Report to the Connecticut Governor's Council on Climate Change

Prepared By: Public Health and Safety Working Group

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LIST OF ACRONYMS

AFN	Access and Functional Needs
BRACE	Building Resilience Against Climate Effects
CADH	Connecticut Association of Directors of Health
CAES	Connecticut Agricultural Experiment Station
CBO	Community-Based Organization
CDC	The Centers for Disease Control and Prevention
CEAP	CT Energy Assistance Program
CEHA	CT Environmental Health Association
CIRCA	Connecticut Institute for Resilience and Climate Adaptation
CWSRF	Clean Water State Revolving Fund
COG	Council of Governments
Conn-OSHA	CT Occupational Safety and Health Administration
COWRA	CT Onsite Wastewater Recycling Association
CWS	Community Water System
DEEP	CT Department of Energy and Environmental Protection
DEMHS	CT Department of Emergency Management and Homeland Security
DESPP	CT Department of Emergency Services and Public Protection
DMHAS	CT Department of Mental Health and Addiction Services
DWSRF	Drinking Water State Revolving Fund
DoAG	CT Department of Agriculture
DOH	CT Department of Housing
DPH	CT Department of Public Health
DSS	CT Department of Social Services

DWS	Drinking Water Section
EDSS	Electronic Disease Surveillance System
EEEV	Eastern Equine Encephalitis Virus
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GC3	Governor's Council on Climate Change
GSC	Governor's Steering Committee on Climate Change
HAB	Harmful Algal Bloom
HUD	US Department of Housing and Urban Development
HRI	Heat-related Illness
LEOP	Local Emergency Operations Plan
MOU	Memorandum of Understanding
NCCOS	NOAA Centers for Coastal and Ocean Science
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OPM	CT Office of Policy and Management
PHS WG	GC3 Public Health and Safety Working group
PURA	CT Public Utilities Regulatory Authority
PWS	Public Water System
RCP	Representative Concentration Pathway
SRF	State Response Framework
WNV	West Nile Virus
WUCC	Water Utility Coordinating Committee
UConn	University of Connecticut
VBD	Vector-borne Disease

STATEMENT OF SCOPE

The scope of work of the Governor's Council on Climate Change (GC3) Public Health and Safety Working group is the suite of planning and implementation actions needed to address present-day and foreseeable threats to the protection and improvement of the health and safety of all people of Connecticut associated with climate change, with a focus on health equity. Health equity means that everyone has a fair and just opportunity to attain his or her full health potential, and that no one should be disadvantaged from achieving this potential because of income, race, ethnicity, physical status, exposure to environmental contaminants, social position or other socially determined circumstance.

As a GC3 Working group, we recognize dynamic challenges to the promotion of health equity and public health and safety attributable to climate change through at least 2050 in the absence of long-term adaption and resilience planning, and our scope thus also includes the coordination and facilitation required for such planning. These challenges include, but are not limited to, impacts and costs associated with additional Emergency Department visits, hospitalizations, and deaths, as well as a lowered quality of life and increasing social inequality due to the threats of more extreme weather, warmer temperatures, degraded water and air quality, and sea level rise. The social determinants of health are key factors affecting individual and community resilience to climate change impacts. As such, populations most vulnerable vary by location but include: people living with chronic health conditions or disability; people of low wealth, people of color, children and the elderly.

Along with this focus, we acknowledge the influence of the interdependence between people, animals, plants, and their shared environment on optimal health outcomes.

REPORT OVERVIEW

This report provides a broad overview of the impacts of climate change on health and safety of people in Connecticut. It draws upon national, regional, and state-level assessments and scientific studies that have been conducted over the past decade on the impacts of climate change on public health and safety, as well as adaptation and resilience strategies to limit these impacts. It was developed as the first formal work product of the GC3 Public Health and Safety Working group to align with mandates put forward by Executive Order No. 3 to identify, by January 15, 2021, recommendations for adaptation based on the best available, locally-scaled data with prioritization of vulnerable communities (CT Executive Order No. 3 2019). It is comprised of two sections: Section 1 provides an update on the recommendations put forward by the Public Health Working group as part of the Connecticut Climate Preparedness Plan in 2011. Section 2 describes the statements of health impacts of climate change by health impact domain, as outlined in the 2016 report The Health Impacts of Climate Change on Human Health in the United States: A Scientific Assessment (Crimmins et al. 2016).

Both sections of the report were developed by Working group members during the spring and summer of months of 2020 coincident with the COVID-19 pandemic and the extensive response to the pandemic by state agencies. Limited availability of state resources associated with this response resulted in limitations to the comprehensiveness of this report. In particular, the coordination to develop a full set of recommendations addressing the impacts on mental health and well-being of climate change was not possible, as well as a full assessment of the impacts of climate change on nutrition and food security in our state. For this reason, additional work to develop recommendations to address these important health impact domains will be prioritized during Phase II of GC3 activities,

scheduled for 2021 in advance of the final report of the Council for December 31st of that year (CT Executive Order No. 3 2019).

Many recommendations of this report will require funding for staff resources to adequately implement the identified action items. A few examples that will require funding for staff resources:

1. develop, organize and implement the Blue-Ribbon Commission to address extreme heat,
2. address additional work concerning the increased threat of vector borne disease, and
3. coordinate, track and implement within DPH the numerous public health related implementation actions.

Further, many of the recommendations will require funding to support project development such as GIS mapping or for implementing new legislation. It is recognized that funding will be necessary in order to implement many of the report's recommendations. Once public comment is received and the Report is fully vetted by the Working group and its various teams that assisted to develop the recommendations, a process to develop a budget will be undertaken.

SECTION 1. REVIEW AND SYNTHESIS OF THE RECOMMENDATIONS IN THE 2011 CLIMATE CHANGE ADAPTATION AND PREPAREDNESS PLAN AND SUBSEQUENT PLANNING PROCESSES

The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (GSC) was formed in 2010 under Public Act 08-98. During 2010 and 2011 four working groups developed recommendations. A statement of impacts of climate change and recommendations to prepare for such impacts were included in two documents; The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health (Adaptation Subcommittee of the Governor's Steering Committee on Climate Change 2010) and Connecticut Climate Change Preparedness Plan (Adaptation Subcommittee of the Governor's Steering Committee on Climate Change 2011).

The Preparedness Plan included 18 recommendations for protection of public health in Connecticut under future climate scenarios. In the absence of a designated state entity tasked with implementing the recommendations, progress during the intervening decade to address and implement them has been slow. For those recommendations concerning which progress has been made, there is no institutional framework to identify what was achieved.

The Public Health and Safety Working group has reviewed the 18 recommendations from the 2011 Preparedness Plan. Each recommendation was evaluated within the context of the core function of state and quasi-state agencies. Below is a discussion of recommendations from the 2011 Preparedness Plan according to the original recommendations grouped by: 1) Best Management Practices, 2) Research, Monitoring and Education, or 3) Policy, Legislation, Regulation, or Funding.

Best Management Practices

Six Best Management Practices were recommended in the 2011 Preparedness Plan:

- Evaluate current early extreme weather events warning system and emergency response plans.

- Continue to develop and update all municipal emergency preparedness plans for extreme weather events
- Consider the health needs of vulnerable populations in climate change adaptation planning.
- Evaluate ozone non-attainment alert systems.
- Develop cooling station best management practices.
- Develop criteria for school closings and outdoor play during extreme heat events.

Work has been undertaken since 2011 that aligns with the first three of these recommendations that focus on evaluation of early extreme weather events warning systems and emergency response plans, municipal emergency preparedness plans, and vulnerable populations. With respect to the first recommendation for evaluation of extreme weather events warning systems and emergency response plans, Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security (DESPP/ DEMHS) have developed, over the course of the last decade, a comprehensive emergency response strategies consistent with national standards, as more frequent events including pandemics, human caused events and intense extreme weather events continue to tax the emergency management and public health infrastructure. Event warnings originate in CT DESPP/ DEMHS and are transmitted to CT State Agencies and non-profit partners via the Everbridge Mass Notification and Incident Communications System. The Everbridge System is used to notify all of Connecticut's public and private sector partners of upcoming naturally occurring or human caused events. DEMHS notifies its partners of an upcoming event and DPH notifies the local health departments, hospitals, and eldercare facilities and provides them with recommendations. Under the direction of the Unified Command System, the State, through a partnership with DPH, DEMHS, local health departments, Non-Profit partners, first responders and hospitals, evaluates the need for DEMHS

to activate the Emergency Operations Center under the guidance of the State Response Framework (SRF).

The SRF (CT's Response Plan) describes the interaction of the State government with local, federal, and tribal governments, non-governmental organizations, private sector partners, the media, and the public in implementing emergency response and recovery functions in times of crisis. In general, the SRF-describes how the State of Connecticut and its partners work together to support local governments and their residents in response to disasters and emergencies. The State of Connecticut follows up with enacting the State Disaster Recovery Framework, which is scalable to the scope and size of the event, providing a framework for state level support to local and tribal recovery efforts through partnerships with local, State, tribal, non-governmental, and federal organizations. The process for evaluation of this framework following each exercise or real-world incident requiring activation of the State Emergency Operations Centers is detailed in Appendix I.

The 2011 Preparedness Plan also recommended development and regular update of the municipal emergency preparedness plans for extreme weather events. Municipal Local Emergency Operations Plans (LEOPs) were overhauled in 2016, and municipalities have migrated to the new template provided by DEMHS at https://portal.ct.gov/DEMHS/Emergency-Management/Resources-For-Officials/Planning-For-All-Hazards/LEOP/Local-Emergency-Operations-Plan-Resources. The extent to which the new LEOPs include extreme weather events varies by municipality, but, at a minimum, the template does include references to severe weather events. Single and Multi-Jurisdiction Hazard Mitigation Plans prepared per the Disaster Mitigation Act address extreme weather events as required by FEMA and the State to qualify for funding. Hazard mitigation plans are updated every five years and at any given time a large number of the State's municipalities are working with the COGs (or on their

own) to develop updates. LEOPs and hazard mitigation plans have separate purposes, but they intersect in the area of preparedness. Municipalities typically identify public or private facilities that can be used by vulnerable populations as shelters before, during, and after extreme events. During the last few years, communities have taken a greater interest in which facilities can be used as warming and cooling centers, as distinct from community shelters. A DPH-CIRCA sponsored project currently underway aims to collect information on locations and management practices at cooling centers and disaster shelters throughout the state.

Incorporating the health needs of vulnerable populations in climate adaptation planning was also recommended for best practices. This recommendation included use of the Connecticut DPH Database of Vulnerable population Locations by Local Health Departments, plus consideration of vulnerable populations on flood-prone area and provisioning for vulnerable populations in climate adaptation planning. There was no truly concerted effort in identifying vulnerable populations due to climate change throughout the state, and the task was left to state agencies, local health, educational institutions and Community-based Organizations (CBOs).

The Connecticut Green and Healthy Homes Initiative is designed to explore safer and more energy efficient housing as a platform for improved health outcomes through comprehensive, evidence-based home interventions for people who were prone to injury due to falls (seniors and people with disabilities), living with uncontrolled asthma, and children under 6 years old living in homes with lead hazards (Connecticut Green and Healthy Homes Partners 2018). This partnership utilizes an integrative model to identify these vulnerable populations via Medicaid referrals for home interventions to reduce home hazards and healthcare costs and weatherization to reduce energy consumption and costs. The project seeks to retrofit older housing as well as explore the feasibility of passive housing structures for

low-income residents, resulting in long-term public sector cost savings. The project was entering its pilot phase - identifying two sites for these interventions and is currently seeking funding.

The Database of Vulnerable Population Locations was created with data provided by the Centers for Medicare and Medicaid Services and the Connecticut Department of Developmental Services. It was limited to areas with populations that receive services essential to maintaining an individual's health and well-being, such as personal care assistance for basic daily activities or home nursing care. The database was incorporated into the Connecticut Electronic Disease Surveillance System for use by local health departments from 2009 through 2015. This database is no longer active and the data are unavailable.

Since 2005, the CT Department of Economic and Community Development has maintained a Distressed Communities list that is based on "high unemployment and poverty, aging housing stock and low or declining rates of growth in job creation, population, and per capita income." (CGS 32-9p). This list is capped at the top 25 CT municipalities that have low indicators for per capita income, percent poverty, unemployment rate, percent older housing stock, percent educational attainment of high school degree or higher, per capita adjusted equalized net grand list; and percent change in population, employment, and per capita income. The state uses this list to target funds for programs such as housing, brownfields remediation, or open space.

The Urban Resources Initiative at Yale University has three programs to improve community impact, including Community Greenspace, GreenSkills, and Green Infrastructure.
Green Infrastructure program is geared to reduce flooding and pollution associated with stormwater runoff, while improving the water quality to rivers and creating work opportunities and job skills training to community members. In 2018, the program received the Roy Family Award for Environmental

Partnership from the Environmental and Natural Resources Program at Harvard's John F Kennedy School of Government.

Although some towns have undertaken climate change planning efforts, UConn CIRCA (Connecticut Institute for Resilience and Climate Adaptation), through the Resilient Connecticut project funded through the HUD National Disaster Resilience Competition, is conducting large-scale vulnerability assessments and resiliency planning within New Haven and Fairfield Counties. A core objective of the Resilient Connecticut program is to engage and address the needs of vulnerable and under-represented populations. It is expected that community outreach will be designed to have an equitable and inclusive approach aligning with the best practices described by the GC3 Equity and Environmental Justice Working Group. Coordination between CIRCA's planning team and the GC3 working groups is ongoing and will continue through 2021.

Although progress has been made to address three of the recommendations for Best Management Practices in Connecticut described above, we are not aware of work undertaken in the last decade to address the recommendations about ozone non-attainment alert systems, cooling station best practices, and guidelines for school closing and cancellation of athletic events due to extreme heat. These last three recommendations are incorporated into the new set of recommendations produced later in this report, and are thus of continued relevance and needed for adaptation and resilience planning in the state.

Research, Monitoring and Education

Nine recommendations for research, monitoring and education resulted from the planning for the 2011 Preparedness Plan:

- Incorporate climate change preparedness strategies into public health education.

- Intensify vector associated disease monitoring.
- Continue to monitor health ailments caused by ozone non-attainment levels.
- Increase airborne pollen monitoring.
- Develop a database of morbidity and mortality caused by climate change.
- Educate local health department staff on climate change impacts.
- Assist local health departments with climate change adaptation.
- Develop educational materials concerning poor air quality.
- Educate other sectors of state government about public health climate change impacts and adaption.

The first recommendation is to incorporate climate change preparedness strategies into public health education. Education is defined here as ranging from grade school health education to any public health curriculum. There have been annual efforts to require teaching about climate change; however, no bills have been enacted. Climate change in science classes as a standard for Connecticut's public education system is again under legislative review at the time of writing of this report, as Connecticut House Bill 5215. The state has also made progress to incorporate climate science into public education. DEEP is currently developing education materials on the impacts of climate change in Connecticut, and identifies Climate Change as a topic for development as part of its Environmental Curriculum (DEEP site ref). Incorporation of the public health impacts into such programs developed in coordination with DPH has not yet occurred, but to date, assessment of such impacts in the state is only in its earliest stage (DPH 2020; Bozzi and Dubrow 2020). CIRCA hosted a workshop on climate and health in Connecticut as part of its 2019 Resilient Connecticut Annual Summit and initiatives are underway for communications and webinars specific to this topic by CIRCA.

Monitoring vector populations is a critical component of vector-associated disease surveillance, and such efforts have intensified over the last decade in accordance with the first recommendation. The Connecticut Agricultural Experiment Station (CAES) in New Haven currently monitors: 1) vector populations for distribution, abundance and range expansion of existing mosquito and tick species, 2) introduction of exotic/invasive mosquito and tick vectors and associated diseases, 3) dynamics of activity of existing viral, bacterial and protozoan pathogens transmitted by mosquitoes and tick vectors to determine the risk of human infection, and 4) conducts investigations on mosquito and tick biology, ecology, and roles in disease transmission in order to target vector control interventions more effectively.

The CAES Mosquito Trapping and Arbovirus Testing Program monitors mosquito populations that transmit West Nile virus (WNV), a usually mild disease with flu-like symptoms, and the more deadly, eastern equine encephalitis virus (EEEV). Until recently, the program consisted of 91 mosquito trap sites around the state, which were monitored from June to October. In response to an unprecedented outbreak of EEEV in 2019, 16 additional trap sites were added to the program in areas adjacent to red maple and white cedar swamps where *Culiseta melanura*, the principal vector of the virus breeds, and where greater human and equine disease cases have been reported from surrounding communities.

In the United States, the number of reported cases of tick-borne diseases has more than doubled between 2004 and 2016, and over 90% of the nearly 60,000 nationally notifiable vector-borne disease cases reported in 2017 were transmitted by ticks. Monitoring tick populations in Connecticut has historically been conducted by the CAES Passive Tick Surveillance and Testing Program. This statewide program was established in 1990 and mandated to test the blacklegged tick, *Ixodes scapularis*, for *Borrelia burgdorferi*, the causative agent of Lyme disease. In 2015, the program expanded to include

testing for *Babesia microti* and *Anaplasma phagocytophilum*, the causative agents for babesiosis and anaplasmosis, respectively.

In recognition of increasing public health importance of the tick-borne diseases, the CAES initiated a state-wide Active Tick Surveillance Program in 2019 to complement the Passive Tick Surveillance and Testing Program and obtain additional information on the distribution and abundance of ticks and the prevalence of existing and newly emerging disease agents of human concern. Ticks are collected at 40 sites across all eight counties in Connecticut from April through October with a focus on the blacklegged tick. Other tick species tabulated and tested include American dog ticks, *Dermacentor variabilis*, the vector of Rocky Mountain spotted fever; the lone star tick, *Amblyomma americanum*, a southern species that is becoming established in Connecticut and parts of coastal New England; and the newly discovered invasive, exotic Asian longhorned tick, *Haemaphysalis longicornis*, a vector for the viral agent of severe fever with thrombocytopenia in humans, and other pathogens.

DPH currently monitors the public health threat caused by ozone non-attainment levels using the Connecticut Environmental Public Health Tracking Network, which is made possible through federal support. DPH and other public health partners use the data from the tracking system to adequately respond to the public health threat caused by ozone non-attainment levels. The Public Health Workgroup considers the public health threat from ozone non-attainment to be significant and likely to increase, at least in the short-term, due to climate change. Therefore, the Public Health and Safety Working group recommends to its federal public health partners that Connecticut receive the support necessary to continue to monitor the public health threat caused by ozone non-attainment levels.

There is still just one pollen monitoring station in Connecticut, as there was in 2011. It is important to note that many states have no pollen monitoring stations since there is no federal support

for such monitoring. The one station in CT is located at Waterbury Hospital and is funded in house by the hospital. This is one of the longest running monitoring stations in the country over the past 20 years. No progress was made since the 2011 report to increase the number of monitoring stations in CT as funding for such stations has not become available.

One recommendation calls for the development of a database of morbidity and mortality caused by climate change to better assess the impacts of climate change on public health. Multiple databases specific to morbidity and mortality associated with a range of climate-sensitive disease conditions are maintained by DPH. These include 1) the Electronic Disease Surveillance System (EDSS), wherein all reportable infectious disease occurrences in Connecticut are tracked; 2) Connecticut Hospital Association's hospital administrative discharge systems, which has information on the patient discharge diagnoses (a total of up to 15 diagnoses are reported) and discharge status from hospitals throughout Connecticut, 3) Births Registry, a vital events dataset with demographic and medical details for all births registered in the state including data on occurrences of preterm birth, and 4) Deaths Registry, a vital events dataset with demographic and medical details for all deaths registered in the state. Development of a unique dataset specific to morbidity and mortality due to climate change is not identified as a high priority in this review process of the 2020 Public Health and Safety Working group since data on climate-sensitive disease conditions currently exist in databases maintained by the state. Implementation of the BRACE framework would provide the ability to analyze the extent to which patterns and trends in morbidity and mortality throughout the state are attributable to climate change (Marinucci et al. 2014).

The four remaining recommendations, which focused on education and coordination for which DPH would serve as the lead agency, have not been addressed since 2011. These include

recommendations specific to coordination by DPH to educate local health department staff on climate change impacts and to assist local health department planning. Additionally, joint development of education materials and communications on the health risks of poor air quality by DPH and local health departments, as recommended in 2011, has not been undertaken. However, DEEP has developed a curriculum for grades 6-9 focused on air quality, for adoption by Connecticut school districts (DEEP website ref). DPH has not provided training for other agencies in the health impacts of climate change. The poor progress to address these last four recommendations underscores the need for establishing a funded, coordinated entity to address the health impacts of climate change in Connecticut through the BRACE framework.

Policy, Legislation, Regulation and Funding

Three recommendations for Policy, Legislation and Funding in support of public health were put forth in the 2011 Climate Preparedness Plan:

- Develop legislation to allow regulatory agencies to respond to extreme heat conditions in occupational settings.
- Continue to support funding to provide for adequate updates to municipal sewage infrastructure.
- Support funding to provide for adequate updates to municipal water infrastructure.

Specific legislation directed toward state and federal agency responses to extreme heath and heat-related illness in workplaces has been difficult to establish to date. In the absence of legislative mandates, DPH has coordinated since 2014 with both of the federal Occupational Safety and Health Administration (OSHA) offices located in CT that have regulatory oversight of private-sector workplaces as well as Connecticut OSHA (Conn-OSHA) that has regulatory compliance responsibilities for public-

sector workplaces to develop procedures for a cross-agency coordinated response to heat-related complaints and adverse health incidents in workplaces. All of these agencies have agreed to provide similar tracking, messaging, consultation, and referral processes for workers and employers with heat-related complaints and DPH's Memorandums of Understanding (MOUs) with these agencies allow us to share information as needed. At the federal level, in 2016 CDC's National Institute for Occupational Safety and Health (NIOSH) updated their heat stress recommendation document into a proposed framework for a heat standard in workplaces titled *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments* (NIOSH 2016). This document was last updated in 1986, and in recent years, including during the Deepwater Horizon oil spill response of 2010, questions were raised regarding the need for revision to reflect recent research and findings. The latest revision includes additional information about the physiological changes that result from heat stress; updated information from relevant studies, such as those on caffeine use; evidence to redefine heat stroke and associated symptoms; and updated information on physiological monitoring and personal protective equipment and clothing that can be used to control heat stress. In July 2019, HR3668 referred to as the *Asuncion Valdivia Heat Illness and Fatality Prevention Act of 2019*, was introduced in the US House of Representatives. The bill would require OSHA to develop a federal standard on workplace heat stress. Under the proposed bill, OSHA would have two years to propose a heat protection standard to protect both indoor and outdoor workers. If the proposed rule is not promulgated within two years, the House bill would also require OSHA to issue an interim rule that would:

- Establish exposure limits that would trigger protective actions to be taken by employers;

- Require employees to develop heat-illness prevention programs, to include employee monitoring; providing protective clothing, water, and shade; paid rest breaks; allowing employees time to acclimatize to heat conditions; and having an emergency response plan; and
- Include protections for employees from discrimination for exercising their rights under the standard.

The bill was referred to the House Committee on Education and Labor in July 2019 but has not advanced further to date.

DEEP has begun a process of establishing the next Priority List to identify and prioritize critical wastewater infrastructure projects and establish a list of fundable projects depending on level of funding available. To support updates to municipal sewage infrastructure, communities and COGs have undertaken various planning efforts that are increasingly cognizant of climate change and extreme events. For example, Southeastern Connecticut Council of Government (COG) commissioned development of the Southeastern Connecticut Regional Wastewater Management Plan in 2019. The plan addresses long-term needs due to aging sanitary sewer infrastructure, development patterns, and other factors; and recognizes climate change as a factor in these needs and how to address them.

To support updates to public water system infrastructure, the State has undertaken two significant planning efforts that directly address climate change and extreme events. First, public water systems and the COGs participated in the Water Utility Coordinating Committee (WUCC) process from 2016 to 2018, resulting in the development of Coordinated Water System Plans for the three public water supply management areas. Climate change and extreme events – and the pressures caused by them – were addressed in these plans. Second, CIRCA and DPH collaborated to develop a Drinking Water Vulnerability Assessment and Resilience Plan that further addresses water system needs. Private wells are also addressed in the plan.

SECTION 2. DOMAINS OF HEALTH IMPACTS OF CLIMATE CHANGE IN CONNECTICUT AND RECOMMENDATIONS FOR ADAPTATION AND RESILIENCE

Various approaches to classifying the human health impacts of climate change are used by assessments and in adaptation planning efforts. The framework below, based on seven priority domains, was adapted for planning by this Working group for the development of recommendations to the GC3 following that put forth by the report The Health Impacts of Climate Change on Human Health in the United States: A Scientific Assessment (Crimmins et al. 2016). To motivate recommendations and in the absence of a literature-based assessment of health impacts of climate change in Connecticut, Working group members conducted literature reviews to develop statements of the health impacts of climate change within each domain. Working group members developed statements of populations vulnerable to health impacts in each domain, to facilitate development of recommendations targeting such populations, which we defined as segments of the general population that the peer-reviewed literature has identified as being at increased risk for health-related climate impacts, now or in the future (Gamble et al. 2016) . This section of the report first reports on such impacts and vulnerable populations within each domain and then provides recommendations specific to each. Additionally, a section specific to issues that overlap with multiple health domains, i.e. cross-cutting issues, concludes discussion on specific health domains and recommendations. A table that summarizes all recommendations is provided as Appendix II.

Health and Safety Impact Domain: Extreme Heat

Average annual temperature in Connecticut has risen by over 3 degrees Fahrenheit since 1895 (NOAA National Centers for Environmental Information 2020). Rising temperatures due to climate change have significant human health effects. As temperatures warm, the air becomes more humid. This combination of heat and humidity, measured together as the heat index, worsens the health impacts of rising temperatures; when humidity is high, it is harder for a body to cool off by sweating. Higher average temperatures also increase the probability for more extremely hot days. In addition, warmer nighttime temperatures can be especially dangerous to human health, particularly for people living in urban areas and for those without access to air conditioning. This is because the health effects of heat are cumulative, and cool nights are typically an opportunity for the body to cool down; without this cooling off time, heat waves can be even more dangerous. Heat-related health risks vary by season and geography, in part due to acclimatization and structural adaptations. Residents of the Northeast demonstrate a higher sensitivity to heat than in warmer parts of the country. A nationwide study found the Northeast's heat index range, corresponding with significant heat-attributable disease burden, to be 85-95 degrees F (Vaidyanathan et al. 2019). This range, which is lower than that in the US southern regions, reflects a combination of factors including lower acclimatization to extreme heat, less awareness of heat risks, and fewer structural adaptations such as air conditioning.

Following exposure to extreme heat, and after failure of an individual's thermoregulatory response to maintain homeostasis, clinical manifestations range from mild to severe. These conditions include heat exhaustion, heat edema, heat syncope (fainting), and heat stroke and are collectively known as heat-related illness (HRI) (Lugo-Amador, Rothenhaus, and Moyer 2004; Gauer and Meyers 2019). Between 2014 and 2018, a total of 2,053 ED visits (410.60 visits/year) and 208 inpatient

admissions (41.60 admissions/year) for HRI occurred among Connecticut residents (DPH 2020; Hayes, Przysiecki, and Bozzi submitted). Approximately one heat-related death occurs in Connecticut each year (Hayes, Przysiecki, and Bozzi submitted). Extreme heat can also affect mental health and overall well-being. Several studies suggest that extreme heat events may be accompanied by a general increase in aggression and violence (Anderson 1989, 2001). Further, heat waves can limit outdoor physical activity, reducing not only exercise, but also opportunity for social connectedness. Finally, extreme heat worsens ground-level ozone pollution, since ozone is produced through a chemical reaction in the presence of heat and sunlight; this makes high heat days especially dangerous to health, particularly for those with asthma and other respiratory conditions (Nolte et al. 2018).

In the future, summers are likely to be projected to be warmer and drier with higher extreme temperature peaks that will increase the risks of heat-stress on vulnerable populations (Seth et al. 2019; Dupigny-Giroux et al. 2018). In the Northeast region overall, an additional 2,300 premature deaths per year are projected by late century under a high greenhouse gas emissions scenario (RCP 8.5), and 960 additional premature deaths per year under a moderate emissions scenario (RCP 4.5) (EPA 2017).

Vulnerable Populations

Vulnerability to heat increases when either physiological or behavioral responses are compromised. Certain populations, including low-income populations, have limited adaptive capacity due to a lack of adequately insulated housing, inability to afford or to use air conditioning, inadequate access to cooling centers, and inadequate access to routine and emergency health care (Crimmins et al. 2016). Older adults and the homeless are at higher risk, particularly those who have preexisting diseases, those who take certain medications, those who are living alone, or those with limited mobility (Crimmins et al. 2016). Those with mental illness are also vulnerable. Those living in densely populated cities are at

additional risk due to the heat island effect, where artificial surfaces absorb sunlight during the day and then radiate the stored heat at night (Rosenthal, Kinney, and Metzger 2014). The heat island effect can be in part mitigated through equitably distributed nature-based solutions, including urban tree planting and the addition of urban parks and greenspaces; the PHS working group supports recommendations put forward by other GC3 working groups, which call for more funding and support for urban tree planting, conservation, and management in Connecticut.

Young children are vulnerable because they tend to be active and must rely on others to help keep them safe and cool, as well as because of their immature physiology and metabolism (Ahdoot and Pacheco 2015). High-school football players and other outdoor athletes are also vulnerable to heat illness when not properly acclimatized. Pregnant women are more vulnerable to heat-related illness (Kim et al, 2019). In addition, preterm birth, low birth weight and infant mortality have been associated with extreme heat.

Outdoor workers such as agricultural, construction, and utility workers are also at increased risk for heat-related illness, especially where jobs involve heavy exertion (Arbury et al. 2014). Young adults are more likely to be treated in hospital emergency rooms for heat related illness in Connecticut than other age groups. Risk of inpatient admission to a Connecticut hospitals for more severe heat-related illness increases with age and is highest among individuals aged 75 and older (Hayes, Przysiecki, and Bozzi submitted).

Importantly, these factors affecting vulnerability and adaptive capacity are cumulative. For instance, black mothers are three times more likely to die from pregnancy-related problems than white women (Peterson et al., 2019) and are at greater risk for preterm birth and low birth weights, an

outcome shaped by historic marginalization affecting the social determinants of health and exacerbated by higher exposure to air pollution (including ozone) and extreme heat (Bekkar et al, 2020).

PHS – 1 **Create a multi-stakeholder "blue ribbon" commission to develop guidance for schools, day cares, and youth sports teams for prevention of heat-related illness and death.**	
Recommended Implementation Action Description	This action is a revision to the 2011 Recommendation "Develop criteria for school closings and outdoor play during extreme heat events". It expands the scope of the recommendation to include guidance for day cares, and provide the specific action needed to support the development of guidelines. The Commission will also provide a biennial report on all heat-related illness and deaths in Connecticut and associated causes using surveillance data available from the Connecticut Hospital Association and the Connecticut Deaths Registry.
Completion Timeframe	• Less than 2 years
Implementation Entities	By appointment by the Governor, with representation from CT Department of Education, school districts, DPH, CIRCA, local health directors, Connecticut universities, school athletic associations, sports medicine experts, and stakeholders from impacted communities
Climate challenges addressed	This action will address increasing temperatures in Connecticut, and associated risk of exposure to extreme heat in vulnerable populations.
Protection of vulnerable communities	Youth, athletes, and outdoor workers are all considered to be at increased risk to heat-related illness. This commission will develop specific measures appropriate for Connecticut for protection of these populations.
References for action	**Adams, William M., Samantha E. Scarneo, and Douglas J. Casa. 2017.** State-Level Implementation of Health and Safety Policies to Prevent Sudden Death and Catastrophic Injuries Within Secondary School Athletics. The Orthopaedic Journal of Sports Medicine 5, no. 9: 2325967117727262. **Pike, Alicia M, William M. Adams, Robert A. Huggins, Stephanie M. Mazerolle, and Douglas J. Casa. 2019.** Analysis of states' barriers to and progress toward implementation of health and safety policies for secondary school athletics. Journal of Athletic Training 54, no. 4: 361-373. **Sullivan, M. (2016)** OLR Research Report: Air Quality and Temperature in Public Schools 2016-R-0193.

PHS – 2 **Develop legislation to require employers to develop and maintain a written plan to address heat exposure and prevent heat-related illnesses at outdoor worksites and at indoor facilities where potential heat-related hazards may exist.**	
Recommended Implementation Action Description	This action is a revision to the 2011 Recommendation "Develop legislation to allow regulatory agencies to respond to extreme heat conditions in occupational settings." Since Connecticut adopts the federal OSHA standards, developing a new state standard for occupational heat exposure is not practicable. Instead, this recommendation calls for legislation to require private and public sector employers to develop written plans that follow the 2016 "NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments." The criteria include protective measures at heat stress thresholds, including rest and shade; hydration; a heat acclimatization plan; exposure and medical monitoring; hazard notification; worker training; and heat-related record-keeping. The legislation should call for inclusion of this written plan in the larger Emergency Plans required by OSHA (29 CFR 1910.38, 29 CFR 1926.35) and allow review of those plans by OSHA Enforcement officials upon request. This recommendation may require new staffing support to review plans; the role overlaps with oversight of heat-related school policies.
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH Occupational Health Unit, CT Department of Labor's Division of Occupational Safety and Health (CONN-OSHA)
Climate challenges addressed	This action will address increasing temperatures in Connecticut, and associated risk of exposure to extreme heat in vulnerable populations.
Protection of vulnerable communities	Outdoor workers are at higher risk for heat-related illness due to the requirements of work (i.e., they are required to work outdoors and physically exert themselves even in hot weather). In addition, they often lack control over their work environment and important behavioral adaptation decisions like taking breaks or seeking shade (Crimmins, 2016) Workers in hot indoor environments that lack air conditioning (such as dry cleaners/laundry, manufacturing facilities, warehouses, and kitchens/bakeries) also are at risk.

References for action	**Arbury, S., Jacklitsch, B., Farquah, O., Hodgson, M., Lamson, G., Martin, H., & Profitt, A. (2014).** Heat illness and death among workers—United States, 2012–2013. MMWR. Morbidity and mortality weekly report, 63(31), 661. **Crimmins, A., Balbus, J., Gamble, J., Beard, C., Bell, J., Dodgen, D., . . . Herring, S. (2016).** The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. US Global Change Research Program, Washington, DC. **Oregon OSHA, Local Emphasis Program (LEP):** Preventing Heat Related Illness (Revised June 6, 2019). https://osha.oregon.gov/OSHARules/pd/pd-299.pdf **NIOSH. (2016).** NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments. By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106. **Public Citizen et al. (2018).** Petition to OSHA for a Heat Standard. In: Available online at https://www.citizen.org/wp-content/uploads/2439.pdf.

PHS – 3 Establish evidence-based standards for local heat and air quality response plans.	
Recommended Implementation Action Description	This action is an expansion of the 2011 Recommendation to "Develop cooling station best management practices." This action intends to promote the development of state-issued criteria to support heat and air quality response planning, including funding, to be carried out at the local level. This action moves beyond a focus on cooling stations, as proposed in 2011, to include the establishment of evidence-based standards for early and immediate warning systems, including but not limited to communication tools, public service announcements, preparedness protocols, adaptation measures, and vulnerability re-assessment. This includes multi-purpose use of shelters and other designated community sites, including in response to air quality alert days and high pollen days, which are events exacerbated by warming temperatures. Local plans will be incorporated into municipalities' Emergency Operations Plans. Development of the plans requires involvement of the most vulnerable populations in the local planning process to assure that it is acceptable and meets their needs. State issued criteria for response to extreme heat events should also be incorporated as a formalized plan into the state's Incident Command Systems.
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH, DEMHS, CADH, local health directors, Regional Councils of Government, local governments, stakeholders from impacted communities
Climate challenges addressed	This action will address increasing temperatures and worsening air quality in Connecticut, and associated risk of exposure to extreme heat and air quality in vulnerable populations.
Protection of vulnerable communities	The proposal of a heat response plan aims to identify and ensure that local communities adequately address heat vulnerability for all vulnerable populations in their communities.
References for action	**Ebi, K L 2019** Effective heat action plans: research to interventions *Environ. Res. Lett.* **14** 122001. **Benmarhnia T, Schwarz L, Nori-Sarma A and Bell M L 2019** Quantifying the impact of changing the threshold of New York City heat emergency plan in reducing heat-related illnesses *Environ. Res. Lett.* **14** 114006

PHS – 4 **Enact policies to protect low-income residents and renters, particularly those in government supported housing, from indoor heat exposure.**	
Recommended Implementation Action Description	Policies and programs to be pursued include: • Expansion of CT Energy Assistance Program (CEAP) to include cooling assistance and air conditioner purchase • For government-supported housing, legislation requiring landlords to assure a maximum indoor air temperature and indoor air quality. • Partnerships and/or policies to prevent power and water companies from shutting off services to their customers due to nonpayment of bills during extreme heat events. • Pursue funding to implement the Connecticut Green and Healthy Homes Initiative that focuses on the nexus of health, safety, and energy in residential housing needs.
Completion Timeframe	• Less than 2 years
Implementation Entities	CT Department of Health and Human Services, DOH, DPH, stakeholders from impacted communities
Climate challenges addressed	This action will address increasing temperatures in Connecticut, and associated risk of exposure to extreme heat in vulnerable populations.
Protection of vulnerable communities	This action aims to protect low-income populations who are vulnerable to heat-related illness due to factors including a lack of adequately insulated housing, inability to afford or to use air conditioning, inadequate access to cooling centers, and inadequate access to routine and emergency health care (Crimmins et al., 2016).
References for action	**Ito K, Lane K, Olson C. 2018** Equitable access to air conditioning: a city health department's perspective on preventing heat-related deaths. Epidemiology 29(6):749-752. **State HEAP programs with cooling assistance**: https://liheapch.acf.hhs.gov/tables/program_dates.htm **Connecticut Green and Healthy Homes Project**: https://ctgreenbank.com/ct-ghhi/

Health and Safety Impact Domain: Air Quality

When it comes to outdoor air quality, three main types of pollution sensitive to climate change are of most concern (Dupigny-Giroux et al. 2018; Fann et al. 2016). First, ground-level ozone is sensitive to increasing temperatures because it forms when ozone precursors react with sunlight and heat. Ground-level ozone exceedances in Connecticut are currently declining due to reduced emissions of ground-level ozone precursor air pollutants such as oxides of nitrogen and non-methane organic gases (DPH 2020; https://portal.ct.gov/-/media/DEEP/air_monitoring/trends/Ozone_Design_Value_trends.pdf). However, the effects of increasing temperatures may reverse this trend in the future (Stowell et al. 2017). The second concern for outdoor air quality associated with Connecticut's changing climate is pollen, in particular, ragweed pollen. Ragweed pollen is the cause of the most common type of seasonal allergy, hay fever. Throughout the Northeast, ragweed pollen seasons are expected to increase both in length and intensity, due to rising temperatures, as well as greater carbon dioxide in the atmosphere due to greenhouse gas emissions. Finally, wildfires are predicted to increase in intensity and frequency due to climate change, and their emissions are expected to contribute significantly to PM2.5. Although increasing risk of wildfire is primarily a concern for the western United States, emissions from wildfires can travel hundreds of miles (Dupigny-Giroux et al. 2018; Fann et al. 2016). DEEP continues to study the long range transport of wildfire smoke and assess its impact on both ground-level ozone production and fine particulate matter levels in Connecticut (Lindaas et al. 2017; Gong et al. 2017).

Indoor air quality is also predicted to be impacted by climate change (Dupigny-Giroux et al. 2018; Fann et al. 2016; Lane et al. 2013). Increased rates of extreme precipitation and other types of extreme events, including flooding and winter storms, can damage buildings and allow for entry of moisture. Increasing humidity outdoors can also increase condensation and dampness indoors. Indoor

moisture and humidity can then foster the growth of mold, among other indoor air pollutants. Storms and floods, and their associated power outages, can reduce ventilation in buildings, worsening indoor air quality. Power outages during storms and floods also put our residents at risk for carbon monoxide poisoning due to improper use of backup power generators, as well as improper indoor use of wood-burning and other appliances intended for outdoor use (Fann et al. 2016).

Vulnerable Populations

Although air pollution affects everyone, some people are more affected than others. In Connecticut, we experience several days, especially during the summer, when monitored air quality levels exceed the national standard for ozone. We have high rates of asthma and allergies, particularly in our urban areas (Asthma and Allergy Foundation of America 2019). Those most at risk of illness or death from climate-enhanced air pollution include the elderly and children; those with asthma, allergies, and other respiratory conditions; and those with cardiac disease. Puerto Ricans and U.S. born African Americans of all income levels have higher rates of asthma. They are also at higher risk of other air pollution related conditions. Low wealth families are at risk, especially those who live in substandard housing, which is more likely to have leaks that promote mold in addition to entrance of outdoor air pollutants. Outdoor workers are more likely to visit emergency rooms with respiratory symptoms on high ozone days.

Although adaptation strategies are the focus of the recommendations made in this section, some mitigation recommendations were raised by both members of the Air Quality workgroup and in public comments. Although there is an interplay between mitigation actions intended to reduce exposure to air pollutants such as ground-level ozone and fine particulates, whose effects will be enhanced by climate change, as opposed to adaptive strategies intended to achieve similar reductions in exposure, the consensus of the workgroup is that the regulation and mitigation of air pollutants that are

non-greenhouse gases are being actively addressed by existing air quality management programs outside of the GC3 planning process. As such, the mitigation of ozone precursor and fine particulate matter, while critical public health issues of and by themselves, should be differentiated from greenhouse gas mitigation efforts in the context of the GC3 planning process.

While the mitigation concepts discussed here do not deal with mitigation of greenhouse gases, such mitigation will likely also reduce emissions of other pollutants, which are expected to provide co-benefits to the health of Connecticut residents. Many of the other pollutants such as fine particulate matter (PM 2.5) are known to impact asthmatics and people with existing respiratory conditions such as COPD. Connecticut currently meets the national standards for PM 2.5 on a state-wide basis. In Phase 2 of the GC3 planning process, consideration should be given to concepts of first quantifying impacts, and then possibly reducing impacts of these other pollutants, especially on vulnerable populations.

Based on public comments that fall outside the scope of this workgroup's efforts, some of the steps that may be considered for the "other pollutant" mitigation include: increasing fuel efficiency standards for vehicles, promoting clean energy, targeting large sources of combustion related air pollution, and siting restrictions for new point sources in close proximity to residential areas. Research on the health effects of these other pollutants should be expanded to consider neurodevelopmental effects during pregnancy. Expanded monitoring stations for all criteria pollutants should be considered for areas where vulnerable populations live.

PHS – 5 Evaluate Ozone Alert Education Efforts	
Recommended Implementation Action Description	This recommendation is similar to the 2011 Recommendation, "Evaluate ozone non-attainment alert systems". DEEP and DPH should conduct an evaluation on air quality forecasting and public education and outreach efforts DEEP currently implements on a year round basis.. In particular, DPH should survey the public on their awareness of summertime warning about ozone through the Behavioral Risk Factor Surveillance System. Community outreach and focus groups within vulnerable communities should be developed to ascertain input on alert systems and effective communication strategies. In addition, the evaluation should consider new ways of informing the public including wireless emergency alerts via all phones, social media, direct communications to vulnerable populations and direct alerts to institutions such as: youth camps, schools, nursing homes and medical providers. A study in Canada found that air quality alerts alone had limited effectiveness in protecting public health[1].
Completion Timeframe	• Less than 2 years
Implementation Entities	DEEP, DPH, American Lung Association, CADH, NWS, DEMHS, stakeholders from impacted communities
Climate challenges addressed	This recommendation addresses the well documented increase and duration of summertime heat and associated increase in ozone levels.
Protection of vulnerable communities	This recommendation will help assure that vulnerable populations change their behavior on high ozone days to help prevent adverse respiratory diseases. Such groups include asthmatics, people with COPD, communities in inner cities with higher rates of asthma and children.
References for action	**Chen, H., Li, Q., Kaufman, J. S., Wang, J., Copes, R., Su, Y., & Benmarhnia, T. (2018).** Effect of air quality alerts on human health: A regression discontinuity analysis in Toronto, Canada. *The Lancet Planetary Health*, 2(1), e2–e3. doi:10.1016/S2542-5196(17)30185-7 **Ramírez AS, Ramondt S, Bogart KV, Perez-Zuniga R. 2019.** Public Awareness of Air Pollution and Health 361 Threats: Challenges and Opportunities for Communication Strategies To Improve Environmental Health 362 Literacy. J Health Commun. 24:75–83.

PHS – 6 Increase Airborne Allergen Monitoring	
Recommended Implementation Action Description	This recommendation is a restatement of the identically-named 2011 Recommendation. There is currently only one monitoring station in Connecticut that collects data on pollen and mold concentrations, located at Waterbury Hospital. That station does not receive any outside funding and is supported by the hospital. More monitoring of airborne allergens should be a long-term strategy. The state should partner with hospitals and the American Lung Association to establish and fund more robust monitoring systems. Federal grants on this problem should be explored and partners developed who can help with this effort.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DEEP, DPH, American Lung Association, and the national Allergy Bureau – The American Academy of Allergy, Asthma and Immunology (formerly funded by Waterbury Hospital).
Climate challenges addressed	Climate change is projected to increase the amount of pollen and mold due to warmer temperatures and longer growing season.
Protection of vulnerable communities	Asthmatics are likely to be impacted by increases in pollen and mold. Rates of asthma are documented to be higher in CT cities and among minority populations.
References for action	**Sapkota A, Dong Y, Li L, Asrar G, Zhou Y, Li X, Coates F, Spanier AJ, Matz J, Bielory L, Breitenother AG, Mitchell C, Jiang C. 2020.** Association between changes in timing of spring onset and asthma hospitalization in Maryland. JAMA Netw Open 3(7): e207551 **Bozzi, L. and R. Dubrow. (2020).** *Climate Change and Health in Connecticut: 2020 Report*. New Haven, Connecticut, Yale Center on Climate Change and Health. **American Academy of Allergy Asthma & Immunology, Counting Station Information:** http://pollen.aaaai.org/nab/index.cfm?p=DisplayStationInfo; accessed Aug. 8, 2020

PHS – 7 **Estimate the impacts of climate change on 2030 and 2050 ozone levels in Connecticut and identify potential effects on the health of Connecticut residents.**	
Recommended Implementation Action Description	Climate change is predicted to worsen air quality through increased production of ground-level ozone and particulate matter due to higher temperatures, wildfire emissions, and air stagnation events, among other factors. However, impacts will vary by region and state-level projections of impacts on air quality and health are currently not available. Research is needed into the combined effects of air pollution sources in vulnerable locations like cities combined with the predicted increase in ozone levels. Ozone projections are based on complex phot-chemical grid modeling informed by projected emissions inventories and climate condition should be developed for 2030 and 2050, with subsequent projections of impacts on the health of the residents of Connecticut. Successful implementation of this project is contingent on adequate funding.
Completion Timeframe	• 3-5 years
Implementation Entities	DPH, DEEP, Connecticut universities
Climate challenges addressed	Increased temperatures and high heat days (Seth et al. 2019)
Protection of vulnerable communities	Air pollution disproportionately affects the elderly and children and those with asthma, allergies, and other respiratory conditions. Projections of climate-associated reductions in air quality impacts on the health of Connecticut residents will illustrate potential increased disparities and motivate investment in interventions to reduce them.
References for action	**Abel DW, et al. (2018)** Air-quality-related health impacts from climate change and from adaptation of cooling demand for buildings in the eastern United States: An interdisciplinary modeling study. PLoS Med 15:e1002599. **Bai, X. et al. 2018.** Six research priorities for cities and climate change. *Nature* 555, 23–25. **Bozzi, L. and R. Dubrow. (2020).** *Climate Change and Health in Connecticut: 2020 Report*. New Haven, Connecticut, Yale Center on Climate Change and Health. **Orru H., K. Ebi, and B. Forsberg, 2017.** The Interplay of Climate Change and Air Pollution on Health, *Current Environmental Health Reports*, vol.85, issue.9, pp.504-517.

Health and Safety Impact Domain: Vector-borne Diseases

Vector-borne diseases (VBDs) are parasitic, viral, bacterial, and filarial human illnesses transmitted by mostly arthropod vectors, including mosquitoes, ticks, fleas, and several other groups. These account for more than 17% of all infectious diseases, causing more than 700,000 deaths each year worldwide (WHO 2020). Linked, in part, to a warming climate, VBDs are becoming a major public health concern in the U.S. (Molaei et al. 2019), where a total of 642,602 human disease cases were reported to the CDC during 2004–2016 (Rosenberg et al. 2018). Persistently warming temperatures not only lead to the continued geographic range expansion of some vectors but may also extend their active season, thereby altering host availability and abundance, interactions among vectors, pathogens, and hosts, and the prevalence of infection (Molaei et al. 2019) . A warming climate and other environmental changes will affect abundance, distribution, seasonal activity patterns, and interactions among species (Molaei et al. 2019).

In recent years, we have witnessed the introduction, range expansion, and changes in the dynamics and frequency of mosquito-borne arboviruses in the Western Hemisphere. West Nile virus has become firmly established in the continental U.S. since its discovery in the New York City area in 1999 (Lanciotti et al. 1999). EEEV, with sporadic transmission over the past several decades, has made a comeback in 2019 in the Northeast including Connecticut (Morens, Folkers, and Fauci 2019).

Nearly 50 mosquito species in 11 genera have been described in Connecticut, of which 27 species have tested positive for 8 arboviruses (Andreadis, Thomas, and Shepard 2005). Among these mosquitoes, *Culex pipiens* with widespread distribution throughout the state, and *Culiseta melanura* with breeding populations in red maple and white cedar freshwater swaps, are considered principal vectors of WNV and EEEV, respectively (Molaei and Andreadis 2006; Goudarz Molaei et al. 2016).

Several other mosquito species have also been incriminated as bridge vectors of arboviruses to humans and horses in Connecticut because of their opportunistic blood feeding on mammals in addition to birds (Molaei et al. 2008; Molaei, Farajollahi, Armstrong, et al. 2009; Molaei, Farajollahi, Scott, et al. 2009; Molaei, Huang, and Andreadis 2012; Molaei et al. 2013; Goudarz Molaei, Armstrong, Abadam, et al. 2015; Molaei, Armstrong, Graham, et al. 2015; Molaei et al. 2016; Armstrong and Andreadis 2010, 2013; Shepard et al. 2016).

Invasive mosquito species including *Aedes albopictus* and *Aedes japonicus*, with abilities to transmit arboviruses of concern to humans, may soon pose considerable risk to human and animal health in Connecticut. The invasion and spread of *Ae. albopictus* in the U.S. occurred in the past three decades and its range continues to expand. Winter temperature is an important constraint to *Ae. albopictus* northward expansion, with potential range limits located between the 0° and -5°C mean cold month isotherm. Connecticut is located within this climatic zone and therefore, since its first detection in 2006 in the state, *Ae. albopictus* has been monitored statewide by the CAES scientists to assess its northern range expansion and to delineate where populations can stably persist (Armstrong et al. 2017). *Ae*. *albopictus* mosquitoes are currently most abundant in urban and suburban locations along the southwestern shoreline of Connecticut. Field-collected females have been screened for arbovirus infection, and Cache Valley virus and WNV have been isolated, highlighting the threat posed by this mosquito (Armstrong et al. 2017). *Ae. albopictus* inhabits a wide range of environments, from urban to rural, and bites a wide variety of hosts including mammals, birds, reptiles, and amphibians (Faraji et al. 2014; Pereira-dos-Santos et al. 2020). *Ae. albopictus* appears to be more closely associated with humans (Roche et al. 2015; Rochlin et al. 2013) and may preferentially bite humans (Lounibos and Kramer 2016). Domestication, ability to use peridomestic artificial containers, and increasingly hospitable climatic

conditions enabled the spread of *Ae. albopictus* on the heels of human movement and trade (especially tires) (Paupy et al. 2009)in the U.S. and recently in Connecticut. *Ae. albopictus* is a vector for viral pathogens of public health importance including dengue, chikungunya, and Zika viruses (Gratz 2004; Almeida et al. 2005; Rezza et al. 2007; Ruche et al. 2010; Peng et al. 2012; Grard et al. 2014; Delisle et al. 2015; Tsuda et al. 2015), and may also be involved in occasional transmission of WNV, EEEV, Saint Louis encephalitis virus, and La Crosse virus (Vanlandingham, Higgs, and Huang 2016).

Cases of tick-borne diseases doubled in the U.S. between 2004 and 2016, and more than 90% of the nearly 60,000 cases of nationally notifiable VBDs reported in 2017 were linked to ticks (Rosenberg et al. 2018). Lyme disease is now the most prevalent VBD in the U.S., with an estimated 330,000 human cases occurring annually (Hinckley et al. 2014; Nelson et al. 2015; A.M. Schwartz et al. 2017). Connecticut is among the 14 states from which nearly 95% of Lyme disease cases in the U.S. are reported, and it had the 7th highest incidence per 100,000 population (number of confirmed and probable cases) in 2018 (CDC, https://www.cdc.gov/lyme/stats/tables.html). The incidence and geographic range of other tick-borne diseases such as babesiosis and anaplasmosis continues to increase in the northeastern and upper midwestern U.S. (Joseph et al. 2011; Stafford III et al. 2014; Dahlgren et al. 2015; CDC 2016, 2017, 2018; Eisen and Eisen 2018), and the Powassan virus, which can also be transmitted to humans by blacklegged ticks, should also be added to the growing list of tick-borne pathogens.

Of the nearly 15 tick species reported in Connecticut, blacklegged (*Ixodes scapularis*), lone star (*Amblyomma americanum*), and American dog (*Dermacentor variabilis*) ticks are of particular medical and veterinary importance, with blacklegged ticks constituting greater than 80% of all tick species in the state. Blacklegged and lone star ticks, may be recolonizing areas where they thrived historically, before

rampant deforestation and substantial local reduction of key hosts. The blacklegged tick, with pervasive populations in Connecticut, is found throughout the eastern U.S. and southern Canada. This species currently transmits seven important human pathogens including *Borrelia burgdorferi* and *Borrelia mayonii*, *Borrelia miyamotoi*, *Anaplasma phagocytophilum*, *Ehrlichia muris eauclairensis*, *Babesia microti*, and Powassan virus, responsible for Lyme disease, tick-borne relapsing fever, anaplasmosis, ehrlichiosis, babesiosis, and Powassan encephalitis, respectively (Eisen et al. 2017).

The lone star tick has long been established in the southeastern U.S. (Cooley and Kohls 1944), but is expanding into areas of the northeastern U.S. with no previous record of activity (Dahlgren et al. 2016; Stafford III et al. 2018) because of abundant reproductive hosts, an increasingly hospitable climate, and genetic plasticity (Monzón et al. 2016; Molaei et al. 2019). In recent years, lone star ticks have been detected in Maine, Massachusetts, New Hampshire, New Jersey, New York, and Rhode Island, and established populations of this tick species have been documented across most of southern New Jersey, Long Island, coastal Rhode Island, and on Cape Cod and the Islands (Jordan and Egizi 2019; Telford III, Buchthal, and Elias 2019). In Connecticut, established populations of the lone star tick have only been reported in the past few years from Fairfield County in 2017 (Stafford III et al. 2018) and New Haven County in 2019 (Molaei et al. 2019) and 2020 (Molaei unpublished data). Warmer winters may be responsible, in part, for the northward movement and establishment of lone star ticks in New England. Adults of this tick species can successfully overwinter in Connecticut and to some extent, coastal Maine (Linske et al. 2020). Lone star ticks are expected to continue to expand their range, increase in abundance, and rise in importance in the northeastern United States.

Previously considered an aggressive biting pest, the lone star tick is now associated with several human diseases and medical conditions including tularemia (*Francisella tularensis*), rickettsiosis

(*Rickettsia amblyommatis*), ehrlichiosis (*Ehrlichia chaffeensis*, *Ehrlichia ewingii*, and Panola Mountain Ehrlichia), Heartland virus disease (Heartland virus), probably Bourbon virus disease (Bourbon virus), southern tick-associated rash illness or STARI (pathogen unknown), and Alpha-gal syndrome (also known as red meat allergy) (Childs and Paddock 2003; Mixson et al. 2006; Paddock and Yabsley 2007; Loftis et al. 2008; Commins et al. 2011; Godsey Jr et al. 2016; Savage et al. 2017).

In addition to increases in the abundance and range expansion of native tick species, introduction of 140 exotic tick species into the U.S. has been documented. Of the 140, 63 are reported to readily feed on humans and 23 are known to transmit pathogens of public health and veterinary importance (Keirans and Durden 2001; Burridge 2011). The introduction and establishment of the Asian longhorned tick, *Haemaphysalis longicornis*, into the U.S. in 2017 (Rainey et al. 2018) highlights the enduring challenge of invasive ticks of medical and/or veterinary importance. Reports of established populations of the Asian longhorned tick are increasing rapidly along the Eastern Seaboard; it is reported there from North Carolina to Connecticut (Beard et al. 2018); https://www.aphis.usda.gov/animal_health/animal_diseases/tick/downloads/longhorned-tick-sitrep.pdf). The CAES scientists have recently reported introduction of invasive ticks parasitizing humans entering Connecticut, including a *Hyalomma truncatum* from southern Africa (Molaei et al. 2018), an *Amblyomma coelebs* and an *Amblyomma oblongoguttatum* both from Central America (Molaei et al. 2019; Molaei et al. 2020).Importation and potential establishment of new invasive mosquito and tick vectors and associated pathogens into Connecticut will be substantially augmented due to globalization, travel, and expansion of the animal trade (legal and illegal). Climate change will inevitably enhance the establishment of these exotic vectors and pathogens.

<u>Vulnerable Populations</u>

Climate change will variably impact VBDs depending upon the vectors (e.g., mosquitoes and ticks), and the pathogens they transmit, and populations at risk may also change. Transmission of VBDs is influenced by local weather variations, urban and rural landscape characteristics, vertebrate hosts and human behavior that affects vector-human interactions, among other factors (cdc.gov/climateandhealth/effects/vectors). In addition, socio-economic inequalities place certain populations, including those living in poverty, living in sub-standard housing, having poor access to healthcare, and in areas with greater environmental risk factors, at higher risk for VBDs in the face of climate change. It is important to identify human populations at greater risk of VBDs in different climatic and geographic areas and habitat types and focus adaptation strategies and policies on protecting populations who live or spend time near these habitats (Bai, Morton, and Liu 2013).

In Connecticut, the two major mosquito-borne diseases are West Nile virus (WNV) and Eastern Equine Encephalitis virus (EEEV) disease. Since 2000, 162 human cases of WNV and 5 cases of EEEV have been identified, resulting in a total of 5 deaths; most WNV and all EEEV cases required lengthy hospital and ICU stays and often survivors have long-lasting or permanent health problems. Species of mosquitoes of public health concern breed in a variety of habitats including natural and artificial containers (e.g., tires), temporary and semi-permanent woodland pools, floodwater and temporary freshwater pools, tree holes, marshes and edges of ponds, brackish and freshwater wetlands, red maple white cedar swamps, etc. (Andreadis, Thomas, and Shepard 2005). Thus, communities in rural and urban areas in proximity to bodies of water and substandard housing (such as having damaged or no window screens), limited access to preventive measures and healthcare, and inadequate knowledge are at higher risk. Higher incidence of West Nile virus disease has been associated with poverty and urban location in the southeastern and northeastern U.S., respectively (Harrigan et al. 2010) and greater

prevalence of EEEV disease has historically occurred in rural areas of eastern U.S. adjacent to red maple white cedar swamps where *Culiseta melanura*, the principal vector of the virus breeds (Morris, Zimmerman, and Edman 1980; Armstrong and Andreadis 2013). Climate change is predicted to cause expanding populations of mosquitoes which carry Dengue, Zika, and Chikungunya, potentially putting primarily urban residents in Connecticut at risk of these serious diseases if the vector becomes established.

Ticks active in wooded and grassy areas where they can access and feed on a variety of hosts. In Connecticut, Lyme disease, Anaplasmosis, and Babesiosis are well established statewide. An average of 2,718 reported cases of Lyme disease alone have occurred in Connecticut per year since 1995, and it is estimated that incidence of this disease might be 10-fold higher than what is reported (https://wwwnc.cdc.gov/eid/article/21/9/15-0417_article). At least four additional serious tick-borne diseases are emerging across the state, and three invasive tick species are establishing. Early diagnosis and treatment of tick-borne diseases are essential to prevent serious and long-lasting illness and personal prevention is critical to preventing infection. While specific circumstances that underlie tick encounters are not well documented (Eisen and Stafford 2020), up to three-quarters of tick bites in Connecticut and the Northeast are estimated to be acquired in residential settings where forested tick and host habitat is present (Mead et al. 2018; Stafford III, Williams, and Molaei 2017). By contrast, around 20 percent of tick bites appear to be acquired in activities away from the home, likely through neighborhood and recreational activities associated with walking dogs, play near edges of school grounds, hiking and camping at parks and state forests, or through outdoor occupational activities. Outdoor occupational workers can be at higher risk of tick exposure (Schwartz and Goldstein 1990; Schwartz, Goldstein, and Childs 1994; Wallace et al. 2016). Specific disparities in tick-borne disease

incidence are not well characterized. However, both blacks and Hispanics have been reported to have increased signs of late or disseminated infection, suggesting a lack of available prevention information or disparities in early diagnosis and provider follow-up (Fix, Peña, and Strickland 2000; Nelson et al. 2016). The Tick-Borne Disease Working Group Report to Congress 2018 notes that under-represented minority populations need to be included in tick-borne disease studies.

The key for reducing the potential impacts of VBDs under climate change is to evaluate prevention options and identify vulnerable communities in Connecticut. Communities with lower socioeconomic status and limited access to public health services and information on preventive measures are at greater risk of contracting VBDs or not receiving appropriate diagnosis and treatment. Increased and targeted culturally appropriate educational efforts for these groups is needed.

PHS – 8 Establish a State Public Health Entomologist Position	
Recommended Implementation Action Description	Currently, surveillance for vectors and vector-borne diseases (VBDs) as well as various control activities such as research, pesticide regulation, and health prevention are conducted by several state agencies. A public health entomologist would enhance coordination of activities by various state agencies, facilitate interaction with corresponding federal agencies, research and academic institutions, northeast regional climate and health coalition, and public health associations (includes vector control associations). Furthermore, this position would seek additional funding for research and surveillance programs to better position the state to mitigate the impact of climate change on VBDs.
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH, CAES, Connecticut universities
Climate challenges addressed	Introduction of exotic vector species, range expansion of native vector species, and expansion of seasonal activity with warming temperatures.
Protection of vulnerable communities	The key for reducing the potential impacts of VBDs under climate change is to evaluate prevention options and identify vulnerable communities in Connecticut. Communities with lower socioeconomic status and limited access to public health services and information on preventive measures are at greater risk of contracting VBDs or not receiving appropriate diagnosis and treatment. Increased and targeted culturally appropriate educational efforts for these groups is needed. Emphasis should be on the monitor, surveillance, assessment, control strategies of climate change impacts on the health of vulnerable population (low income, communities of color, immigrant groups, indigenous peoples, children and pregnant women, older adults, vulnerable occupational groups, persons with disabilities, and persons with preexisting or chronic medical conditions).
References for action	**Bai, L., L. C. Morton, and Q. Liu. 2013**. Climate change and mosquito-borne diseases in China: a review. Globalization and Health 9: 10. http://www.globalizationandhealth.com/content/9/1/10 **Obenauer, P. J. 2014.** Public health entomology. Florida Entomologist 97: 1270–1271. doi.org/10.1653/024.097.0341 **Spielman, A., R. J. Pollack, A. E. Kiszewski, and S. R. Telford III 2001.** Issues in public health entomology. Vector Borne Zoonotic Dis. 1: 3–19.

PHS – 9 Strengthen Monitoring and Surveillance of Vector Populations and Associated Vector-Borne Diseases	
Recommended Implementation Action Description	Monitoring vector populations and VBDs are complementary and required for determining threats to public health and will guide adaptation strategies. This includes assessing changes in vector abundance, pathogen prevalence in vectors, and disease incidence. Vector and VBDs surveillance should be streamlined and augmented as climate change, spatiotemporal distribution shifts, and new vectors are introduced or expand their range. Disease surveillance augmentation includes increased ability to ensure data quality, completeness and analysis as well as novel approaches. Surveillance also includes identifying and monitoring the most important non-native vectors that would adapt to current and projected future climatic conditions and monitoring VBDs.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, CAES, Connecticut universities
Climate challenges addressed	Introduction of exotic vector species, range expansion of native vector species, and expansion of seasonal activity with warming temperatures.
Protection of vulnerable communities	The key for reducing the potential impacts of VBDs under climate change is to evaluate prevention options and identify vulnerable communities in Connecticut. Communities with lower socioeconomic status and limited access to public health services and information on preventive measures are at greater risk of contracting VBDs or not receiving appropriate diagnosis and treatment. Increased and targeted culturally appropriate educational efforts for these groups is needed. Surveillance should be more rigorous in impoverished urban or isolated rural areas, floodplains, coastlines, and other locations that are more vulnerable to extreme weather, persistent climate change, and social and economic stressors. Monitor also includes coordination with agencies and military bases to protect outdoor workers and service people exposed to high-risk locations.
References for action	**Kading R. C., A. J. Golnar, S. A. Hamer, and G. L. Hamer. 2018.** Advanced surveillance and preparedness to meet a new era of invasive vectors and emerging vector-borne diseases. PLoS Negl Trop Dis. 12(10): e0006761. doi.org/ 10.1371/journal.pntd.0006761. **Fournet, F., F. Jourdain, E. Bonnet, S. Degroote, and V. Ridde. 2018.** Effective surveillance systems for vector-borne diseases in urban settings and translation of the data into action: a scoping review. Infect Dis Poverty. 7: 99. doi: 10.1186/s40249-018-0473-9. **Morris, C. D., M. E. Corey, D. E. Emord, and J. J. Howard.** 1980. Epizootiology of eastern equine encephalomyelitis virus in upstate New York, USA. I. Introduction, demography and natural environment of an endemic focus. J. Med. Entomol. 17: 442–452.

	World Health Organization. 2020. Vector-borne diseases. WHO Home/Newsroom/Fact sheets/Detail/Vector-borne diseases. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases.

PHS – 10 Assess and Project the Impacts of Climate Change on Ticks, Mosquitoes, and Vertebrate Hosts Using Mathematical Models	
Recommended Implementation Action Description	Temperature and precipitation are the two most important climate variables that directly influence vector populations and VBDs' ecosystems. Mathematical models based on data from the past several decades on spatial and temporal distribution and weather pattern changes should be developed. Climatic and environmental conditions determine the distribution and abundance of mosquito and tick vectors as well as their vertebrate hosts which underly the risk of associated diseases. These models will apply research-based simulations using projected weather changes for the next 30 and 60 years and allow informed and effective recommendations that reduce the risk of mosquito- and tick-borne diseases.
Completion Timeframe	• Greater than 5 years
Implementation Entities	DPH, CAES, Connecticut universities
Climate challenges addressed	The anticipated rise in temperature and precipitation in Connecticut, introduction of exotic vector species, range expansion of native vector species, and expansion of seasonal activity with warming temperatures.
Protection of vulnerable communities	Modelling efforts will identify areas where mosquitoes and ticks could successfully breed and proliferate. These are the areas that human populations are at greater risk. Mapping tools and vulnerability indices provides targeted intervention of health risks to vulnerable populations.
References for action	**Bai, L., L. C. Morton, and Q. Liu. 2013.** Climate change and mosquito-borne diseases in China: a review. Globalization and Health 9: 10. http://www.globalizationandhealth.com/content/9/1/10 **Rohat, G., A. Monaghan, M. H. Hayden, S. J. Ryan, and O. Wilhelmi. 2020.** Intersecting vulnerabilities: Climatic and demographic contributions to future population exposure to Aedes-borne viruses in the United States. Environ. Res. Lett. (in press). doi: https://doi.org/10.1101/732644. **Sadeghieh, T., L. A. Waddell, V. Ng, A. Hall, and J. Sargeant. 2020.** A scoping review of importation and predictive models related to vector-borne diseases, pathogens, reservoirs, or vectors (1999–2016). PLoS ONE 15(1): e0227678. doi.org/ 10.1371/journal.pone.0227678.

PHS – 11 Develop Vector-Borne Disease Prevention and Management Guidelines for Schools, Outdoor Recreation, and Homes	
Recommended Implementation Action Description	The topic of VBDs prevention and management should be incorporated into existing public recreational and educational opportunities and updated with changing vector and climate-impacted environmental conditions. Encouraging outdoor activities is important for healthy lifestyles and a goal would be to develop creative means of better communication for mitigating VBDs risks. Currently, there are no criteria or recommendations from the State for school administrators to determine the risk and manage vector populations and prevent VBDs in school settings. The topic of VBDs prevention can be incorporated into existing public health education from grade school health education to any public health curriculum.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, CAES, DEEP, CADH, Connecticut Association of Boards of Education, CT Board of Education, municipalities, State Parks and Forests, Sustainable CT, teacher and administrator associations, simulation curriculum companies.
Climate challenges addressed	Awareness of measures to prevent exposure to and transmission of vector-borne pathogens with the potential introduction of exotic vector species, range expansion of native vector species, and expansion of seasonal activity with warming temperatures.
Protection of vulnerable communities	The key for reducing the potential impacts of VBDs under climate change is to evaluate prevention options and identify vulnerable communities in Connecticut. Communities with lower socioeconomic status and limited access to public health services and information on preventive measures are at greater risk of contracting VBDs or not receiving appropriate diagnosis and treatment. Increased and targeted culturally appropriate educational efforts for these groups is needed. Standard prevention and guidelines developed should be differentiated for delivery at targeted population. Curriculum and public outreach could have different modules applied for different demographic and socioeconomic groups.
References for action	**Fix, A. D., C. A. Peña, and G. T. Strickland. 2000.** Racial Differences in Reported Lyme Disease Incidence. American Journal of Epidemiology 152: 756-759. **Harrigan, R. J., H. A. Thomassen, W. Buermann, R. F. Cummings, M. E. Kahn, and T. B. Smith. 2010.** Economic conditions predict prevalence of West Nile virus. PLoS One 5: e15437. doi:10.1371/journal.pone.0015437. **Mead, P., S. Hook, S. Niesobecki, J. Ray, J. Meek, M. Delorey, C. Prue, and A. Hinckley. 2018.** Risk factors for tick exposure in suburban settings in the Northeastern United States. Ticks Tick-borne Dis. 9: 319-324. **Nelson, C. A., J. A. Starr, K. J. Kugeler, and P. S. Mead. 2016.** Lyme disease in Hispanics, United States, 2000-2013. Emerg. Infec.t Dis. 22: 522-525. **Schwartz, B. S., and M. D. Goldstein. 1990.** Lyme disease in outdoor workers: risk factors, preventive measures, and tick removal methods. Am. J. Epidemiol. 131: 877-885.

	Schwartz, B. S., M. D. Goldstein, and J. E. Childs. 1994. Longitudinal study of *Borrelia burgdorferi* infection in New Jersey outdoor workers, 1988-1991. Am. J. Epidemiol. 139: 504-512. **Wallace, J. W., W. L. Nicholson\, J. L. Perniciaro, M. F. Vaughn, S. Funkhouser, J. J. Juliano, S. Lee, M. L. Kakumanu, L. Ponnusamy, C. S. Apperson, and S. R. Meshnick. 2016.** Incident tick-borne infections in a cohort of North Carolina outdoor workers. Vector Borne Zoonotic Dis. 16: 302-8. doi: 10.1089/vbz.2015.1887.

PHS – 12 Evaluate Vector Control Strategies and Ensure Support for Implementing Sustainable Vector Management Programs	
Recommended Implementation Action Description	Planning strategies for adaptation to climate change and developing tools to control vector populations through environmentally sustainable approaches are of paramount importance. Environmental management is essential for population control of vector species, which comprise of long-term and/or seasonal modification and manipulation of the environment and changing human lifestyles and practices to reduce human contact with infective vectors. Increased and targeted culturally appropriate educational efforts for communities with lower socioeconomic status and limited access to public health services are needed.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, CAES, DEEP, Sustainable CT, stakeholders from impacted communities
Climate challenges addressed	Introduction of exotic vector species, range expansion of native vector species, and expansion of seasonal activity with warming temperatures.
Protection of vulnerable communities	The key for reducing the potential impacts of VBDs under climate change is to evaluate prevention options and identify vulnerable communities in Connecticut. Communities with lower socioeconomic status and limited access to public health services and information on preventive measures are at greater risk of contracting VBDs or not receiving appropriate diagnosis and treatment.
References for action	**Eisen, L., and K. C. Stafford, III. 2020.** Barriers to effective tick management and tick-bite prevention in the United States (Acari: Ixodidae). J. Med. Entomol. XX(X): 1-13 (in press). doi.org/10.1093/jme/tjaa079. **Rose, R. I. 2001.** Pesticides and public health: integrated methods of mosquito management. Emerging Infect. Dis. 7: 17-23. **Stafford III, K. C., S. C. Williams, and G. Molaei. 2017.** Integrated pest management in controlling ticks and tick-associated diseases. J. Integrated Pest Management 8: 28. doi.org/10.1093/jipm/pmx018.

PHS – 13 Monitor Insecticide and Antimicrobial Resistance in Vector Populations and Vector-Borne Pathogens	
Recommended Implementation Action Description	Insecticide resistance poses a serious challenge to current vector control efforts. Resistance and cross resistance to both traditional and new generation of insecticides /acaricides in many species of mosquitoes and ticks have been reported in recent years. Although there is not much information on the status of drug resistance in vector-borne pathogens in Connecticut, establishing a baseline data is important. Monitoring insecticide resistance in vectors and drug resistance in vector-borne pathogens and understanding the underlying mechanisms are required for implementing and sustaining effective control strategies.
Completion Timeframe	• Greater than 5 years
Implementation Entities	DPH, CAES, DEEP, Connecticut universities
Climate challenges addressed	Determine insecticide resistance of any introduced exotic and native vector species with increasing presence in the northeast with expanding geographic distribution.
Protection of vulnerable communities	Not directly relevant for this particular action.
References for action	**Rivero, A., J. Vézilier, M. Weill, A. F. Read, and S. Gandon. 2010.** Insecticide control of vector-borne diseases: when is insecticide resistance a problem? PLoS Pathog. 6(8): e1001000. doi: 10.1371/journal.ppat.1001000. **Wilson, A. L., O. Courtenay, L. A. Kelly-Hope, T. W. Scott W. Takken, S. J. Torr, and S. W. Lindsay. 2020.** The importance of vector control for the control and elimination of vector-borne diseases. PLoS Negl Trop Dis. 14(1): e0007831. doi: 10.1371/journal.pntd.0007831.

Health and Safety Impact Domain: Extreme Events

Projections of future climate scenarios for Connecticut include increased frequencies of both extreme precipitation events and extreme heat events through at least 2050 (Seth et al. 2019). Climate records indicate that the trends of increasing frequencies for some of these types of events date back to at least forty years ago (Seth et al. 2019). Current and projected trends of increasing frequencies of extreme rainfall and heat, in conjunction with increases of sea level rise of 20 inches along Connecticut's coast by 2050 compared to 2000—around which state coastal resilience planning is recommended (O'Donnell 2019) —together dictate a future in which Connecticut residents must be prepared for more frequent heavy rainfall and heat waves, increases in coastal, riverine, and urban flooding, as well as more frequent droughts (Dupigny-Giroux et al. 2018). Additionally, regional projections for the entire Northeast forecast an increased frequency of severe hurricanes and coastal storms (Dupigny-Giroux et al. 2018).

Predicting impacts on the health and safety of Connecticut's residents from exposure to extreme events is complex due to the variable direct and indirect environmental exposures associated with each type and variable potential magnitudes of impacts on essential infrastructure. Risks for direct injury and deaths associated with extreme precipitation events, coastal storms and hurricanes occur during emergency preparation phases in response to coastal storms and hurricanes, during the storm itself, and during post-disaster clean-up (Bell et al. 2016). Flooding is the most significant human health risk associated with extreme precipitation, hurricanes, and coastal storms, and the leading cause of death associated with flooding is drowning during flash flooding (Bell et al. 2016). Coastal and riverine flooding also increase risk for a suite of indirect health impacts including loss of sanitation and contamination of water and food supplies, increased risk for indoor mold, and post-traumatic stress

disorder due to economic losses, community impacts, and direct exposure to life-threatening situations (Lane et al. 2013). Extreme precipitation and resulting runoff are the causes of combined sewer overflows (CSOs) in Connecticut's urban communities such as Bridgeport as well as Springfield and Holyoke in Massachusetts, which are upstream of Connecticut along the Connecticut River. These overflows impair water quality which, in turn, affects recreational uses and sustenance fishing.

Both drought and extreme precipitation undermine crop production and will require unique solutions for adapted irrigation practices, with 30% of crop losses occurring 2013-2016 associated with extreme precipitation (Sweet et al. 2017; Wolfe 2019). Increased drought risk also has direct consequences for drinking water supply and safety (Bozzi and Dubrow 2020). Reservoir and aquifer volumes may decrease rapidly, leading to mandatory conservation and shut-offs that can affect quality of water delivered customers and reduce pressures needed for sanitation or fire protection (DPH DWS observations). Frequent droughts can impact the state's public drinking water supply, safe yields, and drinking water quality, although these become long-term challenges addressed outside the context of extreme events. Droughts also impact recreational waters via risk of exposures to water-borne pathogens and reduced volumes of recreational water bodies themselves.

Extreme events threaten vulnerable essential infrastructures in Connecticut, particularly those in need of repair and replacement due to aging, with downstream effect on human health and safety associated with their impairment and failure (Dupigny-Giroux et al. 2018). Essential infrastructures include roads, water and sewage systems, electric grids, bridges, power plants and electrical grids, safe food and water, sanitation, and health care. Direct washout of water and wastewater utilities, including septic systems, due to extreme precipitation that cause floods as well as coastal storms, results in loss of sanitation and contamination of reservoirs and wells. Damage to transportation and communication

systems can impede evacuation from storm and flood-impacted areas, as well as the ability of medical responders to reach persons in need of medical care due to exposure (Bell et al. 2016). Utility infrastructure loss and associated power outages threatens public health and safety through a variety of mechanisms including failure of water pumping and provisioning equipment, lack of refrigeration of food at safe temperatures to prevent exposure to food-borne pathogens, inability to maintain appropriate indoor temperatures for prevention of exposure to temperature extremes, as well as failure of electronic medical devices such as ventilators and oxygen (Dominianni et al. 2018). Risk of carbon monoxide poisoning may also increase after prolonged power outages when back-up electric generators are used incorrectly indoors.

Vulnerable Populations

Vulnerability to coastal storms and flooding varies according to geography and demographic profile. Populations that reside in Connecticut's coastal floodplain are at the highest risk of high-tide flooding and impacts of storm surge associated with coastal floods (DEEP and DESPP/DEMHS 2019). Communities, whether rural or urban, are susceptible to the effects of riverine flooding, flooding (DEEP and DESPP/DEMHS 2019). Rural populations throughout the United States can be vulnerable due to the lagged response in restoration of power outages (Hales et al. 2014) and communication infrastructure, as we observed most recently during Tropical Storm Isaias in August 2020. Among all geographic areas, those most vulnerable to extreme events are homeless population, those living in institutionalized facilities or those living in poor housing conditions, those with chemical and medical dependence, the elderly, low-income, children, and pregnant women (Bell et al. 2016). Additionally, individuals that are frail and medically incapacitated are considered vulnerable during any type of extreme event, as are individuals with disabilities and with limited English proficiency, due to limited access to care during

power outages and limited knowledge of evacuation routes or understanding warnings and communications for safe evacuation during natural disasters (Bell et al. 2016). First responders are considered particularly vulnerable to long-term mental health impacts associated with response to extreme weather (Dodgen et al. 2016).

Populations vulnerable to drought include those individuals reliant on private wells sourced by groundwater aquifers without redundant access to public systems (Connecticut, CIRCA, and Inc. 2018; DEEP and DESPP/DEMHS 2019; Council 2018). Overall, residents of Connecticut, and the Unites States as a whole, are relatively well-buffered against localized impacts of changes to food production associated with weather-related crop losses, compared to citizens of developing countries (Ziska et al. 2016) due to redundancies in the food system. (Food insecurity is discussed more in depth in **Nutrition, Food Security, and Food Safety section.)** Indirectly, farmers and residents of rural areas are uniquely vulnerable to the indirect effects of drought due to the mental health and economic consequences of sustained crop losses (Bell et al. 2016).

PHS – 14 **Create and maintain a statewide inventory of redundant back-up power services at critical facilities statewide and buildings where institutionalized vulnerable populations reside and establish a long-term funding mechanism for new systems and repairs.**	
Recommended Implementation Action Description	A statewide inventory of redundant back-up power is currently not available. This action will allow for review and assessment of redundant back-up power needs throughout the state for prioritization and outfitting.
Completion Timeframe	• Less than 2 years
Implementation Entities	DEMHS, DPH, CIRCA
Climate challenges addressed	Increasing frequency of severe hurricanes and coastal storms and extreme precipitation and heat events.
Protection of vulnerable communities	A statewide inventory of redundant backup power systems at critical facilities benefits all residents/patients at critical care facilities and other institutionalized populations that may not be able to relocate during extreme events and is important for vulnerable populations including those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness
References for action	Department of Environmental Protection, Department of Emergency Services and Public Protection (Department of Emergency Management and Homeland Security) 2019. 2019 Connecticut Natural Hazards Mitigation Plan Update. Various authors, Local Single and Multi-Jurisdiction Hazard Mitigation Plans, Adopted 2015-2020

PHS – 15 **Enhance support for communication and outreach programs to educate residents about all aspects of preparedness, response and recovery for extreme weather events.**	
Recommended Implementation Action Description	This action will focus on enhancing communication tools and approaches identified by ESF-15, Establishment of the Diverse Communities Working Groups. This working group consists of members from our many ethnically diverse media and communities, as well as members from the functional needs communities. This group has assisted with identifying translation resources for state agencies and outreach strategies to reach each community. During different long-term disasters this group may be convened as a task force to discuss emerging communications needs for each community. Areas for improvement of the working group include 1) Enhanced translation resources for state agencies, such as a centralized translation services or office that can quickly translate items and 2) Translation of messaging into languages other than Spanish. Translating items into every language is not always feasible an effort should be made to translate key messages into the languages spoken in that state. The top three languages include Spanish, Polish and Brazilian Portuguese. Additional support to ensure that broadcasted alerts are communicated via a screen-visible, qualified ASL interpreter and accompanied by captioning.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DEMHS, DPH, DSS, stakeholders from impacted communities
Climate challenges addressed	Increasing frequency of severe hurricanes and coastal storms, and extreme precipitation and heat events.
Protection of vulnerable communities	Incorporation of resilience considerations benefits all populations and provides additional protection for vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness. There are multiple barriers that affect preparedness, including language, literacy, age, functional needs and economic hardships.
References for action	Wozniak-Brown, Joanna. "Rural Resiliency Vision and Toolkit." April 2019. Available at https://resilientrural.com Rhode Island Climate Resilience and Action Strategy.2018. http://climatechange.ri.gov/documents/resilientrhody18.pdf

PHS – 16 Establish State and Regional Access and Functional Needs (AFN) Emergency Preparedness and Response Coordinators	
Recommended Implementation Action Description	Coordination to ensure safe and equitable access to communication and evacuation services and of medical care during natural disasters is critical to the promotion of health equity in Connecticut. Populations most vulnerable to poor access and service disruption include people with disabilities, children, the elderly, and those with chronic medical conditions or rely on medical equipment. This recommendation focuses on the establishment of positions at the state agency level as well within DEMHS Regions to coordinate communication and access to public health and emergency services during natural disasters. A state-level coordinator would be responsible for the development of guidelines and protocols and management of databases of vulnerable populations and would additionally serve as an AFN Officer during invocation of the Incident Command System Structure. Regional coordinators are needed to conduct outreach and manage logistics within communities during natural disasters.
Completion Timeframe	• Less than 2 years
Implementation Entities	DEMHS, DPH, DSS, DMHAS, Dept. of Aging and Disability Services
Climate challenges addressed	Increased frequency of severe hurricanes and coastal storms, and extreme precipitation and heat events.
Protection of vulnerable communities	For this recommendation, we look to Hurricane Katrina as an example of the immediate and long-term impacts to our vulnerable populations. Poor housing conditions lead to the immediate displacement of low-income populations, which were disproportionately black. These same poor populations had problems evacuating as they had no immediate access to transportation. Preparation was a problem to LEP populations, as a third of New Orleans population did not speak English well; this impacted what they needed ahead of the disaster as well as communication for directing toward safe sheltering. People with medical conditions could not find access to medication, leading to more deaths after the hurricane because of lack of access. Long-term effects for children included trauma, and access to safe housing and education even 5 years after the hurricane.
References for action	ADA National Network Learning Session: Integrating the Access and Functional Needs Coordinator Role into your Emergency Operations Center webinar (https://www.adapresentations.org/webinar.php?id=162) Legacy of Katrina: The Impact of a Flawed Recovery on Vulnerable Children of the Gulf Coast (https://academiccommons.columbia.edu/doi/10.7916/D8H420TK)

	Vulnerable Populations: Hurricane Katrina as a Case Study (https://www.researchgate.net/publication/43202736_Vulnerable_Populations_Hurricane_Katrina_as_a_Case_Study)

PHS – 17 Create an updated Hurricane and Storm Evacuation Plan for Connecticut	
Recommended Implementation Action Description	A comprehensive plan for the state to prepare and respond to a severe hurricane or coastal storm has not been updated since its original development in 1994. An updated plan is needed to identify and communicate evacuation routes, inland shelters (particularly those for large-scale evacuation events from the coast), critical facilities and housing in flood zones, and to develop a coordinated strategy for safe evacuation of vulnerable populations in flood-prone areas. This plan and accompanying GIS datasets created to support it should be updated on a regular basis (minimum five years).
Completion Timeframe	• Less than 2 years
Implementation Entities	DEMHS, DPH, DOH, CIRCA, Connecticut universities, Regional Emergency Management Coordinators, stakeholders from impacted communities
Climate challenges addressed	Increasing frequency of severe coastal storms and hurricanes.
Protection of vulnerable communities	The plan is required to develop a specific strategy to prioritize evacuation of vulnerable populations. Incorporation of resilience considerations benefits all populations and provides additional protection for vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	https://www.ct.gov/governorRell//cwp/view.asp?A=2425&Q=308716 https://climatecommunication.yale.edu/wp-content/uploads/2015/03/Coastal_Storm_Survey_Report_2015Mar20.pdf https://www.cga.ct.gov/2016/rpt/2016-R-0200.htm Rhode Island Climate Resilience and Action Strategy.2018. http://climatechange.ri.gov/documents/resilientrhody18.pdf

PHS – 18 **Develop water conservation measures & communication guidelines to manage droughts.**	
Recommended Implementation Action Description	A reasonable level of drought response uniformity is needed to avoid confusion regarding drought responses. Work with drinking water industry committees and the Interagency Drought Workgroup to determine a suitable communication method to inform CWS customers of requested water conservation and water restrictions, and to consider potential reporting requirements to track implementation. CWSs should evaluate and reset drought triggers, giving priority to those systems that have experienced serious impacts in the past decade. Develop model ordinances to aid towns in the development of water restriction enforcement ordinances. Agencies should evaluate conservation measures appropriate and effective to address all stages of drought and consistent with the State Drought Plan
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH, DEEP, PURA, OPM, COGs, CADH, Municipalities, CWSs
Climate challenges addressed	Increases resilience of safe and adequate drinking water during drought events.
Protection of vulnerable communities	Incorporation of resilience considerations benefits all populations and provides additional protection for vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018), **Infrastructure Needs Survey and Assessment** (DWINSA), **Connecticut Drought Preparedness and Response Plan (WPC, 2018**), **Connecticut General Statute 25-33h-1**

PHS – 19 **Develop a GIS database and framework for continued updates to capture critical facilities to identify which PWS they are served by and which critical facilities are served by their own PWS.**	
Recommended Implementation Action Description	Critical facilities include hospitals, shelters, nursing homes, and other places that would be severely and quickly impacted by a loss of public water service in a way that endangers human life. Request that Connecticut COGs and municipalities ensure critical facilities are listed in Hazard Mitigation Plans (in Table format, with addresses) and not just spatially presented in general terms on a map. Develop a secure GIS database to represent critical facilities and which PWS they are served by and identify critical facilities that are their own PWS. Refined data could show which portions of CWSs serve specific critical facilities. Develop guidelines to assess critical facilities that are located far from their sources (to determine what infrastructure facilities are linked to critical facilities) improving restoration times.
Completion Timeframe	Less than 2 years.
Implementation Entities	DPH, COGs, LHD, Municipalities, CWSs
Climate challenges addressed	Increases resilience of safe and adequate drinking water during drought, flooding and severe weather events.
Protection of vulnerable communities	Incorporation of resilience considerations benefits all populations and provides additional protection for vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018), **Infrastructure Needs Survey and Assessment** (DWINSA), **Connecticut Drought Preparedness and Response Plan (WPC, 2018**), **Connecticut General Statute 25-33h-1**

PHS – 20 Update planning guidelines, drought triggers and drought response protocols at least once per decade	
Recommended Implementation Action Description	Update reservoir safe yield calculations to address changing climatic conditions and address new provisions such as Connecticut Streamflow Standards and Regulations. Reevaluate drought triggers and update the drought response plan during each water supply plan pursuant to CGS Section 25-32d update. Determine the appropriate level of drought forecasting based on system demand, system storage, percentage of demand met by surface water supplies, and other inputs. These techniques should consider risk based on both past events and the potential for changing conditions in the future. CWS should also address a fast-developing drought aka "Flash Drought" in their plans.
Completion Timeframe	Less than 2 years
Implementation Entities	DPH, DEEP, PURA, OPM, COGs, LHD, Municipalities, CWSs
Climate challenges addressed	Increases resilience of safe and adequate drinking water during drought events.
Protection of vulnerable communities	Updated reservoir safe yield calculations, planning guidelines, and drought response protocols benefits all populations and provides additional protection for vulnerable populations. These actions are directed toward larger community public water systems that serve numerous vulnerable communities including those located in geographically vulnerable areas subject to climate hazards (such as inner-city heat island effects), those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018), Drinking Water **Infrastructure Needs Survey and Assessment** (DWINSA), **Connecticut Drought Preparedness and Response Plan (WPC, 2018**), **Connecticut General Statute 25-33h-1**

PHS – 21 **Develop emergency interconnections between PWSs to ensure that multiple sources and interconnections are available for mutually beneficial sharing of water during emergencies**	
Recommended Implementation Action Description	Recommend the development of a network of primary and secondary interconnections throughout the three regional WUCCs. The most effective means for increasing resilience in a PWS is to provide interconnections with neighboring systems, which can provide emergency flow. Interconnections are especially effective because they only require the distribution system of the ailing system to be operational. Most PWSs have distribution systems that can be repaired relatively easily in emergency situations using in-house supplies. Areas of the distribution system that cannot be repaired can often be isolated or bypassed. CWSs should ensure that multiple sources and interconnections are available (and other redundancies such as additional tanks and backup power sources) for adequate supplies and potential sharing of water during emergencies. Identify potential areas where system interconnection and/or consolidation. Projects may be eligible for funding through the DPH Drinking Water Section's DWSRF. Increased funding under the Public Water System Improvement Program and additional staffing for the DWSRF Unit to handle increased project workload are also recommended.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, DEEP, PURA, OPM, COGs, CADH, Municipalities, CWSs
Climate challenges addressed	Increases resilience of safe and adequate drinking water during emergencies related to climate change (Drought, Flooding, Extreme Weather events).
Protection of vulnerable communities	Emergency interconnections between PWSs benefits all populations served by these systems and provides additional protection for vulnerable populations. These actions are typically directed toward larger community public water systems that serve numerous vulnerable communities including those located in geographically vulnerable areas subject to climate hazards (such as inner-city heat island effects), those that lack financial or other socioeconomic resources to reduce exposure to climate hazards (including low income and linguistic isolation), and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018), Drinking Water **Infrastructure Needs Survey and Assessment** (DWINSA),

	Connecticut Drought Preparedness and Response Plan (WPC, 2018), **Connecticut General Statute 25-33h-1**

PHS – 22 Use source water protection and the Drinking Water Quality Management Plans to encourage resiliency and increase funding and support for investments in watershed protection	
Recommended Implementation Action Description	Leverage the Local Assistance and Other State Programs Set-Aside within DWSRF (when available) to acquire land in watersheds where high percentages of land are not controlled by the utility or otherwise protected from development. This will be done for the purpose of wellhead protection or to protect recharge areas. Annually encourage PWS to apply to the Open Space and Watershed Land Acquisitions Grant Program managed by DEEP and authorized by CGS Section 7-131d(b), such as via Circular letter. Secure funding to develop Drinking Water Quality Management Plans for reservoir watersheds spanning multiple communities. Begin with watersheds where percent of water company land is relatively low. Additional eligibility and funding under the Public Water System Improvement program may also be an option. Additional staff for DWSRF Unit to handle increased project workload.
Completion Timeframe	• 3-5 years
Implementation Entities	DPH, COGs, LHD, Municipalities, CWSs, stakeholders from impacted communities
Climate challenges addressed	Increases resilience of safe and adequate drinking water during flooding and severe weather events.
Protection of vulnerable communities	Increased protective measures for watersheds due to the potential impacts from climate change is a critical long-term protective measure for safe drinking water across Connecticut. Long-term watershed protection benefits all of Connecticut's population and provides additional protection for vulnerable populations. Safe, reliable, and affordable drinking water is necessary to meet the needs of all vulnerable communities including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards, and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018),

Health and Safety Impact Domain: Water-borne Illnesses

Increased risk of water-related illness is expected under current climate change projections through mid-century (Smith et al. 2014). Potential health impacts are driven by warming temperatures, increased annual precipitation and precipitation intensity, and increased potential for extreme events, changes which are expected both globally (Trtanj et al. 2016) and in Connecticut (Seth et al. 2019; Mullin 2019). Warming temperatures will increase the occurrence and duration of cyanobacteria harmful algal blooms (cyanoHABs), with New England anticipated to experience an increase in number of days with blooms sooner than other areas of the United States (Chapra et al. 2017). Warmer water temperatures also enable the expansion of the geographic range for toxin-producing marine algae, freshwater algal and cyanotoxins, and *Vibrio* bacteria that can cause illness from direct water contact and shellfish consumption (Trtanj et al. 2016). (Levy, Smith, and Carlton 2018) describe how increasing temperature, anticipated to occur in Connecticut, can alter and increase the survival, replication and virulence of waterborne pathogens. Direct impacts from exposure to cyanotoxins, algal toxins, and pathogens include a variety of gastrointestinal illnesses, as well as neurological illness, dermatological and respiratory impacts and liver and kidney damage in humans (Fleming, Backer, and Rowan 2002) along with potential for illness and death in companion animals and livestock (Aiello and Moses 2012). The indirect or cumulative impacts from chronic exposure to cyanotoxins (Funari and Testai 2008) as well as bioaccumulation in fish (Poste, Hecky, and Guildford 2011) are still not well understood, but are experienced especially among populations that rely on fish or shellfish from HABs-impacted waters as a food source (Ibelings and Chorus 2007; L. Peng et al. 2010).

The relationship between water-related illness and extreme events (i.e., precipitation and flooding) has been extensively documented (e.g., (Cann et al. 2013; Trtanj et al. 2016; Dupigny-Giroux et al. 2018). Both annual precipitation and extreme precipitation events, which have already shown

increases over the past several decades (Trtanj et al. 2016), are anticipated to increase through mid-century (Trtanj et al. 2016; Seth et al. 2019). Both deliver pathogens and other pollutants, including the nutrients that fuel cyanoHABs, into recreational waters, drinking waters, and fish and shellfish harvesting waters. There is potential for health impacts due infrastructure failure – at scales from individual residential wells and subsurface disposal systems (i.e., septic systems) to regional wastewater and drinking water treatment systems (Trtanj et al. 2016). Increased variability in precipitation is also anticipated to make drought periods more likely (Seth et al. 2019), impacting the availability of safe potable water from both groundwater and surface water sources. Like other areas of the United States, drinking water, wastewater and stormwater infrastructure in Connecticut is at risk of failure due to direct damage or lack of capacity to handle changing precipitation patterns as well as extreme events. Both shocks (such as storm surge in coastal areas or riverine flooding in inland areas) and chronic stressors (such as sea level rise, warming temperatures, and salt water intrusion) can damage infrastructure that is vital for providing potable water and sanitation, and protecting ambient fresh and marine waters. When treatment and protective barriers break down, exposures to pathogens, chemicals, and cyanotoxins increase, with subsequent health impacts. All of these threats and potential impacts create additional and evolving challenges for both regulated water-related services and for the regulators tasked with enforcing public health and safety standards.

Vulnerable Populations

Although water-related illness can affect any individual, certain populations in Connecticut are more vulnerable to exposure and impacts from water-related illness. In some cases, those vulnerabilities are driven by individual physical characteristics such as age or immunocompromised status (MA 2018; NYSDOH 2015). However, socioeconomic conditions such as length of time in the United States, home

ownership, or food insecurity drive or increase vulnerability (Crimmins et al. 2016). Vulnerable populations in the state can be broadly identified as (1) those who are served by wastewater treatment and water systems of scales ranging from a private well supplying a single residence to a public water system supplying a regional area, and (2) those who live, work, and play in proximity to fresh or marine waters. Within these two broad areas of interest, a variety of factors contribute to vulnerability, including age, health status, race/ethnicity, income, and English-language proficiency, as well as the availability, access, and affordability of drinking water and wastewater disposal. Certain people such as those directly involved with water or wastewater treatment and disposal, or those who must be in contact with water potentially containing pathogens because they work in the fishing/shellfishing or recreational industries, are potentially more vulnerable than others. Geographic location, including rural areas with decentralized drinking water and wastewater sources, coastal areas subject to sea level rise and storm surge, and inland areas subject to flooding, also define vulnerable populations. Within in all these populations, lack of equity exacerbates vulnerability because of diminished resources and adaptive capacity to respond to and cope with the health threats created by climate change (Gamble et al. 2016). Locating and quantifying vulnerable populations relying on decentralized and private drinking water and wastewater disposal (i.e., wells and septic systems), is a challenge, but one that is critical to addressing climate-related health vulnerabilities in Connecticut.

PHS – 23 Use Clean Water State Revolving Funds for statewide subsurface sewage disposal systems management and upgrades.	
Recommended Implementation Action Description	Access to the Clean Water State Revolving Fund would benefit affordable housing and sub-standard sewage system upgrades in rural areas. The Clean Water State Revolving Fund (CWSRF) was identified as a tool for climate change preparedness. Rural populations and disadvantaged communities are underserved due to lack of access to funding. In-equitable funding has hampered decentralized system management and system upgrades that are need both before and after a storm event. Climate change planning for state, regional, and municipal governments is needed for areas relying on decentralized sewage disposal systems in order to protect public health and the environment. Further, the use of CWSRF for improved decentralized management would help prevent climate impacted sprawl by encouraging better development practices.
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH, DEEP, Municipalities, CEHA, CADH, COWRA, Regional COG, Industry professionals, Local Health Departments
Climate challenges addressed	Climate change has the potential to impact areas in CT that rely on decentralized sewage disposal systems by changing the landscape and reducing the carrying capacity of the land to dispose of wastewater in a matter that is protective of both public health and the environment. This is especially a concern in coastal areas and other areas where sea level rise and storm surges can dramatically alter the land that decentralized sewage disposal systems rely on to disperse wastewater in a sanitary manner and result in ineffective treatment which could lead to partially renovated sewage effluent impacting water supply wells or water body. Increased precipitation and increased event frequency and duration are of concern statewide.
Protection of vulnerable communities	Vulnerable communities include those that are geographically vulnerable due to exposure to climate hazards (e.g., coastal, inland floodplain) or lack of redundant or resilient sanitation (e.g., rural areas). In addition, vulnerability is also due to individual physical characteristics based on medical status or age (I.e., pregnant women, children, elderly, immune compromised) or socioeconomic status, including low income and linguistic isolation.
References for action	Clean Water State Revolving Fund (CWSRF): Decentralized Wastewater Treatment: https://www.epa.gov/cwsrf/clean-water-state-revolving-fund-cwsrf-decentralized-wastewater-treatment

	Decentralized Systems: Developing Partnerships to Broaden Opportunities Using the CWSRF: https://www.epa.gov/sites/production/files/2015-04/documents/decentralized_systems-developing_partnerships.pdf Funding Decentralized Wastewater Treatment Systems with the Clean Water State Revolving Fund: https://www.epa.gov/sites/production/files/2016-11/documents/funding_decentralized_wastewater_treatment_systems_with_the_clean_water_state_revolving_fund2.pdf Clean Water Partnership Loan Program: https://www.pca.state.mn.us/sites/default/files/wq-cwp7-35b-fy21.pdf EPA's Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems: https://www.epa.gov/sites/production/files/2015-06/documents/septic_guidelines.pdf Federal 2013 Climate Action Plan https://en.wikipedia.org/wiki/Presidential_Climate_Action_Plan Bacteria Total Maximum Daily Load: https://portal.ct.gov/DEEP/Water/TMDL/Total-Maximum-Daily-Load ,Drinking Water Vulnerability Assessment and Resilience Plan (UConn Circa, MMI, November 2018) https://portal.ct.gov/DPH/Drinking-Water/DWS/Drinking-Water-Vulnerability-Assessment-and-Resilience-Plan-DWVAR-Plan DPH Technical Standards for Subsurface Sewage Disposal (DPH, 2018): https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/environmental_engineering/2018-Uploads/Technical-Standards-2018-Master-011918.pdf Soil-Based Onsite Wastewater Treatment and the Challenges of Climate Change (Amador, Loomis, Cooper, & Kalen – University of Rhode Island),Soil-Based Onsite Wastewater Treatment and the Challenges of Climate Change

PHS – 24 **Develop a statewide GIS database and framework for continued updates that identifies the location of private wells and decentralized sewage disposal systems.**	
Recommended Implementation Action Description	Develop a statewide GIS database that identifies the location of private wells and decentralized sewage disposal systems for resiliency planning. This will help determine at risk communities and populations vulnerable to climate change and will allow for mitigation strategies to be developed. Buildings without a potable well supply or a functional sewage disposal system would be uninhabitable and detrimental to public health. A framework for continued location updates and data management will also be developed. Note that this recommendation may allow for coordination with infrastructure and resource mapping recommendations of other Working Groups.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • 3 to 5 years
Implementation Entities	DPH, DEEP, COGs, WPCAs, Municipalities, CADH, CEHA, Local Health Departments, COWRA.
Climate challenges addressed	An increase of the groundwater table due to storm surge, sea level rise, or increased precipitation and frequency could result in ineffective treatment which could lead to partially renovated sewage effluent impacting a nearby water supply well or water body. Decentralized sewage disposal systems and private wells may be impacted by storm surges, flooding events, drought and elevated groundwater conditions created by increased precipitation and sea level rise.
Protection of vulnerable communities	Vulnerable communities include those that are geographically vulnerable due to exposure to climate hazards (e.g., coastal, inland floodplain) or lack of redundant or resilient sanitation (e.g., rural areas). In addition, vulnerability is also due to individual physical characteristics based on medical status or age (I.e., pregnant women, children, elderly, immune compromised) or socioeconomic status, including low income and linguistic isolation.
References for action	Bacteria Total Maximum Daily Load: https://portal.ct.gov/DEEP/Water/TMDL/Total-Maximum-Daily-Load Drinking Water Vulnerability Assessment and Resilience Plan (UConn Circa, MMI, November 2018) https://portal.ct.gov/DPH/Drinking-Water/DWS/Drinking-Water-Vulnerability-Assessment-and-Resilience-Plan-DWVAR-Plan DPH Technical Standards for Subsurface Sewage Disposal (DPH, 2018): https://portal.ct.gov/-/media/Departments-and-

	Agencies/DPH/dph/environmental_health/environmental_engineering/2018-Uploads/Technical-Standards-2018-Master-011918.pdf Soil-Based Onsite Wastewater Treatment and the Challenges of Climate Change (Amador, Loomis, Cooper, & Kalen – University of Rhode Island), Soil-Based Onsite Wastewater Treatment and the Challenges of Climate Change

PHS – 25 **Develop a monitoring system for water quality parameters critical to the shellfishing industry in real-time to forecast potentially high-risk events.**	
Recommended Implementation Action Description	Develop real-time monitoring of water quality parameters to support the development of more sophisticated hydrodynamic modeling within the near-shore aquaculture environment. Connecticut's shellfishing and aquaculture industry revenues are estimated in excess of $30 million dollars annually. Most of Connecticut's aquaculture are produced in near-shore environments vulnerable to the effects of climate change. Monitoring critical water quality parameters (e.g. water levels, currents, salinity, water temperature, air temperatures) in real-time in coastal waters to support hydrodynamic modeling and allow managers to better predict potential high-risk events associated with naturally occurring bacteria, harmful algal blooms, and pathogens associated with climate change. Extreme weather events can result in weeks to months long closures of shellfish beds and could become a routine occurrence in coming years.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, DoAg, DEEP, LHD, Municipalities, NOAA Centers for Coastal and Ocean Science (NCCOS)
Climate challenges addressed	Increasing water temperatures, increase in Vibrio parahaemolyticus infections, increase in harmful cyanotoxin blooms, extreme weather events, flooding, storm surge, and infrastructure failures.
Protection of vulnerable communities	Vulnerability communities include those that rely on shellfish for income and/or food supply including recreational and commercial shellfish harvesters and those using subsistence fishing due to food insecure. In addition to recreational and commercial shellfish harvesters, those with vulnerability due to exposure to pathogen-impacted shellfish include children, pregnant women, and those with chronic illness, especially the immunocompromised.
References for action	**Cann, K.F., Thomas, D.R., Salmon, R.L., Wyn-Jones, A.P. and Kay, D., 2013:** Extreme water-related weather events and waterborne disease. Epidemiology & Infection, 141(4), pp.671-686. **Chapra, S.C., Boehlert, B., Fant, C., Bierman Jr, V.J., Henderson, J., Mills, D., Mas, D.M., Rennels, L., Jantarasami, L., Martinich, J. and Strzepek, K.M., 2017**: Climate change impacts on harmful algal blooms in US freshwaters: a screening-level assessment. Environmental Science & Technology, 51(16), pp.8933-8943. **Connecticut Institute for Resilience and Climate Adaptation (CIRCA), 2019.** Connecticut Physical Climate Science Assessment Report (PCSAR) - Observed trends and projections of temperature and precipitation. https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/08/CTPCSAR-Aug2019.pdf **Funari, E., & Testai, E., 2008**: Human health risk assessment related to cyanotoxins exposure. Critical reviews in toxicology, 38(2), 97–125. https://doi.org/10.1080/10408440701749454 **Ibelings, B. W., & Chorus, I., 2007**: Accumulation of cyanobacterial toxins in freshwater "seafood" and its consequences for public health: a review.

	Environmental pollution (Barking, Essex : 1987), 150(1), 177–192. https://doi.org/10.1016/j.envpol.2007.04.012 **Levy, K., Smith, S.M. and Carlton, E.J., 2018**: Climate change impacts on waterborne diseases: moving toward designing interventions. Current environmental health reports, 5(2), pp.272-282. **National Centers for Coastal Ocean Science (NCCOS).** n.d. "Vibrio Predictive Models." Accessed August 3, 2020. https://products.coastalscience.noaa.gov/vibrioforecast/ Trtanj, J., L. Jantarasami, J. Brunkard, T. Collier, J. Jacobs, E. Lipp, S. McLellan, S. Moore, H. Paerl, J. Ravenscroft, M. Sengco, and J. Thurston, 2016: Ch. 6: Climate Impacts on Water-Related Illness. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC, 157–188. http://dx.doi.org/10.7930/J03F4MH4

PHS – 26 **Track harmful or potentially harmful cyanobacteria algal bloom data in Connecticut and provide technical assistance to community water suppliers to address and prevent these events**	
Recommended Implementation Action Description	Conduct workshops to discuss limnological trends and potential methods to improve water quality. The outcome from these workshops should be information and resources which CWS may use to prevent, mitigate, and treat cyanobacteria harmful algal blooms (cyanoHABs) with information on the potential effectiveness of various strategies. Request that CWSs track the timing of occurrence and the length of algal blooms each year and provide this information to DPH. To ensure that this is not too burdensome, provide guidance to the CWSs such as a visual guide to cyanoHAB bloom visual identification and checklist of questions to answer.
Completion Timeframe	• Less than 2 years.
Implementation Entities	DPH, COGs, LHD, Municipalities, CWSs
Climate challenges addressed	Adaptation to more frequent favorable bloom conditions due to increased temperature and nutrient pollution from increased rainfall intensity/runoff events, as well as groundwater sources. Increases overall resilience of safe and adequate drinking water during drought, flooding and severe weather events.
Protection of vulnerable communities	Vulnerable populations include those that rely on access to recreational waters for heat refuge including populations without air conditioning or access to cooling centers. In addition, those vulnerable to the adverse effects of waterborne pathogens that are anticipated to increase under a warmer and wetter climate include children; pregnant women, and those with chronic illness, especially immunocompromised individuals
References for action	**Chapra, S.C., Boehlert, B., Fant, C., Bierman Jr, V.J., Henderson, J., Mills, D., Mas, D.M., Rennels, L., Jantarasami, L., Martinich, J. and Strzepek, K.M., 2017**: Climate change impacts on harmful algal blooms in US freshwaters: a screening-level assessment. Environmental Science & Technology, 51(16), pp.8933-8943. Drinking Water Vulnerability Assessment and Resilience Plan (UConn Circa, MMI, November 2018), Coordinated Water System Plan, Final Integrated Reports (MMI, DPH, 2018) Connecticut Drought Preparedness and Response Plan (WPC, 2018)

PHS - 27 **Assess the vulnerability of public recreational freshwater and marine beaches to impacts from climate change and prioritize adaptation options to reduce vulnerability.**	
Recommended Implementation Action Description	Freshwater and marine beaches provide cooling options during high heat, are an in-state recreational resource available to those with limited travel options, and are important for economic revenue to the communities within which they are located. This action would inventory public beaches, documenting existing and potential vulnerability to water quality and beach infrastructure under changing climate and prioritize adaptation options to reduce that vulnerability based on beach gray/green infrastructure, water quality and populations served. This recommendation complements recommendations for coastal water quality monitoring for shellfishing.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DEEP, DPH, Watershed Associations and other NGOs, Municipalities, Academic Institutions, Consulting Engineers and Scientists.
Climate challenges addressed	Increasing air and water temperature (GC3 STWG 2020), increased precipitation intensity and subsequent runoff into receiving waters (US EPA, n.d.) both of which can impact water quality (Chapra et al., 2017; Fleming et al., 2018). Sea level rise and storm surge which can damage grey/green infrastructure (Fleming et al., 2018). Coastal and inland flooding which can impact water quality and damage grey/green infrastructure.
Protection of vulnerable communities	Vulnerable populations include those that rely on access to recreational waters for heat refuge including populations without air conditioning or access to cooling centers. In addition, those vulnerable to the adverse effects of waterborne pathogens that are anticipated to increase under a warmer and wetter climate include children; pregnant women, and those with chronic illness, especially immunocompromised individuals
References for action	**Chapra, Steven C., Brent Boehlert, Charles Fant, Victor J. Bierman Jr, Jim Henderson, David Mills, Diane ML Mas et al.** "Climate change impacts on harmful algal blooms in US freshwaters: a screening-level assessment." *Environmental Science & Technology* 51, no. 16 (2017): 8933-8943. **Fleming, E., J. Payne, W. Sweet, M. Craghan, J. Haines, J.F. Hart, H. Stiller, and A. Sutton-Grier, 2018:** Coastal Effects. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 322–352. doi: 10.7930/NCA4.2018.CH8 **Myers, Monique R., Patrick L. Barnard, Edward Beighley, Daniel R. Cayan, Jenifer E. Dugan, Dongmei Feng, David M. Hubbard, Sam F. Iacobellis, John M. Melack, and Henry M. Page.** "A multidisciplinary coastal vulnerability assessment for local government focused on ecosystems, Santa Barbara area, California." *Ocean & Coastal Management* 182 (2019): 104921.

	Pennetta, Micla, Vera Corbelli, Vincenzo Gattullo, Raffaella Nappi, Vincenzo Maria Brancato, and Dario Gioia. "Beach vulnerability assessment of a protected area of the Northern Campania coast (Southern Italy)." *Journal of Coastal Conservation* 22, no. 5 (2018): 1017-1029. **US EPA. n.d.** "Climate Adaptation and Stormwater Runoff." Accessed August 3, 2020. https://www.epa.gov/arc-x/climate-adaptation-and-stormwater-runoff

PHS – 28 Develop an energy audit program for water systems (Water and Wastewater) to increase energy efficiency and reduce greenhouse gas emissions across the water industry	
Recommended Implementation Action Description	Increase energy efficiency for water and wastewater facilities through the implementation of an energy audit program including; benchmarking, educational outreach, energy efficiency audits, implementation projects, grants and loan forgiveness programs.
Completion Timeframe	• 3 to 5 years
Implementation Entities	DPH, DEEP, Utility Industry, Municipalities, CWSs
Climate challenges addressed	Greenhouse gas emissions
Protection of vulnerable communities	Energy efficiency and concurrent reductions in GHGs benefits all populations, but long-term health benefits will be beneficial to vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards, and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	Connecticut Comprehensive Energy Strategy (Feb 8, 2018), Connecticut Climate Preparedness Plan (2011)

PHS – 29 **Identify and improve wells that are located within a flood zone to increase resilience and reduce risk of flooding.**	
Recommended Implementation Action Description	Flooding is a major issue for both small and large CWSs. It is important to identify systems with public water supply wells in flood zones and ensure adequate measures are taken to protect wells from flooding. Develop a GIS database of wells that are located within a flood zone and ensure sufficient protective measures to reduce the risk of flooding. If wells are found to be inadequately prepared for a flooding event, improvements (or replacement) should be made so the well head is above the 500-year flood event plus appropriate freeboard. Update construction standards to incorporate revised flood projections (100 yr +5 or 500 yr). Incorporate GIS mapping of vulnerable well locations. Well improvement projects may be eligible to be funded by the DWSRF. Additional eligibility and funding under the Public Water System Improvement program may also be an option. Additional staff for DWSRF Unit to handle increased project workload is also recommended.
Completion Timeframe	3-5 years.
Implementation Entities	DPH, COGs, CADH, Municipalities, CWSs
Climate challenges addressed	Increases resilience of safe and adequate drinking water during flooding and severe weather events. Note that although this recommendation focuses on flooding impacts, wells may also be impacted by drought, which is expected to become more likely under future climate.
Protection of vulnerable communities	Vulnerable communities include those that are geographically vulnerable due to exposure to climate hazards (e.g., coastal, inland floodplain) or lack of redundant or resilient potable water supply (e.g., rural areas). In addition, increased vulnerability to potential well contamination due to flooding is also due to individual physical characteristics based on medical status or age (I.e., pregnant women, children, elderly, immune compromised) or socioeconomic status, including low income and linguistic isolation.
References for action	**University of Connecticut, Connecticut Institute of Resilience and Climate Adaptation, & Milone and MacBroom, I. (2018).** *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, Middlesex, and New London Counties*. Connecticut Department of Public Health Retrieved from https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf **Coordinated Water System Plan,** Final Integrated Reports (MMI, DPH, 2018), **Infrastructure Needs Survey and Assessment** (DWINSA), **Connecticut Drought Preparedness and Response Plan (WPC, 2018**), **Connecticut General Statute 25-33h-1**

PHS – 30 **Incorporate resiliency into the consideration of new laws, regulations, and policies and promote greater education of PWS about the importance of resiliency.**	
Recommended Implementation Action Description	Develop regulations to specifically link PWS to resiliency planning and design standards. Include resiliency planning in the consideration of new laws, regulations, and policies and promoting greater education of PWS about the importance of resiliency. Regulations should directly address construction of public water supply wells in flood zones, and requirements should be uniform across the state. Provide guidance to local land use commissions on revising regulations to make well construction in flood zones more stringent. Incorporate a resiliency metric into the sanitary surveys through the small system CAT ("scorecard") and monitor results over time. Update the water supply planning regulations to require assessment of the potential impacts of climate change (changing rainfall patterns, flooding, sea level rise, drought management) on the water system as part of Water Supply Plan updates.
Completion Timeframe	3-5 years.
Implementation Entities	DPH, COGs, CADH, Municipalities, CWSs, stakeholders from impacted communities
Climate challenges addressed	Increases resilience of safe and adequate drinking water during drought, flooding and severe weather events.
Protection of vulnerable communities	Incorporation of resilience considerations benefits all populations, but long-term health benefits will be beneficial to vulnerable populations including those located in geographically vulnerable areas subject to climate hazards, those that lack financial or other socioeconomic resources to reduce exposure to climate hazards, and those with individual physical characteristics or medical conditions that increase their vulnerability, including the elderly, infants, and those with chronic illness.
References for action	Drinking Water Vulnerability Assessment and Resilience Plan (UConn Circa, MMI, November 2018), Coordinated Water System Plan, Final Integrated Reports (MMI, DPH, 2018)

Health and Safety Impact Domain: Nutrition, Food Security, and Food Safety

The fragility of the supply chain has been shown recently as a result of the COVID-19 pandemic. Food systems will be greatly disrupted by climate change, resulting in inadequate food supply, especially among low income populations (Dupigny-Giroux et al. 2018). The nutritional quality of food crops is affected by rising carbon dioxide levels, with a decline in protein content; the depletion of essential minerals such as calcium, copper, iron, and magnesium; and an increase in the ratio of carbohydrates to protein (L Rudolph et al. 2018; Ziska et al. 2016). Decreased nutrient density of foods can negatively impact human health over time and lead to nutritional deficiencies. Research suggests that an increased carbohydrate-to-protein ratio can negatively affect metabolism and body composition Ziska et al. 2016).

Extreme heat, drought, and weather events impact food production through reduced crop yields, decreased milk and egg production, and declining fish yields (Linda Rudolph, Gould, and Berko 2015; L Rudolph et al. 2018). Climate-related disturbances also affect access to and distribution of food. Extreme weather events can disrupt food distribution infrastructure, damage food supplies, and limit access to safe and healthy foods, even in areas not directly affected (Ziska et al. 2016). As supplies decrease, food prices increase and encourage purchasing of high-energy, low-nutrient foods (Linda Rudolph, Gould, and Berko 2015).

Food safety and the incidence of foodborne disease have the potential to be greatly affected by some of the environmental variations associated with climate change (Ziska et al. 2016; Dupigny-Giroux et al. 2018). As was mentioned in previous sections, changes in weather patterns can lead to severe events, such as flooding, drought conditions, and an increase in ambient air temperature and humidity. Keeping the foods we eat safe can become more difficult with these added factors. Flood waters may contain raw sewage and can affect the quality of water used to irrigate the growing fields as

well as water used to rinse produce. Further, flooding can contaminate the soil in which crops are grown and animal feed. Maintaining certain foods at safe temperatures is also an important step in preventing the growth of some bacteria that can cause illness when consumed. Many pathogens prefer warm and moist conditions, which is a concern with an increase in temperature. Refrigeration units must be able to maintain foods at safe temperatures amid the rise in the temperature outside, and power outages due to storms and floods can pose risk for food-borne illness (Ziska et al. 2016).

Vulnerable Populations

Not all individuals and communities are impacted equally by climate change. Low income populations, people of color, infants and young children, pregnant women, the elderly, agricultural workers, people with weakened immune systems and those with underlying medical conditions are more vulnerable to the impacts of climate change on food safety, nutrition, and food access (Ziska et al. 2016). Given that diet quality is significantly lower for low income populations, and access to healthy foods is already limited, exacerbation of existing health disparities for low income underserved communities are likely without interventions to ensure access to healthy foods and strengthening of food supply and distribution. Additionally, low income populations in areas affected most by climate change may be displaced from their homes. Resettling in a new environment, potentially a different country or culture, will be very vulnerable to the impacts of climate change and at high risk for food insecurity.

PHS-31 **Develop state and regional food security action plans to mitigate the risk of climate change and extreme weather events on the food system.**	
Recommended Implementation Action Description	The overarching recommendation regarding nutrition as it relates to climate change is to connect New England state agencies and key stakeholders and organizations across Connecticut communities to develop state and regional food security action plans with the goal of increasing regional food production and strengthening regional food distribution, especially during times of crisis. Connecticut will utilize lessons from existing food security work, incorporating the principles of food sovereignty, which will serve as the basis for learning and building toward long term solutions to be captured in the food security action plan. This includes the work conducted in response to COVID as well as responses to recent severe weather events, such as Hurricane Maria and Tropical Storm Isaias. Examples of current activities to address emergency food needs is the Farms to Families Food Boxes through the Connecticut Department of Agriculture and the Foodshare Emergency Mobile Food Pantry at Rentschler Field in Hartford serving 1,500-2,000 people per day, among many others. We are further drawing on the experiences and examples of the New England regions' food plans, including Massachusetts, Rhode Island, and Vermont. Connecticut's food security action plan will promote a resilient local food supply by : 1) setting minimum targets for production and distribution by food category and location (including urban farming production) that can be coordinated with other New England states to achieve the overall goals for New England food systems and 2) working with other New England states to develop and implement policies, procedures, and plans to ensure that the regional food supply is sufficient to weather global or national food supply chain disruptions caused by climate change and global pandemics; with barriers identified during the COVID-19 pandemic as a focal point for preparedness.
Completion Timeframe	• 1 to 2 years, continue to work with statewide and regional partners to learn from current food systems work to inform action planning process; and • 3 to 5 years for plan development and implementation, although policy implementation may extend greater than 5 years.
Implementation Entities	CT State Agencies; NGOs such as the Farm Bureau the Connecticut Food Association; Academic Institutions; stakeholders from impacted communities
Climate challenges addressed	Food systems will be greatly disrupted by climate change, resulting in inadequate food supply and increased food insecurity, especially among low income populations (Dupigny-Giroux et al., 2018). Additionally, the climate crisis will bring refugees to New England from areas impacted more greatly from other parts of the world. These individuals will likely be at extremely high risk for food insecurity, further increasing the emergency related to food security for the state. Goals for production and distribution, as well as improved access specifically for food insecure populations are crucial to ensure food security for Connecticut residents.

Protection of vulnerable communities	Development of a state food security action plan will engage partners in Connecticut and within New England to mitigate the risk of climate change on the food system, with a focus on protecting vulnerable populations most impacted by climate-related events such as low income people, people of color, children, and the elderly.
References for action	**Dupigny-Giroux, L.A., E.L. Mecray, M.D. Lemcke-Stampone, G.A. Hodgkins, E.E. Lentz, K.E. Mills, E.D. Lane et al. (2018).** Northeast. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. doi: 10.7930/NCA4.2018.CH18

Health and Safety Impact Domain: Mental Health and Well-being

Climate change is recognized to have profound effects on mental health and wellbeing. Mental health impacts are broad and range in severity from psychological distress to clinical illnesses including anxiety, depression, post-traumatic stress disorder, as well as increasing rates of suicide (Burke et al. 2018; Doherty and Clayton 2011; Dodgen et al. 2016). Some of the mental health impacts arise directly from physical impacts of climate change such as from floods and heat stress, while other effects are indirect via impacts on human systems and infrastructure, such as impacts on food security, economic sectors, and human livelihood (Stansbury et al., 2014). In the Northeast, including Connecticut, flooding from storm surges and sea level rise, and extreme precipitation events (particularly in urban areas with more impervious surfaces), are expected to carry physical and mental health consequences (Lieberman-Cribbin et al. 2017). The cumulative and interactive effects of climate change, and the threat perception relayed through public communications negatively impact mental health at the individual and societal levels (Dodgen et al. 2016). The impacts of climate change on mental health limit our capacity to cope, recover, and adapt, and thus adaptation planning for the increased mental health needs of Connecticut residents is an integral part of the revised Connecticut Climate Preparedness Plan (Change 2011).

Although many individuals recover from the mental health effects of climate change events with time, many experience chronic psychological dysfunction. The effects of climate change on physical and mental health are expected to be felt most by vulnerable populations, including those with preexisting mental illness (Doherty and Clayton 2011; Sullivan et al. 2013). In the United States there are an estimated 46.6 million adults in the U.S with an existing mental disorder, and an estimated 11.2 million with a serious mental illness, roughly 4.5 % of all U.S adults (SAMSHA 2019)Chronic mental illness and substance use commonly co-occur with medical comorbidities, which further contributes to the burden

of disease in terms of lifetime disability and early mortality (Walker and Druss 2018). A meta-analysis found that for all-cause mortality 14.3% of deaths worldwide, or 8 million deaths, are attributable to mental disorders (Walker, McGee, and Druss 2015).

In the United States 14 of every 100000 people died by suicide in 2017, making suicide the 10th leading cause of death in the United States (Murphy et al. 2018). Suicide rates have been increasing, up by 33% since 1999 (Curtin, Warner, and Hedegaard 2016). Elevated rates of suicide in certain communities impacted by climate change suggest an association between the effects of climate change and rates of completed suicide (Dumont et al. 2020). A recent study found that, between 1990 and 2010, suicide rates increased 0.7% in United States and 2.1% in Mexico for every 1°C increase in monthly average temperature, and concludes that if climate change proceeds unmitigated under the "business as usual" scenario (RPC) 8.5 temperature increases will add an estimated 5,600 to 26,050 total additional suicides across the U.S. by 2050 (Burke et al. 2018).

The recognition of mental health as a public good has been set forth as part of the Sustainable Development Goals of the United Nations (Patel et al. 2018). This was a significant step toward addressing the excessive burden of mental disorders and substance use in all countries. Mindful of the increasing rates mental illness and substance use in the United States and the profound effects of climate change on mental health predicted in the coming decades, policymakers will need to take proactive steps to measure, monitor, and set forth goals to lessen the impacts of climate change on populations at risk for and experiencing mental health and substance use disorders.

Vulnerable Populations

Special consideration is needed for specific groups of Connecticut's population who are at high risk of distress or adverse mental health outcomes following exposure to climate-related disasters. These

include children, the elderly, pregnant and postpartum women, first-responders, those with pre-existing mental illness, those with low socio-economic status, and the homeless (Dodgen et al. 2016). Furthermore, those with preexisting mental illness have been identified as a population with multiple vulnerabilities to climate change, in particular extreme heat (Gamble et al. 2016). This is in part due to underlying nature of their illness and that medications they are prescribed can impair the body's ability to thermoregulate. Furthermore, they are impacted via the social determinants of health, which limit one's capacity to adapt to extreme heat, such having stable housing with access to air-conditioned spaces, or the having the economic resources to manage electricity costs of air conditioning.

PHS-32 Establish Best Practices for Disaster Case Managers for Addressing Needs of Mental Health Populations in Disaster Response	
Recommended Implementation Action Description	Chronic mental health problems were cited as a common risk factor underlying the delay or complete derailment of post-disaster recovery for some individuals in the aftermath of Superstorm Sandy (CT Rises Volunteers, 2019). This action focuses on the development of best management practices and implementation evaluation for addressing needs of mental health populations by Disaster Case Managers and procurement of sustained funding for accessible and appropriate mental health services during post-natural disaster recovery.
Completion Timeframe	• Less than 2 years
Implementation Entities	DMHAS, DEMHS, Connecticut Long-term Recovery Committee, stakeholders from impacted communities
Climate challenges addressed	Increasing frequency of severe coastal storms and hurricanes, drought, and extreme heat events.
Protection of vulnerable communities	This action provides the framework to bolster the support for individuals with chronic mental health conditions in long-term disaster recovery.
References for action	CT Rises Volunteers and Survivors of Superstorm Sandy. 2019. CT Rises: Planning for Long-term Disaster Recovery. A Guide and toolkit. Supplement to The Local Emergency Management Directory and Municipal Office Handbook. https://portal.ct.gov/-/media/CTRecovers/CT_Rises-Planning-for-Long-Term_Recovery.pdf

Cross-cutting Topics

The Public Health and Safety Working group also recognized during the 2020 planning phase for this report, multiple broad, cross-cutting needs for further development in 2021. Specifically noted was the lack of a coordinating entity to implement the adaptive management framework outlined by the Centers for Disease Control and Prevention (CDC) for protecting vulnerable communities against the negative impacts of climate change. This framework, the Building Resilience Against Climate Effects (BRACE), is currently being implemented nationwide by states with dedicated federal funding from the CDC Climate and Health program (Marinucci et al 2014). Key components of this framework are: assessments to identify vulnerable communities, projections of future disease burden, assessments of suitable interventions for the health impacts of greatest concern, coordination to facilitate implementation of recommended actions, and review of intervention effectiveness. The framework has been used by public health departments in all five states in New England besides Connecticut over the past decade, and The Public Health and Safety Working group expressed concerns that the absence of its utilization in Connecticut has hampered implementation of measures critical to protection of the health and safety of our residents. Such critical measures include development of effective communication campaigns to educate residents of Connecticut about the public health and safety impacts specifically in our state. In recognition of the diverse needs of the state's 169 towns for adaptation and resilience planning, additional areas for further development were: coordination with relevant stakeholders to provide a comprehensive plan for strengthening community resilience[1] against the impacts of climate change, and coordination between state and local municipalities to provide the

[1] Community resilience is the ability of a community to prepare for, withstand, recover from, and adapt to stressors such as climate change and/or severe events associated with climate change.

resources needed for adaptation tailored toward local areas. These broad areas for further development will additionally be prioritized through 2021, in coordination with the Equity and Environmental Justice Working groups and Science and Technology Working groups of the GC3.

PHS-33 Establish a State Climate and Health Coordinator Position	
Recommended Implementation Action Description	The challenge of climate change to public health and safety is vast and complex. The U.S. Centers for Disease Control and Prevention has developed the Building Resilience Against Climate Effects (BRACE) framework as an adaptive management approach for health departments to use to address challenge Currently 17 state and local governments receive federal funding to implement this framework and are actively developing interventions to protect the health and safety of their residents from the negative effects of climate change. Connecticut has not yet adopted this framework and has no program to coordinate and oversee such essential actions. A recent report from the Yale Center on Climate Change and Health highlighted the limitations for action of climate and health resilience by DPH in the absence of additional funding (Bozzi and Dubrow 2020). Responsibilities of this position will include coordination among state and local agencies, Yale Center on Climate Change and Health, CIRCA, and internal DPH programs to monitor environmental and climatic changes, track climate-sensitive health outcomes, and implement recommendations to protect public health and safety, prioritizing vulnerable populations, from the negative health impacts of climate adopted by the GC3; coordination with other state health departments throughout the Northeast currently funded by the CDC Climate and Health program to implement the BRACE framework in Connecticut; build strategic partnerships to improve health resilience throughout the state; and competitive grant proposal submissions to support a climate and health program at DPH.
Completion Timeframe	• Less than 2 years
Implementation Entities	DPH
Climate challenges addressed	Increased frequency of drought, severe hurricanes and coastal storms, and extreme precipitation and heat events.
Protection of vulnerable communities	The first step of the BRACE framework is an assessment of vulnerable populations with respect to a target climate hazard for evaluation, and all subsequent four steps can and will be adapted to provide disease burden projections and intervention assessment, application, and evaluation specific to vulnerable populations identified during this first step. As such, a focus on vulnerable populations is integral to this recommendation.
References for action	United States Centers for Disease Control and Prevention (US CDC). CDC's Building Resilience against Climate Effects (BRACE) Framework. 2018. Available

	online: **https://www.cdc.gov/climateandhealth/BRACE.htm** (accessed on 31 July 2020). Sheehan, M.D.; Fox, M.A.; Kaye, C.; Resnick, B. Integrating health into local climate response: Lessons from the U.S. CDC Climate-Ready States and Cities Initiative. *Environ. Health Perspect.* **2017**. Manangan, A.P.; Uejio, C.K.; Shubhayu, S.; Schramm, P.J.; Marinucci, G.D.; Hess, J.J.; Luber, G. *Assessing Health Vulnerability to Climate Change: A Guide for Health Departments*; US Centers for Disease Control and Prevention: Atlanta, GA, USA, 2015. Available online: **https://www.cdc.gov/climateandhealth/pubs/assessinghealthvulnerabilitytoclimatechange.pdf** (accessed on 31 July 2020). Berry, P.; Enright, P.M.; Shumake-Guillemot, J.; Prats, E.V.; Campbell-Lendrum, D. Assessing Health Vulnerabilities and Adaptation to Climate Change: A Review of International Progress. Int. J. Environ. Res. Public Health 2018, 15, 2626. Bozzi et al. 2020. https://publichealth.yale.edu/climate/YCCCH_CCHC2020Report_395366_5_v1.pdf

REFERENCES

Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. 2010. *The impacts of claimte change on Connecticut agriculture, infrastructure, natural resources, and public health.*

---. 2011. "Connecticut climate change preparedness plan: Adaptation strategies for agriculture, infrastructure, natural resources, and public health climate change vulnerabilities.

Ahdoot, Samantha, and Susan E Pacheco. 2015. "Global climate change and children's health." *Pediatrics* 136 (5): e1468-e1484.

Aiello, Susan E, and MA Moses. 2012. "The Merck Veterinary Manual Online." *Whitehouse Station, NJ: Merck Sharp and Dohme Corp*.

Almeida, A Paulo G, Susana SSG Baptista, Carla AGCC Sousa, M Teresa LM Novo, Helena C Ramos, Nicholas A Panella, Marvin Godsey, M João Simões, M Luisa Anselmo, and Nicholas Komar. 2005. "Bioecology and vectorial capacity of Aedes albopictus (Diptera: Culicidae) in Macao, China, in relation to dengue virus transmission." *Journal of medical entomology* 42 (3): 419-428.

America, Asthma and Allergy Foundation of. 2019. "Asthma Capital 2019." https://www.aafa.org/media/2426/aafa-2019-asthma-capitals-report.pdf.

Anderson, Craig A. 1989. "Temperature and aggression: ubiquitous effects of heat on occurrence of human violence." *Psychological bulletin* 106 (1): 74.

---. 2001. "Heat and violence." *Current directions in psychological science* 10 (1): 33-38.

Andreadis, Theodore G, Michael Charles Thomas, and John J Shepard. 2005. *Identification guide to the mosquitoes of Connecticut*. Vol. 966: Connecticut Agricultural Experiment Station.

Arbury, Sheila, Brenda Jacklitsch, Opeyemi Farquah, Michael Hodgson, Glenn Lamson, Heather Martin, and Audrey Profitt. 2014. "Heat illness and death among workers—United States, 2012–2013." *MMWR. Morbidity and mortality weekly report* 63 (31): 661.

Armstrong, Philip M, and Theodore G Andreadis. 2010. "Eastern equine encephalitis virus in mosquitoes and their role as bridge vectors." *Emerging infectious diseases* 16 (12): 1869.

---. 2013. "Eastern equine encephalitis virus—old enemy, new threat." *N Engl J Med* 368 (18): 1670-3.

Armstrong, Philip M, Theodore G Andreadis, John J Shepard, and Michael C Thomas. 2017. "Northern range expansion of the Asian tiger mosquito (Aedes albopictus): Analysis of mosquito data from Connecticut, USA." *PLoS neglected tropical diseases* 11 (5): e0005623.

Bai, Li, Lindsay Carol Morton, and Qiyong Liu. 2013. "Climate change and mosquito-borne diseases in China: a review." *Globalization and health* 9 (1): 10.

Beard, C Ben, James Occi, Denise L Bonilla, Andrea M Egizi, Dina M Fonseca, James W Mertins, Bryon P Backenson, Waheed I Bajwa, Alexis M Barbarin, and Matthew A Bertone. 2018. "Multistate infestation with the exotic disease–vector tick Haemaphysalis longicornis—United States, August 2017–September 2018." *Morbidity and mortality weekly report* 67 (47): 1310.

Bekkar, Bruce, Pacheco, Susan, Basu, Rupa, & DeNicola, Nathaniel. 2020. "Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review." *JAMA Network Open 3*(6), e208243. https://doi.org/10.1001/jamanetworkopen.2020.8243

Bell, Jesse E, Stephanie C Herring, Lesley Jantarasami, Carl Adrianopoli, Kaitlin Benedict, Kathryn Conlon, Vanessa Escobar, Jeremy Hess, Jeffrey Luvall, and CP Garcia-Pando. 2016. *Ch. 4: Impacts of extreme events on human health.* US Global Change Research Program, Washington, DC.

Bozzi, Laura, and Robert Dubrow. 2020. *Climate Change and Health in Connecticut: 2020 Report.* Yale Center on Climate Change and Health (New Haven, Connecticut).

Burke, Marshall, Felipe González, Patrick Baylis, Sam Heft-Neal, Ceren Baysan, Sanjay Basu, and Solomon Hsiang. 2018. "Higher temperatures increase suicide rates in the United States and Mexico." *Nature climate change* 8 (8): 723-729.

Burridge, Michael J. 2011. *Non-native and invasive ticks*. University Press of Florida.

Cann, KF, D Rh Thomas, RL Salmon, AP Wyn-Jones, and D Kay. 2013. "Extreme water-related weather events and waterborne disease." *Epidemiology & Infection* 141 (4): 671-686.

CDC. 2016. Centers for Disease Control and Prevention. National Notifiable Conditions (Historical), 2016. https://wwwn.cdc.gov/nndss/conditions/notifiable/2016/

---. 2017. Centers for Disease Control and Prevention. National notifiable infectious diseases and conditions: United States. Reported cases of notifiable diseases and rates per 100,000, excluding U.S. territories – United States, 2017. https://wonder.cdc.gov/nndss/static/2017/annual/2017-table1.html

---. 2018. Centers for Disease Control and Prevention. Nationally Notifiable Infectious Diseases and Conditions, United States: Annual Tables, 2018. https://wonder.cdc.gov/nndss/static/2018/annual/2018-table2i.html

Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. 2010. *The impacts of claimte change on Connecticut agriculture, infrastructure, natural resources, and public health.*

---. 2011. "Connecticut climate change preparedness plan: Adaptation strategies for agriculture, infrastructure, natural resources, and public health climate change vulnerabilities."

Chapra, Steven C, Brent Boehlert, Charles Fant, Victor J Bierman Jr, Jim Henderson, David Mills, Diane ML Mas, Lisa Rennels, Lesley Jantarasami, and Jeremy Martinich. 2017. "Climate change impacts on harmful algal blooms in US freshwaters: a screening-level assessment." *Environmental Science & Technology* 51 (16): 8933-8943.

Childs, James E, and Christopher D Paddock. 2003. "The ascendancy of Amblyomma americanum as a vector of pathogens affecting humans in the United States." *Annual review of entomology* 48 (1): 307-337.

Commins, Scott P, Hayley R James, Libby A Kelly, Shawna L Pochan, Lisa J Workman, Matthew S Perzanowski, Katherine M Kocan, John V Fahy, Lucy W Nganga, and Eva Ronmark. 2011. "The relevance of tick bites to the production of IgE antibodies to the mammalian oligosaccharide galactose-α-1, 3-galactose." *Journal of Allergy and Clinical Immunology* 127 (5): 1286-1293. e6.

Connecticut, University of, CIRCA, and Milone & MacBroom Inc. 2018. *Drinking Water Vulnerability Assessment and Resilience Plan: Fairfield, New Haven, MIddlesex, and New London Counties, Cnnecticut Department of Public Health.*

Cooley, Robert Allen, and Glen M Kohls. 1944. "The genus Amblyomma (ixodidae) in the United States." *The Journal of Parasitology* 30 (2): 77-111.

Connecticut Green & Healthy Homes Partners 2018. Connecticut Green & Healthy Homes Pre-Feasibility Analysis Report. https://www.ctgreenbank.com/wp-content/uploads/2018/06/Pre-Feasibility-Analysis-CGHH-June-2018_Final.pdf

Council, Connecticut Water Planning. 2018. *Connecticut Drought Preparedness and Response Plan.*

Crimmins, A, JL Balbus, CB Gamble, CB Beard, JE Bell, D Dodgen, RJ Eisen, N Fann, MD Hawkins, and SC Herring. 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington DC: US Global Change Research Program; 2016.

CT Executive Order No. 3. 2019. https://portal.ct.gov/-/media/Office-of-the-Governor/Executive-Orders/Lamont-Executive-Orders/Executive-Order-No-3.pdf

Curtin, Sally C, Margaret Warner, and Holly Hedegaard. 2016. *Increase in suicide in the United States, 1999-2014*. Vol. 2016: US Department of Health and Human Services, Centers for Disease Control and ….

Dahlgren, F Scott, Kristen Nichols Heitman, Naomi A Drexler, Robert F Massung, and Casey Barton Behravesh. 2015. "Human granulocytic anaplasmosis in the United States from 2008 to 2012: a

summary of national surveillance data." *The American Journal of Tropical Medicine and Hygiene* 93 (1): 66-72.

Dahlgren, F Scott, Christopher D Paddock, Yuri P Springer, Rebecca J Eisen, and Casey Barton Behravesh. 2016. "Expanding range of Amblyomma americanum and simultaneous changes in the epidemiology of spotted fever group rickettsiosis in the United States." *The American journal of tropical medicine and hygiene* 94 (1): 35-42.

DEEP, CT, and CT DESPP/DEMHS. 2019. *2019 Connecticut Natural Hazards Mitigation Plan Update.*

Delisle, E, C Rousseau, B Broche, I Leparc-Goffart, G L'ambert, A Cochet, C Prat, V Foulongne, JB Ferre, and O Catelinois. 2015. "chikungunya outbreak in Montpellier, France, September to October 2014." *Eurosurveillance* 20 (17): 21108.

Dodgen, Daniel, D Donato, N Kelly, A La Greca, J Morganstein, J Reser, J Ruzek, S Schweitzer, MM Shimamoto, and K Thigpen Tart. 2016. *Ch. 8: Mental health and well-being.* US Global Change Research Program, Washington, DC.

Doherty, Thomas J, and Susan Clayton. 2011. "The psychological impacts of global climate change." *American Psychologist* 66 (4): 265.

Dominianni, Christine, Kathryn Lane, Sarah Johnson, Kazuhiko Ito, and Thomas Matte. 2018. "Health impacts of citywide and localized power outages in New York City." *Environmental health perspectives* 126 (6): 067003.

DPH, CT. 2020. *Healthy Connecticut 2025: State Health Assessment.*

Dumont, Caroline, Elizabeth Haase, Trygve Dolber, Janet Lewis, and John Coverdale. 2020. "Climate change and risk of completed suicide." *The Journal of nervous and mental disease* 208 (7): 559-565.

Dupigny-Giroux, L. A., E. L. Mecray, M. D. Lemcke-Stampone, G. A. Hodgkins, E. E. Lentz, K. E. Mills, E.D. Lane, R. Miller, D.Y. Hollinger, W.D. Solecki, G.A. Wellenius, P.E. Sheffield, A.B. MacDonald, and C. Caldwell. 2018. "Northeast. ." In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, edited by D.R. Reidmiller, C.W. Avery, D.R. Easterling , K.E. Kunkel, K.L.M. Lewis, T.K. Maycock and B.C. Stewart. Washington, DC, USA.: U.S. Global Change Research Program.

Eisen, Lars, and Kirby C Stafford. 2020. "Barriers to Effective Tick Management and Tick-Bite Prevention in the United States (Acari: Ixodidae)." *Journal of Medical Entomology*.

Eisen, Rebecca J, and Lars Eisen. 2018. "The blacklegged tick, Ixodes scapularis: an increasing public health concern." *Trends in parasitology* 34 (4): 295-309.

Eisen, Rebecca J, Kiersten J Kugeler, Lars Eisen, Charles B Beard, and Christopher D Paddock. 2017. "Tick-borne zoonoses in the United States: persistent and emerging threats to human health." *ILAR journal* 58 (3): 319-335.

Fann, Neal, Terry Brennan, Patrick Dolwick, Janet L Gamble, Vito Ilacqua, Laura Kolb, Christopher G Nolte, Tanya L Spero, and Lewis Ziska. 2016. "AIR QUALITY IMPACTS." *HUMAN HEALTH THE IMPACTS OF CLIMATE CHANGE ON*: 69.

Faraji, Ary, Andrea Egizi, Dina M Fonseca, Isik Unlu, Taryn Crepeau, Sean P Healy, and Randy Gaugler. 2014. "Comparative host feeding patterns of the Asian tiger mosquito, Aedes albopictus, in urban and suburban Northeastern USA and implications for disease transmission." *PLoS Negl Trop Dis* 8 (8): e3037.

Fix, Alan D, César A Peña, and G Thomas Strickland. 2000. "Racial differences in reported Lyme disease incidence." *American journal of epidemiology* 152 (8): 756-759.

Fleming, Lora E, Lorraine Backer, and Alan Rowan. 2002. "The epidemiology of human illnesses associated with harmful algal blooms." In *Handbook of Neurotoxicology*, 363-381. Springer.

Funari, Enzo, and Emanuela Testai. 2008. "Human health risk assessment related to cyanotoxins exposure." *Critical reviews in toxicology* 38 (2): 97-125.

Gamble, JL, John Balbus, Martha Berger, Karen Bouye, Vince Campbell, Karletta Chief, K Conlon, Allison Crimmins, Barry Flanagan, and C Gonzalez-Maddux. 2016. *Ch. 9: Populations of concern.* US Global Change Research Program, Washington, DC.

Gauer, Robert, and Bryce K Meyers. 2019. "Heat-Related Illnesses." *American family physician* 99 (8): 482-489.

Godsey Jr, Marvin S, Harry M Savage, Kristen L Burkhalter, Angela M Bosco-Lauth, and Mark J Delorey. 2016. "Transmission of heartland virus (Bunyaviridae: Phlebovirus) by experimentally infected Amblyomma americanum (Acari: Ixodidae)." *Journal of Medical Entomology* 53 (5): 1226-1233.

Gong, Xi, Aaron Kaulfus, Udaysankar Nair, and Daniel A Jaffe. 2017. "Quantifying O3 impacts in urban areas due to wildfires using a generalized additive model." *Environmental Science & Technology* 51 (22): 13216-13223.

Grard, Gilda, Mélanie Caron, Illich Manfred Mombo, Dieudonné Nkoghe, Statiana Mboui Ondo, Davy Jiolle, Didier Fontenille, Christophe Paupy, and Eric Maurice Leroy. 2014. "Zika virus in Gabon (Central Africa)–2007: a new threat from Aedes albopictus?" *PLoS Negl Trop Dis* 8 (2): e2681.

Gratz, NG. 2004. "Critical review of the vector status of Aedes albopictus." *Medical and veterinary entomology* 18 (3): 215-227.

Hales, David, William Hohenstein, Marcie D Bidwell, Craig Landry, David McGranahan, Joseph Molnar, Louis Wright Morton, Marcela Vasquez, and Jenna Jadin. 2014. "Rural communities." *Climate change impacts in the United States: the third national climate assessment. US Global Change Research Program, Washington, DC, USA*: 333-349.

Harrigan, Ryan J, Henri A Thomassen, Wolfgang Buermann, Robert F Cummings, Matthew E Kahn, and Thomas B Smith. 2010. "Economic conditions predict prevalence of West Nile virus." *PLoS One* 5 (11): e15437.

Hayes, Laura E , Patricia Przysiecki, and Laura Bozzi. submitted. *A profile of heat-related mortality and hospital utilization for heat-related illness in Connecticut 1999-2018.*

Hinckley, Alison F, Neeta P Connally, James I Meek, Barbara J Johnson, Melissa M Kemperman, Katherine A Feldman, Jennifer L White, and Paul S Mead. 2014. "Lyme disease testing by large commercial laboratories in the United States." *Clinical Infectious Diseases* 59 (5): 676-681.

Ibelings, Bas W, and Ingrid Chorus. 2007. "Accumulation of cyanobacterial toxins in freshwater "seafood" and its consequences for public health: a review." *Environmental pollution* 150 (1): 177-192.

Jordan, Robert A, and Andrea Egizi. 2019. "The growing importance of lone star ticks in a Lyme disease endemic county: passive tick surveillance in Monmouth County, NJ, 2006–2016." *PLoS One* 14 (2): e0211778.

Joseph, Julie T, Sumith S Roy, Navid Shams, Paul Visintainer, Robert B Nadelman, Srilatha Hosur, John Nelson, and Gary P Wormser. 2011. "Babesiosis in lower hudson valley, new york, USA." *Emerging infectious diseases* 17 (5): 843.

Keirans, James E, and Lance A Durden. 2001. "Invasion: exotic ticks (Acari: Argasidae, Ixodidae) imported into the United States. A review and new records." *Journal of Medical entomology* 38 (6): 850-861.

Kim, Jiyoon, Lee, Ajin, and Maya Rossin-Slater. 2019. *What to Expect When It Gets Hotter: The Impacts of Prenatal Exposure to Extreme Heat on Maternal and Infant Health* (Tech. Rep. No. w26384). National Bureau of Economic Research.

Lanciotti, RS, JT Roehrig, V Deubel, J Smith, M Parker, K Steele, B Crise, KE Volpe, MB Crabtree, and JH Scherret. 1999. "Origin of the West Nile virus responsible for an outbreak of encephalitis in the northeastern United States." *Science* 286 (5448): 2333-2337.

Lane, Kathryn, Kizzy Charles-Guzman, Katherine Wheeler, Zaynah Abid, Nathan Graber, and Thomas Matte. 2013. "Health effects of coastal storms and flooding in urban areas: a review and vulnerability assessment." *Journal of environmental and public health* 2013.

Levy, Karen, Shanon M Smith, and Elizabeth J Carlton. 2018. "Climate change impacts on waterborne diseases: moving toward designing interventions." *Current environmental health reports* 5 (2): 272-282.

Lieberman-Cribbin, Wil, Bian Liu, Samantha Schneider, Rebecca Schwartz, and Emanuela Taioli. 2017. "Self-reported and FEMA flood exposure assessment after Hurricane Sandy: association with mental health outcomes." *PLoS One* 12 (1): e0170965.

Lindaas, Jakob, Delphine K Farmer, Ilana B Pollack, Andrew Abeleira, Frank Flocke, Rob Roscioli, Scott Herndon, and Emily V Fischer. 2017. "Changes in ozone and precursors during two aged wildfire smoke events in the Colorado Front Range in summer 2015." *Atmospheric Chemistry and Physics* 17 (17): 10691.

Linske, Megan A, Scott C Williams, Kirby C Stafford, Charles B Lubelczyk, Elizabeth F Henderson, Margret Welch, and Peter D Teel. 2020. "Determining Effects of Winter Weather Conditions on Adult Amblyomma americanum (Acari: Ixodidae) Survival in Connecticut and Maine, USA." *Insects* 11 (1): 13.

Loftis, Amanda D, Tonya R Mixson, Ellen Y Stromdahl, Michael J Yabsley, Laurel E Garrison, Phillip C Williamson, Robert R Fitak, Paul A Fuerst, Daryl J Kelly, and Keith W Blount. 2008. "Geographic distribution and genetic diversity of the Ehrlichia sp. from Panola Mountain in Amblyomma americanum." *BMC Infectious Diseases* 8 (1): 54.

Lounibos, Leon Philip, and Laura D Kramer. 2016. "Invasiveness of Aedes aegypti and Aedes albopictus and vectorial capacity for chikungunya virus." *The Journal of infectious diseases* 214 (suppl_5): S453-S458.

Lugo-Amador, Nannette M, Todd Rothenhaus, and Peter Moyer. 2004. "Heat-related illness." *Emergency medicine clinics of North America* 22 (2): 315-27, viii.

MA. 2018. *Massachusetts State Hazard Mitigation and Climate Adaptation Plan.* https://www.mass.gov/service-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan.

Marinucci, Gino D, George Luber, Christopher K Uejio, Shubhayu Saha, and Jeremy J Hess. 2014. "Building resilience against climate effects—a novel framework to facilitate climate readiness in public health agencies." *International journal of environmental research and public health* 11 (6): 6433-6458.

Mead, P, S Hook, S Niesobecki, J Ray, J Meek, M Delorey, C Prue, and A Hinckley. 2018. "Risk factors for tick exposure in suburban settings in the Northeastern United States." *Ticks and tick-borne diseases* 9 (2): 319-324.

Mixson, Tonya R, Scott R Campbell, James S Gill, Howard S Ginsberg, Mason V Reichard, Terry L Schulze, and Gregory A Dasch. 2006. "Prevalence of Ehrlichia, Borrelia, and Rickettsial agents in Amblyomma americanum (Acari: Ixodidae) collected from nine states." *Journal of medical entomology* 43 (6): 1261-1268.

Molaei Goudarz, Theodore G Andreadis, John F Anderson, Kirby C Stafford III. 2018. An Exotic Hitchhiker: A Case Report of Importation into Connecticut from Africa of the Human Parasitizing Tick, *Hyalomma truncatum* (Acari: Ixodidae). *Journal of Parasitology* 104: 302-305. http://www.journalofparasitology.org/doi/10.1645/18-13.

Molaei, Goudarz, Ary Farajollahi, Phillip M Armstrong, J Oliver, JJ Howard, and Theodore G Andreadis. 2009. "Identification of bloodmeals in Anopheles quadrimaculatus and Anopheles punctipennis from eastern equine encephalitis virus foci in northeastern USA." *Medical and veterinary entomology* 23 (4): 350-356.

Molaei Goudarz, JW Mertins, and Kirby C Stafford III. 2020. Enduring Challenge of Invasive Ticks: Introduction of *Amblyomma oblongoguttatum* (Acari: Ixodidae) Into the United States on A Human Traveler Returning from Central America. *Journal of Parasitology* (In Press).

Molaei, Goudarz, and Theodore G Andreadis. 2006. "Identification of avian-and mammalian-derived bloodmeals in Aedes vexans and Culiseta melanura (Diptera: Culicidae) and its implication for West Nile virus transmission in Connecticut, USA." *Journal of Medical Entomology* 43 (5): 1088-1093.

Molaei, Goudarz, Theodore G Andreadis, Philip M Armstrong, and Maria Diuk-Wasser. 2008. "Host-feeding patterns of potential mosquito vectors in Connecticut, USA: molecular analysis of bloodmeals from 23 species of Aedes, Anopheles, Culex, Coquillettidia, Psorophora, and Uranotaenia." *Journal of medical entomology* 45 (6): 1143-1151.

Molaei, Goudarz, Theodore G Andreadis, Philip M Armstrong, Michael C Thomas, Timothy Deschamps, Esteban Cuebas-Incle, Walter Montgomery, Matthew Osborne, Sandra Smole, and Priscilla Matton. 2013. "Vector-host interactions and epizootiology of eastern equine encephalitis virus in Massachusetts." *Vector-Borne and Zoonotic Diseases* 13 (5): 312-323.

Molaei, Goudarz, Philip M Armstrong, Charles F Abadam, Karen I Akaratovic, Jay P Kiser, and Theodore G Andreadis. 2015. "Vector-host interactions of Culiseta melanura in a focus of eastern equine encephalitis virus activity in southeastern Virginia." *PLoS One* 10 (9): e0136743.

Molaei, Goudarz, Philip M Armstrong, Alan C Graham, Laura D Kramer, and Theodore G Andreadis. 2015. "Insights into the recent emergence and expansion of eastern equine encephalitis virus in a new focus in the Northern New England USA." *Parasites & vectors* 8 (1): 516.

Molaei, Goudarz, Ary Farajollahi, Jamesina J Scott, Randy Gaugler, and Theodore G Andreadis. 2009. "Human bloodfeeding by the recently introduced mosquito, Aedes japonicus japonicus, and

public health implications." *Journal of the American Mosquito Control Association* 25 (2): 210-214.

Molaei, Goudarz, Shaoming Huang, and Theodore G Andreadis. 2012. "Vector-host interactions of Culex pipiens complex in northeastern and southwestern USA." *Journal of the American Mosquito Control Association* 28 (4s): 127-136.

Molaei, Goudarz, Eliza AH Little, Scott C Williams, and Kirby C Stafford. 2019. "Bracing for the worst—Range expansion of the lone star tick in the northeastern United States." *New England Journal of Medicine* 381 (23): 2189-2192.

Molaei, Goudarz, Michael C Thomas, Tim Muller, Jan Medlock, John J Shepard, Philip M Armstrong, and Theodore G Andreadis. 2016. "Dynamics of vector-host interactions in avian communities in four eastern equine encephalitis virus foci in the northeastern US." *PLoS neglected tropical diseases* 10 (1): e0004347.

Monzón, Javier D, Elizabeth G Atkinson, Brenna M Henn, and Jorge L Benach. 2016. "Population and evolutionary genomics of Amblyomma americanum, an expanding arthropod disease vector." *Genome biology and evolution* 8 (5): 1351-1360.

Morens, David M, Gregory K Folkers, and Anthony S Fauci. 2019. "Eastern Equine Encephalitis Virus—Another Emergent Arbovirus in the United States." *New England Journal of Medicine* 381 (21): 1989-1992.

Morris, CD, RH Zimmerman, and JD Edman. 1980. "Epizootiology of eastern equine encephalomyelitis virus in upstate New York, USA: II. Population dynamics and vector potential of adult Culiseta melanura (Diptera: Culicidae) in relation to distance from breeding site." *Journal of medical entomology* 17 (5): 453-465.

Mullin, Cristina. 2019. *Evaluating Climate Change Impacts on Drinking Water Reservoirs and Wastewater System Resilience in Connecticut, U.S.A.* https://opencommons.uconn.edu/dissertations/2353.

Murphy, Sherry L, JQ Xu, Kenneth D Kochanek, and E Arias. 2018. "Mortality in the United States, 2017. NCHS data brief, No 328." *Hyattsville, MD: National Center for Health Statistics*.

Nelson, Christina A, Shubhayu Saha, Kiersten J Kugeler, Mark J Delorey, Manjunath B Shankar, Alison F Hinckley, and Paul S Mead. 2015. "Incidence of clinician-diagnosed Lyme disease, United States, 2005–2010." *Emerging infectious diseases* 21 (9): 1625.

Nelson, Christina A, J Andrew Starr, Kiersten J Kugeler, and Paul S Mead. 2016. "Lyme disease in hispanics, United States, 2000–2013." *Emerging Infectious Diseases* 22 (3): 522.

NOAA National Centers for Environmental Information. 2020. "Climate at a Glance: Statewide Time Series." https://www.ncdc.noaa.gov/cag/.

NIOSH. 2016. *NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments. By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106.*

Nolte, Christopher G, Tanya L Spero, Jared H Bowden, Megan S Mallard, and Patrick D Dolwick. 2018. "The potential effects of climate change on air quality across the conterminous US at 2030 under three Representative Concentration Pathways." *Atmospheric chemistry and physics* 18 (20): 15471.

NYSDOH. 2015. " New York State Department of Health Building Resilience Against Climate Effects (BRACE) in New York State " https://www.health.ny.gov/environmental/weather/docs/climatehealthprofile6-2015.pdf.

O'Donnell, James. 2019. *Sea Level Rise in Connecticut.* https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/02/SeaLevelRiseConnecticut-Final-Report-1.pdf.

Paddock, CD, and MJ Yabsley. 2007. "Ecological havoc, the rise of white-tailed deer, and the emergence of Amblyomma americanum-associated zoonoses in the United States." In *Wildlife and emerging zoonotic diseases: the biology, circumstances and consequences of cross-species transmission*, 289-324. Springer.

Patel, Vikram, Shekhar Saxena, Crick Lund, Graham Thornicroft, Florence Baingana, Paul Bolton, Dan Chisholm, Pamela Y Collins, Janice L Cooper, and Julian Eaton. 2018. "The Lancet Commission on global mental health and sustainable development." *The Lancet* 392 (10157): 1553-1598.

Paupy, Christophe, Hélène Delatte, Leila Bagny, Vincent Corbel, and Didier Fontenille. 2009. "Aedes albopictus, an arbovirus vector: from the darkness to the light." *Microbes and infection* 11 (14-15): 1177-1185.

Peng, Hong-Juan, Hui-Bing Lai, Qiao-Li Zhang, Ba-Yi Xu, Hao Zhang, Wen-Hua Liu, Wei Zhao, Yuan-Ping Zhou, Xin-Guang Zhong, and Shu Jiang. 2012. "A local outbreak of dengue caused by an imported case in Dongguan China." *BMC public health* 12 (1): 83.

Peng, Liang, Yongmei Liu, Wei Chen, Liming Liu, Martha Kent, and Lirong Song. 2010. "Health risks associated with consumption of microcystin-contaminated fish and shellfish in three Chinese lakes: significance for freshwater aquacultures." *Ecotoxicology and environmental safety* 73 (7): 1804-1811.

Pereira-dos-Santos, Taissa, David Roiz, Ricardo Lourenço-de-Oliveira, and Christophe Paupy. 2020. "A Systematic Review: Is Aedes albopictus an Efficient Bridge Vector for Zoonotic Arboviruses?" *Pathogens* 9 (4): 266.

Petersen Emily E, Davis Nicole L, Goodman, David, Cox, Shanna, Syverson, Carla, Seed, Kristi, Shapiro-Mendoza, Callaghan, William, and Wanda Barfield. 2019. "Racial/Ethnic Disparities in Pregnancy-Related Deaths — United States, 2007–2016." *Morbidity and Mortality Weekly Report* 68:762–765. DOI: http://dx.doi.org/10.15585/mmwr.mm6835a3

Poste, Amanda E, Robert E Hecky, and Stephanie J Guildford. 2011. "Evaluating microcystin exposure risk through fish consumption." *Environmental science & technology* 45 (13): 5806-5811.

Rainey, Tadhgh, James L Occi, Richard G Robbins, and Andrea Egizi. 2018. "Discovery of Haemaphysalis longicornis (Ixodida: Ixodidae) parasitizing a sheep in New Jersey, United States." *Journal of Medical Entomology* 55 (3): 757-759.

Rezza, G, L Nicoletti, R Angelini, R Romi, AC Finarelli, M Panning, P Cordioli, C Fortuna, S Boros, and F Magurano. 2007. "Infection with chikungunya virus in Italy: an outbreak in a temperate region." *The Lancet* 370 (9602): 1840-1846.

Roche, Benjamin, Lucas Léger, Grégory L'Ambert, Guillaume Lacour, Rémi Foussadier, Gilles Besnard, Hélène Barré-Cardi, Frédéric Simard, and Didier Fontenille. 2015. "The spread of Aedes albopictus in metropolitan France: contribution of environmental drivers and human activities and predictions for a near future." *PloS one* 10 (5): e0125600.

Rochlin, Ilia, Dominick V Ninivaggi, Michael L Hutchinson, and Ary Farajollahi. 2013. "Climate change and range expansion of the Asian tiger mosquito (Aedes albopictus) in Northeastern USA: implications for public health practitioners." *PloS one* 8 (4): e60874.

Rosenberg, Ronald, Nicole P Lindsey, Marc Fischer, Christopher J Gregory, Alison F Hinckley, Paul S Mead, Gabriela Paz-Bailey, Stephen H Waterman, Naomi A Drexler, and Gilbert J Kersh. 2018. "Vital signs: trends in reported vectorborne disease cases—United States and Territories, 2004–2016." *Morbidity and Mortality Weekly Report* 67 (17): 496.

Rosenthal, Joyce Klein, Patrick L Kinney, and Kristina B Metzger. 2014. "Intra-urban vulnerability to heat-related mortality in New York City, 1997–2006." *Health & place* 30: 45-60.

Ruche, G la, D Dejour-Salamanca, M Debruyne, I Leparc-Goffart, M Ledrans, M Grandadam, S Brichler, Y Souares, GA Denoyel, and JD Poveda. 2010. "Laboratory surveillance of dengue and chikungunya cases imported in metropolitan France 2008-2009." *Bulletin Épidémiologique Hebdomadaire* (31/32): 325-329.

Rudolph, L, C Harrison, L Buckley, and S North. 2018. "Climate change, health, and equity: a guide for local health departments." *Public Health Institute and American Public Health Association*.

Rudolph, Linda, Solange Gould, and Jeffrey Berko. 2015. *Climate change, health, and equity: Opportunities for action*. Public Health Institute.

SAMSHA. 2019. "Mental Health Services Administration.(2018). Key substance use and mental health indicators in the United States: Results from the 2017 National Survey on Drug Use and Health (HHS Publication No. SMA 18-5068, NSDUH Series H-53). Rockville, MD: Center for Behavioral Health Statistics and Quality." *Substance Abuse and Mental Health Services Administration. Retrieved from https://www. samhsa. gov/data*.

Savage, Harry M, Kristen L Burkhalter, Marvin S Godsey Jr, Nicholas A Panella, David C Ashley, William L Nicholson, and Amy J Lambert. 2017. "Bourbon virus in field-collected ticks, Missouri, USA." *Emerging infectious diseases* 23 (12).

Schwartz, Amy M, Alison F Hinckley, Paul S Mead, Sarah A Hook, and Kiersten J Kugeler. 2017. "Surveillance for Lyme disease—United States, 2008–2015." *MMWR Surveillance Summaries* 66 (22): 1.

Schwartz, Brian S, and Michael D Goldstein. 1990. "Lyme disease in outdoor workers: risk factors, preventive measures, and tick removal methods." *American journal of epidemiology* 131 (5): 877-885.

Schwartz, Brian S, Michael D Goldstein, and James E Childs. 1994. "Longitudinal study of Borrelia burgdorferi infection in New Jersey outdoor workers, 1988–1991." *American journal of epidemiology* 139 (5): 504-512.

Seth, A., G. Wang, C. Kirchhoff, K. Lombardo, S. Stephenson, R. Anyah, and J. Wu. 2019. Connecticut Physical Climate Science Assessment Report (PCSAR): Observed trends and projections of temperature and precipitation.

Shepard, John J, Theodore G Andreadis, Michael C Thomas, and Goudarz Molaei. 2016. "Host associations of mosquitoes at eastern equine encephalitis virus foci in Connecticut, USA." *Parasites & vectors* 9 (1): 1-10.

Smith, Kirk, Alistair Woodward, Diarmid Campbell-Lendrum, D Chadee, Yasushi Honda, Qiyong Liu, Jane Olwoch, Boris Revich, Rainer Sauerborn, and Clara Aranda. 2014. "Human health: impacts, adaptation, and co-benefits." In *Climate Change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change*, 709-754. Cambridge University Press.

Stafford III, Kirby C, Goudarz Molaei, Eliza AH Little, Christopher D Paddock, Sandor E Karpathy, and Andrew M Labonte. 2018. "Distribution and establishment of the lone star tick in Connecticut and implications for range expansion and public health." *Journal of medical entomology* 55 (6): 1561-1568.

Stafford III, Kirby C, Scott C Williams, Louis A Magnarelli, Anuja Bharadwaj, Starr-Hope Ertel, and Randall S Nelson. 2014. "Expansion of zoonotic babesiosis and reported human cases, Connecticut, 2001–2010." *Journal of medical entomology* 51 (1): 245-252.

Stafford III, Kirby C, Scott C Williams, and Goudarz Molaei. 2017. "Integrated pest management in controlling ticks and tick-associated diseases." *Journal of Integrated Pest Management* 8 (1): 28.

Stowell, Jennifer D, Young-min Kim, Yang Gao, Joshua S Fu, Howard H Chang, and Yang Liu. 2017. "The impact of climate change and emissions control on future ozone levels: Implications for human health." *Environment international* 108: 41-50.

Sullivan, Greer, Jennifer J Vasterling, Xiaotong Han, Andra Teten Tharp, Teri Davis, Elizabeth A Deitch, and Joseph I Constans. 2013. "Preexisting mental illness and risk for developing a new disorder after hurricane Katrina." *The Journal of nervous and mental disease* 201 (2): 161-166.

Sweet, Shannan K, David W Wolfe, Arthur DeGaetano, and Rebecca Benner. 2017. "Anatomy of the 2016 drought in the Northeastern United States: Implications for agriculture and water resources in humid climates." *Agricultural and Forest Meteorology* 247: 571-581.

Telford III, Sam R, Joanna Buchthal, and Paul Elias. 2019. "Early Questing by Lone Star Tick Larvae, New York and Massachusetts, USA, 2018." *Emerging Infectious Diseases* 25 (8): 1592.

Trtanj, J, L Jantarasami, J Brunkard, T Collier, J Jacobs, E Lipp, S McLellan, S Moore, H Paerl, and J Ravenscroft. 2016. Chapter 6: Climate impacts on water-related illness. The impacts of climate change on human health in the United States: A scientific assessment. US Global Change Research Program.

Tsuda, Yoshio, Yoshihide Maekawa, Kohei Ogawa, Kentaro Itokawa, Osamu Komagata, Toshinori Sasaki, Haruhiko Isawa, Takashi Tomita, and Kyoko Sawabe. 2015. "Biting density and distribution of Aedes albopictus during the September 2014 outbreak of dengue fever in Yoyogi Park and the vicinity in Tokyo Metropolis, Japan." *Japanese journal of infectious diseases*: JJID. 2014.576.

US EPA Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment. Washington, DC; 2017.

Vaidyanathan, Ambarish, Shubhayu Saha, Ana M Vicedo-Cabrera, Antonio Gasparrini, Nabill Abdurehman, Richard Jordan, Michelle Hawkins, Jeremy Hess, and Anne Elixhauser. 2019. "Assessment of extreme heat and hospitalizations to inform early warning systems." *Proceedings of the National Academy of Sciences* 116 (12): 5420-5427.

Vanlandingham, Dana L, Stephen Higgs, and Yan-Jang S Huang. 2016. "Aedes albopictus (Diptera: Culicidae) and mosquito-borne viruses in the United States." *Journal of medical entomology* 53 (5): 1024-1028.

Walker, Elizabeth Reisinger, and Benjamin G Druss. 2018. "Mental and addictive disorders and medical comorbidities." *Current psychiatry reports* 20 (10): 86.

Walker, Elizabeth Reisinger, Robin E McGee, and Benjamin G Druss. 2015. "Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis." *JAMA psychiatry* 72 (4): 334-341.

Wallace, John W, William L Nicholson, Jamie L Perniciaro, Meagan F Vaughn, Sheana Funkhouser, Jonathan J Juliano, Sangmi Lee, Madhavi L Kakumanu, Loganathan Ponnusamy, and Charles S Apperson. 2016. "Incident tick-borne infections in a cohort of North Carolina outdoor workers." *Vector-Borne and Zoonotic Diseases* 16 (5): 302-308.

Wolfe, David. 2019. On "Increasing Resiliency, Mitigation Risk: Examining the Research and Extension Needs of Producers" Before the U.S. House Agriculture Committee Subcommittee on Biotechnology, Horticulture, and Research, June 12, 2019, Washnigton, D.C.

Ziska, Lewis, Allison Crimmins, Allan Auclair, Stacy DeGrasse, JF Garofalo, AS Khan, Irakli Loladze, AA Pérez de León, A Showler, and J Thurston. 2016. "Ch. 7: Food safety, nutrition, and distribution." *The impacts of climate change on human health in the United States: A scientific assessment*: 189-216.

Appendix I. DEMHS After Action Review Process

Adapted State of Connecticut, DEMHS Administrative Plan https://portal.ct.gov/-/media/DEMHS/_docs/Plans-and-Publications/EHSP0007--DEMHS-Administrative-Plan---Final1.pdf?la=en

Corrective Action Process, State After Action Report / Improvement Plan (AAR/IP) and Corrective Action Process (CAP)

1. Exercise Conclusion:
    a. Hot wash is conducted and recorded.
    b. Evaluation forms are collected.
2. Draft AAR/IP/ document:
    a. Collected information from hot wash and evaluation forms are analyzed.
    b. Draft AAR/IP document created and distributed.
3. AAR/IP Meeting:
    a. Draft AAR/IP document discussed.
    b. Specific AAR/IP items chosen.
    c. Within the IP, the Capability Element(s):
        i. Planning, Organization, Equipment, Training, or Exercise are identified for each IP item which then determine the CAP. IP items are updated with to include CAP, owning manager, and due date.
4. Post AAR/IP Meeting:
    a. Updated Draft AAR/IP/CAP document is sent to all participants at the AAP/IP meeting for review.
    b. When accepted by all participants, the AAR/IP/CAP is finalized and redistributed as 'Final'.
    c. The IP contains the following fields:

5. Tracking of the progress of the IP/CAP:
    a. Utilizing a spreadsheet, the implementation steps for prioritized corrective actions are documented and tracked.
    b. The status of open corrective actions is reviewed at each DEMHS Manager's and Supervisor's meeting as a regular item under the Training Unit report.
    c. The final resolution of the IP is documented in the spreadsheet and results are shared with partners. (also see the DEMHS Administration Plan)

6. Prioritization of the Improvement Plan/Corrective Actions (IP/CA):
    a. Priority will be based on the urgency of the gap identified in the IP/CAP
    b. Communications/equipment gaps will be given a higher priority
        i. Priority noted in the IP/CA spreadsheet by the Training Unit
        ii. Referred to Telecommunications/Field Support Manager for review
        iii. Telecommunications/Field Support Manager will determine if there is a need to enhance existing equipment or purchase additional resources.

iv. Telecommunications/Field Support Manager will submit a decision memo on his assessment of the IP gap and the recommended resolution. Based on the approval and any additional guidance on the decision memo the gap will be addressed.
v. Updates will be added to the IP/CA spreadsheet
vi. Updates provided by the Training Unit at the monthly DEMHS Managers and Supervisors meeting.
vii. IP/Corrective Action Spreadsheet updated with final status and closed out. The resulting equipment modification/new purchase will be tested in the next exercise and results noted.

7. Gaps that identify gaps in plans or procedures will be given secondary priority (although lower priority, the IP/CA item will be assigned and addressed as soon as possible)
    a. Priority noted in the IP/Corrective Action spreadsheet by the Training Unit
    b. IP referred to Planning Coordinator for review
    c. Planning Coordinator will determine if there is a need to modify existing plans and procedures or if the development of a new procedure is required.
    d. The Planning Coordinator (or assigned staff) will submit a decision memo on their assessment of the IP gap and the recommendedresolution. Based on the decision memo and any recommended changes, the gap will be addressed.
    e. Updates will be added to the IP/CA spreadsheet
    f. Updates on the status of the IP will provided by the Training Unit at the monthly DEMHS Managers and Supervisors meeting.
    g. IP/Corrective Action Spreadsheet will be updated with final status and closed out
    h. Results (updated plans, procedures, etc.) are shared with partners.
    i. The plan/procedure will be tested in the next exercise. Results will be documented in the IP/CA spreadsheet.

Appendix II. Recommendation Summary Table												
No.	Recommendation Title	Completion Timeframe Years			Action Type							
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
EXTREME HEAT												
PHS-1	Create a multi-stakeholder "blue ribbon" commission to develop guidance for schools, day cares, and youth sports teams for prevention of heat-related illness and death. Pg. 22	●				●	●				
PHS-2	Develop legislation to require employers to develop and maintain a written plan to address heat exposure and prevent heat-related illnesses at outdoor worksites and at indoor facilities where potential heat-related hazards may exist. Pg. 23	●			●			●			●
PHS-3	Establish evidence-based standards for local heat and air quality response plans. Pg. 25	●				●					
PHS-4	Enact policies to protect low-income residents and renters, particularly those in government supported housing, from indoor heat exposure. Pg. 26	●			●	●					

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
AIR QUALITY											
PHS-5	Evaluate Ozone Alert Education Efforts Pg. 30	●				●					●
PHS-6	Increase Airborne Allergen Monitoring Pg. 31		●			●	●		●		
PHS-7	Estimate the impacts of climate change on 2030 and 2050 ozone levels in Connecticut and identify potential effects on the health of Connecticut residents. Pg. 32		●			●			●		
VECTOR-BORNE DISEASES											
PHS-8	Establish a State Public Health Entomologist Position Pg. 41	●						●	●	●	
PHS-9	Strengthen Monitoring and Surveillance of Vector Populations and Associated Vector-Borne Diseases Pg. 42		●			●					
PHS-10	Assess and Project the Impacts of Climate Change on Ticks, Mosquitoes, and Vertebrate Hosts Using Mathematical Models Pg. 44			●		●	●		●		

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
PHS-11	Develop Vector-Borne Disease Prevention and Management Guidelines for Schools, Outdoor Recreation, and Homes Pg. 45		●			●	●				●
PHS-12	Evaluate Vector Control Strategies and Ensure Support for Implementing Sustainable Vector Management Programs Pg. 47		●			●					
PHS-13	Monitor Insecticide and Antimicrobial Resistance in Vector Populations and Vector-Borne Pathogens Pg. 48			●		●	●				
EXTREME EVENTS											
PHS-14	Create and maintain a statewide inventory of redundant back-up power services at critical facilities statewide and buildings where institutionalized vulnerable populations reside and establish a long-term funding mechanism for new systems and repairs Pg. 53	●				●				●	

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
PHS-15	Enhance support for communication and outreach programs to educate residents about all aspects of preparedness, response and recovery for extreme weather events Pg. 54		●			●					●
PHS-16	Establish State and Regional Access and Functional Needs (AFN) Emergency Preparedness and Response Coordinators Pg. 55	●						●			●
PHS-17	Create an updated Hurricane and Storm Evacuation Plan for Connecticut Pg. 57	●				●	●				
PHS-18	Develop water conservation measures & communication guidelines to manage droughts Pg. 58	●				●	●				●

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
PHS-19	Develop a GIS database and framework for continued updates to capture critical facilities to identify which PWS they are served by and which critical facilities are served by their own PWS Pg. 59	●				●				●	
PHS-20	Update planning guidelines, drought triggers and drought response protocols at least once per decade Pg. 60	●				●	●				
PHS-21	Develop emergency interconnections between PWSs to ensure that multiple sources and interconnections are available for mutually beneficial sharing of water during emergencies Pg. 61		●			●	●				
PHS-22	Use source water protection and the Drinking Water Quality Management Plans to encourage resiliency and increase funding and support for investments in watershed protection Pg. 63		●			●	●				

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
WATER-BORNE ILLNESSES											
PHS-23	Use Clean Water State Revolving Funds for statewide subsurface sewage disposal systems management and upgrades. Pg. 67	●			●						
PHS-24	Develop a statewide GIS database and framework for continued updates that identifies the location of private wells and decentralized sewage disposal systems. Pg. 69		●			●	●			●	
PHS-25	Develop a monitoring system for water quality parameters critical to the shellfishing industry in real-time to forecast potentially high-risk events. Pg. 73		●			●			●	●	●
PHS-26	Track harmful or potentially harmful cyanobacteria algal bloom data in Connecticut and provide technical assistance to community water suppliers to address and prevent these events Pg. 73	●				●			●	●	
PHS-27	Assess the vulnerability of public recreational freshwater and marine beaches to impacts from climate change and prioritize adaptation options to reduce vulnerability. Pg. 74		●			●			●	●	

No.	Recommendation Title	Completion Timeframe Years			Action Type						
		< 2	5	>5	Legislative	Programmatic		Staff Position	Monitoring and Future Projections	Mapping and GIS Support	Communication
						State Agency	Non-State Agency				
PHS-28	Develop an energy audit program for water systems (Water and Wastewater) to increase energy efficiency and reduce greenhouse gas emissions across the water industry Pg. 76		●			●	●				●
PHS-29	Identifying and improve wells that are located within a flood zone to increase resilience and reduce risk of flooding. Pg. 77		●			●	●			●	
PHS-30	Incorporate resiliency into the consideration of new laws, regulations, and policies and promote greater education of PWS about the importance of resiliency. Pg. 78		●		●						●
NUTRITION, FOOD SECURITY, AND FOOD SAFETY											
PHS-31	Develop state and regional food security action plans to mitigate the risk of climate change and extreme weather events on the food system Pg. 81	●				●	●				
MENTAL HEALTH AND WELL-BEING											
PHS-32	Establish best practices for disaster case managers for addressing needs of mental health populations in disaster response Pg. 86	●				●	●				
CROSS-CUTTING TOPICS											
PHS-33	Establish a State Climate and Heath Coordinator position Pg. 89	●				●		●	●	●	●

Appendix III. Public Health and Safety Working Group Members and Health Domain Affiliation

Working Group Chair:
Deputy Commissioner Heather Aaron, DPH

Co-leads on behalf of DPH Deputy Commissioner Heather Aaron:
Laura Hayes, DPH
Lori Mathieu, DPH

HEALTH DOMAIN TEAMS

Extreme Heat
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Mariana Fragomeni, UConn
Laura Hayes, DPH
Mark Mitchell, George Mason University

Air Quality
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Paul Farrell, DEEP
Laura Hayes, DPH
Anne McWilliams, EPA Region 1
Mark Mitchell, George Mason University

Vector-borne Diseases
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Jocelyn Mullins, DPH
Huan Ngo
Kirby Stafford, CAES

Extreme Events
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Todd Berman, United Illuminating
Laura Bozzi, Yale University
Amanda Clark, DPH
Michele DeLuca, City of Norwalk
Ken Dumais, DEMHS
Christine Kirkchoff, UConn
Diane Mas, Fuss & O'Neill, Inc.
Lori Mathieu, DPH
Robert Scully, DPH
Ryan Tetreault, DPH
Orlando Velazco, DPH
Jeri Weiss, EPA Region 1
Kirk Westphal, Brown and Caldwell
Joanna Wozniak-Brown, CIRCA

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Laura Hayes, DPH
Sarah Lowe, Yale University
Michelle Riordan-Nold, CT Data Collaborative

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