DISASTER RESILIENCE

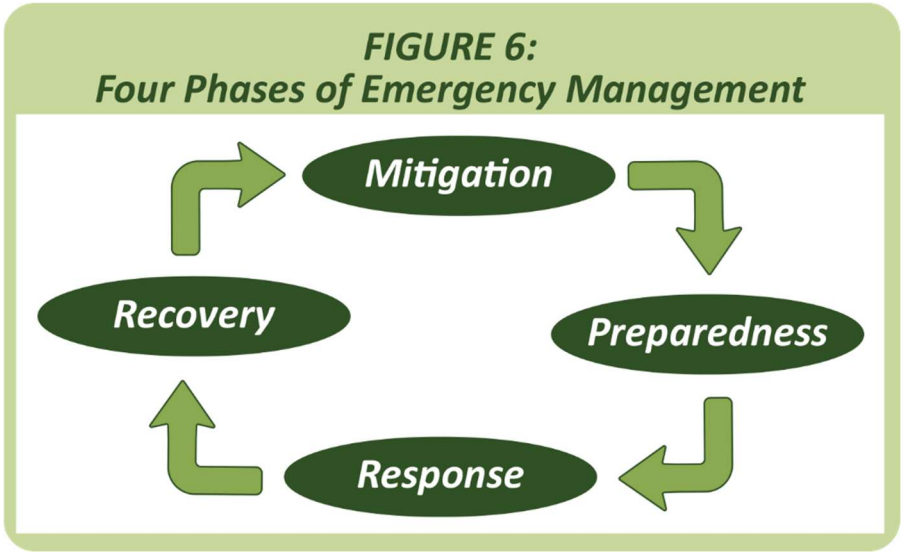
GOALS

1. **Reduce the loss of life, injury, and economic harm resulting from all-hazards events and climate change and focus efforts on those who are most vulnerable to impacts.**
2. **Reduce infrastructure damage and the financial losses incurred by municipal, residential, industrial, agricultural and commercial establishments due to disasters.**
3. **Ensure the region's communities are resilient to all-hazards events; include hazard mitigation planning, such as flood resiliency, in the municipal planning process.**

BACKGROUND

Resiliency is the ability of a community to respond and adapt to natural and human-caused disasters. Vermont Statutes require that regional plans include a flood resilience element. This plan incorporates a broader all-hazards resilience element instead of a flood resilience element due to the broad impact of disasters of all types on our region.

FIGURE 6:
Four Phases of Emergency Management



The impact of expected, but unpredictable, natural and human-caused disasters can be reduced through community planning. The purpose of this section is to provide communities in the Northwest region with all- hazards disaster resilience planning goals and policies that will help mitigate risks to public and private investments by protecting flood-prone and other vulnerable areas through municipal land use plans, municipal ordinances and capital improvement plans. The four phases of emergency management are mitigation, preparedness, response and recovery (Figure 6). In addition, economic resilience to disasters and to the impacts of Climate Change are important factors to incorporate into NRPC's future planning efforts.

The emergence of the Coronavirus disease (COVID-19) created a global pandemic which greatly impacted Vermont communities beginning in 2020. COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. The pandemic affected all sectors of society including economic, public health and education systems. Federal, state and local governments responded with innovative solutions to limit disruptions and continue operations so that citizens could return to daily life. The efforts also sought to mitigate impacts to local economies by allowing essential services to continue to operate. There are now better systems in place to cope with a future

pandemic including public health surveillance, monitoring and response, improved food systems security, expanded broadband services in unserved and underserved areas and continuity of operations for governments.

Scientists are concerned that the changing climate could increase future events similar to the COVID-19 pandemic. Moreover, climate change is causing major shifts in weather patterns, sea levels, animal habitats, and temperatures. As these climate extremes continue to increase in severity and variability, many of the dangers discussed in the chapters are at risk of increasing.

Mitigation

Hazard mitigation is any sustained action that reduces or eliminates long-term risk to people and property from natural and human-caused hazards and their effects. Based on the results of previous mitigation efforts, federal and state agencies have come to recognize that it is less expensive to prevent disasters than to repair damage after a disaster has struck. Communities have opportunities to identify and implement disaster resiliency goals and policies through their municipal land use planning process, land use regulations and local hazard mitigation plans. Hazards cannot be eliminated, but it is possible to determine what the most likely hazards are, ascertain where their impacts would be most severe and then identify local actions that can be taken to reduce their severity.

Preparedness

This phase includes developing plans for what to do, where to go and who to call for help before an event occurs—actions that improve the chances of successfully dealing with an emergency either individually or as a community. Franklin and Grand Isle Counties annually update their Emergency Operations Plans and provide the adopted plans to the NRPC and the Vermont Division of Emergency Management. In addition, local and regional public safety officials regularly participate in simulated disaster exercises.

Response

Public safety and well-being during an emergency depend on how prepared communities and individuals are to respond to a crisis. By being able to act responsibly and safely, communities and individuals will be better protected.

Planning for, financing, and providing an efficient system of public facilities for fire and police protection, as well as emergency medical services (EMS), is essential to ensuring the safety and well-being of residents now and into the future. Given the rural geography and lower population density outside of the City and Village areas, coordinated regional planning and shared services among municipalities can enhance response times and service effectiveness while minimizing costs. Sustainable funding mechanisms, such as state and federal grants and community-supported capital improvement plans, will be vital to upgrading or replacing aging infrastructure, modernizing equipment, and supporting the recruitment and retention of first responders.

The Franklin County International Firefighters Association, the Grand Isle County Mutual Aid Association and Local Emergency Planning Committee Districts 4 and 13 serve their member municipalities throughout the region by offering planning, training and exercising for all-hazards events.

Emergency service organizations and municipalities have mutual aid agreements in place to assist one another during emergency responses. There are two fire mutual aid associations in the region: the Franklin County International Firefighters Association and the Grand Isle County Mutual Aid Association. Each association is composed of municipal first response and rescue agencies within each county. There is a mutual aid agreement between the municipalities of each county and between each association to assist one another in times of crisis, and it offers agreed-upon rates of reimbursement for expended resources.

TABLE 7: First Response Agencies Serving the Region

Municipality	Law Enforcement*	EMS	Fire Department	Mutual Aid Agreement
Alburgh	VSP and GICSO	Alburgh Rescue	Alburgh Fire	X
Bakersfield	VSP and FCSO	Enosburg Ambulance	Bakersfield VFD	X
Berkshire	VSP and FCSO	Enosburg Ambulance	Berkshire VFD	X
Enosburg Falls	VSP	Enosburg Ambulance	Enosburg VFD	X
Enosburgh Town	VSP	Enosburg Ambulance	Enosburg VFD	X
Fairfax	VSP and FCSO	Fairfax Rescue	Fairfax VFD	X
Fairfield	VSP and FCSO	AmCare Ambulance	Fairfield VFD East Fairfield VFD	X
Franklin	VSP and FCSO	Enosburg Ambulance	Franklin Fire Dept.	X
Fletcher	VSP	Fairfax Rescue Cambridge Rescue	Fairfax VFD Cambridge VFD	X
Georgia	VSP and FCSO	Georgia Rescue	Georgia VFD	X
Grand Isle	VSP and GICSO	Grand Isle Rescue	Grand Isle VFD	X
Highgate	VSP and FCSO	Missisquoi Valley Rescue, Inc.	Highgate VFD	X
Isle La Motte	VSP and GICSO	Alburg Rescue Grand Isle Rescue	Isle La Motte Fire Company	X
Montgomery	VSP	Montgomery Rescue	Montgomery VFD	X
North Hero	VSP and GICSO	Grand Isle Rescue	North Hero VFD	X
Richford	VSP and FCSO	Richford Ambulance	Richford VFD	X
Sheldon	VSP and FCSO	AmCare Ambulance	Sheldon Fire Dept.	X
South Hero	VSP and GICSO	South Hero Rescue	South Hero VFD	X
St. Albans City	STACPD and VSP	AmCare Ambulance	St. Albans City Fire Dept.	X
St. Albans Town	STACPD and VSP	AmCare Ambulance	St. Albans Town VFD	X
Swanton Town	SVPD and VSP	Missisquoi Valley Rescue, Inc.	Swanton Village Fire Dept.	X
Swanton Village	SVPD and VSP	Missisquoi Valley Rescue, Inc.	Swanton Village Fire Dept.	X

**VSP - Vermont State Police* **FCSO - Franklin Co. Sheriff's Office* **GISCSO - Grand Isle Co. Sheriff's Office*
**STACPD - St. Albans City Police Department* **SVPD - Swanton Village Police Department*

Recovery

After the immediate danger of an emergency is over, continued public safety and well-being will depend on the community's ability to cope with getting life back to normal. During the recovery period, communities must be able to manage disaster-related financial burdens. At this time, communities should also consider steps to take that would mitigate the effects of future similar disasters.

The 2019 Halloween Storm, 2018 Missisquoi River flood, 2011 Lake Champlain flood, Tropical Storm Irene, and ice storms in 1998 and 2013 have increased public recognition of the need to link regional and municipal land use planning, mitigation planning and capital improvement planning. Although our region was largely spared from impacts, severe flooding in July of 2023 and 2024 further stressed the need for flood preparedness. Communities can improve their resiliency by following a comprehensive planning process that considers impacts from natural and human-made disasters.

IDENTIFYING HAZARDS AND ASSESSING VULNERABILITY

The NRPC used a FEMA approved Hazard Identification Risk Assessment (HIRA) process to rank hazard types in the region (Table 8). Additionally, Vermont Agency of Transportation's Resilience Planning Tool is used to supplement the HIRA. Hazards that scored High in the ranking system are considered the worst threat in terms of their probability of occurrence and their impact on the community. The risk assessment produces a Relative Risk score using a qualitative process to compile estimates of the likely frequency of occurrence, the extent of the community impact and the likely consequences in terms of public safety, property damage, economic impacts and harm to environmental resources. The resulting analysis provides a Relative Risk score for each hazard as High, Moderate or Low. ~~This information is summarized below and can be found in more detail within local hazard mitigation plans for communities as well as the Franklin & Grand Isle All Hazards Assessment prepared by the NRPC.~~

TABLE 8: Relative Risk

HAZARD	RELATIVE RISK
Flood, Fluvial Erosion	High
Severe Winter Storm, Extreme Cold, Ice Storm	High
Severe Thunderstorms (hail, high winds, lightning)	High
Severe Wind, Tropical Storm, Hurricane	Moderate
Hazardous Materials	Moderate
Structure Fire	Moderate
Landslides	Moderate
Heat & Drought	Moderate
Invasive Species	Moderate
Terrorism	Moderate
Ice Jam	Low
Major Fire -Wildfire	Low
Tornado	Low
Earthquake	Low

SOURCE: *FEMA Hazard Identification Risk Assessment*

Because of limited roadway access points and the geography of the Islands, Grand Isle County has a unique vulnerability to being isolated as a result of natural or man-made disasters. Grand Isle Mutual Aid, with support from NRPC, meets regularly to coordinate among first responders in the county.

It should be noted that the region's overall risk rating is low (380 out of a possible high of 1,200 points in the Risk Assessment tool).

HIGH RISK HAZARDS

Flooding and Fluvial Erosion

The greatest risk to the region and the state is from flooding in the form of inundation and fluvial erosion. The region is most prone to flooding during the spring and summer months. During spring, partially frozen soils, melting snow and springtime rains produce an annual spring flood cycle. During summer, localized storm events produce flood conditions as soils become quickly saturated by high volumes of rain. Recent storms have caused significant damage to local transportation infrastructure, typically due to inappropriately sized culverts and other diversion systems. Erosion along stream banks from flooding often affects the roads, facilities, residences and utilities located nearby. Localized flash flooding is becoming more common as large

TABLE 9: Federal Disaster Declarations in the Region

	Franklin County	Grand Isle County
DR-1184 (July 15 – 17, 1997)	Severe Storms and Flooding	Not affected
DR-1201 (Jan. 6 – 16, 1998)	Severe Winter Storm / Ice Storm	Severe Winter Storm / Ice Storm
DR-1228 (June 17 – Aug. 17, 1998)	Severe Storms and Flooding	Not affected
DR-3157 (Mar. 5 – 7, 2001)	Not affected	Severe Winter Storm
DR-1428 (June 5 – June 13, 2002)	Not affected	Severe Storms, Tornado and Flooding
DR-1559 (Aug. 12 – Sept. 12, 2004)	Severe Storms and Flooding	Not affected
DR-1778 (June 14 – 17, 2008)	Severe Storms and Flooding	Severe Storms and Flood
DR-1784 (July 18, 2008)	Severe Storms and Flooding	Not affected
DR-1951 (Dec. 1 – 5, 2010)	Severe Winter Storms and Flooding	Not affected
DR-1995 (Apr. 23 – May 9, 2011) *Individual Assistance Declaration	Severe Storms and Flooding	Severe Storms and Flooding
DR-4043 (Apr. 23 – May 9, 2011)	Severe Storms and Flooding	Severe Storms and Flooding
DR-4022 (Aug. 27 – Sept. 2, 2011)	Severe Storms and Flooding	Severe Storms and Flooding
FEMA 338 EM (Aug. 29, 2011)	Tropical Storm Irene	Tropical Storm Irene
DR-4178 (Apr. 15 – 18, 2014)	Severe Storms and Flooding	Not affected
DR-4207 (Dec. 9 – 12, 2014)	Severe Winter Storm	Not affected
DR-4356 (Oct. 29 – 30, 2017)	Severe Storms and Flooding	Severe Storms and Flooding
DR-4380 (May 4 – 5, 2018)	Not affected	Severe Storms and Flooding
DR-4474 (Oct. 31 – Nov. 1, 2019)	Severe Storms and Flooding	Not affected
EM-3597 (Cat. B) (Aug 22 – 29, 2021)	Tropical Storm Henri	Tropical Storm Henri
DR4695 (Dec. 22 – 24, 2022)	Severe Storms and Flooding	Severe Storms and Flooding
DR-4532 (Jan 20, 2020 – May 11, 2023)	Covid-19 Pandemic	Covid-19 Pandemic
EM-3595 (Cat. B) (July 9 – 17, 2023)	Flooding	Flooding
DR 4770 (Jan. 9 – 13, 2024)	Severe Winter Storm	Severe Winter Storm
EM-3609 (Cat. B) (Aug. 8 – 14, 2024)	Tropical Depression Debby	Tropical Depression Debby

SOURCE: *FEMA*

rainstorms impact small areas during brief periods. Floods can be worsened by ice or debris dams and the failure of infrastructure (especially culverts), private dams and beaver dams.

In the region, there is a history of flooding and fluvial erosion along the Missisquoi River, Trout River, Tyler Branch, Black Creek, Rock River and Pike River, and along the shores of Lake Champlain as well as many brooks. Studies have shown that damaging floods are occurring in areas outside of mapped special flood hazard areas. The greatest threat to flooding is caused by changes in land use and increased development near riverbanks and in floodplain areas. Increased development encroachment on rivers and streams leads to greater volumes of stormwater runoff and greater erosion of stream banks. Improperly built stormwater infrastructure also disrupts stormwater flow and can overload culverts with additional stormwater.

Federal Major Disaster Declarations since 1995 due to flooding in the region are listed in Table 9.

The Vermont Agency of Natural Resources (ANR) has adopted river corridor protection, an avoidance strategy to restore and protect the natural stability of rivers and minimize flood damage. River corridor protection is recognized as a critical state wide goal in statute. Municipalities protecting River Corridors are eligible for incentives including increased post-disaster funding.

TABLE 10: Structures Identified within Flood Zones 2023 (approximate)

COUNTY	Total Structures	Camp	Mobile Home	Multi Family	Other Residential	Single Family	Commercial	Government	House of Worship	Industrial	Public	Utility	Other/Unknown
Franklin County	1,128	441	59	35	5	413	64	2	2	2	11	10	84
Grand Isle County	536	262	39	1	4	177	13	0	1	0	1	2	36

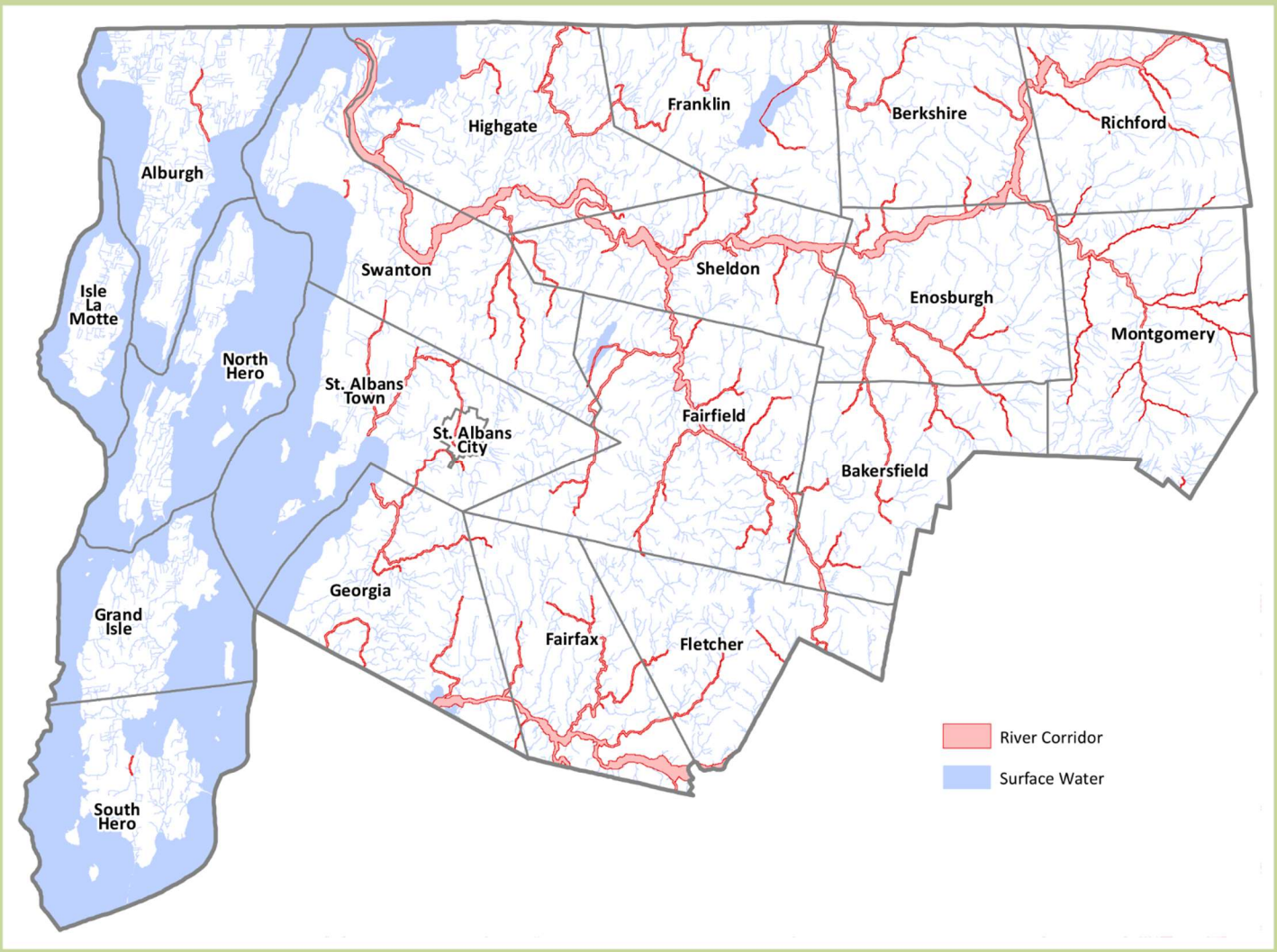
SOURCE: *Flood Insurance Rate Maps & E911 Data*

TABLE 11: Structures Identified within River Corridors 2023 (approximate)

COUNTY	Total Structures	Camp	Mobile Home	Multi Family	Other Residential	Single Family	Commercial	Government	House of Worship	Industrial	Public	Utility	Other/Unknown
Franklin County	645	21	63	59	3	363	48	5	1	6	6	17	53
Grand Isle County	1	0	0	0	1	0	0	0	0	0	0	0	0

SOURCE: *Vermont Agency of Natural Resources & E911 Data*

MAP 16: River Corridors



SOURCE: *Vermont Agency of Natural Resources*

Severe Winter Storms, Extreme Cold, Ice Storms

The second greatest risk to the region is from severe winter weather including winter storms, ice storms and extreme cold. In northwestern Vermont, a severe winter storm can last for several days and can be accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, substantial drifting and dangerous wind chill. Strong winds, accumulations of ice and heavy snow can knock down trees, utility poles, communication towers and power lines. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. People have been trapped at home for up to two weeks without utilities or other services. Some of the worst winter storms in the region have left ice accumulations of 2 to 4" (January 1998 and December 9, 2014) as well as wind speeds up to 50 mph (December 23, 2022). On the evening of December 22 through the evening of December 23, Vermont was hit by a winter storm "bomb cyclone", leaving nearly 100,000 without power and wind gusts approaching 75 mph.

Severe Thunderstorms (Hail/High Winds/Lightning)

Thunderstorms are the most frequent natural hazard event occurring in Vermont. Thunderstorms and their associated hazards can occur anywhere in the region at any time of the year; however, spring and summer are the most common times for severe thunderstorms. Supercell thunderstorms that produce tornadoes can be the most destructive and cause widespread damage to land, crops and property. Severe thunderstorms can produce hail that is damaging to crops, structures and vehicles as well as lightning that can damage infrastructure, plants and property, and can start forest fires. Flash floods are likely to occur after a severe thunderstorm that produces a large amount of precipitation over a short duration. Mountainous areas in the region are particularly prone to flash flooding due to the steep terrain. According to the EPA as well as The Center for Climate Sciences at NASA's Jet Propulsion Laboratory, it's a relatively well-accepted fact within the science community that as global temperatures increase, extreme precipitation and including more intense short duration storms will very likely increase as well.

MODERATE RISK HAZARDS

Severe Winds, Tropical Storms, Hurricanes

Severe winds are a hazardous threat to the region and most commonly accompany other storm events. They typically occur as strong frontal systems move across the Adirondacks and southern Canada from the west. The region is far inland and unlikely to receive a direct hit from a hurricane; however, severe winds from tropical storms have occurred as weakened storms originating in the Atlantic Ocean track near the region (Table 12).

Power lines and trees are most vulnerable to wind. Power outages can result in significant loss of business, high repair costs and threats to public safety.

TABLE 12: Tropical Storm Impact

NAME	DATE
Unnamed	November 3, 1927
Andrew	August 1990
Floyd	September 1999
Hannah	September 14 - 15, 2007
Isidore	September 27, 2007
Katrina	August 30, 2005
Irene	August 28, 2011
Henri	August 22 - 29, 2021
Debby	August 8 - 14, 2024

Mobile home parks are uniquely vulnerable to flooding resulting from tropical storms. This increased risk is related to siting of park communities in flood hazard areas, and limitations of the structures themselves. Income, disability status and age can make park residents more vulnerable to the impacts of disasters with fewer resources for recovery. An assessment completed in 2012 by researchers at the University of Vermont found that one-fifth of Vermont's 247 mobile home parks have at least one lot that is located within a flood hazard area, and nearly 12% of all mobile home park lots are located in flood hazard areas.

Hazardous Materials (Fixed Site and Transport)

The third greatest risk to the region is from a hazardous materials incident. Local industry, natural gas and fuel oil distributors, and agricultural operations present the opportunity for a hazardous materials incident either at a fixed site or during transport anywhere within the region. Areas at risk for a stationary or on-site hazardous materials incident include the locations of hazardous materials manufacturing, processing or storage facilities, as well as all hazardous waste treatment, storage and disposal sites. Areas at risk for a hazardous materials transport incident include the region's transportation corridors and adjacent population

centers. The Highgate Springs Border Station in Franklin County is a heavily traveled port of entry that is served by Interstate 89 (with connections from Routes 2, 78 and 105) and receives a high volume of freight trucks containing hazardous materials.

There are two active rail lines in the region that move freight: the New England Central Railroad (NECR) and the Northern Vermont Railroad (NVRR). The threat of a derailment and/or hazardous materials spill exists along every rail line in operation, although mandated rail yard speeds greatly reduce the probability of a derailment resulting in a spill.

Any incident that occurs within the region requires an initial response conducted by the local fire departments. The nearest hazardous materials (HazMat) response vehicle is located at the IBM facility in Essex, Vermont. HazMat decontamination trailers are stationed in Swanton Village, Essex Junction and South Hero.

Structure Fire

The Vermont Fire Marshall's Report notes that Vermont has a high per-capita death rate from fire compared to other states. Vermont experiences an average of 8 fire deaths a year. Fire safety officials, fire departments and other safety advocates have all contributed to the overall reduction in fire deaths over time. Although, the National and State fire death rates have decreased, the elderly and young children are still the most vulnerable populations. Older adults have a greater risk of fire death than the overall population. In the five-year period from 2017 to 2021, 31% of Vermont's fire deaths have been seniors over the age of 65. This is a drop from 48% during the five-year period (2012-2016). Although fire causes vary, there are several common contributing factors such as poverty, climate, education, code enforcement and demographics.

According to the State Fire Marshal in 2021, cooking fires and heating appliances continue to be the leading causes of structure fires in Vermont. Unattended cooking was the leading cause of cooking fires and casualties. Almost one third of the people killed by cooking fires were asleep when the fire started. More than half of the non-fatal injuries occurred when people tried to control the fire themselves. A lead contributing factor to home heating fires is failure to clean creosote from solid-fueled heating equipment chimneys. Vermont ranks first in the nation for its per-capita use of wood for heat, with at least one in six Vermont households use wood products as their primary heating source. The long cold Vermont winters put added stress on heating systems. Furthermore, fluctuating fuel prices can force people to use alternative heating sources that may not be safe. An improperly installed and maintained heating appliance is dangerous and can result in carbon monoxide poisoning or be the source of a fire.

Vermont's housing stock is dominated by older, owner-occupied homes. It is the second oldest in the nation behind Maine. About 44% of the housing stock is comprised of year- round, owner-occupied homes built before 1950. A third of all rental and owned homes in the state were built before 1950. (State Fire Marshal, 2021)

A fire in a downtown can be devastating. In 1997, a fire engulfed the City Feed and Lumber building and warehouse in St. Albans City. The fire also threatened the neighboring Century Arms building, a local weapons manufacturer, and the Fonda Container building. In 2005, a fire destroyed much of the historic downtown

block in Enosburg Falls. For that fire, 11 fire departments responded through mutual aid plus one department from Sutton, Quebec. On December 2, 2022, a series of structure fires occurred in the St. Albans City that were pushed by high winds. One 18,000 sq ft warehouse, a vacant house and barn were destroyed with over $600,000 in damages.

Landslides

Vermont has a relatively high incidence of landslides partially due to soils. Clay “hard pan” soils reside underneath sand; water that infiltrates the sand rests on top of the clay, resulting in a sheering effect that causes the sand and topsoil to slide off the clay. This type of disaster rarely results in injury, but it can destabilize roads and threaten structures. Landslides can be caused by seismic events, manmade or natural changes to groundwater flow, removal of vegetation, and manmade or natural undercutting of steep banks. In the region, slides along the Missisquoi River in Highgate have threatened residential properties, a cemetery, the Highgate Transfer Station, infrastructure and local roads.

Heat and Drought

Prolonged periods of heat and drought are increasingly affecting northern Vermont. These hazards pose serious risks to public health, infrastructure, and local economies. High temperatures increase the likelihood of heat-related illnesses such as heat stroke and heat exhaustion, especially among the elderly, those with underlying health issues, low income and the homeless. Drought can limit water availability for drinking, irrigation, and sanitation. Both conditions strain healthcare systems, emergency services, and infrastructure—power grids may be overwhelmed during heatwaves due to increased cooling demands, while water systems and firefighting capacity may be compromised during droughts. Agriculture is particularly vulnerable, as heat and dry conditions reduce crop yields, stress livestock, and endanger industries like maple sugaring that rely on seasonal weather patterns. Outdoor activities and local events may also be disrupted, impacting tourism and recreation-based income.

Climate change is driving more frequent and intense heatwaves and longer-lasting droughts in the region. Days above 90°F are expected to increase, particularly during July and August, though heat events may extend into the spring and fall. Drought severity, measured by precipitation deficits, soil moisture, and streamflow, is also projected to worsen. These hazards often overlap, compounding their effects on ecosystems, the economy, and community well-being. While the urban heat island effect is less pronounced in rural areas, places with limited tree cover or poor ventilation still face heightened localized heat risks. Natural systems such as forests, wetlands, lakes and rivers can also be stressed, leading to ecological degradation and increased wildfire vulnerability.

Over the past 50 years alone, air temperatures in Vermont have increased more than 4°F in winter and more than 2°F in summer. The risk of heat related events including heat waves will increase in Vermont, with the number of days reaching 87°F per year are expected to increase from 6 to 20 (CDC). To help prevent heat related events, municipalities in the region have begun local emergency planning efforts to reduce their vulnerability to heat, both in response to an extreme heat event and as part of longer-term planning to lessen future risk. Examples include developing shelter annexes within their local emergency management plans which includes identifying local cooling spaces and cooling shelters and resources support lists. To safeguard

people's health in the short term, local municipalities can establish early warning systems, cooling areas, and raise awareness about heat related illness. Municipalities can modify roads, train tracks, and other infrastructure to use more heat-resilient materials and reduce heat absorption. Heat-waves are capable of placing high stress on electricity systems and cause possible disruptions. It is crucial that the Northwest Region continues its commitment to implement energy efficient measures throughout the network to lower the risk of these events.

Invasive Species

Infestations of invasive species threaten the diversity and survival of native species and can affect commercial, agricultural or recreational activities that depend upon the native species. They negatively impact the quality of wildlife habitat, create financial burdens for landowners and reduce the economic value of working forests. Sugarmakers, foresters, conservation groups, landowners and water facility operators are increasingly concerned about the economic toll of managing invasive species. In Vermont, a landowner could spend $200 to $800 per acre or more to manage invasives (Vermont Chapter of The Nature Conservancy). The maple, elm, horse chestnut, willow, ash, poplar, European mountain ash, hackberry, and hemlock have all seen population impacts from invasives. A caterpillar infestation caused more than $8 million in damage to the 2001 hay crop in Vermont, with some farmers losing up to 90% of their crop that year. Invasive plants and pests—such as Eurasian Watermilfoil and zebra mussels in Lake Champlain and the Asian Longhorned Beetle and hemlock wooly adelgid (HWA), cause millions more in damage in Vermont annually. The arrival of the Emerald ash borer (EAB) in the region has the potential to devastate ash trees in forests and communities, the state, municipalities; foresters and conservation groups have begun mitigation efforts to prevent their spread.

Emerald Ash Borer
PHOTO CREDIT: *VT ANR*

Terrorism

Terrorist events are possible in the region but are considered rare. Two types of terrorism could occur: international and domestic. The region is situated along the northern border of the United States and contains several Ports of Entry into Canada. Border crossings in upstate New York at Champlain and Rouses Point connect New York to Vermont via Route 78. Lake Champlain is an open waterway between New York and Vermont that flows north into Canada as well. Interstate 89 provides easy transportation to population centers located in New York City, Boston and Washington, DC.

Domestic acts of terrorism such as a school shooting incident, bomb threats and citizen confrontations at government offices are a regional concern. Schools have prepared by implementing school crisis plans, adding security features to school buildings, and conducting drills with local law enforcement and first response agencies.

LOW RISK HAZARDS

Ice Jams

Ice jams occur in streams and rivers when warm temperatures and heavy rain cause snow to melt rapidly, and they typically take place in sharp river bends, decreases in slope and constrictions within the stream channel as well as at confluences. The five most notable locations where ice jams occur in the region are the Lamoille River along VT 104A between Georgia and Fairfax near the Georgia High Bridge; the Missisquoi River along VT 78 west of Swanton Village; the Missisquoi River in East Highgate; the Missisquoi River along VT 105 between Enosburgh and Berkshire; and West Hill Brook at the intersection with VT 118 in Montgomery.

From 1867 to 1999, there were 753 ice jams on 74 rivers and in 127 towns in Vermont. The Lamoille and Missisquoi Rivers (both of which flow through the region) each account for nearly 10% of all statewide ice jams. These ice jams occur most often in March (44%), January (24%) and February (18%). There are 99 records of ice jams along the Missisquoi River alone. (U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL).

Most recently, mid-winter ice jam break ups have occurred in Swanton and Highgate in January 2020 and January 2018. These ice jams caused flooding related damages to roads and residential properties, along with evacuations. The impacts occurred mainly along N River St (VT78) and Monument Rd. In 2020, a Missisquoi River Ice Jam report issued for this stretch of river was developed by the Army Corps of Engineers and reviewed by state and local officials. The report noted that an advance mitigation measure that should be investigated further is an early warning system. This system would require engineering to include a variety of elements including but not limited to stream gages, weather forecast stations, web cameras, ice motion detectors, first hand observers, etc. The main objective of such a system would be to allow for the collection of data and information to assist emergency managers with staging a response to a probable or imminent ice jam event. As these events are becoming more frequent, residences, buildings and other infrastructure built within the floodplain will be susceptible to all flood types, including those caused by ice jams.

Major Fire - Wildfire

Wildfire in the region typically comes in the form of grass fires. Forest fires in the NRPC region are currently rare; however, the fuel potential for large fires exists. Grass fires occur in spring and early summer as fields are cleared of fall and winter debris. Wildfire suppression comes from the local fire department and mutual aid organizations. Throughout the region, large tracts of forested land could be at risk during sustained dry periods. With changing weather patterns associated with climate change, wildfire risks are increasing in Vermont. The NRPC region can expect and should plan for increasing wildfire danger in the coming decades, as well as air quality impacts from fires in adjacent regions, states and Canada. Education and outreach to increase community awareness will be important.

Tornado

Tornadoes may form when strong thunderstorms track through the area. These phenomena are rare in Vermont. Environmental impacts would include felled trees, while business impacts would take the form of destroyed crops. Building damages may include destroyed windows, torn roofs and destroyed barns. Tornadoes occurred in Franklin County on June 18, 1957; June 13, 1961; August 3, 1970; and July 19, 1972.

Earthquake

Earthquakes have been felt in the region and remain a geologic possibility. The region is situated in a moderate earthquake zone. Although earthquakes are not a frequent event, they have the potential to cause extensive damage to masonry (i.e., brick) buildings that are not reinforced as well as older bridges. FEMA used its Hazus earthquake risk analysis and loss model to conduct an analysis at the regional level in 2004. There is moderate potential for serious damage to buildings and infrastructure where losses would easily be in the millions if a high- magnitude earthquake occurred.

CLIMATE CHANGE

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Increasing concentrations of greenhouse gases in the atmosphere are causing climate patterns to change. Predicted impacts of climate change include more variable temperatures and rainfall, extreme weather events and rising lake levels.

Vermont is often considered a “climate haven,” and one of the best protected states from natural hazards and the effects of climate change. However, many of the state’s greatest hazards are climate driven. Extreme weather events such as the more frequent and severe precipitation events experienced in the past decade will likely cause a greater frequency of current “100-year flood” levels (severe flood levels with a one-in-100 likelihood of occurring in any given year). Higher temperatures could lead to greater risk of wildfire or drought conditions.

Impacts to the regional economy from climate change could be significant, especially where deciduous forests (e.g., maple, beech and birch forests) are concerned. Warmer fall temperatures would mean decreased colors and decreased tourist revenues during the foliage season. Warmer temperatures and a shorter spring season could affect the quality and quantity of sap produced, impacting the maple sugaring industry.

Water quality could be diminished as well, with more frequent algae blooms in Lake Champlain, Fairfield Pond, Lake Carmi, Arrowhead Mountain Lake and Metcalf Pond. This would drive down property values for lake shore properties, decreasing the tax base of municipalities.

One of the largest impacts from Climate Change will be seen in the agricultural sector. Some of the heating effects of climate change have lengthened the grow season, created milder average temperatures, and therefore have allowed for the expansion of new species into Vermont. The changing climate is also bringing agriculture setbacks, with fruit-bearing species like apples struggling with shorter winters, and the maple syrup industry in danger due to higher temperature variations impacting the length and quality of the sugaring season. Climate models predict overall tougher growing conditions caused by higher variability in temperature and precipitation, including floods and droughts leading to potential crop damage. According to the EPA, increases in temperature will likely reduce milk yields and slow weight gain in dairy cows. The projected increases in temperature will negatively affect operations, because production costs will increase with reductions in milk and meat production.

Vermont's hunting and fishing industry will also be affected by climate change. Warmer summers and shorter winters will result in an increased growing season and create changes in the makeup of natural communities. As ecological conditions change, habitats may become less suitable for some species and more suitable for others. For example, certain climate-sensitive habitats such as the high-elevation spruce fir forest may shrink or vanish, with implications for specialized species. Some species of fish and wildlife may shift their distribution on the landscape to follow the presence of preferred or essential habitats. Species formerly uncommon in Vermont, or only present during warmer seasons, may become more commonplace. Vermont's Fish and Wildlife Department states that habitat and species management will be critical in adapting to climate change, as will the protection of conservation lands.

Residents of the region rely on Vermont's downhill ski industry for recreation and employment. A shortened ski season due to briefer winters will mean decreased earnings for seasonal ski industry workers and related tourism businesses. Many ski areas have begun to expand upon recreation opportunities, such as offering summer recreation camps, to make the resorts economically viable year-round.

DISASTER RESILIENCY

Front Line Communities

Frontline communities are those that experience the "first and worst" consequences of climate change. These communities include smaller, less resourced municipalities, low-income homeowners, renters, individuals without homes, and those who have high transportation burdens. Traditionally underserved and impacted communities must be identified, and their input solicited on the expansion and creation resiliency efforts.

Historically, the effects of climate change and local disasters have not been equally distributed, and this is no different in Vermont. Hurricane Irene was a terrible disaster, and left millions of dollars of damage throughout the state. Although this was an extreme weather event, it is not isolated. The University of Vermont projects approximately 5.29 billion dollars in flood damages in the next century. (Inequities in the distribution of flood risk under floodplain restoration and climate change scenarios, Jesse D. Gourevitch, Rebecca M. Diehl, Beverley C. Wemple, Taylor H. Ricketts, January 2022).

This dollar value is more than double the expectations under current weather conditions, but the projected increased severity of storms due to climate change causes a 148% increase. The study found that low-income homeowners and mobile home owners are expected to face the largest burden from flooding, with mobile homes facing much higher risk compared to higher-value properties. 5.8% of all mobile homes are exposed to inundation during a 500-year flood event. By comparison, approximately 1.9% of all multi-family and commercial properties are exposed to flooding. Although the study presents that 20% of these hazards can be alleviated by floodplain restoration, higher-value properties are expected to benefit more from this investment. If these disparities go unnoticed, flood risk could continue to be a factor to inequality in society.

A strategy to help remove some of these unequal effects is using metrics of social vulnerability, which ranks flood projects with consideration for their social vulnerability. In Vermont, the socioeconomic and demographic variables needed to create the variable are not paired with property data sets, and therefore

makes it much harder to measure. It is important that social measures are taken into consideration in planning to ensure the most equitable outcome. Vermont's Municipal Vulnerability Tool, currently under development by the Vermont Climate Council, should help identify more vulnerable communities.

Infrastructure

Disaster resilience efforts seek to alter hazards by eliminating or reducing the frequency of occurrence; avert hazards by redirecting their impact by means of a structure or land treatment; adapt to hazards by modifying structures or standards; or avoid hazards by stopping or limiting development. Disaster-resilient projects include:

- Implementing proactive land use planning that encourages development or redevelopment outside of floodplains and other flood-prone areas
- Ensuring critical facilities are safely located
- Establishing and enforcing appropriate building codes to promote safer development
- Identifying and upgrading undersized culverts
- Properly building and maintaining roads
- Flood-proofing structures
- Tying down propane/fuel tanks in flood-prone areas
- Elevating furnaces and water heaters
- Identifying and modifying high-traffic incident locations and routes
- Ensuring an adequate water supply
- Elevating structures or utilities above flood levels
- Buying out and relocating structures to less vulnerable areas
- Providing information to the public

The Local Hazard Mitigation Plan (LHMP), helps communities identify important local hazards, prioritize steps, and find access to funding. There are a wide variety of ways that communities can invest into mitigation. To help address issues, the State of Vermont has developed the Transportation Resilience Planning Tool to identify at-risk areas of Vermont infrastructure. They have set forward four groups of mitigation strategies to support broad planning and to begin an alternative analysis to reduce vulnerability. Mitigation recommendations were established based on the characteristics that contribute to vulnerability and criticality for each location. The strategies include River and Road Stabilization (fortify road embankments, bridges, or culverts to resist erosion), Conveyance of Flood Flows (Increase space for passing water, sediment, and other flood debris), Floodplain Protection and Road Relocation (Protect floodplains and river corridors from permanent infrastructure), and Improve Vegetation (Naturalize the riverbanks, and riparian buffers to provide filtration, and natural habitat). Making these changes to communities is key to mitigation, and ensuring peoples safety and health.

Economic Resiliency

Resilience pertains to how a community sustains itself through change via adaptation and occasional transformation. One aspect of economic resilience is the way a community reduces economic losses due to disasters. Investing in infrastructure to lessen the impacts of flooding and other disasters is one-way

communities and businesses can limit rebuilding and recovery costs. Protecting functioning river corridors and floodplains can lessen the impacts of flooding. Maintaining the local economy during times of disaster—including saving jobs and keeping businesses open—is an indicator of a healthy, strong community. The Economic Chapter provides additional information about Climate Resilience.

GOALS AND POLICIES

1. **Reduce the loss of life, injury, and economic harm resulting from all-hazards events and climate change and focus efforts on those who are most vulnerable to impacts.**
   a. Leverage existing public health infrastructure to build climate resilience and engage and serve front line communities that are most vulnerable.
   b. Ensure that municipalities identify emergency management directors and emergency management coordinators who are qualified to fulfill the duties as required under Title 20 V.S.A. § 6.
   c. Ensure that municipal and regional response plans are in place for large events including community events such as fairs, festivals and sporting events.
   d. Ensure that all municipalities and major employers have flood emergency preparedness, all-hazards preparedness and response plans in place that include a focus on those who are most vulnerable to impacts.
   e. Except in growth areas designated in local and regional plans, discourage new development in identified flood hazard, fluvial erosion and river corridor protection areas.
   f. New development built in flood hazard and river corridor protection areas must not exacerbate flooding and fluvial erosion.
   g. The rate of growth and development should not exceed the ability to provide services including emergency police and medical services.
   h. Support local volunteer efforts and mutual aid agreements during response and recovery efforts.
   i. Utilize Vermont's new Municipal Vulnerability Tool to identify key communities or parts of communities that need additional support to plan for the impacts of climate change.

2. **Reduce infrastructure damage and the financial losses incurred by municipal, residential, industrial, agricultural and commercial establishments due to disasters.**
   a. Support community projects and grant applications that seek to reduce losses from all-hazards events through programs to elevate, relocate or retrofit buildings and infrastructure within flood-prone areas, prioritizing people or communities at greatest risk.
   b. Consider conservation of open space by acquisition of repetitive loss structures.
   c. Identify sites that have limited to zero risk of natural hazards for potential future residential, commercial and industrial development activities.
   d. Promote good construction practices and enforce effective building codes and local ordinances to eliminate structural problems during hazard events.
   e. Ensure facilities such as schools, daycare providers, government, public utilities and public safety facilities are not located in areas identified as being at high risk for natural or manmade disasters.

3. **Ensure the region's communities are resilient to all-hazards events; include hazard mitigation planning, and climate resiliency, in the municipal planning process.**

a. Recognize the connections between land use, stormwater, road design and maintenance as well as how they might be affected by disasters and climate change, and incorporate mitigation into site design and infrastructure planning.
b. Ensure that resiliency measures are compatible with natural features, including floodplains, river corridors, land adjacent to streams, wetlands, and upland forests; historic resources; the character of neighborhoods; and the capacity of the community to implement them.
c. Encourage communities to identify vulnerable areas with known hazards and consider impacts of climate change when planning for future land development.
d. Support the municipal adoption of all-hazards resilience plans (24 V.S.A. Section 4382) and river corridor, flood plain and buffer bylaws.
e. Evaluate land use restrictions within designated flood zones such as no-build zones and prohibition or tie down of buoyant hazardous materials storage tanks.
f. Ensure communities remain in good standing with the National Flood Insurance Program.
g. Protect and restore floodplains and upland forested areas that attenuate and moderate flooding and fluvial erosion.