Governor's Council on Climate Change (GC3)
Infrastructure and Land Use Adaptation Working Group
Recommendations Report
September 21, 2020
DRAFT

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Introduction and Process

As originally formatted in early 2020 the Adaptation and Implementation Work Group was comprised of four subordinate working groups:

- Land Use and Buildings
- Public Health and Safety
- Utility Infrastructure
- Transportation

As the working groups proceeded it became apparent that the Public Health and Safety sub-group should be elevated to a free standing working group on the same level as (and independent from) the Adaptation Planning and Implementation work group. Accordingly what follows are the consolidated recommendations from remaining three subgroups to the renamed Infrastructure and Land Use Adaption Working Group.

Each group was populated with subject matter experts covering many but not all of the aspect needing consideration. Through the spring and summer of 2020 these three groups collectively held nearly 25 meetings working through the issues within their subject areas. Although the COVID-19 pandemic limited the various groups' from working physically together and taking public comment in person, the process included a robust inclusion of direct public commentary during many of the meetings.

Each group worked initially to define the respective scope and vision of their subject area and to review relevant existing work product. Once a preliminary understanding of the scope and vison was defined, each group began to develop a list of recommendations that were first discussed internally and then vetted through both public comment and additional research and discussion.

As these separate lists of recommendations were consolidated into a final draft list, that list was vetted through the Equity and Environmental Justice (Vulnerable Communities) work group on August 18, 2020 and that process provided valuable feedback on the substance and priority of many of the recommendations.

What follows is the consolidated list of recommendations as developed through the process described above. The recommendations are organized by work group and further prioritized by actions which are implementable in both immediate, short term and longer term time frames.

The challenge of adaptation planning and implementation is an evolving process and will take a sustained effort of ongoing research, stakeholder engagement and planning to execute well on behalf of the citizens of the state.

This list is not an end point but a starting point.

Vision

Climate change adaptation is an investment in Connecticut's future, enabling us to improve response in urgent situations, reduce risk and preserve assets into the future. Connecticut is responsive and flexible as science evolves and demographics shift. Our economy, environment, and quality of life thrive.

Scope

The Infrastructure and Land Use Adaptation Working Group addressed climate change adaptation issues focused on the built environment. The Working Group organized around three theme areas: Transportation, Land Use & Buildings and Utility Infrastructure. Within each of these areas, a scope of work was established as follows.

Transportation

- Resilience of the state's transportation infrastructure and assets including roads, highways, bridges, bus transit, rail operations, bicycle and pedestrian amenities, ports and airports.
- Comprehensive, multi-jurisdictional planning
- Transportation system is equitable and accessible for all Connecticut residents

Land Use & Buildings

- Conservation and development practices at all scales, from neighborhoods to the entire state.
- Location of future development, specifically targeting currently developed areas while prioritizing the conversation and preservation of natural areas.
- Current and future building practices, sustainable development and community health; sustainable building materials and practices such as passive house, especially for affordable housing development projects to provide a more resilient and healthy built environment for the state's most vulnerable populations.

Utility Infrastructure

- Focus on critical infrastructure groups necessary for the economic resilience and physical health and safety of all people of Connecticut.
- Communications, Fuel, Drinking Water, Waste Water, Electricity, Stormwater & Flood Control, Dams; recognizing interconnectedness
- Support local and regional planners as well as local and state officials and all utility stakeholders.

Climate Change Impacts to Infrastructure and Land Use in Connecticut

Climate is changing in Connecticut, as a result of historical and continuing global emissions of greenhouse gases.[i] While the Connecticut Climate Preparedness Plan 2011 began highlighting the observed and expected magnitude of these changes[ii], work initiated by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) has recently been undertaken to downscale the assessment of climate change impacts to support state and local planning efforts.[iiiiv] An updated summary report of anticipated climate change impacts in Connecticut is

currently in development through the GC3 Science and Technology Working Group. In lieu of that report, the Infrastructure and Land Use Working Group has summarized CIRCA's recent findings as the current best available science for Connecticut.

While the magnitude of long term changes to Connecticut's climate (2100 and beyond) remains sensitive to the trajectory of global greenhouse gas emissions[v], there is high confidence on near term impacts (2050) due to historical emissions that have already occurred. As can be seen in recent assessments of sea-level rise, air temperature, and precipitation, small changes to our climate can have big impacts on the conditions that affect people, infrastructure, ecosystems, and land use patterns.

Sea-level Rise: Local measurements of the ocean surface show that sea-level is rising (SLR) in Long Island Sound, and that the rate of SLR has increased, averaging ~4mm per year since 1976. Connecticut is expected to experience up to 20 inches of sea level rise by 2050, relative to the National Tidal Datum (NAVD88), and continuing increases thereafter. In the longer-term, SLR may be as much as 3 to 7 feet higher by 2100, though projections differ significantly, based on the evolution of global greenhouse gas emissions in this century, and the modeling of sensitive climate feedbacks such as, how rapidly global ice sheets melt in response to warming. Projections for Connecticut should be updated at least every 10 years to reflect changing science and to increase the confidence of longer-term local guidance for planning.

However, in the near-term, 20 inches of SLR is likely to significantly increase the frequency of flooding from tides and storms along the Connecticut coast. As the overall water level of Long Island Sound rises, flood levels that we've previously experienced from less frequent, but big impact tropical storms and hurricanes, can occur from nor'easters and more common annual storms. What we experience today as "severe" flooding from storm surges of 4-5 feet, will occur 5 to 10 times more often in 2050[vi]. Areas that currently flood once every 10 years now, will likely flood every 2 years or more by 2050. Chronic flooding in floodplains and low-lying areas along Connecticut's coast will be a major challenge for infrastructure and land-use as a result of climate change.

Air Temperature: Since 1895, Connecticut's annual average air temperature has been increasing by 0.3°F per decade, totaling 3°F warmer as of today. Seasonal averages have also been increasing, with winter experiencing the greatest increase. Observations show more warming along the southern coast and eastern half of the state. According to high CO_2 emission scenarios (RCP 8.5), average temperatures in Connecticut are predicted to rise 5°F (± 1°F) by 2050 and continue rising thereafter. The most seasonal increase will likely be in summer.

As in the case with SLR, small increases in the overall annual temperature average can result in big impacts to human health, infrastructure, and land use. "Summer days" refer to the number of days per year when the daily maximum temperature is above 77°F. Statewide, summer days have increased since the 1950s with the most significant increase in southwestern Connecticut, currently averaging ~81 per year. By 2050, summer days will likely increase to 118, reflecting longer and hotter summer months. By 2050, the number of days where daily

maximum temperature in Connecticut exceeds 90°F will likely rise from ~5 on average today to ~25; and days above 100°F will rise from less than ~1 on average currently to ~4.

"Tropical nights" refer to the number of days per year when the daily minimum temperature is above 68°F, reflecting warm overnight temperatures. Currently Connecticut averages ~10 tropical nights per year, with the greatest increase over the previous century occurring along the southern coast. By 2050 the number of tropical nights is projected to increase to ~40, requiring more energy and cooling capacity across the state. "Frost days" refer to the number of days per year when the daily minimum is below 32°F. In most of the state, frost days have significantly decreased since the 1950s, currently averaging ~124 days per year. By 2050 frost days will continue decreasing to ~85, reflecting milder, shorter winter months. By 2050 and beyond, Connecticut will experience longer hotter summers, more heat waves, and more extreme temperature events as a result of climate change.

Precipitation and Storms: In a warmer Connecticut, precipitation will likely increase because of evaporation and changes to the water cycle. Precipitation across Connecticut has been increasing by 0.17 inches per decade since 1985, with the largest increase occurring in Fall. By 2050, average annual precipitation is expected to increase ~8% (4 inches per year), with much of the increase occurring in winter and spring.

Indices of precipitation are expected to increase, including the number of days with more than 1 inch of precipitation, from 12 currently to 14 days per year on average. The number of heavy precipitation days [from 3 to 5 days]; and fraction of total precipitation accounted for by heavy precipitation [from 15% to 20 %] will also increase by 2050. The maximum 1-day precipitation amount will likely increase by +27%, from 2.8 inches currently to 3.5; and maximum 5-day precipitation will increase +20%, from 4.5 inches currently to 5.4. While more of the precipitation we experience will likely come from more intense rainfall events, the risk of drought may also increase due to evapotranspiration, though modelling consensus is mixed on the question of drought and will require further study to improve confidence.

Tropical and extra-tropical cyclones, also known as hurricanes and nor'easters, have impacted Connecticut going back centuries. Major historical storms (Long Island Express, 1938; Carol, 1954; Gloria, 1985; Irene, 2011; Sandy 2012; Jonas, 2016; Isais, 2020) periodically track towards Connecticut and wreak havoc on infrastructure and land use. The long term implications of how climate change will impact the overall number of these cyclones, as well as, their track and intensity in the future is unclear, though is currently being studied. Regardless of the climate change effect, Connecticut will continue to be at risk from these storms, requiring rigorous hazard mitigation planning to prevent loss of life and damage to infrastructure.

Equity & Environmental Justice – Vulnerable Communities

Climate change impacts will affect all residents in the State of Connecticut through increased flooding, sea level rise, stronger and more frequent storms and increased high heat days. The impacts will most acutely affect minority and low/moderate income communities less able to adapt or improve their resilience due to economic limitations, disinvestment in their communities and historic lack of directed engagement in planning processes.

In order to ensure an equitable and comprehensive plan, the Governor's Council of Climate Change (GC3) includes broad representation and coordination with stakeholders and partners that work, live and engage with these communities often not included in large scale planning activities. Ongoing engagement with members of the Equity and Environmental Justice Working group, throughout the discussion and drafting of recommendations, ensures the appropriate equity lens has been applied to all draft recommendations. Additionally, a presentation to the Adaptation Sub-group of the EEJ Working Group further refined the draft recommendations with input from all EEJ Adaptation sub-group members with diverse backgrounds and experience.

The State of Connecticut can only achieve its climate change adaptation and mitigation goals if the planning process engages and includes residents, public and private partners and stakeholders from all backgrounds and socio-economic levels. The Adaptation Planning and Implementation Work Group will continue to engage and coordinate with the EEJ working group throughout the remainder of the GC3 planning process.

Status of 2011 Report Recommendations

The Working Group reviewed the Connecticut Climate Change Preparedness Plan (2011) to identify recommendations that are considered to have value moving forward but for which there has been insufficient progress to date. The 2011 Plan was an important step forward in climate change adaptation planning for Connecticut and provides valuable background and context for identifying the strategies and actions for adaptation in the future. Recommendations in 2011 Plan generally did not set specific implementation timeframes and measureable outcomes, nor assign responsibility for implementation and tracking. Consequently, characterization of progress to date is difficult or imprecise. Nonetheless, the Working Group was able to draw some insights and guidance from the 2011 Plan. A general assessment of the 2011 recommendations for each of the three sectors addressed in this report is provided below.

Transportation

- The Plan contained only one recommendation specific to the transportation sector, which was to "determine vulnerable transportation routes and transportation options that may adversely impact natural resources and human mobility needs under future climate change projections." Some other recommendations, such as "develop decision tools to evaluate replacement, modification, and design life for infrastructure" and "assess flooding risk to natural and built infrastructure" apply to transportation as well as other sectors. While some progress has been achieved toward these goals through the development of various data and tools for assessing impacts of climate change conditions, completion of resilience planning efforts at

municipal and regional levels, and the planning and design practices of the Connecticut Department of Transportation, a critical need for additional action in these areas continues into the future. Thus, several of the current recommendations address assessment, planning and design to reduce transportation vulnerability.

Land Use and Buildings - The Plan contains numerous recommendations pertaining to assessing the vulnerability of land uses and the built environment, implementing practices such as Low Impact Development, and particularly, strategies for increasing sustainability of water use. The State Water Plan, completed in 2019, was a major accomplishment toward the goal of increasing sustainability water use. There has also been some progress through CIRCA and numerous municipal and regional resilience plans in assessing vulnerability, as well as progress in implementing low-impact development practices driven, in part, by regulatory requirements for stormwater management. The overall objectives of all of these strategies remain relevant and are being carried forward in several different recommendations pertaining to resilience planning and implementation, building code enhancements, land conservation and development practices.

Utility Infrastructure – The majority of the recommendations in the Plan pertaining to utility infrastructure are directed toward public water supply and water management. The State Water Plan, adopted in 2019, represents a major step forward in planning and management of the state's water resources and addresses several of 2011 recommendations. A few of the 2011 recommendations relate specifically to wastewater infrastructure, and some address utility infrastructure in general, such as developing climate assessment tools for planning and design of infrastructure. None of the recommendations pertain directly electric or other utility infrastructure. While a few of the recommendations, such as promoting water reuse and reducing combined sewer overflows, have been carried forward directly, most others have been incorporated to varying degrees into new recommendations.

Recommended Implementation Actions

The Working Group developed a list twenty-eight Draft Recommended Implementation Actions in the categories of Transportation, Land Use & Buildings and Utility Infrastructure, as well one general recommendation not specific to these categories. Recommended Implementation Actions emerged from discussions of working group members during meetings of the full working group and subgroups assigned to each of the three categories, and were informed by input from stakeholders who participated in the meetings or submitted written comments. Working group members drafted the language of the recommendations. As a result of constraints imposed by the COVID pandemic, the Working Group did not have the opportunity to assess, discuss and develop the full set of draft recommendations to the extent desired. The Working Group made the decision to group the recommendations in two "bins." Those recommendations that the Working Group determined were adequately developed, grounded in previous planning efforts, or having a higher degree of urgency are included below as recommendations that are proposed for implementation or more focused development outside of the GC3 process in 2021. The remainder of the recommendations are briefly summarized in Table 1 and will be further assessed and discussed by the Working Group during the continuing GC3 process.

General:

Recommended Implementation Action Title G-1. Establish a State-wide Climate Adaptation Implementation Committee	
Recommended Implementation Action Description	An Implementation Committee will coordinate and oversee the implementation of strategies and actions pertaining to climate adaptation and resiliency that are established in various state-level reports and plans, such as the GC3 recommendations and State Natural Hazard Mitigation Plan. The Committee will provide accountability for implementation entities assigned with tasks to increase statewide resiliency.
Completion Timeframe	1 to 2 years
Implementation Entities	State agencies, COGs, CIRCA, NGOs, Water Planning Council; representatives from vulnerable communities
Climate challenges addressed	Impacts to the natural and built environment associated with projected changes in sea level, precipitation and heat.
Protection of vulnerable communities	A primary element of the committee's mission will be a focus on vulnerable communities that may experience disproportionate impacts from changes in sea level, precipitation and heat.
References for action	Connecticut Climate Preparedness Plan (2011); Resilient MA Action Team https://www.mass.gov/info-details/resilient-ma-action-team-rmat

Transportation:

Recommended Implementation Action Title T-2. Improve statewide evacuation route planning and vulnerability assessment.	
Recommended Implementation Action Description	Climate related impacts will likely increase the need for localized evacuations due to increased coastal and inland storm events. A statewide evacuation routing database should be established, and the identified evacuation routes should be analyzed against predicted climate change impacts vulnerability to climate change projections such as increases in SLR, heat and precipitation to determine the vulnerabilities under increased climate change scenarios. Highly vulnerable portions of the evacuation routes should be prioritized for resilience improvements. The analysis and planning activities should be conducted on the hyper-local neighborhood scale to ensure specific needs of each community are included in the analysis. Planning and assessment should engage the State Mobility Ombudsmen Program and paratransit companies.
Completion Timeframe	3-5 years
Implementation Entities	CTDOT, CTDEMHS, COGs, Municipalities
Climate challenges addressed	Climate impacts including SLR, coastal storm surge, riverine flooding and increased precipitation events will have a significant impact on the state's road network and the ability of residents to safely evacuate vulnerable areas. The identification and prioritization of evacuation routes across the state will allow for more coordinated planning and implementation for improving the routes that will be increasingly needed as coastal and inland storms increase evacuation needs across the state.
Protection of vulnerable communities	Vulnerable communities may have greater difficulty evacuating and thus are more dependent on certain infrastructure. Building upon the vulnerable community assessment being conducted by the EEJ Working group, the evacuation route database should include information on the vulnerable communities relying on the identified routes. Additional information regarding the transit dependent portions of the identified EEJ communities is a critical dataset to better understand the evacuation resources necessary to ensure the safety of all residents. This planning needs to be conducted within each specific community at a neighborhood scale including a significant amount of public participation. Often, EJ communities are note represented in these types of planning efforts and therefore their specific needs are not incorporated into the planning. Required hyper-local planning also provides the community with ownership of plan and a better understanding of how the planning work is then used to implementation resiliency measures.
References for action	

Recommended Implementation Action Title T-3. Conduct vulnerability assessment using standard methodology on all publicly funded transit operations and facilities, and infrastructure for use by pedestrians, bicycles and people with disabilities.	
Recommended Implementation Action Description	The transit focused vulnerability assessments will focus on the both operations (routing/rail lines) and transit facilities including rail yards, bus depots, rail stations, bus stations, control centers and any other facilities critical to transit operations, as well as paths and related infrastructure for use by pedestrians, bicycles and people with disabilities. Climate related impacts such as vulnerability to projected increases in SLR, heat and precipitation will cause disruptions in transit service and affect ability to use facilities designed for pedestrian, bicycles and people with disabilities across the state. Bus transit route planning will need to utilize the assessments to better understand the deficiencies in their current routing and modify the routes for increase resilience. Additionally, transit planning needs to address how increased high heat days will impacts transit users, specifically as it relates transit users waiting for a bus without any shelters to provide shade. Transit users also face impacts owing to increased frequency of downpours and severe weather. Vulnerabilities in the state's rail lines, storage and maintenance facilities will have a significant impact on operations. The utility infrastructure providing the electrified rail lines is also critical to continued operations. Pedestrian paths and bridges may require modifications to design and use, particularly in flood prone areas.
Completion Timeframe	3-5 years
Implementation Entities	CTDOT, Amtrak, MetroNorth, CT Transit, CIRCA, non CTDOT public transit operators.
Climate challenges addressed	The vulnerability assessment will analyze SLR, storm surge and inland flooding and its impact on transit operations. This will include daily tidal inundation as well as coastal and inland related flooding events. This action does not directly reduce carbon emissions, but resilient transit operations reduce the number of single occupancy vehicles on the road thereby reducing overall carbon emissions for the state. Increased high heat days will likely effect transit users ability to use transit services without adequate sheltering infrastructure. Additional analysis should also be conducted on the rail lines to determine their vulnerability extreme high heat.
Protection of vulnerable communities	Many of the state's vulnerable populations are dependent on transit system and pedestrian/bicycle paths for commuting to and from work, accessing shopping and many other critical daily uses. As such, a more resilient, continuously operating transit system and pedestrian/bicycle infrastructure is necessary to ensure these vulnerable communities and populations have ongoing access to jobs and services throughout the state.
References for action	

Recommended Implementation Action Title	
T-4. Identify geographically isolated communities due to limited ingress/egress resulting from coastal and inland flooding events using 2050 SLR, storm surge and inland flooding predictions.	
Recommended Implementation Action Description	The road network is essential for providing safe ingress/egress to vulnerable communities across the state. Communities with limited ingress/egress, especially those identified through the EEJ assessment of vulnerable communities, should be identified through a comprehensive and standardized assessment process. This assessment needs to be conducted on the hyper-local, neighborhood scale to ensure the specific needs of each community are identified and addressed. The initial identification of potentially isolation communities should then be incorporated municipal and statewide evacuation planning. This planning work needs to incorporate both high intensity precipitation events, coastal and inland storms and blue sky tidal inundation.
Completion Timeframe	3-5 years
Implementation Entities	CIRCA, DEMHS, Council of Governments, Municipalities, Transit Districts
Climate challenges addressed	The identification of potentially isolated communities will analyze SLR, storm surge and inland flooding, including flood depths for statewide assessment of at risk neighborhoods. This action does not directly reduce carbon emissions but provide local and state officials with a better understanding of how the existing road network will function under climate change impacts.
Protection of vulnerable communities	The mapping of vulnerable communities by the Equity and Environmental Justice Working Group should be included in this identification process, especially related to early evacuation planning and response. The planning and analysis conducted in the identified EJ communities needs to be done at the neighborhood scale to ensure that the specific needs of each hyper-local community fully addresses the current uses and includes buy in and feedback from the entire community.
References for action	

Recommended Implementation Action Title	
T-5. Continue to pursue best available science for updating standards and guidelines used in transportation engineering design; including sources of sufficient confidence, specificity, acceptance and scale for CT/northeast region	
Recommended Implementation Action Description	Action is relevant to infrastructure durability and longevity, and compliments natural hazard mitigation planning. Continue working with federal and state partners to update sources of data inputs to bring those sources up to the present. After identification by and acceptance of Science and Technology Working Group's future climate change projections for CT, those projections should be evaluated in terms of updates to data inputs used when applying standards and guidelines.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Periodically. Standards and guidelines that are revised through multi-state or state-federal collaboration are reviewed and revised on schedules set by the jurisdictions participating. • 2 years for standards/guidelines on Stream flow (collaboration with lead agency USGS) for ungauged streams, update to CT version of "StreamStats" (point-and-click regression equations)
Implementation Entities	CT DOT generally, plus partnership with participating jurisdictional federal agencies, other state DOTs, and American Association of State Highway and Transportation Officials (AASHTO).
Climate challenges addressed	Intended to address the climate change impacts that are most likely for CT or the northeast region. Reduction or increase in carbon emissions is unknown.
Protection of vulnerable communities	Updating standards and guidelines to continue to incorporate best available science protects vulnerable communities by infrastructure durability and longevity, as well as minimizing impacts in project areas.
References for Action	NCHRP 15-61 (Kilgore, et al., 2019), Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure Pending NCHRP/TRB Research: - Project 20-44(23), "Pilot Test of Climate Change Design Practices Guide for Hydrology and Hydraulics," and - Project 15-61A, "Updates to the Design Practices Guide for Applying Climate Change Information to Hydrologic and Coastal Design of Transportation Infrastructure."

Recommended Implementation Action Title	
T-6. Create a statewide GIS database of culverts, flood gates, tide gates and other water control structures that restrict flow. Develop a framework for continued identification and documentation of such structures.	
Recommended Implementation Action Description	Water management systems provide resilience but can also be the choke points that increase flooding when not properly maintained. There is currently no state-wide database with the locations of these flooding control measures which are necessary for more accurate localized modeling.
Completion Timeframe	Less than 2 years to create database and framework; identification and documentation is a long-term process.
Implementation Entities	CTDOT, CTDEEP, CIRCA, Municipalities
Climate challenges addressed	Flood control systems are necessary to moderate the flow of tidal and inland water courses and can help mitigate flooding events. However, increases in SLR, storm surge and inland flooding can overwhelm these systems reducing their functionality and potentially increasing flooding.
Protection of vulnerable communities	A statewide database of flood and water control systems will ensure more accurate assessment of vulnerabilities for all communities, including those identified by the EJ working group. Many of the vulnerable communities across the state are in flood prone areas that include flood control measures, a database of these systems will enable more detailed and accurate modeling for climate change vulnerabilities communities. This increased accuracy will allow for better planning and implementation of mitigation measures.
References for action	State Natural Hazard Mitigation Plan, 2019; HVA Culvert Assessment Program; North Atlantic Aquatic Connectivity Collaborative Database search page; Wozniak-Brown, Joanna. "Rural Resiliency Vision and Toolkit." April 2019. Available at https://resilientrural.com

Land Use & Buildings:

Recommended Implementation Action Title	
LUB-3. Establish Connecticut community resilience program.	
Recommended Implementation Action Description	The program would ensure consistent and comprehensive approach to accelerate greater local to state resilience to extreme weather and other climate related impacts, with a focus on more resilient development, land use and building practices. It would provide technical assistance to municipalities and COGs on resilience actions. It would include activities and actions that relate to inland and coastal, urban and rural, towns and cities, across Connecticut. It would address both short-term and long-term impacts of climate change. It would also endeavor to bring together all relevant planning documents and local stakeholders. This effort should prioritize vulnerable populations who may not have the resources to self- evacuate in an emergency.
Completion Timeframe	Less than 2 years to initiate the program and 2-4 years for implementation.
Implementation Entities	CGA, CT DEEP, OPM, CTDOT, CT DOH, Municipalities, COGs, CIRCA, Eastern CT State University Sustainable CT, DPH, local Health Directors, CT SeaGrant, Uconn CLEAR (AdaptCT), NGOs
Climate challenges addressed	The overall resilience program will incorporate climate related impact into the planning process initially using a planning horizon of 2050. The SLR, storm surge, inland flooding and temperature extreme predictions downscaled by CIRCA and others will be incorporated into the program to ensure a standardized analysis across the state. In addition, the program would analyze the potential impacts of other issues including increased severe storms, tornados, high wind events and microbursts.
Protection of vulnerable communities	The program would require significant, localized public engagement and participation from the communities identified as part of the EEJ working group vulnerable communities mapping project. Neighborhood scale planning, especially in vulnerable communities, is essential to ensure the needs of these communities are fully incorporated into the planning process. Fully inclusive public engagement provides a foundation for the continual engagement. Ongoing outreach is necessary when planning for the dynamic impacts of climate change.
References for action	Massachusetts Municipal Vulnerability Program; Climate Smart NY; Sustainable CT; The Nature Conservancy Municipal Resilience Program https://www.communityresiliencebuilding.com/ ; Resilient Rhody https://www.riib.org/mrp DPH programs that work on weather and climate impacts Resilient Design Institute - www.resilientdesign.org AIA Resilience and Adaptation Initiative - www.aia.org /pages/2906-aias-resilience-and-adaptation-initiative

Recommended Implementation Action Title	
LUB-5. Convene a Task Force including representatives and stakeholders from state agencies, municipalities and non-governmental organizations to review relevant planning documents, evaluate alternatives and develop a proposal to address needs related to ownership, operation and maintenance of resilience structures.	
Recommended Implementation Action Description	Resilience structures such as flood walls and tide gates exist across the state and new projects are and will be proposed. A mechanism for supporting ownership, long-term operation and maintenance of infrastructure solutions implemented for purposes of increased resilience is needed. Federal grants do not provide funds for O&M so this responsibility has to be taken on by the grantee. A state agency/authority could assume responsibility for operating and maintaining structures and systems, providing sustained funding and expertise, and potentially owning resilience structures. Alternatively, municipalities could fulfill this role with increased authority and funding. This is an important companion to the recommended municipal community resilience building program recommendation.
Completion Timeframe	Less than 2 years
Implementation Entities	CGA OPM, DAS, DEEP, DOT, DECD, municipalities, NGOs, COGs, DPH, Local Health Directors
Climate challenges addressed	As sea level rises and precipitation patterns change there are likely to be increasing demands for structures and systems to provide protection from coastal and inland flooding. The need for O&M support has emerged in the context of large-scale projects in planning stages in Bridgeport and New Haven as well as smaller scale structures such as tide gates and public living shoreline projects. These structures and systems would enhance resilience for existing vulnerable developed areas and infrastructure. Municipalities may lack the resources to provide O&M and in some cases the solutions implemented may be multi-jurisdictional requiring support at a regional level.
Protection of vulnerable communities	Vulnerable communities often located in flood prone areas and financially distressed urban communities may be particularly challenged to provide for the O&M needs of resilience structures and systems. For example, the Resilient Bridgeport project currently being planned will increase the resilience of the South End community.
References for action	http://mgaleg.maryland.gov/2020RS/Chapters_noln/CH_236_sb0457e.pdf

Recommended Implementation Action Title	
LUB-8. Establish an Energy Efficiency and Healthy Homes (EEHH) Equity Fund to assist low to moderately low income households increase the energy efficiency and thermal comfort and safety of their homes and remove the indoor health barriers to efficiency upgrades such as weatherization.	
Recommended Implementation Action Description	Provide direct grants and incentives to LMI households for energy efficiency upgrades including the removal and remediation of the barriers to these upgrades. LMI households have limited utility budgets and are therefore most impacted by the immediate health effects of climate change effects such as extreme heat and cold. Energy upgrades can reduce utility budgets, improve indoor air quality (with significant health benefits) and provide comfort and safety throughout the year. LMI households often have less access to participate in healthy homes programs and related incentives, and it is important to note that LMI families do not typically live in sponsored affordable housing developments which must meet standards of efficiency and building quality. Furthermore, energy efficiency measures are often not possible or safe when there are barriers such as hazardous materials in the home including asbestos, mold, PCBs, or Lead Based Paint. It is also not safe to air seal homes when these and other hazards such as High Carbon Monoxide from combustible furnaces or appliances, radon gas vapor, natural gas leak encroachment are present. Improving energy efficiency for LMI households is not possible unless these health and safety barriers are also addressed. A holistic approach to the delivery of healthy home retrofits is needed.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • 1 year to establish EEHH Equity Funding Source • 3 years to meet 30% request, GHG - 2% reduction • 5 years to meet 50% request, GHG - 5% reduction
Implementation Entities	Utilities, Agencies, CGA, Municipalities, NGOs, CT-DOH, DPH, Local Health Directors
Climate challenges addressed	There is broad consensus on the importance of residential energy efficiency as key to GHG emission reduction. Residential direct energy use in Connecticut homes assumes 17.5 % all Carbon Emissions, that is in addition to the emissions created during the power generation phase of the cycle. We cannot achieve overall GHG emission reduction goals or meet the state goal of Weatherization of 80% of households without addressing this critical need for LMI households.
Protection of vulnerable communities	This recommendation is in support of vulnerable communities.
References for action	https://efficiencyforall.org/wordpress/wp-content/uploads/2017/04/h1801.pdf Green and Healthy Homes Initiativehttps://www.greenandhealthyhomes.org/wp-content/uploads/GHHI-Weatherization-Health-and-Safety-Report1.pdf Environmental Defense Fund https://www.edf.org/sites/default/files/documents/liee_national_summary.pdf Energy-Plus-Health Playbook https://e4thefuture.org/groundbreaking-energy-plus-health-playbook-released/

Utility Infrastructure:

Recommended Implementation Action Title	
UI-5. UI-5. Update safe daily yield calculations and assess current drinking water quality measures/testing to understand and address climate change impact.	
Recommended Implementation Action Description	Existing safe daily yield calculations are based on outdated precipitation and use scenarios for the state's drinking water reservoirs. This is necessary to ensure adequate supply of state drinking water supplies. Water quality testing and protection measures need to be reevaluated and upgraded to match changing and predicted conditions and the new points of risk.
Completion Timeframe	Less than 2 years
Implementation Entities	CT DEEP, CT DPH, Executive Branch, CGA, Municipalities, NGOs, Academic Institutions, Relevant Utilities
Climate challenges addressed	Assuring safe and adequate drinking water sources and protecting raw water quality will sustain these supplies for vulnerable populations.
Protection of vulnerable communities	
References for action	Connecticut Climate Preparedness Plan (2011), pp. 14, 15

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Recommendations for Further Review in 2021

Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
UI-1	**Inventory and geo-locate vulnerable utility facilities and their service areas and overlay to prioritize vulnerable populations.**	This is the cornerstone piece of information necessary to prioritize points of greatest risk and necessary investment. Each utility has unique areas of potential interconnected risk. For example, the electricity infrastructure should distinguish between its transmission, distribution and generation assets. Likewise, drinking water infrastructure must consider both private and conventional water system points of risk. Similarly, fuel supply must consider storage, distribution, and transportation.
UI-2	**Require that all utility sectors be subject to statutory and policy-based directives that require the consideration of all projected climate change impacts in their planning**	The governance and regulatory requirements regulating different utility infrastructure sectors is inconsistent. Statutory and policy-based directives are critical to ensure the reporting of points of potential risk. By providing guidance as to the structure and the scope of vulnerability assessments, risk can be allocated appropriately between vulnerabilities within a sector and vulnerabilities compared sector to sector.
UI-3	**Confirm there is sufficient planning and resources for a unified disaster response and recovery across all seven utility sectors, this should include annual drills and communications strategies**	In a post-storm recovery scenario, chain of command and communication protocols are essential in ensuring rapid recovery of services to Connecticut communities. Vulnerability assessments should include the modeling of potential service interruptions and specify chain of command and communication procedures. Given the interconnectedness of utility infrastructure, it is necessary that there be prompt communication not only within a specific sector, but across all sectors.
UI-4	**Study the appropriate techniques for overall resiliency that balance the costs and climate benefits associated with different electric distribution strategies**	It is necessary to understand and compare the impacts of various protection strategies for overall resiliency including microgrids, undergrounding and other adaptive measures. We have to be in a position to holistically compare the tradeoffs associated with storm risk and the climate benefits to urban, suburban, and vulnerable communities.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
UI-6	**Identify and incentivize construction of high-priority water supply interconnections to improve resiliency**	To improve water supply resiliency, it is necessary to identify areas where water supply systems could be interconnected in response to regional water shortages. This type of planning and infrastructure will ensure regional water supply flexibility in a changing climate.
UI-7	**Assess viability and future needs for wastewater reuse strategies**	Significant volumes of water are presently being underutilized for some of their potential benefits. Potable, non-potable, and high-quality non-potable wastewater have the potential to provide the state with various benefits while preserving the highest value of potable resources.
UI-8	**Continued emphasis on resolution of chronic CSO over-flow conditions**	CSO over-flows create human health and environmental issues for Connecticut, particularly in vulnerable communities. With the increase in extreme rainfall events, CSO over-flows will continue to be a persistent problem.
UI-9	**Determine what dams are vulnerable to changing climate**	To properly understand the risk, it is necessary to evaluate the question of whether existing hydraulic capacity modeling is consistent with projected increased precipitation events.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
UI-10	**Identify and prioritize funding for critical infrastructure**	Utility infrastructures do not operate across a consistent business and governance models. Small water systems are known to be chronically short on the financial resources necessary to provide consistent water quality. Likewise, municipal wastewater infrastructure is also financially stressed and commonly relies on highly competitive Clean Water Act funding opportunities, which are insufficient to meet Connecticut's needs in the aggregate.
UI-11	**Evaluate standing advisory council for infrastructure in EEJ communities**	To ensure resiliency in vulnerable communities, local stakeholders should be engaged in the necessary planning and implementation processes to ensure community needs are recognized in all cases. Permanent advisory groups will ensure community interests are a fixed part of planning in utility infrastructure projects.
UI-12	**Price utility infrastructure risk correctly**	Given the known changes in climate and commensurate changes in probabilities for severely disruptive events to utility infrastructure, the cost of these interruptive events must be appropriately modeled and calculated to fully understand bonding priorities.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
UI-13	**Assess, plan for, and Implement actions to improve access to services and availability of electricity for people with disabilities, limited mobility or special medical needs.**	Storms or climate-driven changes such as increased frequency of extreme heat events may create conditions under which people with critical needs such as those with disabilities, limited mobility or special medical needs are unable to access essential services. Conduct an assessment of and develop a plan for addressing the needs of such vulnerable populations. The plan should include, but not be limited to: Utilities creating a priority list for community-dwelling people using electricity-driven devices for medical use; prioritizing programs for mobile solar panels, backup generators for people over 55+ and people with disabilities for prepared disaster events; creating electricity centers (similar to cooling centers) for people who will need electricity and internet for disability-related needs; promoting Smart 911 where people with disabilities can inform fire departments and first responders in advance of their needs; and creating solar outlets in neighborhoods, so if the power goes out, electricity can still be accessible for emergency needs.
LUB-1	**Establish state-wide storm water utility.**	Increased precipitation across the state will exacerbate existing storm water management issues. A state-wide utility would allow for watershed scale planning and implementation of storm water capture.
LUB-2	**Prioritize Low Impact Development to mitigate the effects of stormwater runoff, especially where combined sewer stormwater systems still exist.**	Low impact development, analyzed at a watershed scale should include BMPs for sustainable development, agriculture water, and drinking water treatment. Siting decisions should minimize the impact to climate vulnerable locations such as riverine flood plains, coastal flood zones, inundation prone areas, and erosion. There should also be a prioritization of 303d impaired watersheds, where LID will work in concert with storm water management to reduce impairments state wide.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
LUB-4	**Update State Building Code.**	The State Building Code should be modified to address resiliency measures including climate related impacts such as stronger storms, increased precipitation events, high winds, and increased temperatures and require construction materials and designs that mitigate these impacts. Address shelter-in-place measures such as sustainable building materials, reinforced structural design, passive survivability, and increased building elevation requirements for all critical activities with respect to 500 year base flood elevations. Increased storm water controls to be required or incentivized through either the state-wide regulations, local zoning regulations or requirements for the use of public funding. Update the State Building Code with additional amendments to the referenced International Energy Conservation Code (IECC) for new buildings with critical activities to require stricter building envelope and system efficiency requirements to both reduce carbon emissions and facilitate shelter-in-place. Require existing buildings at Level 3 Renovations to meet IECC for new construction except as waivered by the Office of the State Building Official. Incentivize alternate building energy strategies to reduce peak and annual energy demand such as passive cooling, daylighting, and solar thermal for projects with potential energy savings.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
LUB-6	**Incentivize and prioritize redevelopment of previously used sites within established neighborhoods, including Brownfield Remediation**	Low impact infill redevelopment includes promoting and prioritizing redevelopment and infill development in urban centers and village centers to preserve greenspace, offer housing and commercial opportunities to a diverse racial and socio-economic population, and reduce transportation impacts. Additionally, in less developed area conservation subdivisions should be required in local zoning to increase forest block side and reduce negative edge effects. Consider adaptive reuse and urban infill projects targeted to benefit a diverse group of racial and socio-economic households and communities. Increase incentives for brownfield remediation; require stricter standards for both state funded and private development for removal, consolidation, or in-situ treatment of historical contamination. Historic industrial and manufacturing uses throughout the state have created an abundance of underutilized development sites with significant levels of contamination. The underdeveloped sites decrease the ability for municipalities to enact infill development strategies or create more resilient environments through additional open space. Additionally, a significant portion of these site are located in or adjacent to EJ communities so these communities are negatively affected directly by the increased contamination levels and indirectly through decreased environmental resilience. Furthermore, the locations of many brownfield sites along the coastal and riverine areas of the state further exacerbate their vulnerabilities to climate change through increased inundation and transport, salt water intrusion and storm water capture. This action would prioritize the remediation of these contaminated sites, focusing on those in or near EJ communities to standards that would allow for redevelopment or the creation of resilient open space.

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Cat#	Recommended Implementation Action Title	Recommended Implementation Action Description
LUB-7	**Inventory, assessment, and prioritized protection of currently undeveloped land.**	Preserve undeveloped land including, but not limited to, natural lands, parks, floodplain, salt marshes, headwaters, watershed areas, and riparian zones which currently provide immediate and ongoing protection for people and the built environment. The assessment will include the identification of ecosystem services for the undeveloped areas. The prioritization will evaluate the separate areas for their immediate and long-term vulnerabilities to climate related impacts. The CT Green Plan and open space funding should prioritize conservation and acquisition of habitats at highest risk to climate change and those with populations at highest risk of danger.
T-1	**Conduct vulnerability assessment using standard methodology on the entire road and pedestrian/bicycle network using 2050 estimates.**	The road and pedestrian/bicycle network vulnerability assessment will analyze the systems vulnerability to climate impacts such as SLR, storm surge and inland flooding. The assessment will allow for state-wide prioritization of improvement projects to address the deficiencies in the system. The assessment needs to include both roads, bridges, and pedestrian/bicycle infrastructure initially at a screening level with more in-depth analysis for the most vulnerable areas. The analysis will include assessment of the connections between the road network and critical facilities, including not limited to hospitals, emergency shelters and utility infrastructure.

Notes and References

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[iv] O'Donnell, J. (2019). Sea Level Rise in Connecticut Final Report. UConn Connecticut Institute for Resilience and Climate Adaptation. https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/10/Sea-Level-Rise-Connecticut-Final-Report-Feb-2019.pdf

[v] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

[vi] Liu, C., Jia, Y., Onat, Y., Cifuentes-Lorenzen, A., Ilia, A., McCardell, G., Fake, T. and O'Donnell, J. (2020) Connecticut Coastal Towns Storm Surge and Significant Wave Height Dataset, (v.1), [Plots and Data File], University of Connecticut, Connecticut Institute for Resilience and Climate Adaptation, Retrieved from https://resilientconnecticut.uconn.edu/resources/datasets/connecticut-coastal-towns-storm-surge-and-significant-wave-height-dataset/