Name of the Exhibit: **ExhibitDNeed**

Applicant: **The State of Connecticut**

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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 (Att.E, p116-118). 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 (Exhibit B, p. 4). 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 (Att.E, p.119). 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 (Att.E, p.120-121). 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. 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 (Att.E, p.122-123).; 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 (Att.E, p.124-125). 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 (Att.E, p.126-127). Hurricane surge data overlayed on the SoVi map demonstrates that highly vulnerable populations are specifically vulnerable to flooding (Att.E, p.128-129). A CCM report on disproportionate burdens shows that 4 out of the 25 towns categorized as "distressed" were among those Sandy seriously affected. (Att.E, p.130). Sandy inundation and the anticipated flooding from a Category 3 Hurricane were mapped for each municipality. (Att.E, p.131-146). Coupled with 12" of sea level rise, flooding will be devastating at the local scale (Att.E. p.147). 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. (Att.E, p.148-149). Moreover, anticipated inundation from future hurricanes along the shores of New Haven and Fairfield Counties is extensive (Att.E, p.150-151).

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 (Att.E, p.152). 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). (Att.E, p.153). 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 (Att.E, p.154-161). This assessment identified 15 areas meriting further analysis, 8 of which fall within the Most Impacted and Distressed counties (Att.E, p.162-163).

Our science-based risk assessment therefore focuses on a more detailed analysis within these identified areas to help guide eventual project selection (Att.E, p.164). 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 (Att.E, p.165). Next, areas of historic flooding were identified using 1) individual properties damaged by Sandy (Att.E, p.166-167), 2) areas with repetitive and severe repetitive loss properties (Att.E, p.168-171), and 3) areas with the greatest damage during Sandy and Irene (measured by expenditure through FEMA's IHP grants (Att.E, p.172).Third, areas of social vulnerability were identified by 1) the Social Vulnerability Index (SoVI®) composite score (Att.E, p.126-127) and 2) low or moderate income areas (identified by HUD for FY2014) (Att.E, p.124-125).

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 (Att.E, p.173-174). 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 (Att.E, p.175). These typologies, vulnerable due to land use patterns and physical geography, repeat along the state's coastline (Att.E, p.176). 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 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 (described in more detail in Exhibit E). 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 (Att.E, p.177).
- **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 (Att.E, p.178-180).

- **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 deepwater 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 (Exhibit G, pg. 42-43) and funding mechanisms have been created or augmented (Exhibit E, pg. 37-38). The State Legislature passed *An Act Concerning Connecticut Global Warming Solutions* (2008), which called for the Climate Preparedness Plan, finalized in 2013 (Exhibit G, pg. 42). 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, detailed in Exhibit E, 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 (Exhibit E, pg. 32-35).