**5: Vulnerability Summary**

Each hazard profile in this plan included discussion on vulnerability in categories of People, Built Environment, Natural Environment, and Economy. In practice there is no separating these categories of vulnerability, they are all connected with cross-cutting challenges. This section explores compounding vulnerabilities due to exposure to natural hazards and climate change.

Common Issues Across Hazards

As the vulnerability sections of hazard profiles were developed there were potential hazard impacts on people, the built environment, the natural environment, the economy that came up repeatedly. These reoccurring vulnerabilities begin to paint a picture of risk and exposure across Vermont’s landscape. The following is a summary of who and what may be most impacted by multiple hazards that can occur in Vermont.

**People**

People who were identified as having risk factors that increase susceptibility and exposure in multiple hazards profiles were:

* those on electricity-dependent in-home life support equipment;
* isolated residents;
* rural residents;
* people with access or mobility differences;
* older adults;
* people who are pregnant;
* those who are immunocompromised or living with chronic health conditions;
* unhoused individuals;
* manufactured/mobile home residents;
* outdoor workers;
* children;
* people lacking the economic resources to adequately prepare, adapt, and recover.

Other common themes included that multiple hazards could lead to carbon monoxide poisoning from generators improperly installed or with failed ventilation systems, and communication is essential for people’s wellbeing before, during, and after a hazard event.

There is a great deal of crossover amongst the demographics identified above. There are also compounding issues that make certain individuals more vulnerable to hazard events.

When asked who their frontline communities were in a Vermont-wide survey of municipal staff and volunteers, towns across Vermont overwhelmingly responded that their aging populations were the most vulnerable to hazards and would have the most difficult time recovering. The demographic of older adults was followed by low or “modest” income persons and those who live alone. Other frontline communities were those on in-home medical equipment, businesses and residents in the floodplain, those with mobility challenges, mobile home residents, those with mental health conditions, rural and isolated persons, those without backup heat or water, people living near railroads lines, farm/agricultural business owners and workers, and maple sugar makers.

**Built Environment**

The built environment assets that are vulnerable to multiple hazards in Vermont are electrical, water, transportation, and communication infrastructure. Loss of these systems would have direct impacts on people’s ability to heat and cool their homes, power in-home life support equipment, travel and receive emergency assistance, access safe drinking water, and maintain a functioning home or business.

Multiple hazards can disrupt these major infrastructure systems with cascading effects. For example, a loss of electricity will impact well pumps, heating systems, and the internet.

Emerging vulnerabilities include dependence on electricity for internet, cell coverage, and charging vehicles. Many people in Vermont depend on electricity to maintain wireless internet for cell coverage, often their only phone. Additionally, many people working from home depend on electricity and wireless internet to work from home and send or receive information.

**Natural Environment**

Common impacts to the natural environment due to multiple hazards are to tree and forest health, water quantity and quality, soil, and overall ecosystem balance. These impacts to the natural environment affect people as well. For example, water quality issues can impact drinking wells, recreational fish habitat, swimming areas, and other natural assets Vermont depends on. Water, soil and tree health have impacts on the economy further discussed under economy.

Natural disasters are part of the normal cycles of our landscapes and ecosystems. Negative consequences of natural hazards are primarily seen where the natural environment interacts with built environment, people, and economy. The resilience of the natural environment to disasters is however, changing with climate change, as typical weather patterns are altered and plant and animal life are not given time to adapt to new conditions. The health of natural environment is often a first indicator of slow-moving hazards such as drought, invasive species and other hazard impacts accelerated by climate change.

**Economy**

In assessing the economic vulnerabilities across hazards that the major economic impacts of hazard events and climate change in Vermont are seen in tourism, agriculture, and forestry products.

There were multiple impacts to the dairy industry due to electricity loss, extreme temperatures and water stress. Dairy cows maintain a range of temperatures where they are comfortable and conditions outside those parameters can often lead to stress which can reduce the yield produced. Most dairy farms in Vermont are open to the outdoors and do not use air conditioning systems beyond fans. Electricity is needed for the cooling, refrigeration, and pasteurization of milk products, and a loss of electricity will require dumping of milk produced. Hazards that impact industries linked to dairy farming, such as feed crops, can also result in ripple effects that impact industry after industry.

Across hazards vulnerabilities were also observed in maple syrup production. Sugaring as an industry falls between agriculture, forestry, and tourism and as a result of these overlapping relationships impacts to this industry can have pronounced impacts. Maple sugaring is a key industry within the State, as Vermont produces roughly 42% of maple products in the nation[[1]](#footnote-2). Changes in climate have resulted in shifts to the native range of sugar producing trees. This includes shifts northward towards areas that receive colder winters, with weather that creates freeze thaw events allowing sap to flow[[2]](#footnote-3). This would typically take place over several weeks, however, as spring temperatures begin earlier the sugaring season decreases in length.

Under historic conditions, the insulating layer of a thick snowpack regulates ground temperatures and protects tree roots. That needed snowpack has been declining in Vermont over the past few decades, exposing the root systems of sugar maples to colder temperatures. A deeper frost layer dramatically reduces the ability of the sugar maple to take up water and nutrients through frost damaged roots. A reduction in the snowpack has been shown to decrease the growth rate of sugar maples by 40%[[3]](#footnote-4). Growth is also hindered by invasive pests such as the spotted lanternfly and the asian long-horned beetle which could target maples as they expand northward away from the range of ailanthus altissima trees (commonly known as tree of heaven)[[4]](#footnote-5). These declines in the productivity and success of sugar maples impact both the sugaring and forestry industries which rely on Vermont’s stock of sugar maple.

Impacts to the forestry industry are also noticeable through a variety of hazards including drought, invasive species, and wildfire. These hazards can compound to increase impacts. Droughts can negatively impact forest inventories by increasing mortality and reducing growth due to a reduction in water availability[[5]](#footnote-6). Wildfire conditions can also be created during prolonged droughts due to how dry vegetation is, increasing its flammability. The loss of stock as a result of a fire event can be an economic loss not easily recovered. One of the largest threats to forestry industries across the country is the presence of invasive species that either target species (emerald ash borer[[6]](#footnote-7)) or strangle native plant species (asiatic bittersweet[[7]](#footnote-8)). The out-competition of native species critical to Vermont forestry threatens the success of the industry, resulting in large investments into invasive species removal. The increasing abundance of invasive species within forests can lead to a change in the fuel dynamics present in the event of a fire. Observations indicate that changes in fuel characteristics brought about by nonnative species invasions can lead to changes in fire behavior and alter fire regime characteristics such as frequency, intensity, extent, type, and seasonality of fire impacting native plant and animal communities. Invaded forest communities in the Northeast often had a substantially higher cover of shrubs than uninvaded communities, resulting in increased height and density of surface fuels and suggesting an increased potential for fire to carry into the tree canopy8.

Impacts to the agricultural sector can result in significant losses in crop production. These losses can take a major toll on the economic success of farmers around the state. Crop insurance is a tool that can be used by farmers to protect the value of their goods in the event of their destruction. There are many different crop insurance programs offered throughout the state which can be found on the University of Vermont Extension website[[8]](#footnote-9). In 2022, Vermont farmers paid $1.5 million in crop insurance, protecting 86,301 acres providing $42.3 million in liability protection. Of the amount protected, $2.1 million was paid from insurers to farmers to cover losses in 2022[[9]](#footnote-10), providing some economic safety net for farmers dealing with natural hazards. Not all farms are covered by insurance however, having determined that payments are too great a burden to maintain.

Hazards will cause business disruptions including supply chain issues, loss of inventory and cost of recovery, and an inability for employees and customers to travel. Other notable impacts seen across hazards were to water quality and fish habitat, another essential tourism draw and cultural asset.

Vermont prides itself on maintaining a connection to the rural countryside, curating an image of the rural idyll that helps drive much of Vermont’s tourism. Seasonal drivers of tourism include autumnal foliation, winter sports, and fishing. Changes in water availability and climate stress can limit how vibrant the colors of leaves appear, impacting how many people choose to visit Vermont. The same goes for winter recreation, as a decline in snow will hurt the numerous ski resorts throughout the State. Hazards like wildfire can impact access to many of Vermont’s famous hiking trails such as the Long Trail, if such a hazard presents a danger to recreationalists. Water quality impacts across hazards can impact fish habitat and related tourism.

**Cross-Cutting Vulnerabilities and Compounding Issues**

Beyond the potential of simultaneous occurrence, several of the hazards also have the potential to *cause* other hazards. Causal relationships are identified in Table 18 (with causal hazards identified in green and resulting hazards identified in blue) and further addressed in pertinent hazard assessment sections. Combined with the projected increases in both precipitation and temperature, this assessment highlights the more significant compounding impacts that Vermont can anticipate in the future due to climate change.

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| **Table 18: Causal Relationships Between Hazard Impacts** |
| **Secondary Hazard** **Impact****(Result)** | Fluvial Erosion | Inundation Flooding | Ice | Snow | Wind | Heat | Cold | Drought | Landslides | Wildfire | Earthquake | Invasive Species | Infectious Disease | Hail |
| **Primary Hazard** **(Causal)** |
| Fluvial Erosion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Inundation Flooding |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ice |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Snow |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Wind |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Heat |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Cold |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Drought |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Landslides |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Wildfire |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Earthquake |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Invasive Species |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Infectious Disease |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hail |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Compounding Natural Hazards**

Extreme heat and the presence of invasive species are examples of compounding natural hazards that affect Vermont. Compounding natural hazards are hazards and events which may accelerate another hazard in the process, increasing the vulnerability of the affected area. It is important that compounding natural hazards are closely monitored, as an increase in frequency can have a creeping effect on correlated natural hazards.

**Heat**

Extreme heat events in Vermont have increased in frequency in the past decade, causing large-scale impacts on people who live in affected areas. In a ranking determined by the product of probability and the average potential impact of each hazard, extreme heat was the third most significant hazard experienced in the state of Vermont for 2023 (See Table 16, Section 4 Opener). The high ranking was due to the factors listed above, and the cross-cutting impacts associated with drought, wildfire, invasive species, and infectious disease.

As higher temperatures lead to higher evapotranspiration rates, the probabilities of drought and wildfire events increase. Evapotranspiration can leach moisture from vegetation and soil, which can cause short-term drought in an extreme heat event. However, with the average annual temperature in Vermont increasing by 3.6°F[[10]](#footnote-11), the State is experiencing much warmer climates in shorter periods of time. Native species that are accustomed to colder climates may not easily adjust to warmer, and potentially drier climates. Such an increase in average annual temperature is likely to lead to a higher frequency of drought, as more moisture is lost to the surrounding atmosphere. Similarly, as this process unfolds, wildfire events may increase in frequency. Vegetation with lowered moisture levels have a higher probability of burning in the event of a wildfire. An ecosystem with much lower moisture levels might experience a rapid-moving and more devastating wildfire due to increased flammability.

A warmer climate may lead to an increase in invasive species and infectious disease outbreaks in Vermont. As the United States experiences warming due to climate change, animals and plants will undergo climate migration to the Northeast region due to its comparative resilience. Within this migration, it is likely that the state of Vermont sees the introduction of more invasive species who can now withstand Vermont’s warmer climate. Just as the quantity of invasive species may increase with heat in Vermont, infectious diseases outbreaks increase in probability. As noted in the Invasive Species profile, vector-borne diseases (e.g., Lyme, West Nile, and Eastern equine encephalitis) are more frequent in warmer climates. Heat can also cause water stratification, leading to increased levels of cyanobacteria, which can cause minor skin rashes, sore throats, diarrhea, stomach problems, or occasionally more serious health problems.

Compounding hazards can have detrimental impacts on adaptation behaviors and emergency response strategies. Cyanobacteria blooms are common during periods of extreme heat, which may make some water bodies unavailable as a cooling resource. Similarly, the COVID-19 pandemic created a barrier to providing safe congregate emergency shelters. Using air conditioning is one of the most effective ways to prevent heat-related health impacts – power loss concurrent with periods of extreme heat have had fatal impacts in some parts of the country in recent years, particularly when medical or long-term care facilities have experienced extended power loss during extreme heat.

**Invasive Species**

Just as heat can precipitate multiple other hazards, the presence of invasive species can accelerate the frequency of landslides, wildfires, and infectious disease outbreaks. Invasive species are an example of a creeping hazard, in which large-scale change occurs over time, instead of through one major event. Over time, invasive species crowd out native species and take over entire ecosystems. As invasive species crowd out native trees and shrubs on steep slopes, landslides may increase in frequency as less of a barrier exists to prevent such mass wasting events. Similarly, the defoliation and crowding out of native species may lead to increased probability of wildfire. Buildup on the forest floor may allow wildfire to spread more easily and affect a wider geography. Invasive plants also have the potential to harbor disease-carrying insects such as ticks and mosquitos. As invasive plants crowd-out native species and increase in quantity, more of these disease-carrying insects can exist in a given ecosystem and thus the probability of an outbreak will increase.

**Compounding Social Issues**

**Environmental Justice**

In Vermont today significant planning and funding is being directed to adapt to climate change conditions at the same time as we try and find room in our existing cities, towns, and villages for more affordable housing.

A range of existing and compounding social, environmental, built, and economic issues have been discussed in this plan. Historical planning, private development, and government investment have contributed to the environmental and social issues within hazard prone areas.

Addressing environmental justice (EJ) provides the opportunity to connect hazard mitigation, environmental quality, and social equity. The U.S. Environmental Protection Agency (EPA) defines EJ as:

*The fair treatment and meaningful involvement of all people regardless of race, color, national origin, culture, education, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair Treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal environmental programs and policies.*

EJ scholars have broadened the EPA definition to include vulnerable groups such as children, older adults, the immune-compromised, and future populations. A more recent body of research shows vulnerability to climate change as an environmental burden on those who have limited resources to move, mitigate, or adapt to, climate change effects. Vermont’s environmental justice policy defines an environmental justice focus community as having annual median household income not more than 80 percent of the State median household income; Persons of Color and Indigenous Peoples (BIPOC) comprise at least six percent or more of the population; or at least one percent or more of households have limited English proficiency.

The disproportionate burden of climate change and natural hazards on low-income, marginalized, and vulnerable populations, is an environmental justice issue. Vermont can address environmental justice issues by addressing the effects of climate change on vulnerable populations. Vermont’s new environmental justice policy states that environmental justice requires providing a proportional amount of resources for community revitalization, ecological restoration, resilience planning, and a just recovery to communities most affected by environmental burdens and natural disasters.

Vulnerability is not a measure of wealth, but a measure of assets, or lack thereof. Assets can be social networks and customs, money, land, or knowledge and skillsets. Assets are unique to a place and culture. Vulnerability can also fluctuate with life cycles; the very young and very old are in vulnerable categories, particularly in lower income communities. Pre-existing illnesses and physical disabilities of elderly populations limit their mobility and their capacity to cope with climate change impacts, including slow moving and extreme weather events. Depending on multiple factors people may not be able to evacuate during an emergency due to mobility, financial limitations, or a lack of family or friends to relocate to.

An analysis by University of Vermont researchers found that mobile homes are more likely than permanent structures to be located in a flood hazard area. During Tropical Storm Irene, mobile parks and over 561 mobile homes in Vermont were damaged or destroyed. Mobile homes make up 7.2 percent of all housing units in Vermont and were approximately 40 percent of sites affected by Tropical Storm Irene.

Another University of Vermont study reports that BIPOC individuals were seven times more likely to have gone without heat in the past year, and over two times more likely to have trouble affording electricity[[11]](#footnote-12).

Historically underprivileged populations have greater vulnerabilities to climate change around the world and Vermont is not exempt. Marginalized populations lack political power, financial resources, and mobility. This is in part due to discriminatory practices that segregate those with less socioeconomic power into the highest-risk neighborhoods, usually without access to insurance and loans as security against climate change impacts. In a post-disaster scenario, disparities become more visible as some households are able to afford to rebuild, while others either live in unhealthy conditions or lose their homes completely due to the cost of rebuilding and insurance. Wealthy homeowners and municipalities are also better set-up to participate in government - funded home buyout programs and relocate within their communities.

How Vermont mitigates risk of exposed assets can either reduce or perpetuate vulnerabilities. People living in hazard prone areas have felt and will feel the brunt of hazard and climate change impacts. In investing resources in hazard prone and marginalized communities, Vermont must ensure that these communities can benefit from improvements, rather than be pushed out by competition for housing and loss of affordability.

Meaningful consideration of environmental justice issues is vital in the planning process for Vermont, and identification of environmental justice issues or unintended consequences of a mitigation action on frontline communities should trigger not only minor revisions to the project, but major changes to the plans and projects for the floodplain and other hazard prone areas.

**Food Security**

Food security can be impacted in multiple ways due to hazard events and climate change. Each hazard profile in this Plan discusses impacts to agriculture, which has downstream impacts on food availability. For example, an early frost in May can mean that there is limited local fruit and vegetables available that year, driving up the costs of groceries for consumers.

In a different aspect of food security, disaster events can cause closures of grocery stores for extended periods of time. Given the rural nature of Vermont, a region covering multiple towns may only have one grocery store available, and closure of that grocery store will impact the entire region and its communities.

**Housing**

Vermont has a historic housing shortage that today is nothing short of a housing crisis. There is a shortage of all affordable housing options in both rural and more urban parts of the State including availability of starter homes and smaller, affordable housing units. The lack of housing prices out young families and older adults that need to downsize their homes while remaining within their communities and social networks. When housing for young families is not available, people are forced to leave the State for more affordable markets. This has impacts on the tax base as well as local school populations. Many local elementary schools are under pressure to close due to waning student numbers. Given Vermont’s topography and population density, these local elementary schools are necessary to allow for the safe and efficient transportation of students to and from school. A loss of local schools also removes potential shelters and localized resilience hubs from isolated communities.

In 2020 an existing problem and its impacts became exponentially worse. The COVID-19 pandemic hit at a time when an entire generation of people were recovering from set-backs due to the Great Recession and were ready to buy homes and start families. Historically low interest rates for mortgages and fear of urban locations due to COVID-19 led to a house-buying rush in Vermont. The competition for homes and low housing stock has made homeownership unattainable for many people. The cost of rent has also increased with demand at the same time as many landlords sell their rental housing in the seller’s market. According to a 2022 study from Hazard University’s Joint Center for Housing Studies, the median home price along the central border with New Hampshire was $325,172, requiring a household income of $89,415. In northwest Vermont the median home price was $420,917, requiring an income of $115,742[[12]](#footnote-13). The median household income in Vermont was $67,674[[13]](#footnote-14). Those home prices have continued to rise with historic low inventories as people hold onto existing homes and low mortgage interest rates that have since risen in response to inflation.

The in-migration of people to Vermont during the COVID-19 pandemic, and accelerated housing crisis, serves as a warning of issues we will face in housing as people move away from exposed coastal areas and hotter climates to Vermont to escape climate change impacts. As discussed within the environmental justice section, many of the people moving to Vermont will be wealthier, having the assets to move away from the worst climate change impacts, further exacerbating affordability of housing in Vermont if supply cannot keep up with demand. Climate migration is further discussed under Future Trends and Concerns.

The housing crisis means that people are not able to afford safe homes. Individuals and families may be forced to buy or rent homes that are susceptible to flooding or erosion. For those who do buy homes, affording to weatherize or resiliently retrofit a home will be unattainable. Renters are typically not in a position to weatherize or retrofit a home.

When working class people cannot afford homes, overwhelmingly regulation on development will get the blame. Those regulations are often environmental laws, including Act 250, protections for natural habitat, and river corridor development restrictions. These regulatory mechanisms are necessary to ensure safe and resilient development in Vermont, and weakening these regulations will set the State back on the path to resilience.

With current and projected increases in populations due to both the COVID-19 pandemic and climate migration, development planning must account for expected growth while aligning with community character and vision. The VT Climate Action Plan published in December 2021 urges cities and towns to follow a compact settlement pathway, following Vermont’s existing village center development patterns. Compact settlement refers to developing within already established residential and commercial centers, as opposed to uninhabited areas. Compact settlement provides health, economic, and environmental benefits. The structure provides a network of resources to community members and protects the environment by preventing forest fragmentation[[14]](#footnote-15). However, given Vermont’s history of development along waterways and in the floodplain, there is a balance to strike between compact development within already urbanized centers, and ensuring that we are not putting people and businesses in harms way.

Many people were experiencing homelessness prior to the COVID-19 pandemic, many more lost their homes during the COVID-19 pandemic. Vermont determines the number of people living outside, or houseless, on a single day each year with the point-in-time count. Prior to the onset of Covid, Vermont’s count hovered around 1,000 and 1,500 people in contrast to 2021 with a count of 2,591 and 2022 when the count rose to 2,780[[15]](#footnote-16). During the emergency declaration phase of COVID-19, housing programs were available for many people experiencing homelessness. With the end of these programs with the end of the federal funding through the emergency declaration in May 2023, the question of where these Vermonters will go remains unanswered.

People without homes are significantly more vulnerable to hazards events. They are potentially exposed to extreme heat and cold, wildfire smoke, ticks and mosquitoes, and are exposed to elements of all natural hazards in Vermont. Many people experiencing homelessness are older adults or have chronic health conditions that can be exacerbated by extreme heat. Both heat and cold can lead to deaths. Vermont cannot reduce our vulnerabilities without addressing homelessness.

**Individual and Community Well-Being**

One change in the 2023 plan from the 2018 plan is how we assess hazard impacts on people. Conventional methods assess the impact of hazards by the number of people injured or killed by a hazard event. This method misses most of the picture of how hazards impact lives. For example, a small flood may cause mold to grow in a home, and while this did not cause death, it can have significant long term health impacts on those living there. Another example could be invasive species, or the many hazards that impact the health and longevity of trees. Numerous studies show the benefits of trees in urban and suburban neighborhoods. A loss of trees may not cause deaths, but can have an effect on mental health, a sense of place, heat, wind, and flood mitigation, and well-being at a community scale.

**Futures Trends and Concerns**

Since the 2018 State Hazard Mitigation Plan, the state of Vermont has experienced the acceleration of climate change, as well as the effects of a global pandemic. Thus, it is important to recognize that such large-scale disasters may occur in the future, and that with its somewhat-resilient climate, Vermont may experience a large population increase. Keeping these possibilities in mind, mitigation efforts must be put towards affordable housing and preparation for events that may affect “community lifelines” described below.

**Climate Migration**

Climate migration was discussed generally during 2018 plan development. Ultimately, the Steering Committee decided that this was a topic to consider in more detail in the next version of the SHMP. Climate refugees will not be from one place or demographic. As portions of the U.S. become more arid and as sea levels continue to rise, Vermont may begin to see significant increases in population. Vermont will continue to see an increase in population due to amenity migrants, typically wealthier older people who may vacation in Vermont. These migrants may change primary residency to Vermont as their current residencies face increased climate vulnerability. While Vermont may not be the primary location for climate migrants, its more stable climate can be enticing for those in at risk areas. Many factors play into the decision making of where to migrate if forced to including age, race, gender, and severity that can make it hard to determine how far people are willing to travel[[16]](#footnote-17). Regardless, it is important that the State of Vermont develops a plan in accordance with a possible large-scale increase in population. Affordable housing is an issue that many current Vermont residents are faced with, and as the State welcomes climate migrants, demand may skyrocket the price of housing even further.

Climate migrants may be a future vulnerable population to consider within each hazard profile if an affordable housing plan is not considered. The lack of affordable housing will not only impact the population of Vermonters already seeking homeownership or affordable rents, but also climate migrants and refugees. Vermont will and should welcome climate refugees, or those fleeing trauma and uninhabitable conditions in their former home countries. However, Vermont is not currently set-up to properly house populations with fewer financial resources.

**The Unexpected Effects of Hazard Events**

FEMA’s identification of “community lifelines” (safety and security, food-water-shelter, health and medical, energy (power and fuel), communications, transportation, and hazardous materials) reflects broad recognition that hazard events can have complex, far-reaching, compounding, and cascading consequences. For example, a long-term outage of electrical power across a wide region, regardless of whether precipitated by ice storm, wind event, cyber attack, or other cause, will disrupt individual lives and social order in profound and potentially life-threatening ways. The immediate response concerns for events which rise to the level of creating “social chaos” is cross-cutting and ties back to Vermont’s State Emergency Operations Plan including the Prevention and Protection Mission Area Plan, which covers “Long-Term Utility Outage” among “Technological and Human-Caused Hazards”.

Local Vulnerability

In conjunction with the risk assessment, VEM staff conducted a vulnerability assessment, which predicts the extent of damage that may result from a hazard event of a given intensity in a given area and considers damage to the existing and future built environment, the natural environment, and populations within Vermont. Vulnerability was determined by identifying the threats posed to people, property, the environment, and the economy. Hazard-specific vulnerability is detailed further in the individual hazard profiles.

Though a small state, Vermont’s topography and mountainous setting can result in geographic isolation during severe storms, which can have significant localized impacts. A localized storm can drop a significant amount of water into a small watershed, devastating one town or cutting it off from the rest of the State, while causing no damage to an adjacent town on the other side of a mountain. The mountainous areas in Vermont vulnerable to these phenomena are numerous. Because of the steep mountain topography, damage from frequently occurring extreme weather events in any specific location may occur often or only once in a lifetime, which makes it difficult to plan for and respond to events.

Coupled with this topographic isolation, the rural nature of the State can also result in isolation from necessary emergency response efforts. Most communities in Vermont have an identified local Emergency Operations Center (EOC) and/or shelter for its residents, should an event warrant their opening and often require a back-up energy source, typically in the form of generators. In order to keep these critical facilities functioning in times of need, VEM is regularly contacted for equipment and training requests and financial assistance. Other critical facilities that have applied for funding through the State are wastewater treatment plants and fire departments, which require back-up energy sources during events that may result in community-wide power loss (e.g. flooding, wind storm, ice/snow storm), or which require flood-proofing to reduce vulnerability to flood damage.

In addition to ranking hazard significance, RPCs also listed the communities within their regions that are most vulnerable to natural hazards and explained what makes them vulnerable. The responses are represented in Table 22. VEM staff used this local vulnerability information to inform the assessment of each hazard and the mitigation strategy (see: Mitigation Strategy).

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| **Table 22: Local Vulnerability by Regional Planning Commission** |
| **RPC** | **Municipality** | **Vulnerability** |
| ACRPC | Goshen | Populations are clustered along rivers within narrow valleys in high elevations. Small community, limited resources.  |
| ACRPC | Lincoln, Ripton | Populations are clustered along rivers within narrow valleys in high elevations. |
| ACRPC | Starksboro | Populations are clustered along rivers within narrow valleys in mid-high elevations. Small community, limited resources. |
| ACRPC | Whiting | Small community with very limited resources.  |
| BCRC | Bennington | The downtown area is within a flood zone.  |
| BCRC | Pownal | Many mobile home parks exist within floodplains and are subject to frequent flooding.  |
| CCRPC | Bolton, Huntington, Jericho, Richmond, Underhill | Steep roads vulnerable to fluvial erosion and flooding. |
| CVRPC | Barre City, Montpelier | Downtowns in floodplain prone to flooding and ice jams, vulnerable populations at risk due to cold, critical facilities potentially at risk, ice and wind capable of causing power/internet outages  |
| CVRPC | Northfield | Much of the town exists within a floodplain, and the river has a sharp bend adjacent to the downtown area which makes the town vulnerable to ice jams and associated debris.  |
| CVRPC | Plainfield | Vulnerable to flooding due to topography and soils, debris jam potential, and public infrastructure in need of upgrade. Limited transportation routes and potential for isolation. Proximity to the Marshfield Dam. |
| CVRPC | Waterbury Town/Village | Downtown location and critical facilities prone to flooding and near Waterbury Dam, age and condition of infrastructure, vulnerable populations, potential for long-term power outages. |
| LCPC | Johnson/Cambridge | Vulnerable to flood inundation and ice jams due to low lying downtown, as well as snowfall, wind, and extreme cold due to winter storms affecting Lamoille County.  |
| MARC | Chester | The village is located at the confluence of 5 different rivers/streams, vulnerable to flooding and erosion and still seeing effects from Irene, Route 11 and Route 35 are at risk of blockage. |
| MARC | Ludlow/Ludlow Vlg | Critical infrastructure located within floodplain, including the village center.  |
| NRPC | Bakersfield | Transportation routes parallel rivers and streams and are vulnerable to flooding, as well as events that cause treefall and block roads. Undersized culverts are not built to handle intense precipitation. Much of the population relies on medical equipment and specialized healthcare.  |
| NRPC | Enosburgh | Fluvial erosion and inundation risk, power lines vulnerable to ice, forested land cover, winds from the west gain strength over lake. |
| NRPC | Highgate | Much of town at risk of inundation and fluvial erosion in the spring, ice jam-related flooding in East Highgate, power lines vulnerable to ice, soil composition is primarily sand on top of clay which makes the town vulnerable to landslides.  |
| NRPC | Montgomery | Soils and topography create risk of flooding and erosion, power lines vulnerable to ice, remoteness and forested land cover, winds from the west gain strength over lake. |
| NRPC | Isle La Motte | Island landform vulnerable to flood inundation, one road connects island to neighboring town, remote, transportation and communication network interrupted due to winter storms, power lines vulnerable to ice, winds from the west gain strength over lake. |
| NRPC | Swanton Town/Village | Pre-flood regulations development at risk of flood inundation, power lines vulnerable to ice, winds from the west gain strength over lake. |
| NVDA | Coventry | Vulnerable to ice jams |
| NVDA | Hardwick | Majority of development around bodies of water, at risk of flooding and ice jams. |
| NVDA | Lyndon | Multiple towns drain into the area.  |
| NVDA | Newport, St. Johnsbury | Vulnerable to flooding due to proximity to rivers.  |
| RRPC | Mendon, Brandon, Pawlet, Rutland City | Infrastructure in the river corridor vulnerable to flooding and fluvial erosion. Towns are extremely vulnerable to flash flooding and road washouts which may block transportation. High percentage of gravel roads on steep slopes.  |
| TRORC | Hancock, Pittsfield, Rochester, Stockbridge | Steep slopes that were damaged by Irene at risk of fluvial erosion, road infrastructure located near water bodies vulnerable to inundation risk, easily isolated during storm events as transportation routes may be blocked. |
| TRORC | Strafford | Majority of homes and infrastructure located along West Branch of Ompompanoosuc River, putting the town at risk of flooding.  |
| WRC | Jamaica | Historic development pattern cause vulnerability to fluvial erosion and inundation, affecting the surrounding town and transportation routes. Subject to fast-moving floodwaters and erosion due to topography |
| WRC  | Londonderry | Villages within the floodplain with development pressures in vulnerable areas, Dam in disrepair in North Village, EAB present  |
| WRC | Marlboro | Topography and development patterns create a risk of fluvial erosion, Rt 9 vulnerable to erosion due to steep banks and slides in river corridors |
| WRC | Newfane | Transportation infrastructure and development are low-lying and downstream within a floodplain which accelerates vulnerability to flooding, especially vulnerable to landslides along their roads.  |
| WRC | Wilmington | Location of downtown and historic development pattern cause a risk of flooding and fluvial erosion, history of ice jams in North Branch and downtown, EAB present. |

**Town Survey**

Based on the VEM hazard mitigation planning survey circulated to towns in 2023, improving land use regulations, upgrading infrastructure, and expanded communication before and during disasters are high priorities for better protecting their most vulnerable residents. In order to do this, they not only need funding, but expanded local staff capacity and additional technical assistance. These priorities and needs align with the assessment done through the State hazard mitigation planning process and proposed mitigation strategy.

Map of communities that responded to survey

Towns want to adopt river corridor bylaws and enforce floodplain development regulations, but continue to face barriers both technical, capacity related, and politically.

Specifics in infrastructure improvements included right sizing culverts and bridges to withstand precipitation and snowmelt events that meet or exceed bankfull width of a waterway, strengthening distribution lines, upgrading village water lines, establishing microgrids, and addressing transportation vulnerabilities due to landslides and fluvial erosion. Multiple towns identified the importance of protecting community gathering spaces, such as general stores and municipal buildings, as critical for overall resilience.

After COVID-19 and the multiple of funding sources that became available for recovery efforts, the problem was no longer solely that municipalities desperately needed funding for projects, but that they needed help in managing the funding that was suddenly available. In the survey of towns conducted for the SHMP, over 70% said that limited staff capacity to apply for funding was a barrier to obtaining funding. Small towns also found the funding programs to be complex and confusing to understand what grants could be used for different projects. The second most common response to the survey was that towns do not know what grants are available for the projects they want to do. Staff capacity and clarity of funding programs were existing challenges that were exacerbated after the global pandemic, and remain challenges for Vermont’s municipalities.

Vulnerability of State-Owned Buildings:

Buildings and General Services (BGS), through a 2018 SHMP subgrant, is the lead agency for a statewide assessment of State-owned buildings located either in the FEMA-mapped floodplain and/or the river corridor. This assessment, which included all State-owned and leased properties, considered both criticality of the buildings’ functions and the vulnerability of the structures based on location.

As the two most significant hazards identified in this Plan, the BGS risk assessment project focused primarily on fluvial erosion and flood inundation vulnerability. Further, assessing risk based on these hazards was fairly straightforward, as BGS could access both State and FEMA mapping data specific to fluvial erosion and inundation flooding. Using these data, BGS assessed vulnerability of an individual structure according to its proximity to the FEMA-mapped 100- and 500-yr floodplains, as well as the river corridor. An overall vulnerability score was assigned to each structure using a point system outlined in the Appendix to Section 3. Structures were then assessed according to their criticality to the following State functions:

* Emergency Operations
* Government Operations
* Public Safety
* Public Health
* Public Service
* Economic Activity
* Cultural Resources

BGS then used the scores for criticality and vulnerability to determine building prioritization for developing mitigation measures. The risk assessment also includes information on each building’s current function, construction type and year, number of floors, building replacement cost, cost of personal property and cost of computer equipment. A detailed description of this risk assessment, prioritization process and alternatives analysis for the top priority State-owned structures can be found in the Appendix to Section 3.

Though the BGS project focused primarily on fluvial erosion and inundation flooding, the data acquired are pertinent to all natural hazards profiled in this Plan that could impact State-owned or leased structures. That is, a building’s replacement cost will be the same regardless of what hazard was responsible for its destruction. Similarly, a building’s criticality score does not differ hazard-to-hazard. Further, without high fidelity hazard mapping data for all natural hazards, determining true vulnerability of a structure based on proximity to a clearly delineated hazard area is very difficult. The full list of all State-owned buildings and their replacement costs as defined above in is the Appendix to Section 4.

1. https://www.uvm.edu/news/story/study-vermont-maple-industry-contributes-more-300-million-sales-states-economy [↑](#footnote-ref-2)
2. https://www.fs.usda.gov/ccrc/topics/maple-syrup [↑](#footnote-ref-3)
3. https://www.themaplenews.com/story/study-shows-declining-winter-snowpack-is-hurting-the-sugar-maple/231/ [↑](#footnote-ref-4)
4. https://www.vtinvasives.org/news-events/news/two-new-invasive-species-could-invade-north-country-landscape-officials-trying-to-protect-sugar [↑](#footnote-ref-5)
5. https://www.fs.usda.gov/ccrc/topics/effects-drought-forests-and-rangelands#:~:text=Economic%20Consequences%20of%20Drought&text=Droughts%20can%20negatively%20impact%20forest,to%20wind%20and%20water%20erosion. [↑](#footnote-ref-6)
6. https://vtinvasives.org/land/emerald-ash-borer-vermont [↑](#footnote-ref-7)
7. https://vtinvasives.org/invasive/bittersweet-asiatic [↑](#footnote-ref-8)
8. https://www.uvm.edu/extension/agriculture/ag-risk-management [↑](#footnote-ref-9)
9. https://cropinsuranceinamerica.org/vermont/ [↑](#footnote-ref-10)
10. <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series/43/tavg/ann/2/1895-2023?base_prd=true&begbaseyear=1895&endbaseyear=2022&trend=true&trend_base=10&begtrendyear=1895&endtrendyear=2023> [↑](#footnote-ref-11)
11. <https://legislature.vermont.gov/Documents/2022/Docs/ACTS/ACT154/ACT154%20As%20Enacted.pdf> [↑](#footnote-ref-12)
12. <https://www.jchs.harvard.edu/son-2022-affordability> [↑](#footnote-ref-13)
13. <https://www.census.gov/quickfacts/VT> [↑](#footnote-ref-14)
14. <https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf> [↑](#footnote-ref-15)
15. <https://s3.documentcloud.org/documents/22122817/homelessness-report.pdf> [↑](#footnote-ref-16)
16. https://communityresilience-center.org/wp-content/uploads/2020/12/Climate\_Migration\_Report.pdf [↑](#footnote-ref-17)