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

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Introduction and Process

Climate change adaptation and resilience uses data and planning to create a natural and built environment more resistant to and better prepared for the changing climate. As originally formatted in early 2020 the Adaptation and Implementation Work Group, focusing on hyper-local to statewide resilience, was comprised of four subordinate working groups:

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

As the sub-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 subgroup consisted of subject matter experts from the public, private and non-profits sectors. Through the spring and summer of 2020, the subgroups collectively held nearly 25 meetings at which all members discussed the many topics related to each subgroup focus area. Although the COVID-19 pandemic limited the ability to meet in person and provide public in person public forums, the process included a robust inclusion of direct public commentary during many of the meetings.

The initial work of each subgroup centered on defining their respective scope and vision and reviewing relevant work products and sources. With a more specific scope and vision, each group began developing recommendations which were discussed and refined several times within the subgroup and the larger working group.

A draft list of recommendations was presented to Equity and Environmental Justice (Vulnerable Communities) work group on August 18, 2020. The substantial and valuable feedback from the EEJ members provided better understanding on the substance and the priority of many of the recommendations.

The Infrastructure and Land Use draft report was released for public review on September 22, 2020 and was presented and discussed at a public forum on October 5, 2020. The public comment period continued until October 21, 2020. Written comments received during the public comment period as well as those raised during the public forum were compiled. As was done throughout the planning process, the comments received were used to further refine and revise the recommendations for the final draft.

Adaptation planning and implementation is a constantly evolving process requiring sustained and deliberate ongoing research, stakeholder engagement and adaptive planning. The list of recommendations contained in this report represent the first phase of the GC3 with additional work continuing throughout 2021. Many valuable comments, suggestions and questions were raised during the public review and comment period. The Working Group carefully considered

all public input and in some cases the recommendations were revised accordingly. Many of the public submissions will need additional discussion and research and were incorporated into a list of “Additional Topics for Further Consideration”, included at the of the report. These topics will help to guide the ongoing deliberations of the GC3 moving forward.

Vision

Climate change adaptation is an investment in Connecticut's future, enabling us to improve resilience for acute and long-term stressors, 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.
- Equitable and accessible transportation network for all Connecticut residents

Land Use & Buildings

- Conservation and development practices at all scales, from neighborhood to statewide.
- Locate 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.
- 7 utility infrastructure themes; Communications, Fuel, Drinking Water, Waste Water, Electricity, Stormwater & Flood Control, Dams; recognizing the 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

Connecticut's climate is changing 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 (SLR), 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 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 to increase thereafter. In the longer- term, SLR may be as much as 3 to 7 feet by 2100, though projections differ significantly, based on the magnitude of future 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.

In the near term, the 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 coastal areas will be a major challenge for infrastructure and land-use.

Air Temperature: Since 1895, Connecticut's annual average air temperature has been increasing by 0.3°F per decade, totaling 3°F warmer 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 the Intergovernmental Panel on Climate Change's (IPCC) 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 about (~) 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 is unclear and 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 measurable 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. 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 initially proposed recommendations require additional discussion, evaluation and stakeholder engagement are needed before they can move forward. These recommendations are briefly summarized in the table "Recommendations for Further Review in 2021". One Recommended Implementation Action, LUB-9, was added following the public comment period.

There were several public comments received that the Working Group generally agrees with, though were hard to fit into the frame of climate change adaptation/resilience. Many of these comments are being addressed, in whole or part by the Mitigation Working Group. Some other comments recommended specific actions that the Working Group determined are already covered under a broader existing recommendation, so are deemed included though no change was made to the existing language.

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, public health professionals, COGs, CIRCA, NGOs, Water Planning Council; representatives from other critical stakeholders particularly 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, Council of Governments, Municipalities
Climate challenges addressed	Climate impacts including SLR, coastal storm surge, riverine flooding and increased precipitation events will have a significant impact on portions of the state and local 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 not 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	Commonwealth of Massachusetts Statewide Evacuation Coordination Plan (2019), FEMA Planning Considerations: Evacuation and Shelter-in-Place.

Recommended Implementation Action Title	
T-3. Conduct vulnerability assessment using standard methodology on all publicly funded transit (bus and rail) operations and facilities, and infrastructure for use by pedestrians, bicycles and people with disabilities.	
Recommended Implementation Action Description	The public transit vulnerability assessments will focus on operations (routing/rail lines) and transit facilities including rail yards, bus depots, rail stations, bus stations, control centers and any other facilities critical to public 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 some disruptions in public 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 may 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 affect 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. While the availability and accessibility of transit and pedestrian/bicycle access is important for all, populations of special concern include people of low income, teenage and adult non-drivers, and people with disabilities. 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	North County Transit District Threat and Vulnerability Assessment

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 non-storm 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 provides 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, evaluate those projections 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 federal agency United States Geological Service) 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), and related research entities.
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	National Cooperative Highway Research Program (NCHRP) 15-61 (Kilgore, et al., 2019), Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure Pending NCHRP/TRB (Transportation Research Board) 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 and water flow structures that are intended to restrict flow (or unintentionally do). Develop a framework for	
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, Council of Governments
Climate challenges addressed	Flood control systems are necessary to moderate (or allow) 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 facilitate dialogue amongst state, regional 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, TNC, Municipalities, COGs, CIRCA, SustainableCT, 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 at ECSU; TNC's Community Resilience Building Program – www.CommunityResilienceBuilding.org; Resilient Rhody and State of Rhode Island Municipal Resilience Program 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

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. The approach for removal of barriers must take into account the safety of workers, residents and the community, and existing regulatory controls.
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/

Recommended Implementation Action Title	
LUB-9. Reduce stormwater pollution and flooding, and help municipalities afford green infrastructure and resiliency investments, by passing statewide enabling legislation for stormwater authorities.	
Recommended Implementation Action Description	Authorize municipal governments, through new legislation, to establish municipal stormwater management authorities or similar. The stormwater authority would provide municipalities the ability raise revenue related to stormwater management that can be used to finance flood mitigation efforts and green infrastructure improvements.
Completion Timeframe	1 year to 2 years to pass legislation and provide guidance on the establishment of the local authority.
Implementation Entities	CGA, Municipalities, CTDEEP
Climate challenges addressed	Increased several rain events, increased local flooding.
Protection of vulnerable communities	This recommendation is in support of vulnerable communities.
References for action	

Utility Infrastructure:

Recommended Implementation Action Title	
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, such as potential for contaminants such as PFAS (or others) to enter drinking water supplies during flood events. Any such changes will be based on best available science and modeling, be consistent with the State Water Plan and other relevant water supply planning processes, and consider other environmental, social and economic impacts.
Completion Timeframe	Less than 2 years
Implementation Entities	CT DEEP, CT DPH, public health professionals, Executive Branch, CGA, Municipalities, NGOs, Academic Institutions, Relevant Utilities, WUCCs
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

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. Security concerns must be considered in planning for dissemination of the assembled data.
UI-2	**Require that all utility sectors be subject to statutory and policy-based directives that require the consideration of relevant 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. Planning should address management and oversight of utilities during recovery from an emergency.
UI-4	**Study the appropriate techniques for overall resiliency that balance the costs and climate benefits associated with different electric generation, transmission and distribution and telecommunications strategies**	It is necessary to understand and compare the impacts of various protection strategies for overall resiliency including microgrids, undergrounding and other adaptive measures. The study will include evaluation of strategic undergrounding of electric transmission and distribution. 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. The assessment should address the potential impacts to the environment, including trees, (Ref. https://stormwise.uconn.edu/) as well as social and economic impacts and risks associated with various strategies.

Recommendations for Further Review in 2021		
Cat#	**Recommended Implementation Action Title**	**Recommended Implementation Action Description**
UI-6	**Identify the potential resiliency benefits 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. Such planning will be consistent with the State Water Plan and other relevant water supply planning processes, and consider other environmental, social and economic impacts.
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.

Recommendations for Further Review in 2021		
Cat#	**Recommended Implementation Action Title**	**Recommended Implementation Action Description**
UI-10	**Identify and prioritize funding for all critical utility infrastructure**	Utility infrastructures do not operate across a consistent business and governance models. Funding sources across these sectors may include rate-payers, market-based consumer pricing, government grant or loan funds, and/or private market financing. Small water systems are known to be chronically short on the financial resources necessary to provide consistent water quality. Municipal wastewater infrastructure is also financially stressed and commonly supported by grant and loan funding opportunities, which are insufficient to meet Connecticut's needs in the aggregate. Fuel and telecommunications are primarily driven by consumer pricing, which may not adequately address emergency situations or equity considerations.
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.

Recommendations for Further Review in 2021		
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 and other essential utilities 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 will consider the needs of vulnerable populations, the risks posed by climate change impacts and the interrelationships of the various utility sectors; and will identify actions such as alternative sources of electricity, prompt restoration of utility services and options for providing accommodations to serve critical needs in the short-term during outages.
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. Evaluation of this approach should consider potential issues of local acceptance of such a centralized approach, and should evaluate alternatives such as informal collaboratives.
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.

Recommendations for Further Review in 2021		
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. Update should be done working through the established SBC adoption process and should prioritize adoption of the 2021 International Building Code. 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.

Recommendations for Further Review in 2021		
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.

Recommendations for Further Review in 2021		
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.

Additional Topics for Further Consideration

1. Increase Green Infrastructure and Nature-based solutions funding and encourage implementation as a primary solution to flooding and stormwater management.

2. Funding and technical assistance to municipalities for improving resiliency and hardening infrastructure

3. Requiring climate resilient practices on State properties

4. Utility Infrastructure should be separately studied within each of the seven utilities, and then the interrelationships among them and with Transportation and Land Use could be more effectively addressed. Specify the nature and extent of the interconnections between utility sectors. Better address the central role of electricity in all of the "theme areas," not only utility infrastructure, but transportation and land use & buildings. Give consideration to the risks that may be heightened due to the interrelationships among the separate utility infrastructures.

5. As part of UI-10, consider drinking water financing tools: grant/loan forgiveness as a component of DWSRF and CWF, DWSRF funding for work on water supply dams, DWSRF or other funding to support interconnections; Infrastructure Bank to fund infrastructure improvements.

6. Low Impact development. More needs to be said on this topic. Low impact development is a broad concept and needs more specificity to be meaningful.

7. Energy Efficient Patterns of Development: Encourage energy-efficient patterns of development, the use of solar and other renewable forms of energy, and energy conservation.

8. Importance of higher density development strategies that reduce infrastructure costs and costs of services. Discourage the extension of critical infrastructure into areas expected to be impacted by Sea Level Rise or increasing storm. Importance of steering urban infrastructure away from areas where development should not occur since it would exacerbate future flooding or be inconsistent with our long term need to reduce investment in areas that will be ceded over to the rising sea.

9. Transfer of Development Rights: Encourage innovative applications of transfer of development rights along coastal Connecticut or even along riparian corridors in inland areas of our state as a means to de-emphasize growth along the sea coast and transfer those development rights to inland municipalities that might be amenable to a joint venture strategy.

10. Revise CGS 8-23 "Section 8-23 - Preparation, amendment or adoption of a plan of conservation and development" to include climate change as a required consideration. These could include restriction development in flood zones, encouraging conservation areas in flood zones, managing heat islands, etc.

11. The state POCD should incorporate climate change into its priorities,

especially in funding priorities and designation of growth areas.

12. While FEMA does not require climate change to be considered in Natural Hazard Mitigation Plans, the State should mandate it in local POCDs through agency policy or enabling statute.

13. Create multi-generational capital improvement plans for infrastructure projects. Plans of Conservation and Development and Natural Hazard Mitigation Plans operate on ten- and five-year scales, respectively. Large scale infrastructure requires planning, construction, and maintenance beyond those time-scales.

14. Land use data, such as parcels and planimetric information, should be standardized across the State with funding and technical assistance provided to municipalities and COGs to undertake the effort, similar to Massachusetts and New York.

15. Develop an implementation plan for LUB-3 Community Resilience Building Program.

16. Following completion of transportation vulnerability assessment pursuant to T-1 andT-3, undertake transportation planning that considers options for adaptation measures to protect facilities (e.g., elevation) and relocation away from vulnerable areas. Planning should also consider climate mitigation goals, such as reducing emissions by increased use of freight rail, electrification, and pedestrian/bicycle infrastructure.

17. Consider the extent to which evacuation routes will become an opportunity for transit-oriented development, especially in upland areas.

Notes and References

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