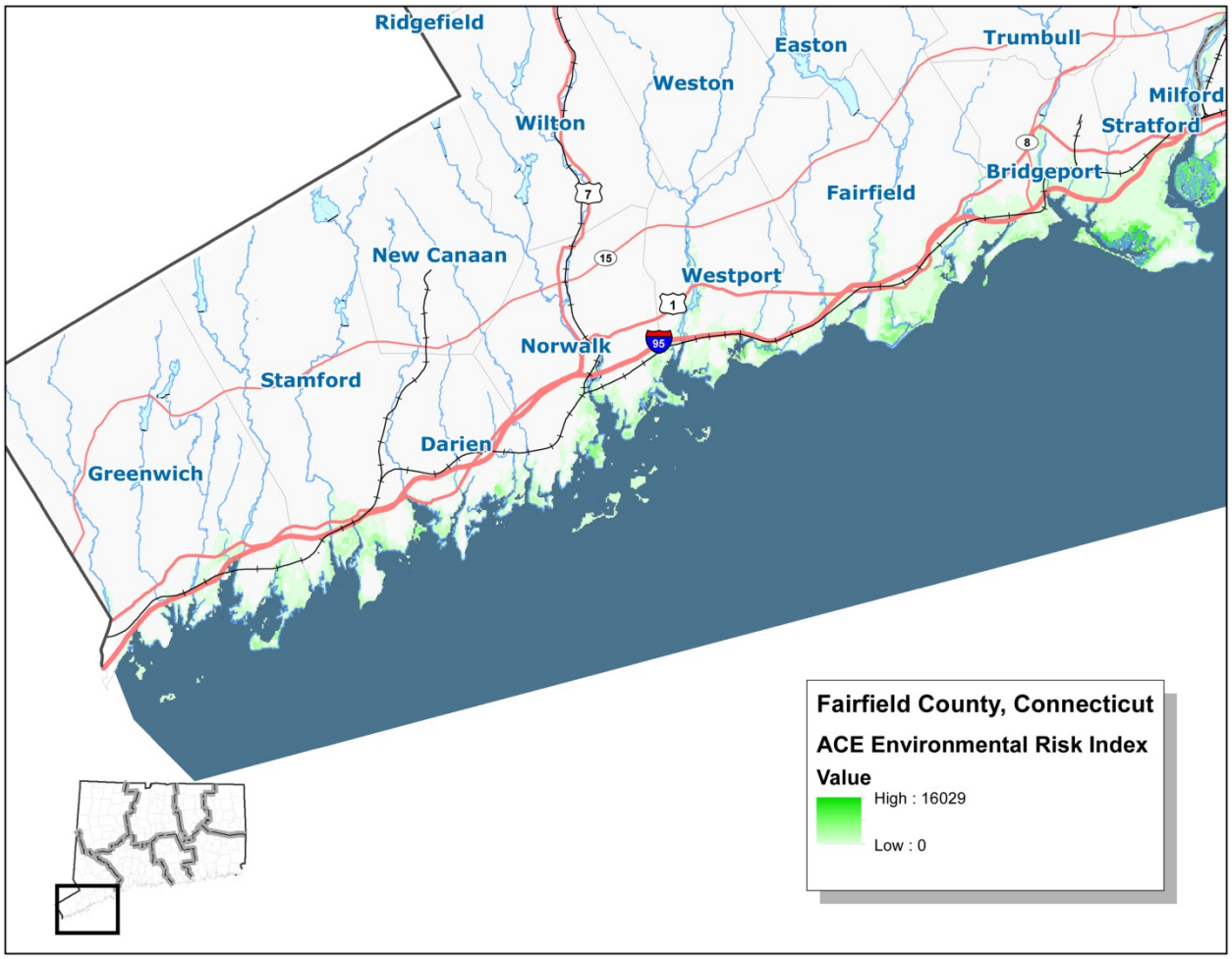


Figure 39: Army Corps of Engineers Environmental Risk Index for New Haven County

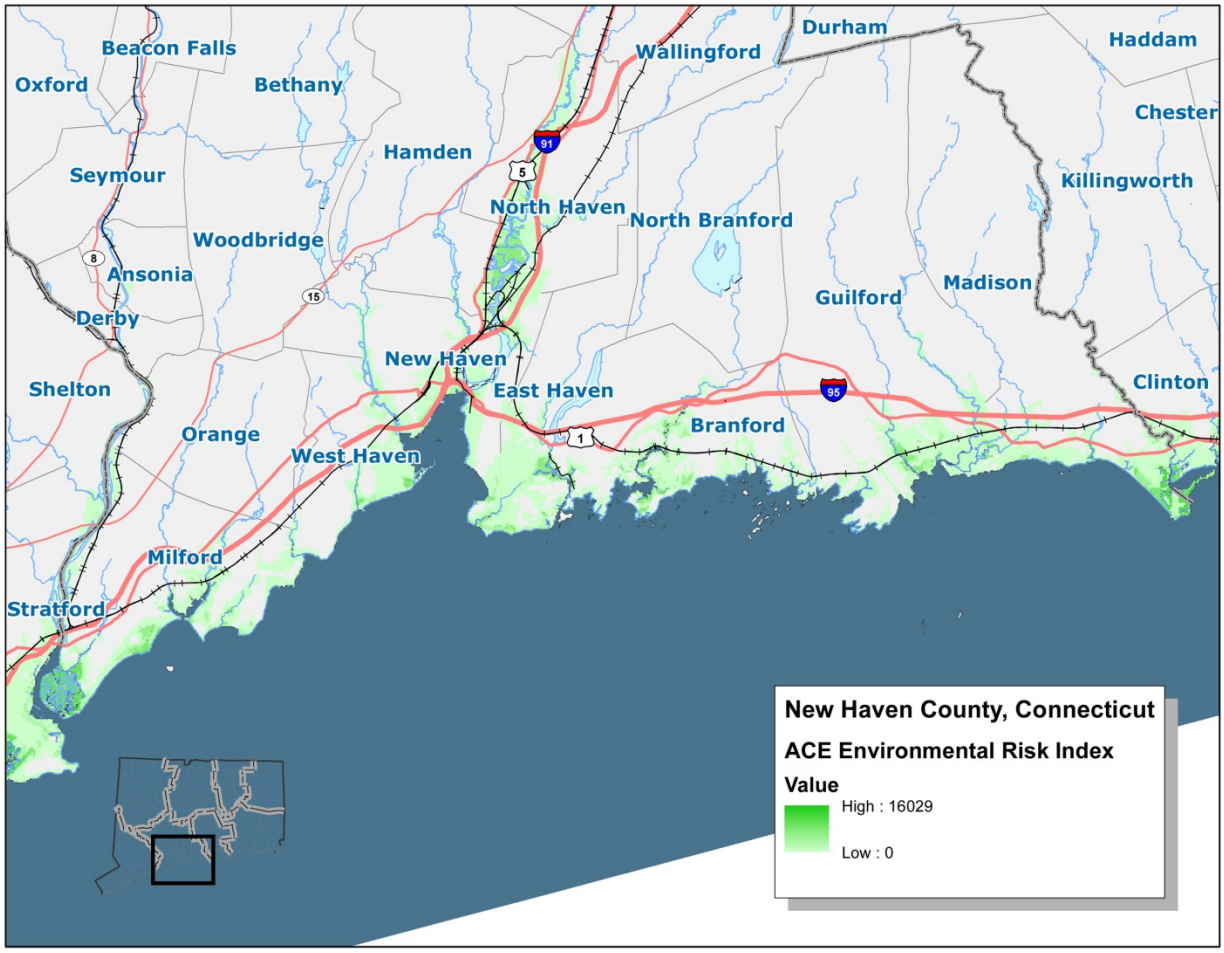


Figure 40: Army Corps of Engineers Social Vulnerability Risk Index for Fairfield County

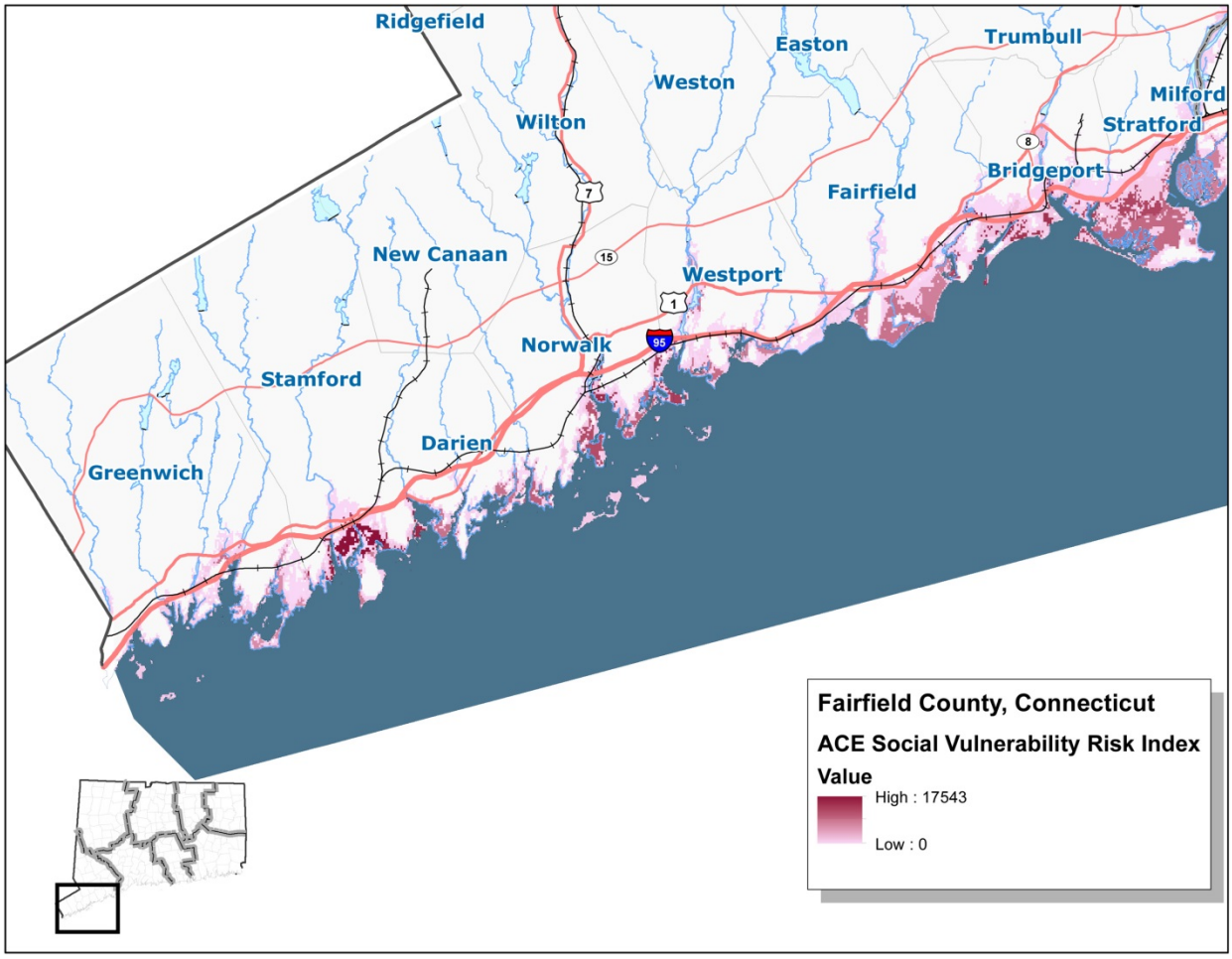


Figure 41: Army Corps of Engineers Social Vulnerability Risk Index for New Haven County

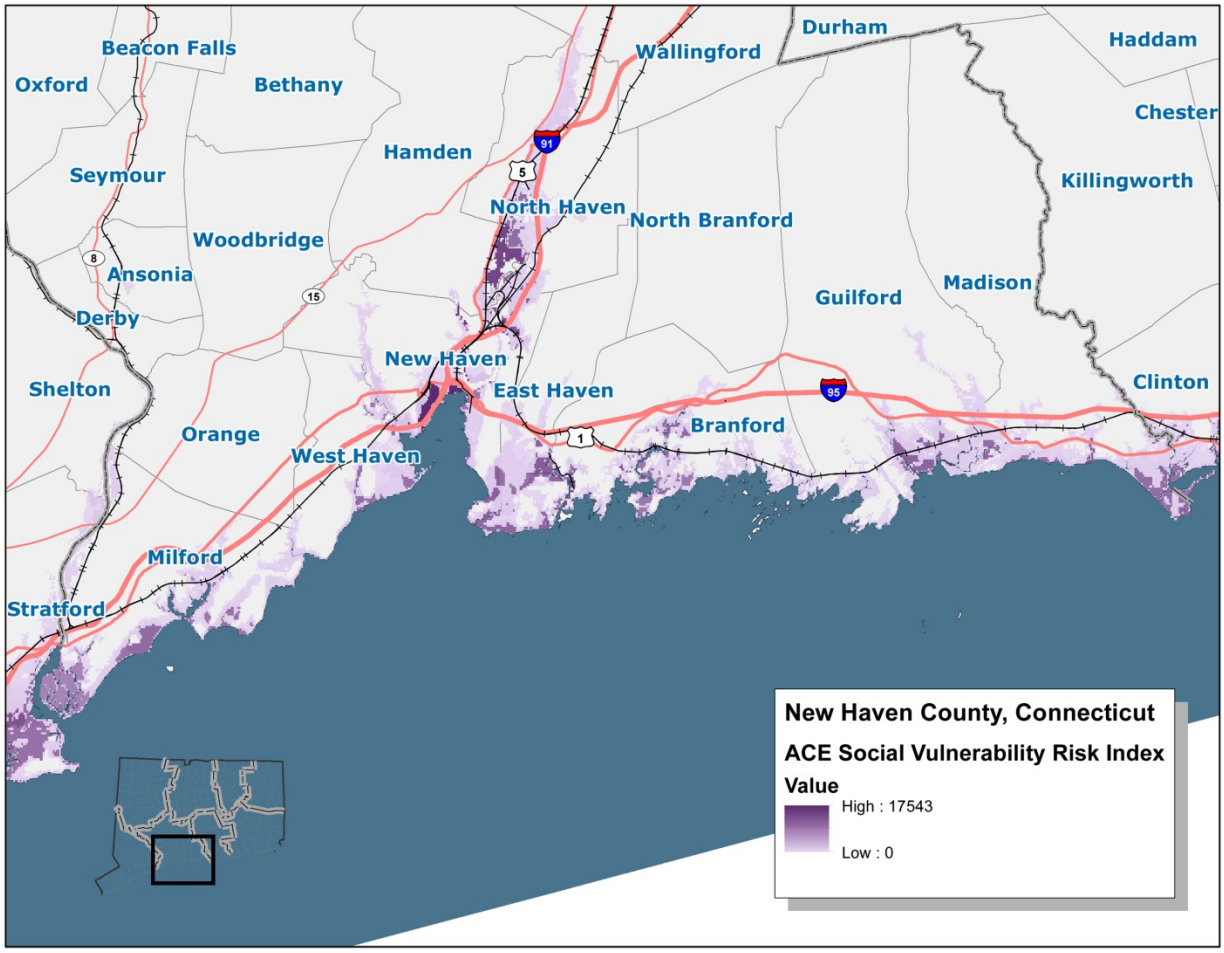


Figure 42: Army Corps of Engineers Infrastructure Risk Index for Fairfield County

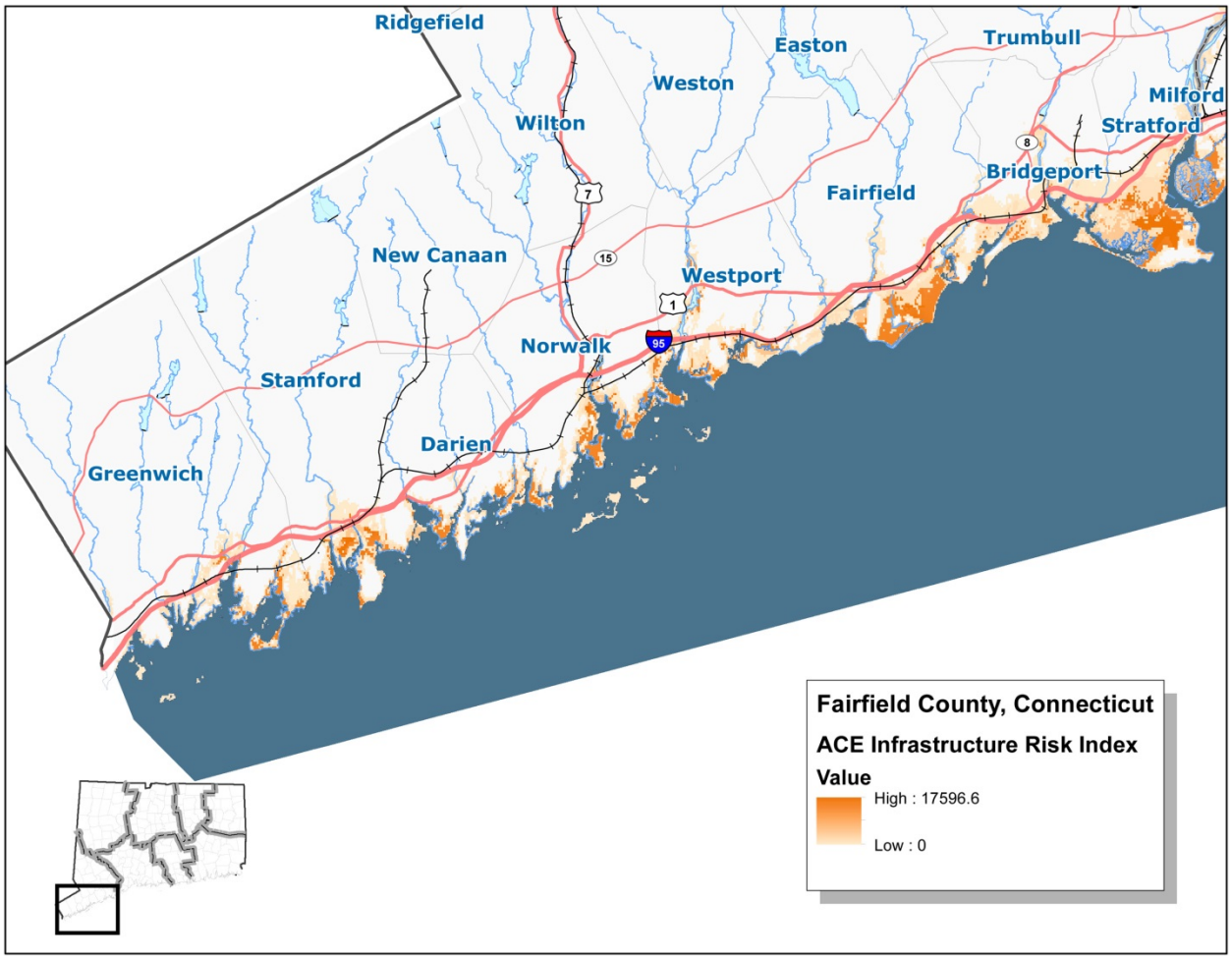


Figure 43: Army Corps of Engineers Infrastructure Risk Index for New Haven County

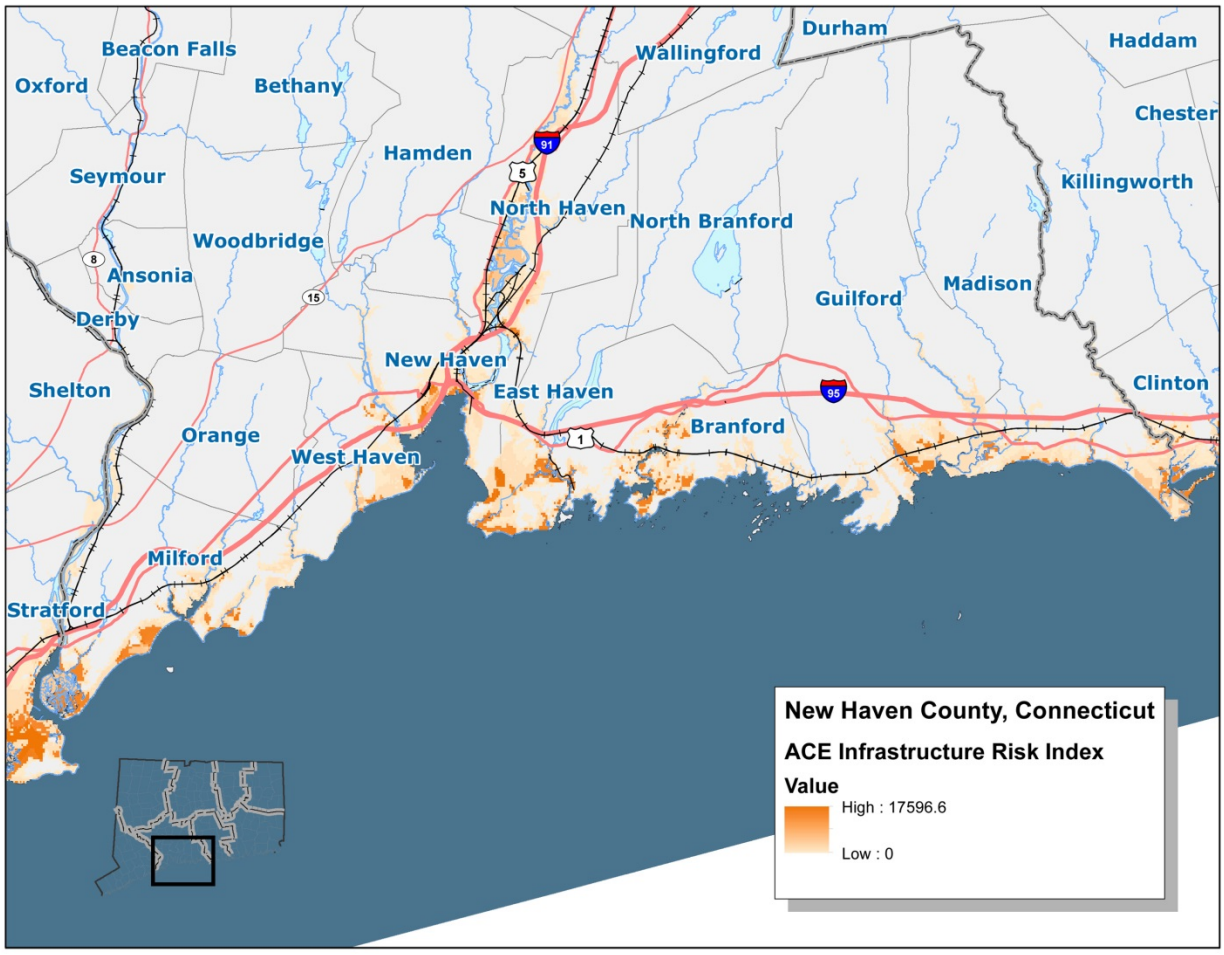


Figure 44: Army Corps of Engineers Composite Risk Index Value for Fairfield County

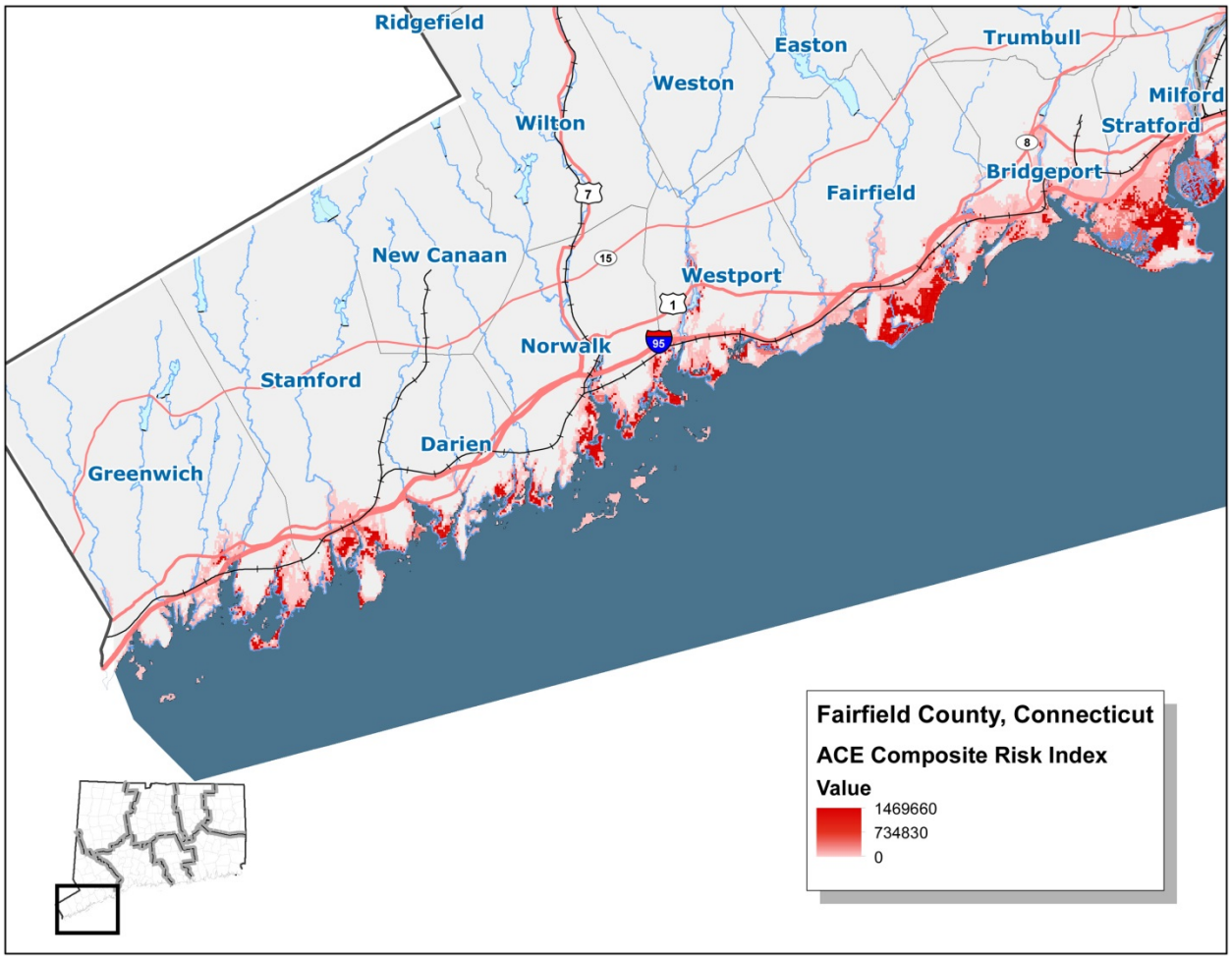


Figure 45: Army Corps of Engineers Composite Risk Index Value for New Haven County

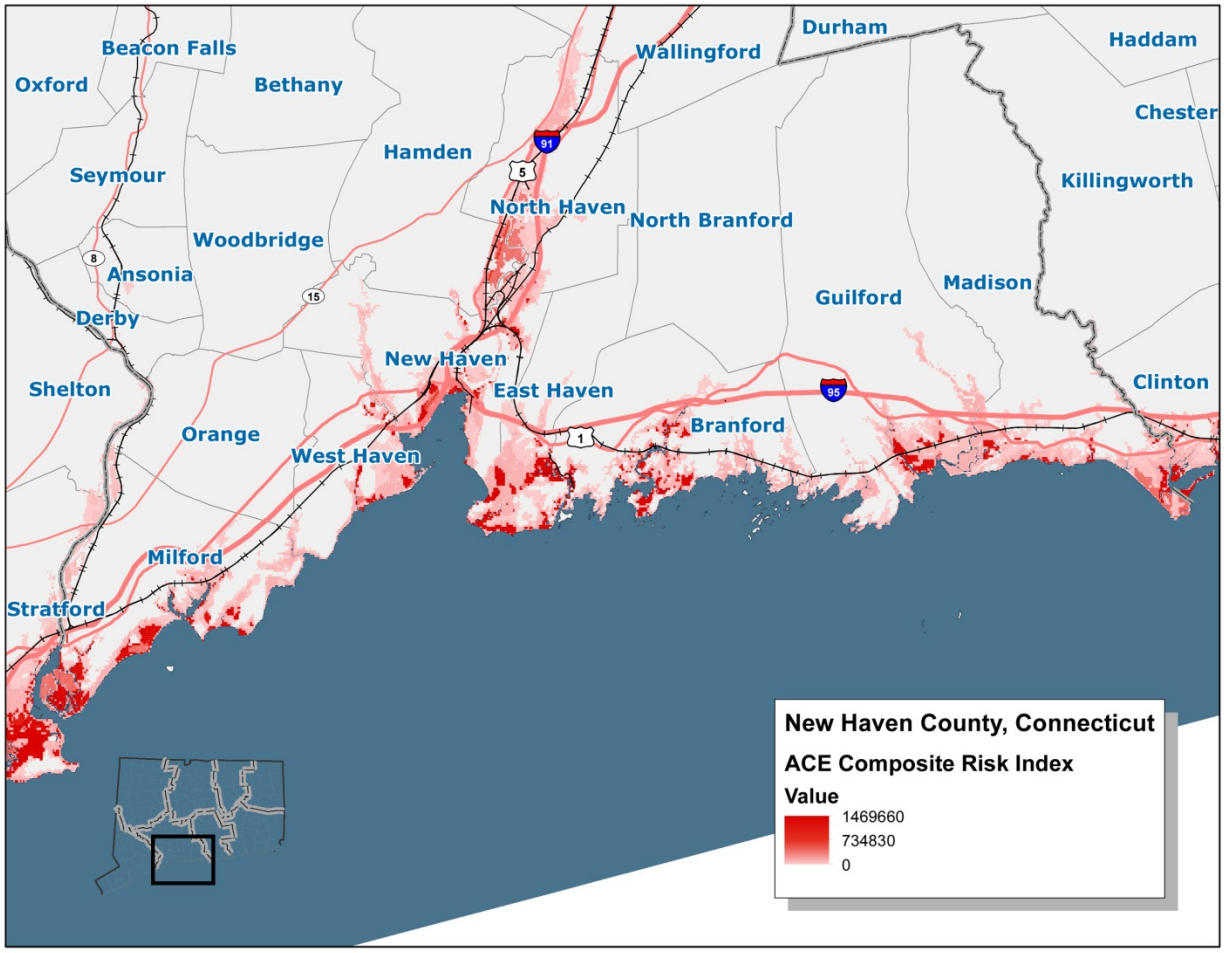


Figure 46: Army Corps of Engineers Risk Areas Fairfield County

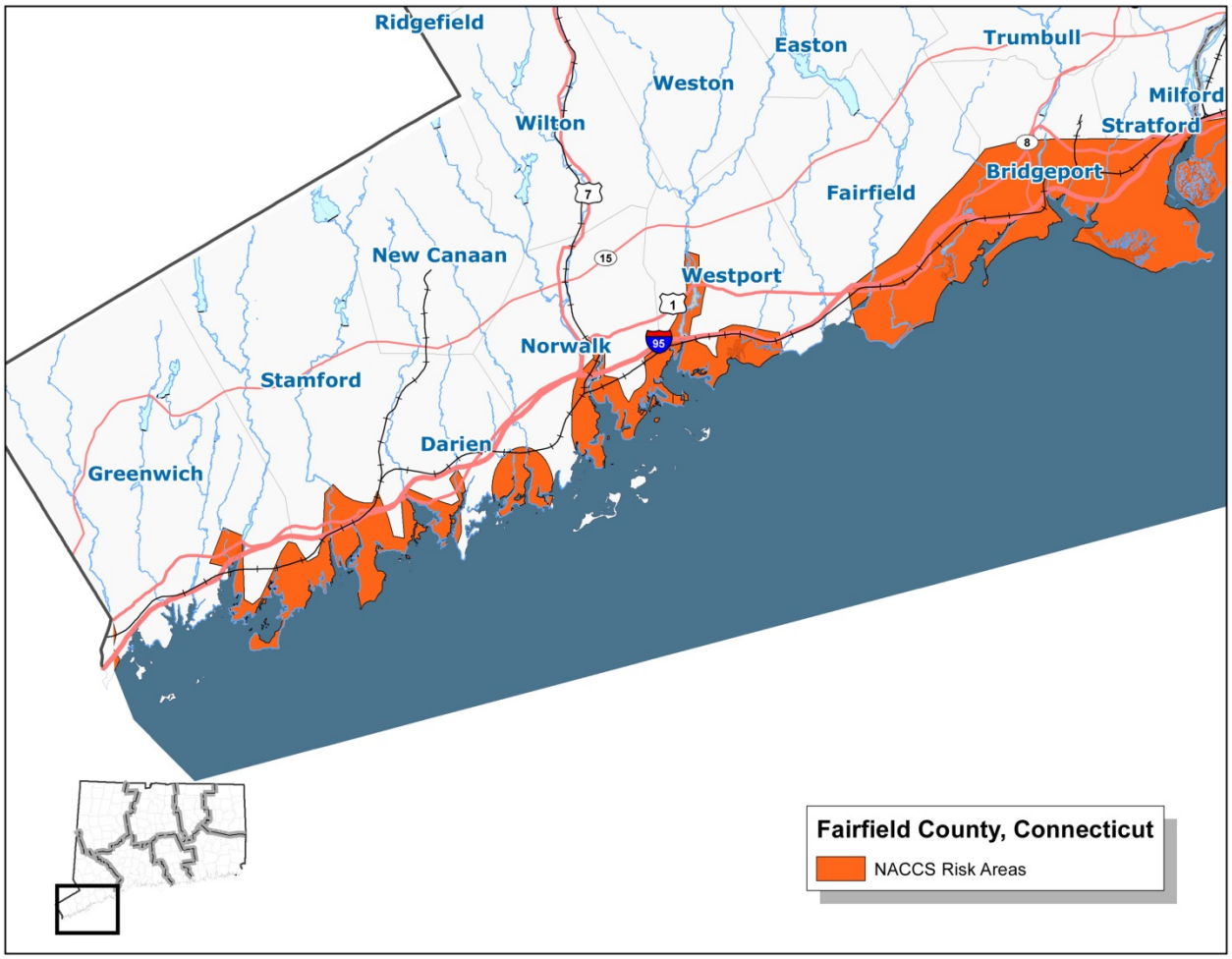


Figure 47: Army Corps of Engineers Risk Areas New Haven County

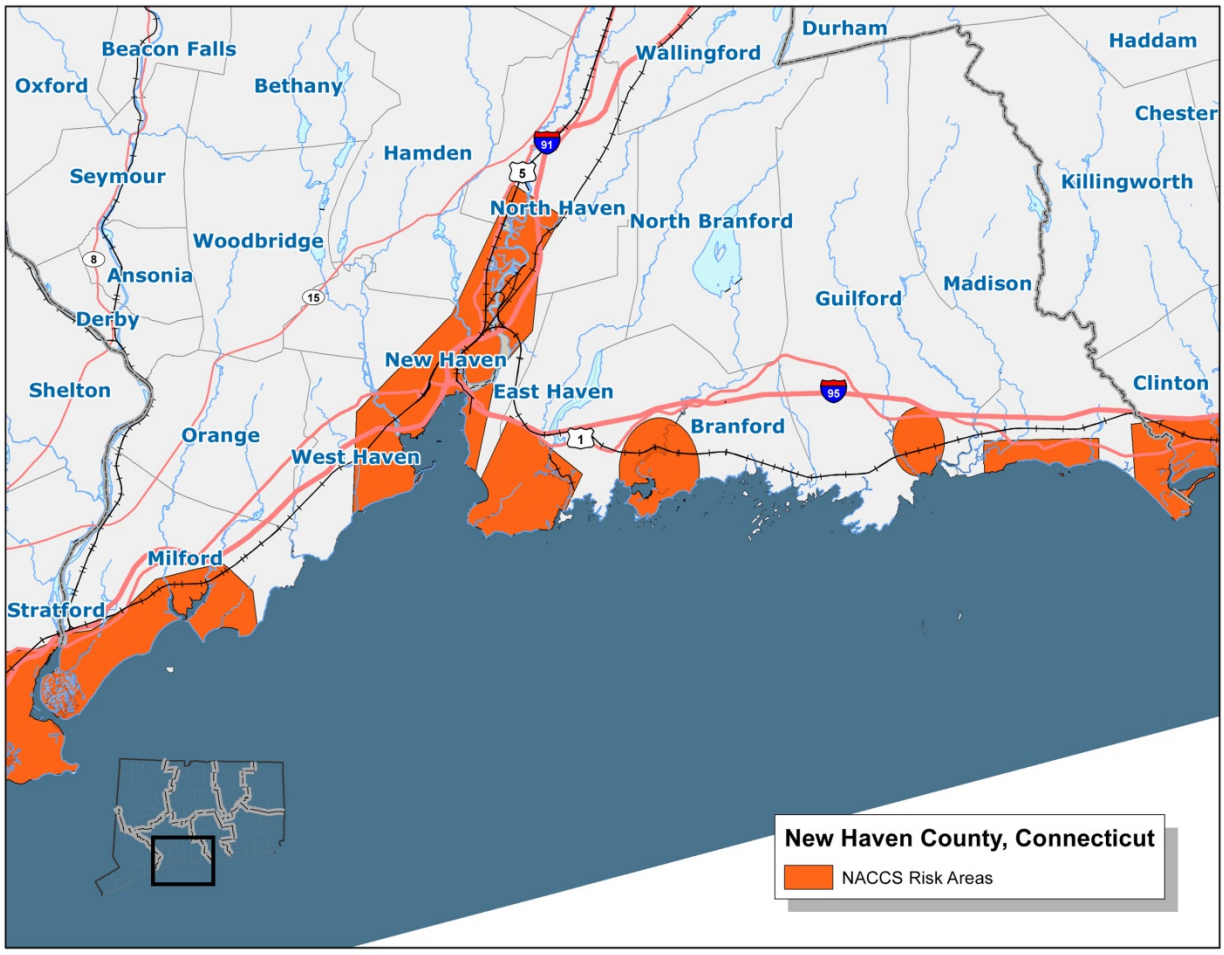


Figure 48: Site-specific Mapping Technique to Guide Project Selection



Figure 49: Egress typologies Vulnerable to Flooding; Potential “Pinch Points” in Evacuation Routes

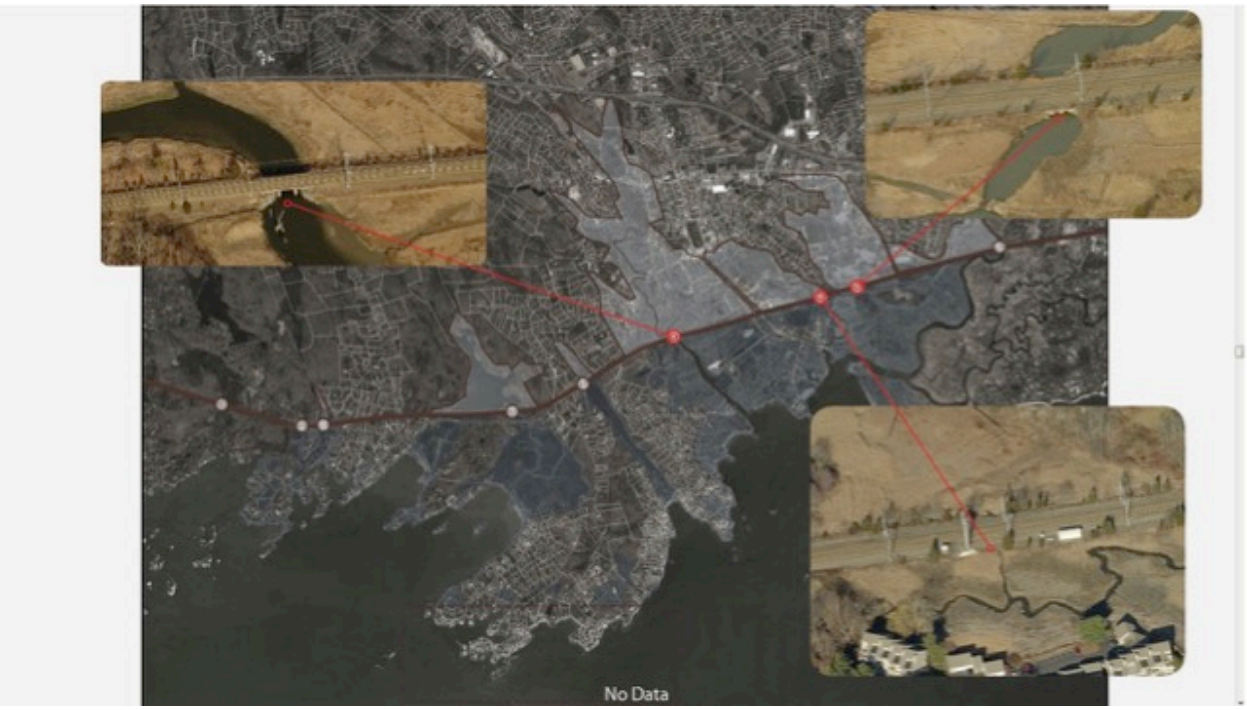


Figure 50: Properties Damaged by Hurricane Sandy in Fairfield County

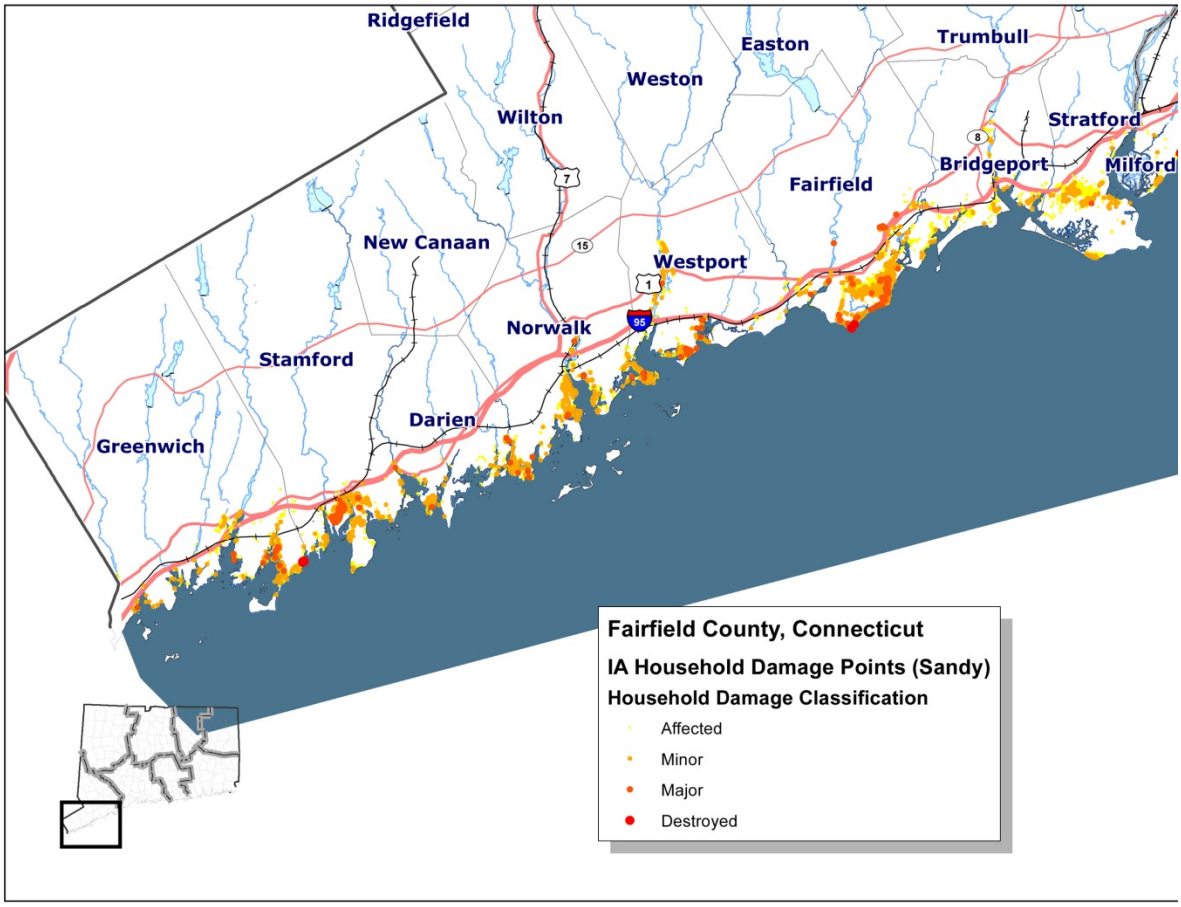


Figure 51: Properties Damaged by Hurricane Sandy in New Haven County

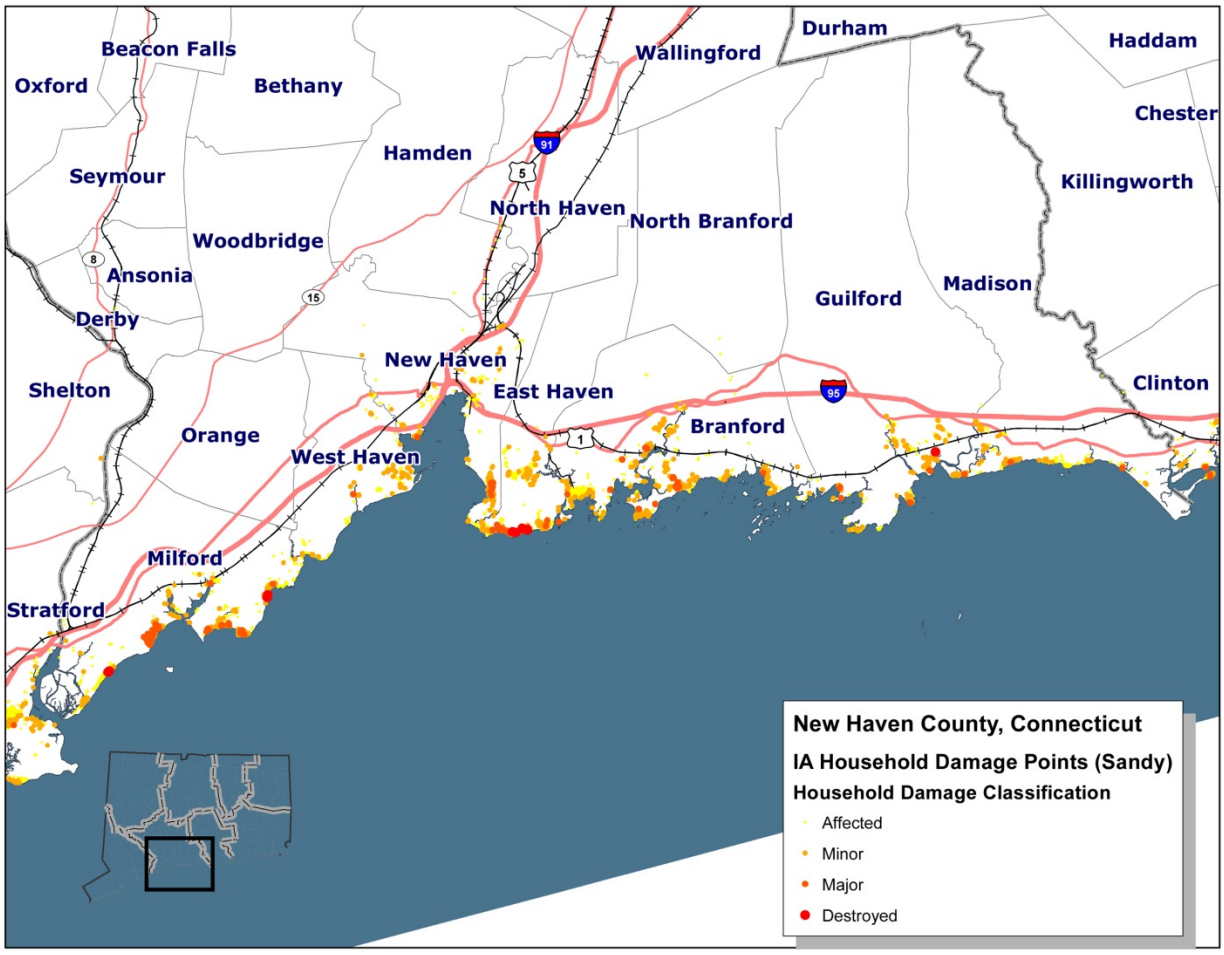


Figure 52: Areas of Repetitive Loss Properties in Fairfield and New Haven Counties

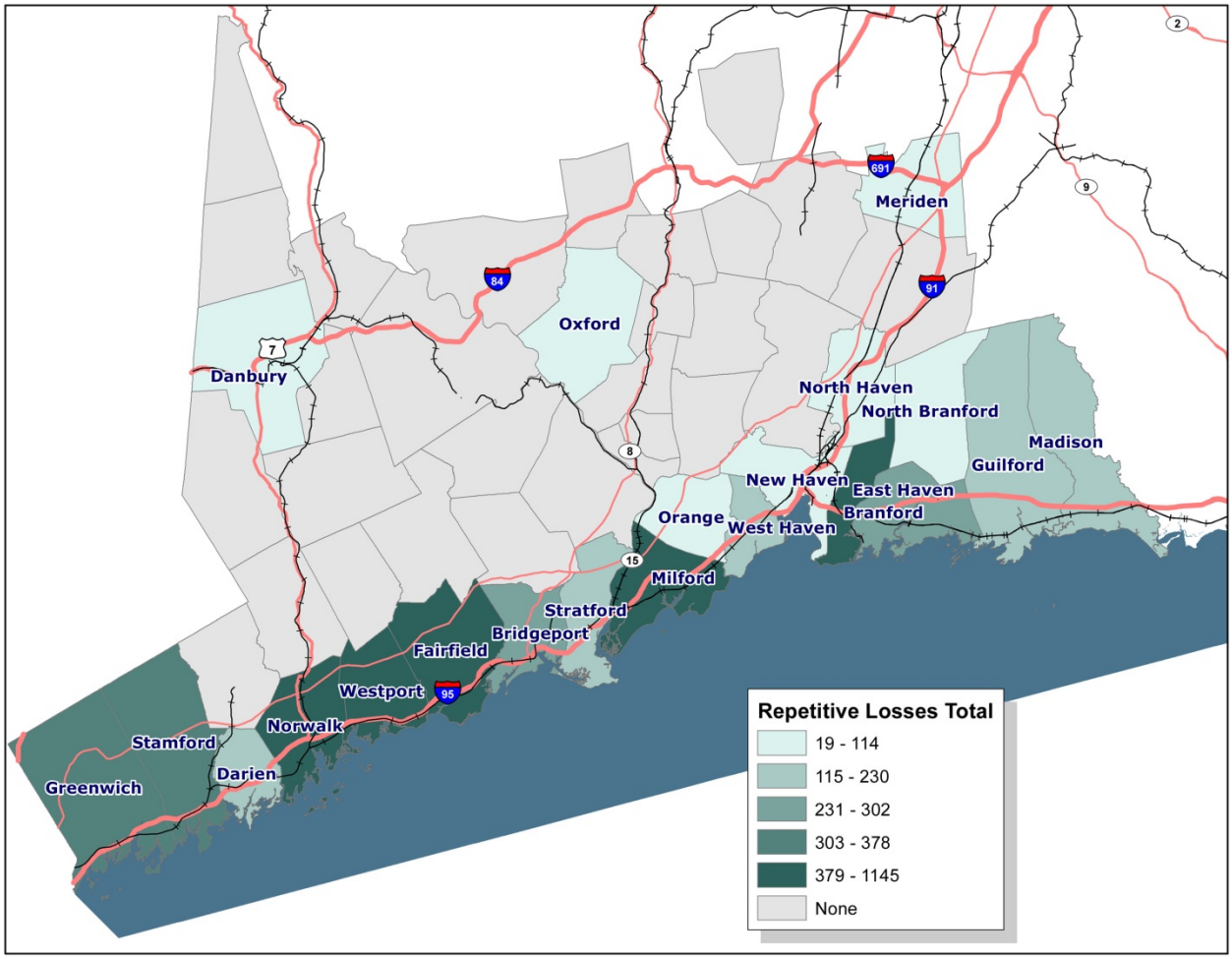


Figure 53: Repetitive Loss Costs in Fairfield and New Haven Counties

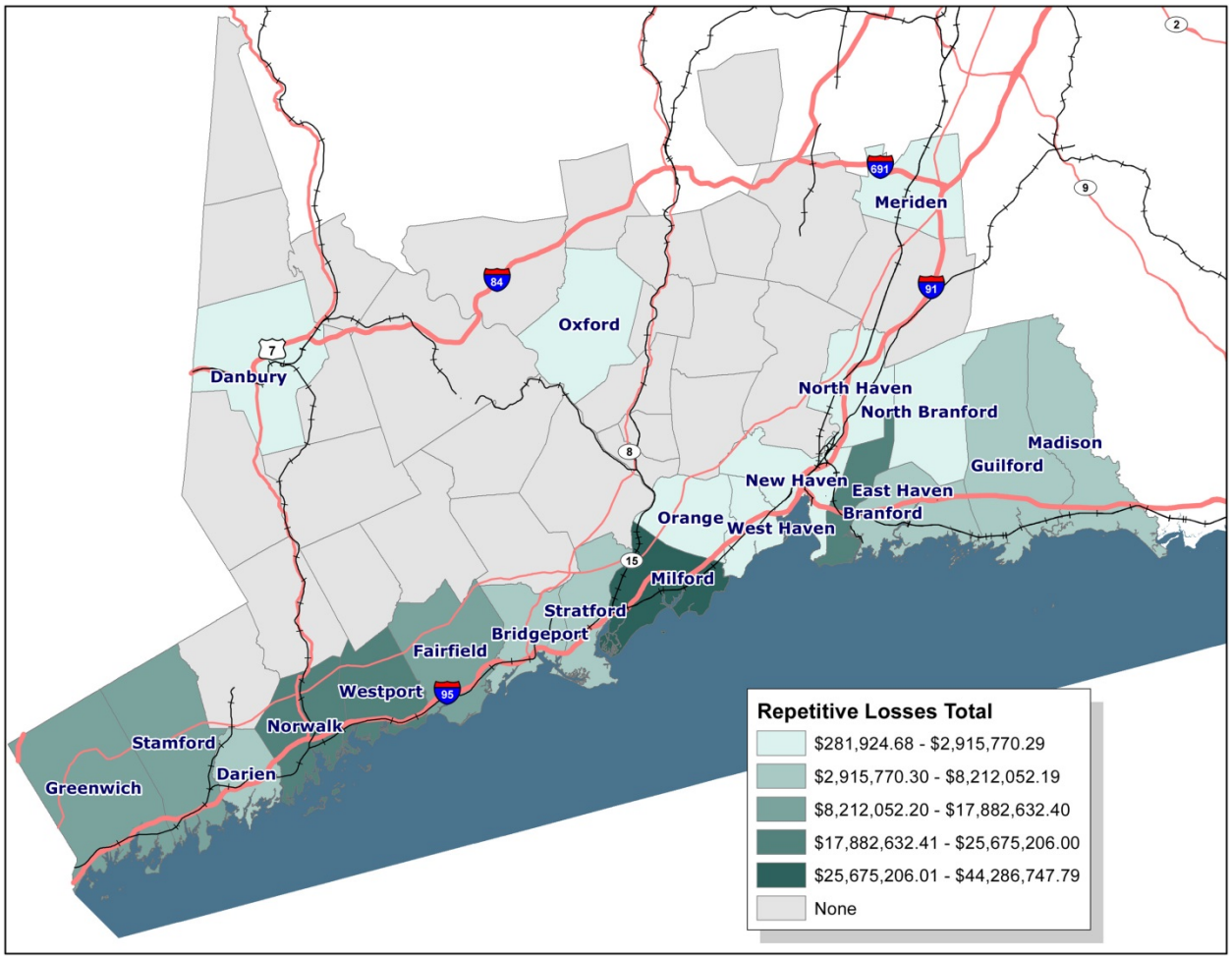


Figure 54: Areas of Severe Repetitive Loss Properties in Fairfield and New Haven Counties

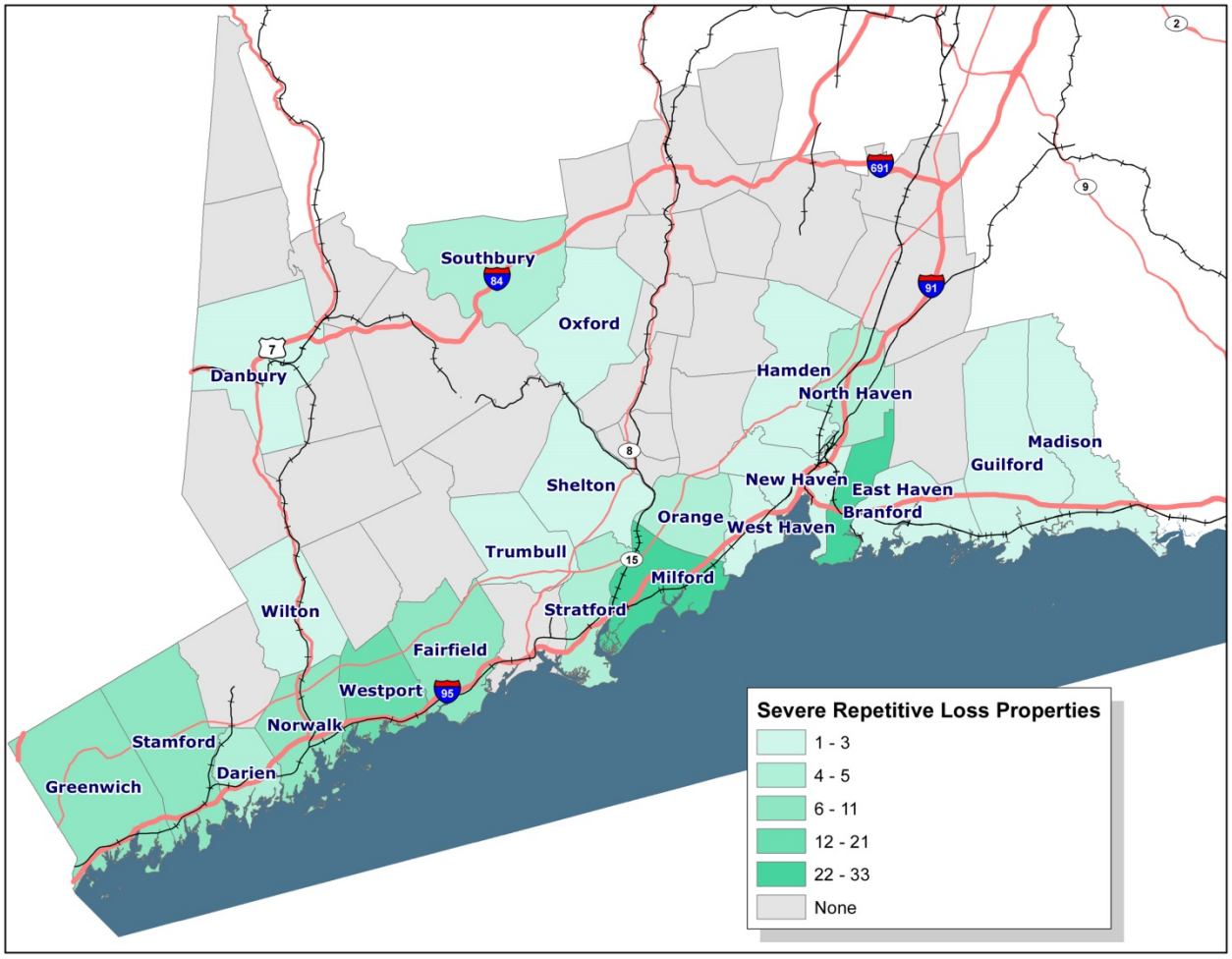


Figure 55: Severe Repetitive Loss Costs in Fairfield and New Haven Counties

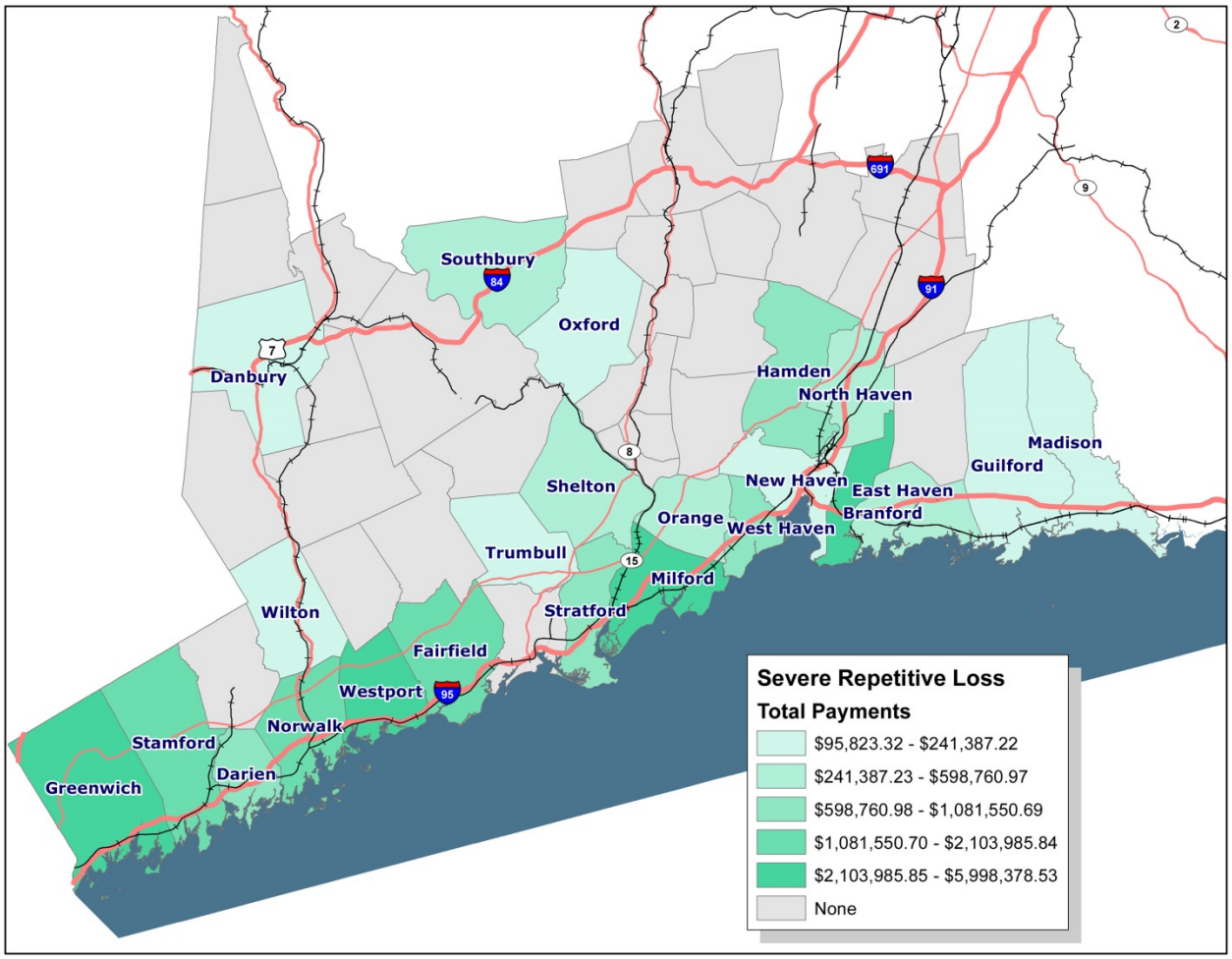


Figure 56: Communities hard hit by both Tropical Storm Irene and Hurricane Sandy (measured by federal expenditure for IHP grants for)

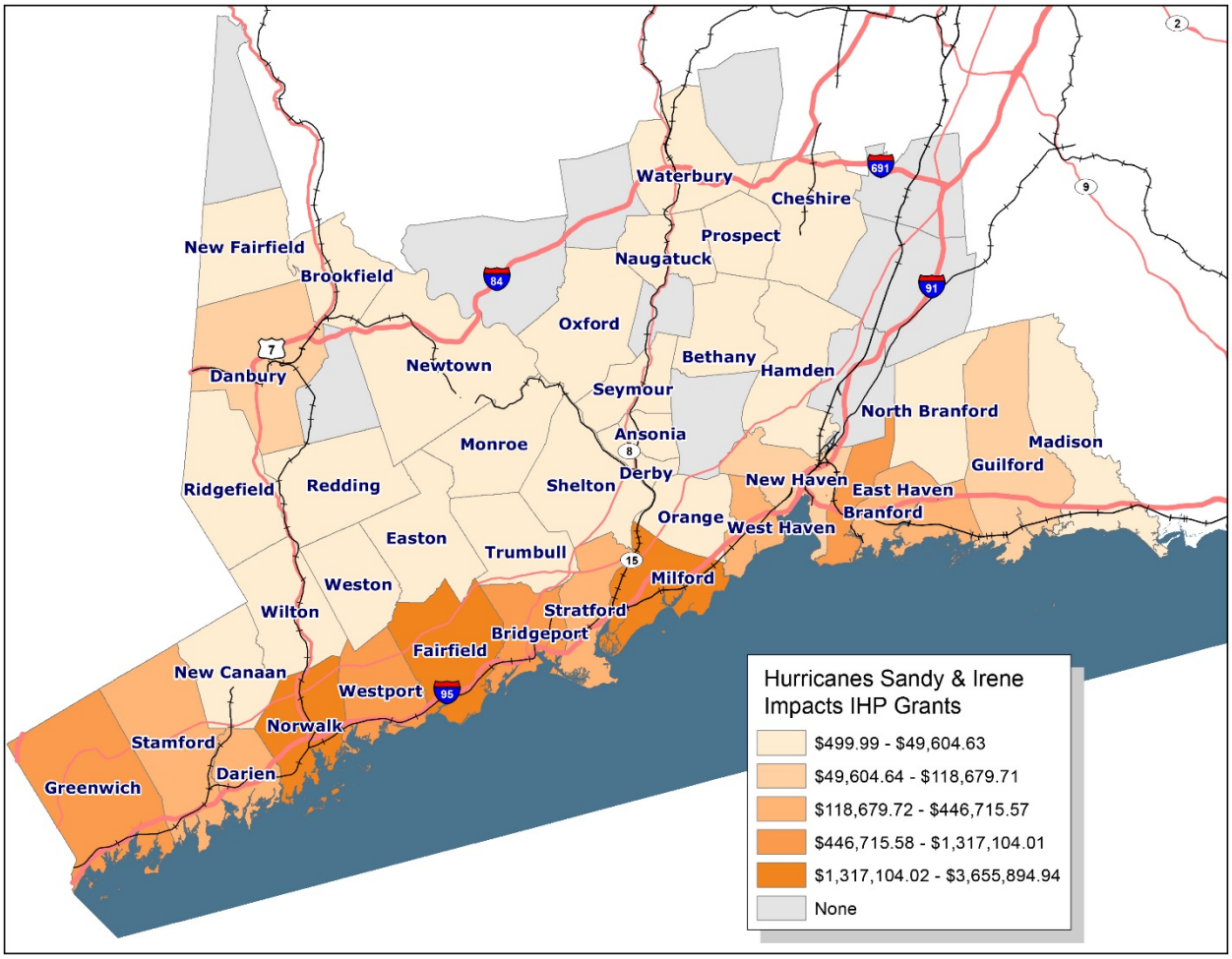


Figure 57: Quaternary Geology of Fairfield County

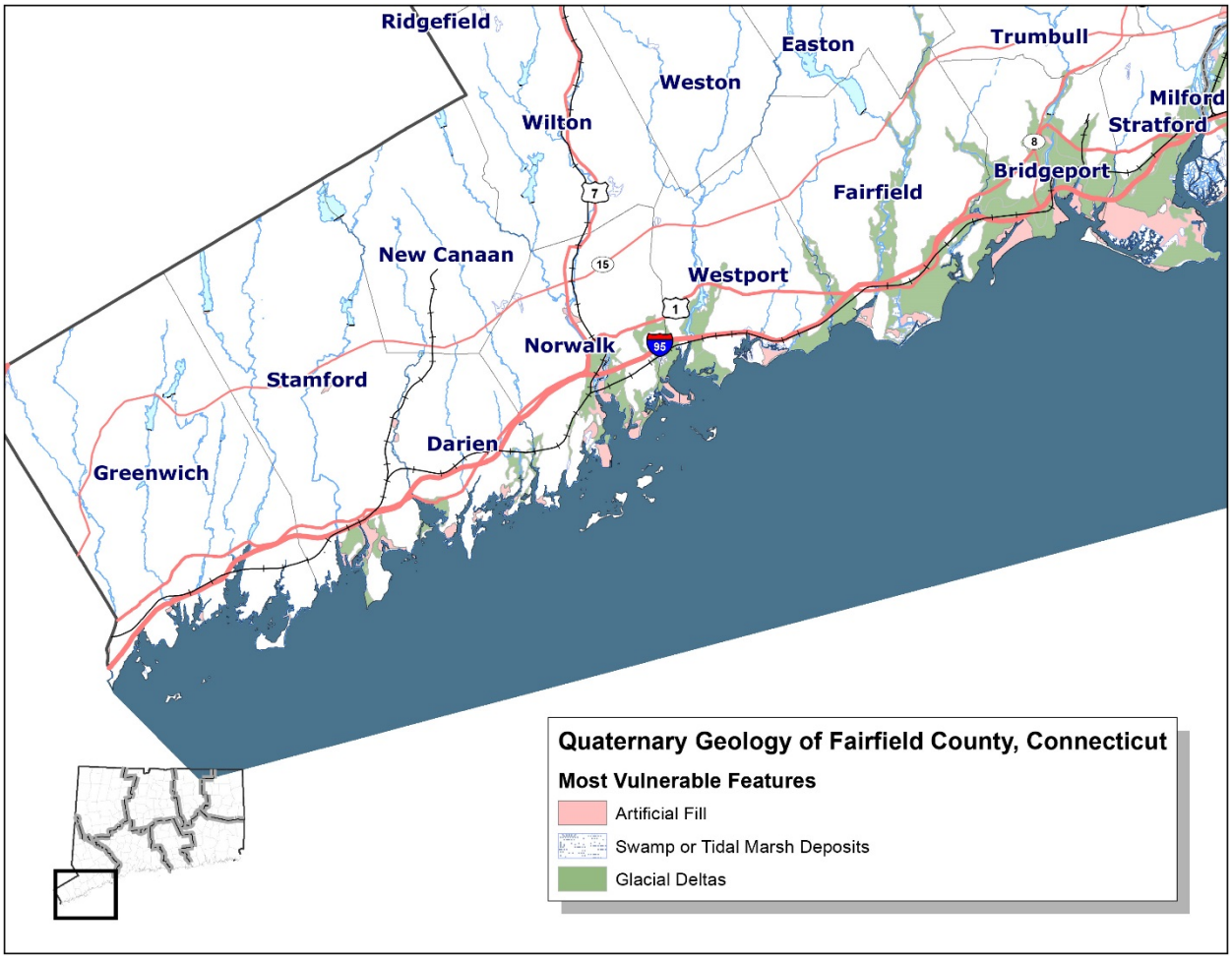


Figure 58: Quaternary Geology of New Haven County

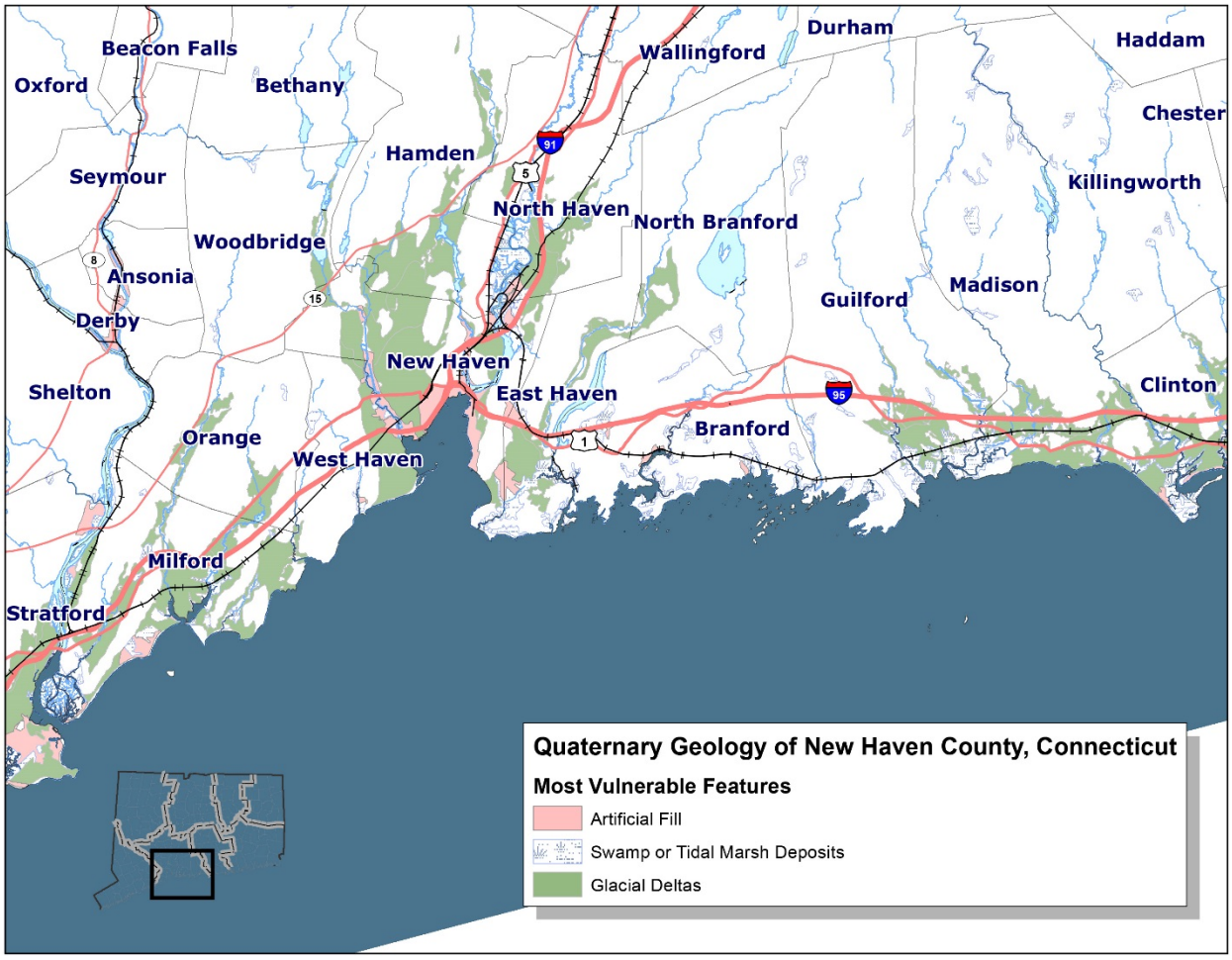


Figure 59: Vulnerable Coastal Typologies

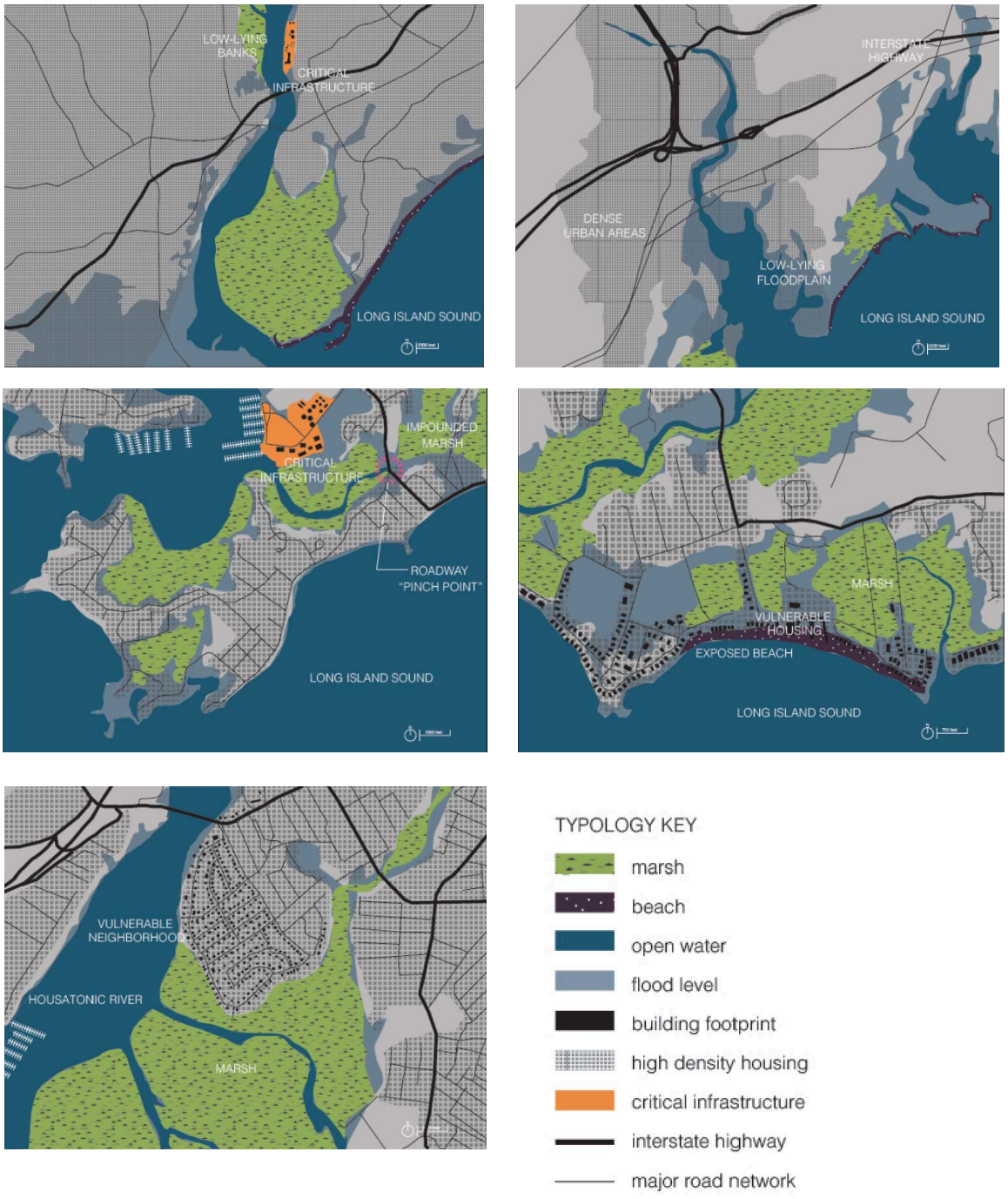


Figure 60: Frequency of Vulnerable Coastal Typology: Beaches Backed by Marsh along Fairfield & New Haven Counties' Coasts

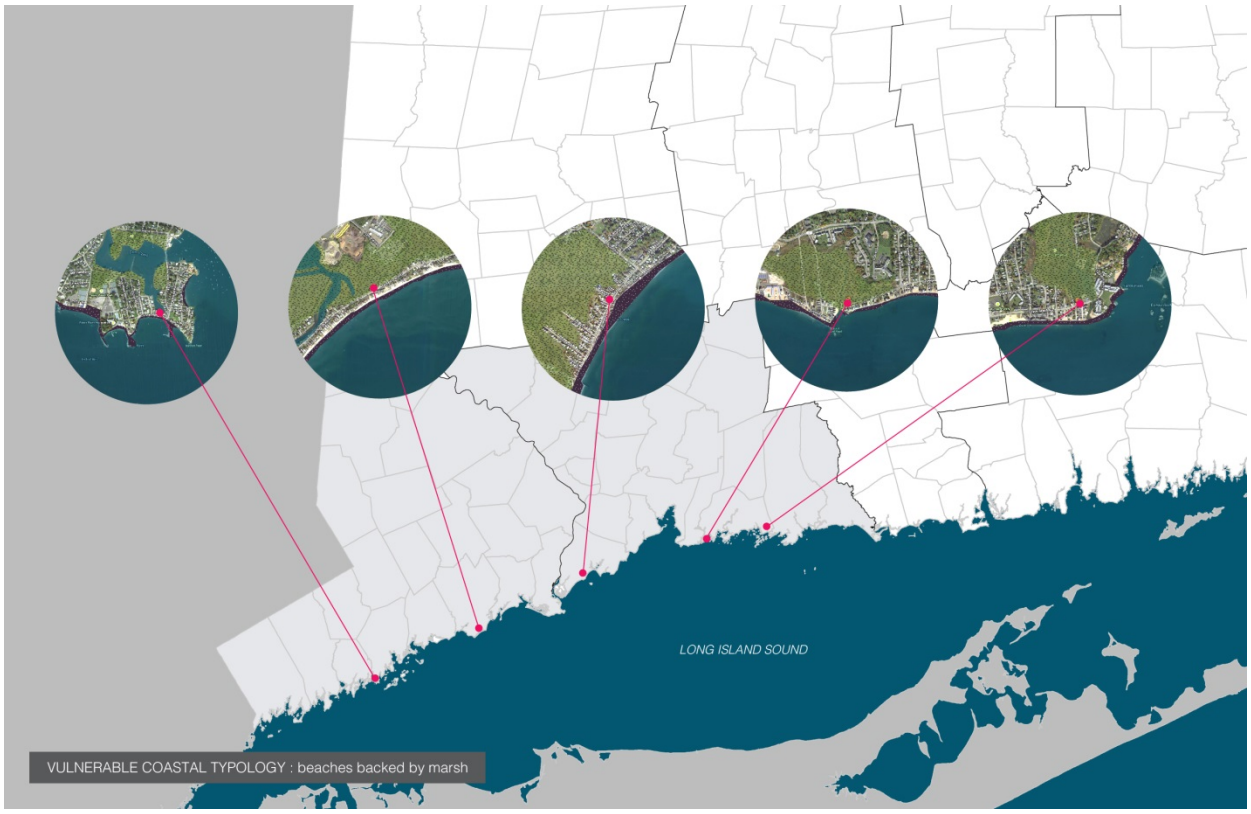


Figure 61: Brownfields in Fairfield and New Haven Counties

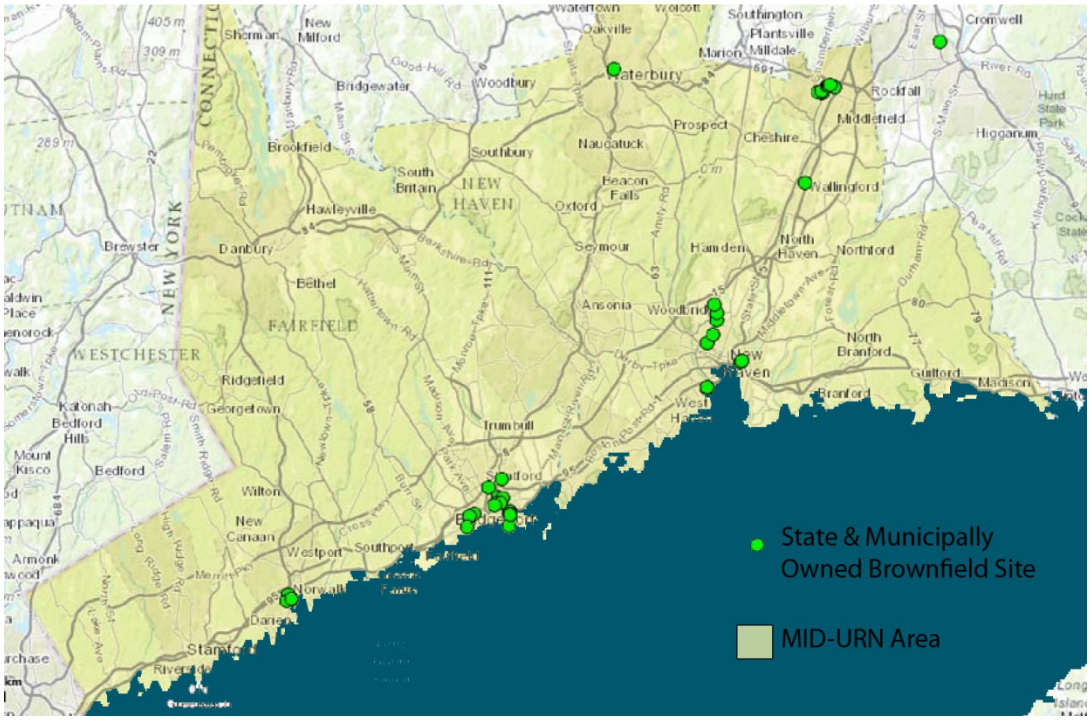
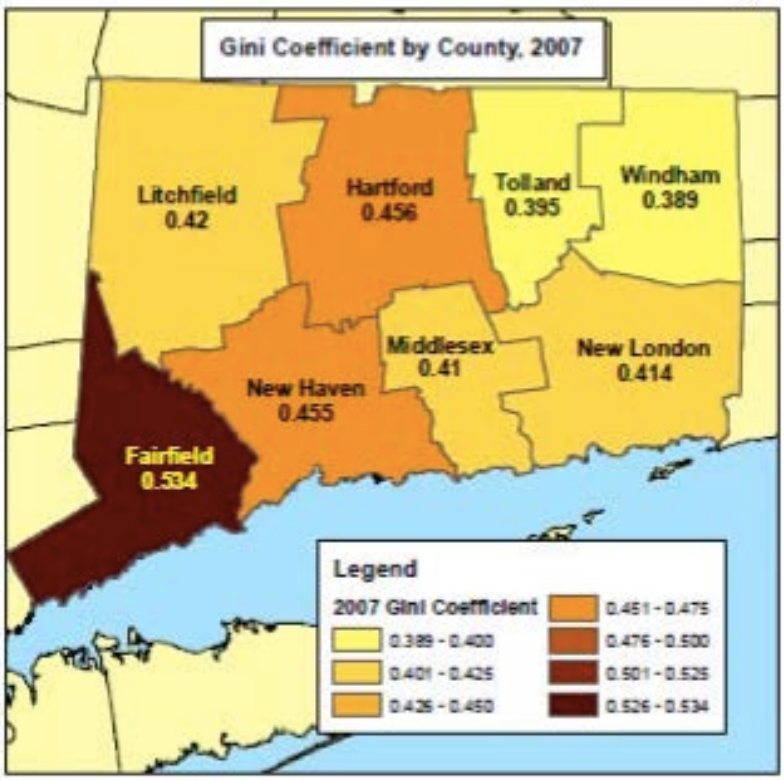


Figure 62: Gini coefficient (a measure of inequality) by county



Source: Connecticut Voices for Children

Figure 63: Gini coefficient (a measure of inequality) in Fairfield County

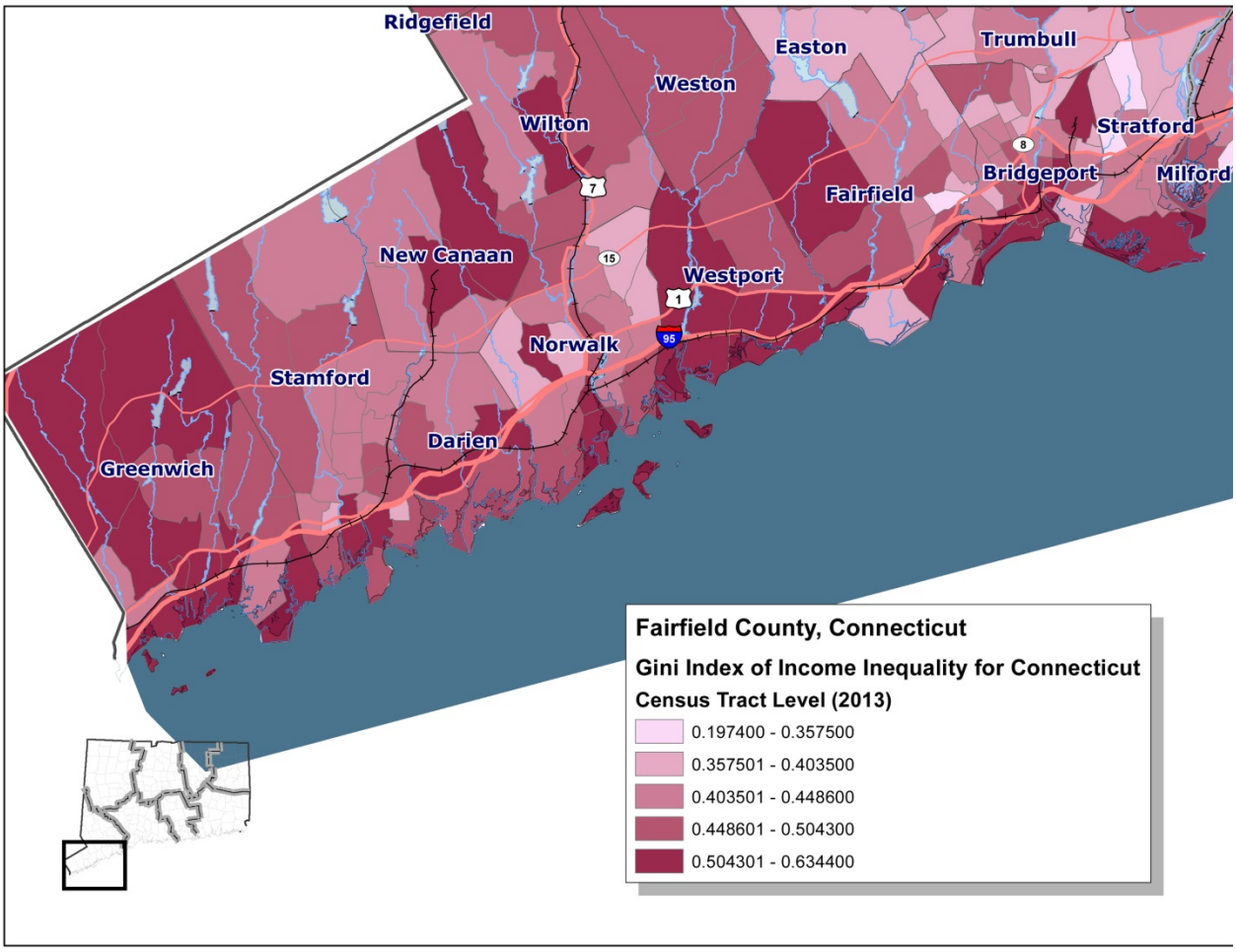


Figure 64: Gini coefficient (a measure of inequality) in New Haven County

